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Final Feasibility Study

West Lake Landfill Operable Unit-1

Prepared for

The United States Environmental Protection Agency Region VII

Prepared on behalf of

The West Lake Landfill OU-1 Respondents

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EXECUTIVE SUMMARY

This Final Feasibility Study (FFS) for Operable Unit-1 (OU-1) of the West Lake Landfill (the Site) was prepared at the direction of the U.S. Environmental Protection Agency (EPA) to present further evaluations of potential remedial alternatives to address the presence of radiologically impacted materials (RIM) contained within portions of some of the landfill units at the Site. This FFS was prepared in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), relevant EPA guidance documents (including, but not limited to, EPA's 1988 Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA), the EPA's December 9, 2015 Statement of Work (SOW) for the RI Addendum and FFS, and the May 6, 2016 Abbreviated Work Plan for the RI Addendum and FFS.

The Site is a 200-acre, inactive solid waste disposal facility that accepted wastes for on-site landfilling from approximately the 1950s through 2005. OU-1 consists of two landfill disposal areas (Areas 1 and 2) and a 1.78-acre parcel of land known as the Buffer Zone/Crossroad Property where radionuclides have been identified within the soil and solid waste materials. Operable Unit-2 (OU-2) consists of the remainder of the Site, including areas never used for landfilling, several inactive fill areas containing sanitary waste or demolition debris (which were closed prior to state regulation), and a permitted, inactive sanitary landfill (the Bridgeton Landfill). This FFS does not address remedial options for the portions of the Site that comprise OU-2.

RIM at the Site consists of soils containing radium and thorium isotopes intermixed with and interspersed within an overall matrix of municipal solid waste (MSW) and non-radionuclide bearing soil in portions of two areas of the West Lake Landfill. These two areas have been identified as Areas 1 and 2 (Figure ES-1). Disposal of MSW within these areas ended in 1974, at which time MSW disposal was shifted to other portions of the Site. The original discontinuous nature of the placement of soil cover over the top of the uneven surface of the landfill waste during the period of active operations, the use of Site soil and quarry spoil material that did not contain radionuclides above background levels as cover material during the same period of time, and the waste decomposition, consolidation and differential settlement that occurred over the subsequent 40 years has resulted in the occurrences of radionuclides in soil being interspersed and intermixed within portions of the MSW in Areas 1 and 2. In addition, although the Buffer Zone/Crossroad property was never used for landfilling, radionuclides have been documented as being present on this portion of the Site – likely as a result of historical soil erosion from adjacent, sloped portions of Area 2. Additional information regarding the nature and extent of the occurrences of radionuclides and other aspects of the surface and subsurface conditions at the Site can be found in the 2000 Remedial Investigation (RI) and the 2016 RI Addendum.

Consistent with the NCP, a Remedial Investigation (RI) and Feasibility Study (FS) were previously completed for OU-1 and approved by the EPA in 2006. Based on those reports, EPA developed a Proposed Plan for OU-1 and, after an extended public comment process including three public meetings, issued a Record of Decision (ROD) in 2008. The ROD-selected remedy called for containment of the RIM and solid waste materials within a new multi-layered engineered landfill cover system, long-term operation and maintenance and environmental monitoring, and land use controls (including deed restrictions).

In January 2010, EPA directed Respondents to prepare a Supplemental Feasibility Study (SFS) for OU-1 to evaluate two additional potential remedial alternatives. Specifically, EPA directed the OU-1 Respondents to perform an updated engineering and cost analysis of the ROD-selected remedy, and to also conduct a similar analysis of two new alternatives to excavate all RIM in excess of a specified cleanup level from OU-1 and either send the excavated materials to a permitted, out-of-state landfill for disposal ("complete rad removal" with off-site disposal), or re-dispose of the excavated material in a new engineered landfill cell to be built within the boundaries of the Site ("complete rad removal" with on-site disposal)[1].

In December 2015, EPA directed Respondents to perform additional investigation and monitoring and to prepare an addendum to the RI, as well as this FFS, which expands on and augments the prior Supplemental Feasibility Study (SFS) completed in 2011 and the original Feasibility Study (FS) completed in 2006 (both of which were previously reviewed and approved by EPA) and evaluates additional remedial alternatives identified by EPA. Specifically, this FFS provides further evaluation of the containment remedy that was previously evaluated in the original FS and subsequently selected by EPA in 2008 as the remedial action for OU-1, as documented in the ROD (ROD-selected remedy). This FFS also presents additional evaluations of (1) the "complete rad removal" with off-site disposal alternative, which was one of two "complete rad removal" alternatives previously evaluated in the 2011 SFS; (2) a partial excavation alternative that would remove material containing either combined radium or combined thorium activities above 52.9 pCi/g and located within 16 feet of the 2005 topographic surface; and (3) a partial excavation alternative that would remove material containing either combined radium or combined thorium above 1,000 pCi/g, regardless of depth. The option to re-dispose the excavated material in an on-site engineered cell was previously removed from consideration by EPA, and therefore was not presented in the FFS. In accordance with the NCP, this FFS also includes discussion of a No Action Alternative (which operates as a baseline against which all the remedial alternatives are evaluated).

In this FFS, the remedial alternatives are evaluated using the nine criteria set forth in CERCLA and the NCP: two threshold criteria (1) overall protection of human health and the environment and; (2) compliance with applicable or relevant and appropriate requirements of other environmental regulations (ARARs); and five primary balancing criteria including (3) long-term effectiveness and permanence; (4) reduction of toxicity, mobility or volume through treatment; (5) short-term effectiveness; (6) implementability; and (7) cost. The two remaining criteria – State and community acceptance – will be evaluated by EPA as part of any future decision

[1] Although a "complete rad removal" with on-site disposal alternative was evaluated in the SFS, EPA did not require this alternative to be further evaluated in the FFS.

process. In addition to the nine CERCLA/NCP criteria, at EPA's direction the long-term effectiveness and permanence of each remedial alternative was evaluated relative to potential effects of climate change, potential impacts of a tornado, the potential impacts of a subsurface reaction, and potential construction of a thermal isolation barrier. At EPA's direction, environmental justice considerations relative to the long-term effectiveness and permanence of each alternative and potential short-term impacts associated with each remedial alternative were also evaluated.

Overall, the results of the FFS evaluations indicate the following:

1. Protection of Public Health and the Environment

   - All of the remedial alternatives -- the ROD-selected remedy, the "complete rad removal" with offsite disposal alternative, and the two partial excavation alternatives meet EPA's criteria for overall protection of human health and the environment.

   - The No Action alternative is not protective of human health and the environment (see the updated Baseline Risk Assessment (Auxier, 2016)).

2. Compliance with ARARs

   - All of the alternatives, except No Action, would comply with ARARs.

Because the No Action Alternative did not meet the threshold criteria of protection of public health and the environment and compliance with ARARs, it is not discussed as part of the evaluation of the primary balancing criteria below.

3. Long-Term Effectiveness and Permanence

   - With the exception of No Action, all of the remedial alternatives would result in long-term risks below the health risk range that EPA uses to assess the protectiveness of remedial alternatives at Superfund sites (see Table ES-1 and Appendix H).

   - All of the alternatives would rely on engineering measures and institutional controls that have been used and demonstrated as being effective and permanent at numerous municipal solid waste sites and other Superfund sites.

   - The effectiveness of the remedial alternatives is not expected to be significantly impacted by possible climate change or a tornado, and none of the remedial alternatives present adverse impacts or risks if a subsurface heating event were to occur or would be impacted by installation of a thermal isolation barrier, provided that such a barrier was installed prior to or concurrent with implementation of a remedial action.

   - A screening-level analysis did not identify any environmental justice concerns relative to the Site.

4. Reduction in Toxicity, Mobility or Volume Through Treatment

   - Because radionuclides are naturally-occurring elements that cannot be fully modified or destroyed by physical, chemical, or thermal processes, none of the alternatives include treatment technologies that would reduce the toxicity, mobility or volume through treatment as a primary component.

   - The excavation alternatives would reduce the volume of the materials left onsite.

   - All of the alternatives would reduce the mobility of the radionuclides.

5. Short-Term Effectiveness

   - None of the remedial alternatives are expected to pose risks to the general public above EPA's accepted risk range during remedy implementation (Table ES-1).

   - The short-term risks to on-site workers associated with the "complete rad removal" and partial excavation alternatives are projected to exceed EPA's acceptable risk range.

   - The ROD-selected remedy is not expected to pose risks to workers above EPA's generally accepted risk range, whereas, all of the excavation alternatives are projected to expose workers to unacceptable risks from exposure to chemicals; however, these risks may be mitigated through use of personal protective equipment and appropriate health and safety procedures.

   - None of the alternatives are expected to result in radiation doses to workers above the limits established by OSHA and NRC.

   - None of the alternatives are expected to result in measurable, long-term impacts to plants or animals.

   - The time required to achieve the RAOs would be shortest for the ROD-selected remedy, would take twice as long for the 52.9 partial excavation alternative compared to the ROD-selected remedy, three times as long for the 1,000 partial excavation alternative and five times longer for the "complete rad removal" with off-site disposal alternative compared to the ROD-selected remedy.

6. Implementability

   - All of the remedial alternatives are considered to be implementable.

   - The "complete rad removal" and partial excavation alternatives likely will pose a greater potential bird or other wildlife hazard to aircraft and airport facilities than the ROD-selected remedy, because performing the excavation remedies would (1) open up larger areas of the landfilled waste to excavation; (2) require the excavation, handling, and relocation of larger volumes of waste material; and (3) take significantly longer to complete than the ROD-selected remedy.

- The “complete rad removal” and the partial excavation alternatives would require the existing MSW transfer station building to be relocated due to the potential for impact to the structural integrity of the building from excavation of material near the foundation of the building. Relocation of the existing transfer station would require buyout of the asphalt plant lease in order to provide space for the relocated transfer station building

7. Cost

- Of the four remedial alternatives (excluding the No-Action alternative), the cost estimate for the ROD-selected remedy is the lowest, followed by the partial excavation alternatives and then the “complete rad removal” with off-site disposal alternative (Table ES-1).

Table ES-1 summarizes in numerical format the results of the FFS evaluation of long-term risks, short-term risks, time to achieve the remedial action objectives, and the estimated costs of each of the alternatives.

Table ES-1: SUMMARY OF POTENTIAL RISKS, IMPLEMENTATION SCHEDULES AND ESTIMATED COSTS WEST LAKE LANDFILL FFS REMEDIAL ALTERNATIVES

	ROD-Selected Remedy	**52.9 pCi/g to a 16-ft depth Partial Excavation Alternative**	**1,000 pCi/g Partial Excavation Alternative**	**"Complete Rad Removal" with Off-Site Disposal**
Long-term residual cancer risk after 1,000 years	<1 x 10^{-7} (less than 0.1 extra incidence in 1,000,000 people)	<1 x 10^{-7} (less than 0.1 extra incidence in 1,000,000 people)	<1 x 10^{-7} (less than 0.1 extra incidence in 1,000,000 people)	<1 x 10^{-7} (less than 0.1 extra incidence in 1,000,000 people)
Short-term risks during cleanup	On-Site Workers Industrial accidents: 2.8 Cancer risk: 9.2 x 10^{-5} (0.92 extra incidences in 10,000 people) Hazard Index 1.12 Worker dose: 187 mrem/yr	On-Site Workers Industrial accidents: 8.5 Cancer risks: 1.2 x 10^{-3} (12 extra incidences in 10,000 people) Hazard Index 1.12 Worker dose: 720 mrem/yr	On-Site Workers Industrial accidents: 11.7 Cancer risks: 2.4 x 10^{-3} (24 extra incidences in 10,000 people) Hazard Index 1.12 Worker dose: 867 mrem/yr	On-Site Workers Industrial accidents: 17.8 Cancer risks: 2.2 x 10^{-3} (22 extra incidences in 10,000 people) Hazard Index 1.12 Worker dose: 405 mrem/yr
	Community Transportation accidents: 0.61 Cancer risk: <1 x 10^{-7} (less than 0.1 extra incidence in 1,000,000 people) Greenhouse gas emissions: 19,000 tons Waste excavation volume 126,000 bcy	Community Transportation accidents: 10.6 Cancer risks: <1 x 10^{-7} (less than 0.1 extra incidence in 1,000,000 people) Greenhouse gas emissions: 43,000 tons Waste excavation volume 501,000 bcy	Community Transportation accidents: 16.6 Cancer risks: <1 x 10^{-7} (less than 0.1 extra incidence in 1,000,000 people) Greenhouse gas emissions: 53,000 tons Waste excavation volume 825,000 bcy	Community Transportation accidents: 34.9 Cancer risks: <1 x 10^{-7} (less than 0.1 extra incidence in 1,000,000 people) Greenhouse gas emissions: 83,000 tons Waste excavation volume 1,572,000 bcy
Time to reach remedial action objectives	2.7 years	5.9 years	9 years	13.4 years
Estimated Costs	Capital construction: $67,000,000 OM&M per year: $167,000 to $326,000 Present Worth (millions $) Discount rate 7% 1.5% 0% 30 years 64 70 73 200 years 64 77 102 1,000 years 64 78 241	Capital construction: $313,000,000 OM&M per year: $167,000 to $326,000 Present Worth (millions $) Discount rate 7% 1.5% 0% 30 years 265 305 318 200 years 265 312 348 1,000 years 265 312 487	Capital construction: $361,000,000 OM&M per year: $167,000 to $326,000 Present Worth (millions $) Discount rate 7% 1.5% 0% 30 years 275 342 365 200 years 276 349 395 1,000 years 276 350 534	Capital construction: $616,000,000 OM&M per year: $167,000 to $326,000 Present Worth (millions $) Discount rate 7% 1.5% 0% 30 years 420 566 619 200 years 420 573 649 1,000 years 421 573 788

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Figure ES-1

Areas of Landfill Operations

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

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Appendices

List of Acronyms

ACM	asbestos containing materials
AEC	Atomic Energy Commission
ALI	Annual Limits on Intake
amsl	above mean sea level
AOA	Air Operations Area
AOC	Administrative Order on Consent
ARAR	Applicable or Relevant and Appropriate Requirements
ARRA	American Recovery and Reinvestment Act
ASAOC	Administrative Settlement Agreement and Order on Consent
bcy	bank cubic yard
BDAT	Best Demonstrated Available Technology
bgs	below ground surface
Bi	Bismuth
BMP	Best Management Practice
BNSF	Burlington Northern Santa Fe
BRA	Baseline Risk Assessment
CCDF	Conditional cumulative density function
CCL	Compacted clay/silt liner
C&D	Construction and demolition
CERCLA	Comprehensive Environmental Recovery, Compensation, and Liability Act
cf	cubic feet
CFR	Code of Federal Regulations
cm	centimeter
CM	Construction Manager
cm/sec	centimeter per second
COCs	Chemicals of concern
COPC	Constituent of Potential Concern
CQAO	construction quality assurance officer
CSR	Code of State Regulations
cy, or cu yd	cubic yard
DAC	Derived air concentration
DCGL	Derived concentration guideline level
DOD	Department of Defense
DOE	United States Department of Energy
DOT	United States Department of Transportation
DQO	data quality objective
dtrs	daughters
EDTA	ethylenediaminetetraacetic acid
EJ	Environmental Justice
EMSI	Engineering Management Support, Inc.
ENRCCI	Engineering News Record Construction Cost Index
E.O.	Executive Order
EPA	United States Environmental Protection Agency

List of Acronyms (continued)

FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FS	Feasibility Study
FFS	Final Feasibility Study
FUSRAP	Formerly Utilized Sites Remedial Action Program
ft	feet
GCL	Geosynthetic clay liner
gm, or g	gram
GRA	General Response Action
HAZMAT	Hazardous Materials
HDPE	high density polyethylene
HEB	Heat extraction barrier
HP	health physicist
hr	hour
IB	Isolation barrier
IBAA	IB Alternatives Analysis
IC	Institutional Control
IK	Indicator kriging
IM	Intermodal
INEEL	Idaho National Engineering and Environmental Laboratory
IP	industrial packaging
K	Potassium
kg	kilogram
L	liter
LAACC	Large Area Activated Charcoal Canisters
LBSR	Leached barium sulfate residues
lbs	pounds
lcy	loose cubic yard
LDR	Land Disposal Restrictions
LFMR	Landfill mining and reclamation
Li	Lithium
LLRW	Low level radioactive waste
LoMR	Letter of Map Revision
LPGAC	Liquid Phase Granular Activated Carbon
LSA	low specific activity
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCL	Maximum contaminant level
MCLG	MCL goal
MDNR	Missouri Department of Natural Resources
MDOT	Missouri Department of Transportation
MDWTP	Michigan Disposal Waste Treatment Plant
MECA	Missouri Environmental Covenants Act
MED	Manhattan Engineering District

List of Acronyms (continued)

MeV	Million electron volts
m	meter
mg	milligram
mm	millimeter
mo `	month
MOU	Memorandum of Understanding
Mrem	millirem
MSD	Metropolitan St. Louis Sewer District
MSW	Municipal solid waste
MSWLF	Municipal Solid Waste Landfill
N	Nitrogen
Na	Sodium
NARM	NORM and Accelerator – Produced Radioactive Material
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NMOC	non-methane organic compound
NORM	Naturally occurring radioactive material
NPL	National Priorities List
NRC	Nuclear Regulatory Commission
NS	Norfolk Southern
O	Oxygen
O&M	operation and maintenance
OM&M	operation, maintenance, and monitoring
OSHA	Occupational Safety and Health Administration
OSR	Off-Site Rule
OSTRI	Office of Superfund Technology Research and Innovation
OU	Operable Unit
Pb	Lead
PCB	Poly-chlorinated biphenyl
pCi	pico Curie
PFLT	Paint Filter Liquids Test
Po	Polonium
POTW	Publicly-Owned Treatment Works
PPE	Personal protective equipment
PRG	preliminary remediation goal
RA	Remedial action
Ra	Radium
RACM	Regulated asbestos-containing material
RAGS	Risk Assessment Guidance for Superfund
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RDWP	Remedial Design Work Plan

List of Acronyms (continued)

RG	Remediation Goal
RI	Remedial Investigation
RIM	Radiologically Impacted Material
RMC	Radiation Management Corporation
RML	radioactive material license
ROD	Record of Decision
RSMo	Revised Statutes of Missouri
RTO	Regenerative Thermal Oxidation
SAP	Sampling and Analysis Plan
sec, or s	second
SEC	Securities and Exchange Commission
sf or sq ft	square feet
SFS	Supplemental Feasibility Study
SGS	Segmented gate system
Si	Silicon
SLAPS	St. Louis Airport Site
SLDS	St. Louis Downtown Site
SOW	Statement of Work
SSE	Subsurface Smoldering Event
SSPA	S.S. Papadopoulos & Associates
SSR	Subsurface reaction
STLAA	St. Louis Airport Authority
SVOC	Semi-Volatile Organic Compound
SWMP	Solid Waste Management Program
SWPP	Stormwater Pollution Prevention Plan
t	ton
TAL	Target Analyte List
TBC	To-be-considered
TC	Toxicity Characteristic
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total dissolved solids
TEDE	Total Effective Dose Equivalent
TENORM	Technologically Enhanced Naturally Occurring Radioactive Materials
Th	Thorium
TPH	Total Petroleum Hydrocarbons
TSCA	Toxic Substances Control Act
TSDF	Treatment, storage, and disposal facility
U	Uranium
µg	microgram
UMTRCA	Uranium Mill Tailings Radiation Control Act
Unat	Natural Uranium
µR/hr	microRoentgens/hr
U.S.C.	United States Code
USACOE	United States Army Corps of Engineers

List of Acronyms (continued)

USDA	United States Department of Agriculture
USEI	US Ecology Idaho
UTS	Universal Treatment Standards
VCA	verification of current acceptability
VOCs	Volatile Organic Compounds
WAC	Waste Acceptance Criteria
WL	Working Level
yr	Year

1 INTRODUCTION

In an October 9, 2015 letter to Cotter Corporation (N.S.L.), Laidlaw Waste Systems (Bridgeton) (n/k/a Bridgeton Landfill, LLC) and Rock Road Industries and the U.S. Department of Energy (Federal Respondent), collectively, the West Lake Landfill Operable Unit-1 (OU-1) Respondents ("Respondents" or "OU-1 Respondents"), the United States Environmental Protection Agency (EPA) informed Respondents that additional work was necessary to accomplish the objectives of the Remedial Investigation/Feasibility Study for OU-1 (EPA, 2015a). EPA also provided a Statement of Work (subsequently revised on December 9, 2015) (EPA SOW) (EPA, 2015b) that identified the additional work that needed to be performed, including preparation of a Final Feasibility Study (Final FS or FFS). In accordance with the EPA SOW, the OU-1 Respondents prepared an Abbreviated Work Plan for a Remedial Investigation Addendum and Final Feasibility Study (RI Addendum/FFS Work Plan) (EMSI, 2016a) that was approved by EPA on May 18, 2016 (EPA, 2016a). On behalf of the OU-1 Respondents, Engineering Management Support, Inc. (EMSI) has prepared this FFS to address the requirements set forth in the EPA SOW as further described in the RI Addendum/FFS Work Plan.

1.1 Background

The West Lake Landfill Site (the Site) is located within the western portion of the St. Louis metropolitan area on the east side of the Missouri River. The Site has an address of 13570 St. Charles Rock Road, Bridgeton Missouri. The Site consists of an approximately 200-acre parcel of land that includes six identified waste disposal areas or units, including Radiological Area 1 (Area 1), Radiological Area 2 (Area 2), a closed demolition landfill, an inactive sanitary landfill, and the North Quarry and South Quarry portions of the permitted Bridgeton Landfill. These six identified areas were used for solid and industrial waste disposal from approximately the 1950s through 2004.

The areas of the West Lake Landfill where radiologically-impacted materials (RIM) are present have been designated by EPA as OU-1. The radionuclides within OU-1 include materials generated by the Manhattan Engineering District (MED) and Atomic Energy Commission (AEC) activities resulting from extraction and concentration of uranium from various ores, as further described in the RI Addendum (EMSI, 2016b). OU-1 comprises Radiological Area 1 and Radiological Area 2 (or more simply as Area 1 and Area 2). In addition to RIM, these two areas also contain municipal solid waste (MSW), industrial waste and construction and demolition (C&D) debris, which may contain other non-radionuclide constituents such as trace metals and volatile organic compounds (VOCs) typically found in MSW landfills. OU-1 also includes a 1.78-acre parcel of land adjacent to Area 2 known as the Buffer Zone. Although the Buffer Zone has never been used for landfilling, RIM has been documented to be present on this parcel of land as well. Investigations and evaluations of non-radioactive constituents in other parts of the Site outside of Areas 1 and 2 are being performed by Bridgeton Landfill, LLC under a separate operable unit (OU-2) RI/FS.

In 1990, EPA listed the Site on the National Priorities List (NPL) under the Comprehensive Environmental, Response, Compensation and Liability Act of 1980 (CERCLA). EPA designated Areas 1 and 2 as OU-1 and the remainder of the Site as OU-2. In 2016, EPA publicly announced that it will be designating a third operable unit, OU-3, to address groundwater conditions at the Site.

In accordance with a 1993 Administrative Order on Consent (AOC) (EPA, 1993a), and over the period from 1994 to 2008, the OU-1 Respondents conducted numerous Site investigations that included the collection and analysis of waste/soil samples and monitoring of the quality of surface water, sediment, groundwater and air at the Site. During this same time period, the OU-1 Respondents also performed numerous evaluations and prepared various comprehensive reports, including a Remedial Investigation (RI) report (EMSI, 2000), a Baseline Risk Assessment (BRA) report (Auxier & Associates, Inc. 2000), and a Feasibility Study (FS) report (EMSI, 2006). These studies and evaluations were considered by EPA in the development of a Proposed Plan for OU-1 (EPA, 2006a) and the subsequent selection of a remedial action as described in the Record of Decision (ROD) for OU-1 (EPA, 2008).

After issuance of the ROD, and as a result of internal deliberations and further consideration of certain comments provided by interested community members, EPA determined in 2010 that additional investigation was warranted, and instructed the OU-1 Respondents to perform a Supplemental Feasibility Study (SFS) (EPA, 2010). Work on the implementation of the ROD Remedial Design Work Plan and negotiation of the associated Consent Decree was accordingly suspended while the OU-1 Respondents performed the necessary evaluations and prepared the SFS report (EMSI et al., 2011) to assess potential remedial alternatives for removal of the RIM from the Site. EPA also requested, and the OU-1 Respondents performed, additional environmental monitoring of groundwater (EMSI, 2012a, 2013a, 2013b and 2014a) and air quality (Auxier and EMSI, 2016a, 2016b, and 2016c), as well as additional characterization of Areas 1 and 2 (including additional drilling, logging, sampling and laboratory analyses). The additional site data were incorporated into an RI Addendum (EMSI, 2016b) and updated BRA (Auxier & Associates, Inc. 2016a).

In the EPA SOW, EPA stated that the FFS shall be a comprehensive document incorporating the elements of and updating as appropriate the June 2006 FS (EMSI, 2006) and the 2011 SFS (EMSI et al., 2011). The FS evaluated six containment (capping) alternatives that were considered in EPA's selection of a containment remedy for OU-1 as documented in the OU-1 ROD (EPA, 2008). The SFS evaluated two "complete rad removal" alternatives: excavation of the RIM and offsite disposal, and excavation and disposal of the RIM in a new engineered landfill cell at the Site. The SFS also included additional evaluation of the ROD-selected remedy, including more detailed estimates of the potential risks, costs, and schedule commensurate with the level of additional detail developed for the excavation alternatives.

1.2 ROD-Selected Remedy

A description of and reasons for selection of the final remedy for the Site are presented in EPA's ROD for OU-1 (EPA, 2008). In particular, EPA reached the following conclusions:

- The ROD-selected containment remedy for OU-1 would protect human health and the environment by providing source control and institutional controls for the landfilled waste materials.

- The source control and institutional control methods would prevent human receptors from contacting the waste material.

- The source control method would mitigate contaminant migration to air and restrict infiltration of precipitation into the landfill, which contributes to protection of groundwater quality.

The components of the ROD-selected remedy include the following:

1. Installation of landfill cover meeting the Missouri closure and post-closure care requirements for sanitary landfills, including enhancements consistent with the standards for uranium mill tailing sites, *i.e.*, armoring layer and radon barrier;
2. Consolidation of radiologically contaminated surface soil from the Buffer Zone/Crossroads Property to the containment area;
3. Application of groundwater monitoring and protection standards consistent with requirements for uranium mill tailing sites and sanitary landfills;
4. Surface water runoff control;
5. Gas monitoring and control, including radon and decomposition gas as necessary;
6. Institutional controls to prevent land and resource uses that are inconsistent with a closed sanitary landfill site containing long-lived radionuclides; and
7. Long-term surveillance and maintenance of the remedy.

Performance standards for each of the remedy components are described in Section 12 of the ROD.

Subsequent discussions between EPA Region 7 and EPA's Office of Superfund Remediation and Technology Innovation (OSRTI) identified the following additional performance standards for the ROD-selected remedy:

- The proposed cover should meet Uranium Mill Tailings Remediation Control Act (UMTRCA) guidance for a 1,000-year design period including an additional thickness as necessary to prevent radiation emissions.

- Air monitoring stations for radioactive materials should be installed at both on-site and off-site locations.

- Groundwater monitoring should be implemented at the waste management unit boundary and also at off-site locations. The groundwater monitoring program needs to be designed so that it can be determined whether contaminants from the Site have migrated across the waste management unit boundary (i.e., the boundary of OU-1) in concentrations that exceed drinking water Maximum Contaminant Levels (MCLs). The groundwater monitoring program needs to measure for both contaminants that have historically been detected in concentrations above MCLs (e.g., benzene, chlorobenzene, dissolved lead, total lead, dissolved arsenic, total arsenic, dissolved radium and total radium) and broader indicators of contamination (*e.g.*, redox potential, alkalinity, carbonates, pH and sulfates/sulfides).

- Flood control measures at the Site should meet or exceed design standards for a 500-year storm event under the assumption that the existing levee system is breached.

These items were addressed through performance of additional evaluations and additional monitoring as described below.

The SFS analysis incorporated these additional performance standards and refined the description and evaluation of the containment remedy that was selected in the ROD to document that the proposed measures were designed to be protective for projected increases in both gamma radiation and radon emissions anticipated to occur over the next 1,000 years.
EPA implemented a program of offsite air quality monitoring in 2014 and 2015 (TetraTech, 2014, 2015a, 2015b, 2015c, 2015d and 2015e). A comprehensive program for monitoring air quality around the perimeter of Areas 1 and 2 was implemented in 2015 (Auxier and EMSI, 2014) and continues to be conducted through the date of this FFS. The results of this air monitoring are presented in various quarterly monitoring reports (Auxier and EMSI, 2016a, 2016b, and 2016c) and were described in the RI Addendum (EMSI, 2016b).

Four comprehensive, Site-wide groundwater monitoring events were conducted in 2012-2013. The results of the additional groundwater monitoring activities are presented in various monitoring reports (EMSI, 2012a, 2013a, 2013b and 2014a) and also in the RI Addendum (EMSI, 2016b).

Additional measures to prevent impacts in the unlikely event of flooding were also included as part of the additional evaluation of the ROD-selected remedy; however, it should be noted that subsequent evaluations by the Federal Emergency Management Agency (FEMA) have determined that Areas 1 and 2 are located outside of the Missouri River floodplain.

1.3 Scope of the FFS

This FFS has been prepared to provide additional evaluation of a select group of potential remedial alternatives for OU-1 specified by EPA in the SOW, as described below. The FFS also addresses various additional evaluations identified by EPA in the EPA SOW, and which are further set forth in the RI/FFS Work Plan.

1.3.1 Remedial Alternatives

The EPA SOW and the RI/FFS Work Plan identified six remedial alternatives to be evaluated in the FFS:

1. No Action (2006 FS Former Alternative L1)– Required by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and RI/FS guidance to provide a baseline against which all of the other alternatives are evaluated;

2. Partial Excavation 1,000 picoCuries/gram (pCi/g) (2006 FS Former Alternative L6 and Alternative F4) – Excavation of all soil/waste containing combined radium (radium-226 plus radium-228) or combined thorium (thorium-230 plus thorium-232) with activity levels greater than 1,000 pCi/g;

3. Partial Excavation 52.9 pCi/g to 16 feet bgs – Excavation of all soil/waste containing combined radium or combined thorium with activity levels greater than 52.9 pCi/g down to a total depth of 16 feet beneath the 2005 topographic surface;

4. Partial Excavation Based on Expected Land Use – Partial excavation of all soil/waste containing combined radium or combined thorium with activity levels greater than a risk-based level to be developed based on the reasonably anticipated future land use of the Site;

5. Full Excavation with Offsite Disposal ("complete rad removal") – Excavation of all soil/waste containing combined radium or combined thorium with activity levels greater than 7.9 pCi/g; and

6. 2008 ROD-Selected Remedy (2006 FS Former Alternative L4 and Alternative F4) – Containment consisting of regrading and installation of a new landfill cover and other remedial components for the landfill, as described in Section 1.2, and consolidation of any radiologically-impacted soil that may remain on the former Ford Property (now known as the Buffer Zone and Crossroads Lot 2A2) into the containment areas in Area 1 and 2 prior to placement of additional fill and construction of the new landfill cover.

The EPA definition (EPA, 2010) of the "complete rad removal" alternative is based on the unrestricted land use criteria for combined radium and combined thorium activities as specified in OSWER Directives No. 9200-4.18 and 9200-4.25 (EPA, 1997a and 1998). Although uranium is a contaminant of concern at the Site, uranium was not found to be a driver for identification of RIM, because any locations/depth intervals that contained uranium above its criterion for "complete rad removal" (54.5 pCi/g) also contained radium and/or thorium activity levels greater than their respective criteria for unrestricted land use. In addition, no uranium equivalent criteria were identified by EPA for the partial excavation alternatives. Therefore, these alternatives are based solely on the combined radium and combined thorium activity levels. As noted above, use of the combined radium and combined thorium activity levels to define the materials to be included in the scope of the partial excavation alternatives should also result in inclusion of any materials with commensurate uranium activity.

1.3.2 Additional Evaluations Required by the SOW

The EPA SOW required (and the RI/FFS Work Plan describes) various additional engineering and other types of evaluations to be performed as part of the FFS.

1.3.2.1 Additional Technology Evaluations

The EPA SOW requires additional evaluations of several technologies, including:

- Volume separation techniques and other physical and/or chemical treatment technologies as they relate to partial and full excavation alternatives;
- Evaluation of the long-term effectiveness of proposed landfill caps/covers in addressing both humid region conditions and long-term shielding of the RIM;
- Evaluation of the long-term effectiveness of a landfill cap/cover on potential migration of chemicals-of-concern (COCs) to leachate and groundwater;
- Evaluation of apatite/phosphate based treatment technologies as appropriate to solid matrices[1]; and
- Additional evaluation of potential technologies to control bird populations based on the methods described in the draft Bird Mitigation Plan (LGL, Ltd., 2015) as part of the Isolation Barrier Alternatives Assessment (EMSI et. al., 2014a and EMSI, 2015a).

1.3.2.2 Other Additional Evaluations

The EPA SOW required several other additional evaluations to be performed as part of the FFS, including the following:

[1] Evaluation of these technologies relative to possible groundwater applications may be further considered and/or implemented under the pending new operable unit, OU-3.

- Discussion and consideration of the occurrence of an exothermic subsurface reaction (SSR)[2] and evaluation of an Isolation Barrier (IB), including a brief discussion of pending/ongoing IB-related design and field work;

- Acknowledgement of any environmental justice concerns;

- Updates to the evaluation of potentially applicable or relevant and appropriate requirements of other environmental regulations (ARARs), and in particular, additional detailed assessment of the requirements associated with the UMTRCA and the Resource Conservation and Recovery Act (RCRA) Subtitle C landfill cover design requirements as appropriate;

- Discussion of climate change and vulnerabilities associated with extreme weather events (such as potential impacts associated with possible flooding or tornadoes) and any system vulnerabilities to potential climate change in accordance with EPA's "Climate Change Adaptation Technical Fact Sheet: Landfills and Containment as an Element of Site Remediation (EPA, 2014a) and the EPA Region 7 Climate Change Adaption Implementation Plan (EPA, 2014b); and

- Potential impacts of an SSE within OU-1 and the effects of an IB on the remedial alternatives presented in this FFS.

The EPA SOW also requires the FFS to include information associated with (and results of) the following studies that have been performed by the Respondents since 2006 (including revisions made to these documents based upon EPA comments):

- Supplemental Feasibility Study (EMSI et al., 2011);

- Discount Rates and Cost Estimates Evaluation (EMSI, 2014b and 2013c);

- Phase 1 RIM Investigation (EMSI et al., 2016a);

- Area 1 and Area 2 Additional Characterization (EMSI, 2015b);

- Alternate Cover Designs Evaluation (EMSI, 2015c and 2014c);

- Partial Excavation Alternatives (EMSI, 2014d, 2015d, and 2015e);

- Evaluation of the Use of Apatite/Phosphate Treatment Technology (EMSI, 2013d);

[2] This reaction has previously been called a "subsurface smoldering event" (SSE). However, the current understanding of the reaction is that it is occurring within saturated landfill materials in the absence of oxygen, which indicates that it is not the result of a fire or smoldering (combustion). Accordingly, current references are to an "SSR," or subsurface reaction, rather than the prior SSE terminology.

- Evaluation of Possible Effects of a Tornado on Integrity of the ROD Selected Remedy (EMSI, 2013e and 2013f);
- Evaluation of Risks Associated with Subsurface Smoldering Events (EMSI, 2014d and 2013g);
- Radon Flux Calculations (Auxier and EMSI, 2016d); and
- Bird Mitigation Analysis (LGL, Ltd, 2015).

1.3.3 NCP Required Evaluations of Remedial Alternatives

All of the remedial alternatives are to be evaluated using the threshold and primary balancing criteria set forth in the NCP, 40 CFR § 300.430 (EPA, 2009a). These criteria include the following:

- Threshold Criteria:
  - Overall Protection of Human Health and the Environment; and
  - Compliance with ARARs.
- Primary Balancing Criteria:
  - Long-term Effectiveness and Permanence;
  - Reduction of Toxicity, Mobility, or Volume through Treatment;
  - Short-term Effectiveness;
  - Implementability; and
  - Cost.

These evaluations have been performed in this FFS consistent with the requirements set forth in the NCP and EPA's RI/FS guidance (EPA, 1988a) using the same methodologies that were previously used and described in the SFS and FS reports (EMSI et al., 2011 and EMSI, 2006). Additional descriptions of these criteria are presented in Section 6 of this FFS.

The NCP also requires remedial alternatives to be evaluated in terms of "Modifying Criteria," which include State and community acceptance. State acceptance will be evaluated by EPA based on comments and feedback provided by the Missouri Department of Natural Resources (MDNR) on the FFS and subsequent Proposed Plan. State and community acceptance will be evaluated by EPA as part of any decision process that may be undertaken by EPA after completion of the FFS and are not considered in this document.

A comparative analysis of the results of the evaluations of the alternatives against the No Action alternative was also performed. The relative performance of each of the alternatives was evaluated against the performance of the other alternatives for each of the threshold and primary balancing criteria during the comparative analysis. This comparative analysis is intended to identify the advantages and disadvantages of each alternative.

1.4 FFS Approach

This FFS has been developed pursuant to a October 9, 2015 letter from EPA to the OU-1 Respondents (EPA, 2015a), the EPA SOW (EPA, 2015b), and the EPA-approved Abbreviated Work Plan for an RI Addendum and FFS (EMSI, 2016a). This report has been prepared to address the requirements of the EPA SOW, EPA-approved Work Plan, and the NCP, in accordance with EPA's Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, OSWER Directive 9355.3-01 (EPA, 1988a), "Guidance for Data Useability in Risk Assessment", OSWER Directive 9285.7-09A (April 1992) (EPA, 1992a), "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination," OSWER Directive 9200.4-18, (August 1997) (EPA, 1997a), "Clarification of the Role of Applicable, or Relevant and Appropriate Requirements in Establishing Preliminary Remediation Goals under CERCLA," OSWER Directive 9200.4-23, (August 1997) (EPA, 1997b), "Use of Soil Cleanup Criteria in 40 CFR Part 192 as Remediation Goals for CERCLA Sites," OSWER Directive 9200.4-25 (February 1998) (EPA, 1998), "Remediation Goals for Radioactively Contaminated CERCLA Sites Using the Benchmark Dose Cleanup Criteria in 10 CFR Part 40 Appendix A, I, Criterion 6(6)," OSWER Directive 9200.4-35P (April 2000) (EPA, 2000a), and other EPA FS-related guidance documents (*e.g.*, EPA, 1991a and EPA, 2000b).

This FFS includes:

- A summary discussion of Site conditions and other information presented in the RI Addendum for OU-1 (EMSI, 2016b), including addressing the findings in United States Nuclear Regulatory Commission (NRC) reports (NRC, 1988 and RMC, 1982 and 1981) that evaluated the radiological disposal areas at the West Lake Landfill Site;

- The nature and extent of RIM in Areas 1 and 2 and the Buffer Zone/Crossroads Property and information regarding the occurrence of non-radiological hazardous substances in Areas 1 and 2;

- A summary of the characterization of potential Site risks presented in the updated BRA for OU-1 (Auxier, 2016a);

- Further information and evaluation pertaining to a negative easement on the property held by the City of St. Louis, and its potential impacts on remedy implementation for OU-1;

- Additional information about environmental monitoring during remedy implementation and long-term maintenance and operations;

- Evaluation of potential treatment technologies for the RIM; and

- Evaluation of potential ARARs and remedial technologies, descriptions of the six remedial alternatives to be evaluated, evaluation of the six alternatives using the threshold and primary balancing criteria, and a comparative analysis of the alternatives.

Where necessary for the evaluation of the alternatives, or as otherwise appropriate for completion of the FFS, brief summaries or tabulations of the results of prior Site evaluations are provided; however, the prior reports should be reviewed or consulted for additional details and specific information relative to those evaluations.

1.5 Report Organization

This report is organized as follows:

Section 1: Introduction – Presents information regarding the scope and approach used to complete the FFS.

Section 2: Site Conditions – Summarizes information regarding Site conditions as they relate to the alternatives evaluated in the FFS. Detailed information about Site conditions was presented in the [draft] RI Addendum report for OU-1 (EMSI, 2016b) and a summary discussion of Site conditions related to the development and evaluation of remedial alternatives was presented in the FS and SFS reports for OU-1 (EMSI, 2006 and EMSI et al., 2011). This section provides a description of occurrences of radionuclides in soil/waste, air, surface water, sediment, and groundwater at the Site. In addition, this section describes the nature, general locations, and overall lateral and vertical extent of RIM. This section also provides a summary of the occurrences of chemical constituents in soil/waste and groundwater. Finally, this section provides a brief summary of the results of the updated BRA (Auxier, 2016a).

Section 3: ARARs – Summarizes information regarding potential ARARs and remedial action objectives (RAOs) as they relate to the remedial alternatives evaluated in the FFS. Additional, detailed information about potential ARARs and RAOs was presented in the FS and SFS reports (EMSI, 2006 and EMSI et al., 2011).

Section 4: Remedial Technologies – Summarizes information regarding additional remedial technologies that may be potentially applicable to the partial excavation and “complete rad removal” alternatives evaluated in the FFS. Additional, detailed information about potentially applicable technologies was presented in the FS and SFS reports (EMSI, 2006 and EMSI et al., 2011).

Section 5: Remedial Alternatives – Provides descriptions of the partial excavation alternatives, the “complete rad removal” with off-site disposal alternative, and the ROD-selected remedy alternative that are the subject of the detailed evaluations presented in Sections 6 and 7. Descriptions of other remedial alternatives previously developed and evaluated for OU-1 that were not included in the list of alternatives identified by EPA for evaluation in this FFS were presented in the FS and SFS reports (EMSI, 2006 and EMSI et al., 2011) and are not repeated in this FFS report.

Section 6: Detailed Analysis of Alternatives – Presents a detailed analysis of the six remedial alternatives relative to the threshold and balancing criteria defined by the NCP.

Section 7: Comparative Analysis of Alternatives – Presents a summary comparison of the six remedial alternatives in terms of the threshold and balancing criteria defined by the NCP.

Section 8: References – Provides a list of references cited in this report.

This FFS also includes the following appendices:

Appendix A: Existing Institutional Controls, City of St. Louis Negative Easement and Restrictive Covenant on West Lake Landfill, and FAA ROD, MOU and Advisories
Appendix B: Estimated Three-Dimensional Extent of Radiologically Impacted Material
Appendix C: Off-site Disposal Facilities – Waste Acceptance Criteria
Appendix D: Evaluation of the Use of Apatite/Phosphate Treatment Technologies
Appendix E: Technical Memorandum: Evaluation of Potential "Hot Spot" Occurrences and Removal of Radiologically-Impacted Soil
Appendix F: Cover Thickness Calculations
Appendix G: Conceptual Bases for Costs of Occupational and Environmental Monitoring Associated with Each Remedial Alternative
Appendix H: Evaluation of Potential Risks Associated with the Proposed Remedial Alternatives
Appendix I: Estimated Greenhouse Gas Emissions Associated with the Alternatives
Appendix J: Estimated Project Schedules for the Remedial Alternatives
Appendix K: Estimated Costs for the Remedial Alternatives
Appendix L: RIM Average Activity Levels
Appendix M: Excavation and Final Grading Plans.

2 SITE CONDITIONS

The purpose of this Section 2 is to provide information necessary to support the evaluation of remedial technologies and alternatives presented in Sections 4, 6, and 7. This section summarizes the site conditions at the West Lake Landfill. It is divided into five subsections:

- Section 2.1 provides information regarding the Site and the surrounding area, including discussions and/or descriptions of historical landfill operations and disposal areas; Superfund Operable Units (OUs) on the Site; current Site uses; Site zoning, use restrictions and easements; surrounding land uses; and proximity to the Missouri River floodplain.

- The nature and extent of radionuclide occurrences in OU-1 are discussed in Section 2.2, including the source of the radionuclides; general locations of RIM in Areas 1, 2, and the Buffer Zone/Crossroads Property; lateral and vertical extent of RIM; estimated volume of RIM; radiological characterization of the RIM in Areas 1 and 2; projected radionuclide decay and in-growth of the RIM; and the evaluation of principal threat wastes. Section 2.2 also includes information regarding the occurrence of non-radiological hazardous substances (trace metals, petroleum hydrocarbons, volatile and semi-volatile organics, pesticides and PCBs) in soil samples collected from Areas 1 and 2, as well as discussions regarding the potential for occurrences of hazardous wastes and asbestos-containing materials in the landfill matrix.

- The presence of radionuclides in air is discussed in Section 2.3.

- Occurrences of radionuclides in stormwater, surface water and sediment are discussed in Section 2.4.

- Brief descriptions of the Site geology and hydrogeology and the nature and extent of radionuclide and chemical occurrences in groundwater near Areas 1 and 2 are provided in Section 2.5.

- Finally, Section 2.6 includes summaries and conclusions from the baseline human health and screening-level ecological risk assessments.

2.1 Site Location and Surrounding Area

The West Lake Landfill Superfund Site is located within the western portion of the St. Louis metropolitan area on the east side of the Missouri River (Figure 2-1). The Site is located approximately one mile north of the intersection of Interstate 70 and Interstate 270 within the city limits of the City of Bridgeton in northwestern St. Louis County. The Site has an address of 13570 St. Charles Rock Road, Bridgeton, Missouri.

The Site is bounded to the north and east by St. Charles Rock Road (State Highway 180) and by the Crossroads Industrial Park to the northwest (Figures 2-2 and 2-3). Taussig Road, commercial properties, and agricultural land are located to the southeast. The Site is bounded to the southwest by Old St. Charles Rock Road (now vacated) and the Earth City Industrial Park (Earth City) stormwater/flood control pond. The Earth City commercial and industrial complex continues to the west and north of the flood control pond and extends from the Site to the Missouri River. Earth City is separated from the river by an engineered levee system owned and maintained by the Earth City Flood Control District.

The Site is divided into six areas:

- Radiological Area 1, which is adjacent to (and in part overlain by) waste material within the North Quarry portion of the Bridgeton Landfill;
- Radiological Area 2;
- The Closed Demolition Landfill;
- The Inactive Sanitary Landfill;
- The Bridgeton Landfill (including the North Quarry portion and the South Quarry portion); and
- The Buffer Zone.

These areas are discussed further below.

2.1.1 Historic Landfill Operations and Disposal Areas

The West Lake Landfill Superfund Site is an approximately 200-acre parcel of land containing multiple areas of differing past operations. The Site was used agriculturally until a limestone quarrying and crushing operation began in 1939. The quarrying operation continued until 1988 and resulted in shallow excavation areas and two quarry pits, the North Quarry Pit and the South Quarry Pit (Figure 2-3), which were excavated to maximum depth of 240 feet below ground surface (bgs) (Herst & Associates, 2005). The relationship between the quarries and Area 1 is shown on Figure 2-3.

The Site contains several areas where solid wastes have been disposed. The date on which landfilling activities started at the West Lake Landfill is not known with certainty and has been variously cited as beginning in or around the early 1950s (EMSI, 2000), or as starting in 1952 or possibly 1962 (Herst & Associates, 2005). The Site was not officially permitted for use as a sanitary landfill until 1952. EPA has reported that "from 1941 through 1953 it appeared that limestone extraction was the prime activity at the facility; however, as time passed the focus of the activity appeared to shift to waste disposal" (EPA, 1989). EPA has reported that historical aerial photography from 1953 indicates use of a landfill had commenced (EPA, 1989). Mine spoils from quarrying operations were deposited on adjacent land immediately to the west of the quarry (Herst & Associates, 2005). Portions of the quarried areas and adjacent areas were subsequently used for landfilling municipal refuse, industrial solid wastes and construction and demolition debris. EPA has reported that liquid wastes and sludges were also disposed of at the

Site (EPA, 1989). These operations, which predated state and federal laws and regulations governing such operations, occurred in areas that subsequently have been identified as Area 1, Area 2, the Closed Demolition Landfill, and the Inactive Sanitary Landfill (Figure 2-3).

The early landfilling activities at the Site (prior to 1974) were not subject to state permitting (although they were still subject to an authorization issued by the county), and the portion of the Site where these activities occurred has been referred to as the "unregulated landfill." Waste disposal in St. Louis County was regulated solely by county authorities until 1974, when the Missouri Department of Natural Resources (MDNR) was formed. Landfill activities conducted after 1974 were subject to permits obtained from the Missouri Department of Natural Resources (MDNR).

Additional discussion of the history of landfill operations, including a discussion of permitted disposal operations at the Site, is presented in Section 3.3 of the RI Addendum (EMSI, 2016b).

2.1.2 Superfund Operable Units

Superfund-program remedial action at the Site is currently divided into two operable units (OUs). OU-1 includes the solid wastes and RIM disposed in Areas 1 and 2. Area 1, which encompasses approximately 17.6 acres, is located immediately to the southeast of the Site entrance. Area 2, which encompasses approximately 47.8 acres, is located in the northwestern part of the Site. On the west side of Area 2 is the property referred to in the OU-1 RI (EMSI, 2000) as the Ford Property because it was previously owned by Ford Motor Credit, Inc. In 1998, the majority of the Ford Property was sold to Crossroad Properties, LLC and has since been developed into the Crossroads Industrial Park. Ford initially retained the 1.78 acres immediately adjacent to the western boundary of Area 2, but subsequently transferred ownership of this parcel of land to Rock Road Industries, Inc. in order to provide a buffer between the Site and the adjacent property, and therefore this parcel has been identified as the Buffer Zone (Figure 2-3). Due to the presence of radionuclides in surface soils, the Buffer Zone is also included as part of OU-1.

OU-2 consists of the other landfill areas at the Site that are not impacted by radionuclides, including the Inactive Sanitary Landfill located adjacent to Area 2, the Closed Demolition Landfill, and North and South Quarry portions of the Bridgeton Landfill. OU-2 also includes a surface water retention pond, abandoned leachate lagoons, a closed leachate retention pond, a former soil borrow area, a current soil stock pile area, a current stormwater retention basin, and an active leachate treatment facility associated with the Bridgeton Landfill. The Closed Demolition Landfill and the Bridgeton Landfill, while designated as part of OU-2, are regulated by the MDNR pursuant to State of Missouri solid waste regulations and are not being actively addressed by EPA. To the extent that the presence of, or activities associated with, these OU-2 areas potentially impact OU-1 and the remedial alternatives considered by this FFS, those impacts are discussed in the appropriate FFS sections.

OU-1 Area 1 is situated on the northern and western slopes of a topographic high within the overall Site. Ground surface elevation in Area 1 varies from 490 feet above mean sea level (AMSL) on the south side of Area 1 to 452 feet AMSL at the roadway near the Site access road along the north side of Area 1 (Figure 2-4). OU-1 Area 2 is situated between a topographic high of landfilled materials to the south and east, and the Buffer Zone/Crossroads Property to the west. The highest topographic level in Area 2 is about 500 feet AMSL on the southwest side of Area 2, sloping to approximately 470 feet AMSL near the top of the landfill berm (Figure 2-4). The upper surface of the berm along the western edge of Area 2 is located approximately 20 to 30 feet above the adjacent Buffer Zone/Crossroads Property and approximately 30 to 40 feet higher than the water surface in the flood control channel located to the southwest of Area 2. A berm on the northern portions of Area 2 controls runoff to the adjacent properties.

2.1.3 Current Site Uses

The Site is located in a predominantly industrial area. The entire Site area, including the areas investigated as part of OU-1 and OU-2, has been the site of historic limestone quarrying operations, as well as landfill operations. Other activities on the OU-2 portion of the property currently include a solid waste transfer facility, a leachate treatment facility, and an asphalt batch plant operation (Figure 2-3).

With the exception of the Buffer Zone, all of the Site has previously been developed and has been used for, or in conjunction with, disposal of solid wastes at the Site or is currently being used in conjunction with the various industrial operations conducted at the Site. Areas 1 and 2, the Closed Demolition Landfill, the Inactive Sanitary Landfill, and the North and South Quarry portions of the Bridgeton Landfill (Figure 2-3) were all used for disposal of solid wastes. Current activities in these areas consist of maintenance of the landfill covers and environmental monitoring. Extraction of groundwater/leachate continues to be performed on an ongoing basis from the North and South Quarry portions of the Bridgeton Landfill.

In addition to the area containing the Site access road and an office trailer/weigh station, there are areas located outside of the solid waste disposal units in which industrial activities are conducted at the Site. These include the area in the central portion of the Site where the solid waste transfer station, leachate treatment facility, and the asphalt batch plant are located (Figure 2-3). The asphalt batch plant operates at the Site pursuant to a long-term (99-year) lease. The OU-2 stormwater retention pond and OU-2 on-site soil borrow and stockpile area are also located at the Site (Figure 2-3).

2.1.4 Site Zoning, Use Restrictions, and Easements

Current owners of the land encompassed by the Site and of adjacent properties are shown on Figure 2-5. The land use zoning for the Site and adjacent properties is shown on Figure 2-6. The southern portion of the Site is zoned M-1 (manufacturing district, limited). Although the northern portion of the Site is zoned R-1 (one family dwelling district), this area has never been used for residential purposes, is bounded on all sides by industrial and commercial uses, and has been used for industrial purposes for more than 50 years.

In addition, various restrictions on land use have been implemented at the Site (Figure 2-7) to reflect: (1) use of the Site as a solid waste disposal facility; (2) the presence of radiologically-impacted materials in Areas 1 and 2; and (3) the proximity of the Site to the Lambert-St. Louis International Airport. In particular, residential land use has been precluded at the West Lake Landfill (including Areas 1 and 2) by restrictive covenants recorded in May 1997 by each of the fee owners against their respective parcels. These restrictive covenants also prohibit use of groundwater from beneath the Site. Construction activities and commercial and industrial uses have also been precluded on Areas 1 and 2 by a Supplemental Declaration of Covenants and Restrictions recorded by Rock Road Industries, Inc. in January 1998, prohibiting the placement of buildings and restricting the installation of underground utilities, pipes, and/or excavation upon its property. These covenants automatically renew fifty (50) years from the date first recorded and every twenty five (25) years thereafter. The covenants grant EPA, the MDNR, and the owners the right to enforce the covenants' restrictions and cannot be terminated without written approval of their respective owners, MDNR and EPA. Copies of these land use covenants are included in Appendix A to this report. Consequently, even though a portion of the Site is zoned residential, as a practical matter, the only reasonable future use of the Site is commercial-industrial, not residential.

The Site is located northwest of the Lambert-St. Louis International Airport (Lambert Field). Much of the Site, including more than half of Area 1, is located at its closest point within approximately 9,166 feet of the start of Runway 11 (end of Runway 29), which is less than the FAA siting guidance of a 10,000-foot separation radius (Figure 2-8). Numerous flight tracks pass over the West Lake Landfill Site (Figure 2-8). In 2005, the City of St. Louis entered into an Negative Easement and Declaration of Restrictive Covenants Agreement with Bridgeton Landfill, LLC (among other entities) to prohibit depositing or dumping of new or additional putrescible waste on the entirety of the Bridgeton Landfill after August 1, 2005 (City of St. Louis, 2005). This negative easement stemmed in part from an earlier determination by the Federal Aviation Administration (FAA) and the United States Department of Agriculture, Animal and Plant Health Inspection Service (USDA) that the Site was a hazardous wildlife attractant for the Lambert-St. Louis International Airport (City of St. Louis, 2010). In particular, the proximity of the airport to the Site presents a risk of bird strikes. Certain types of scavenging birds (e.g., gulls, crows) are attracted to exposed putrescible wastes at landfills, and accordingly can present a bird strike risk to passing aircraft. Similarly, bird flocks also pose a serious risk to aircraft (by, e.g., being sucked into the jet engines of commercial aircraft, thereby causing complete engine failure).

2.1.5 Surrounding Land Uses

Land use in the area surrounding the Site is commercial and industrial. The Crossroads Industrial Park is located on the north and west of the Site. The property to the north and east of the Site, across St. Charles Rock Road, is moderately developed with commercial, retail and manufacturing operations. The Earth City Industrial Park is located adjacent to the Site on the south and west, across Old St. Charles Rock Road. Various manufacturing facilities are located to the east of the Site, across St. Charles Rock Road. The Republic Services area office and refuse collection vehicle parking and repair facilities are located on the southeast side of the Site and the Boenker farm (agricultural property) is located to the south of the Site.

Two residential communities are present within approximately one mile of the Site. The Terrisan Reste mobile home park is located on the east side of St. Charles Rock Road approximately one-half mile to the southeast of Area 1 and nearly one mile to the southeast of Area 2 (near the intersection of St. Charles Rock Road and Interstate 270) (Figure 2-2). The Spanish Village neighborhood, which contains mixed single and multi-family residential units as well as commercial and industrial facilities, is located to the south of the Site just north of I-70, approximately one mile from Areas 1 and Area 2 (Figure 2-2).

2.1.6 Missouri River Floodplain

The limits of the geomorphic floodplain of the Missouri River were delineated based on information obtained from the MDNR, as further described in the RI Addendum (EMSI, 2016b). Portions of the Site, including all of Area 2 and much of Area 1, are located within the geomorphic floodplain of the Missouri River.

The topography of the Site area has been significantly altered by quarry activities and by placement of quarry spoils and landfill materials. Consequently, although portions of the Site were built over the historic (geomorphic) floodplain, landfilling activities have significantly increased the topographic elevation of much of the Site (Figure 2-4) such that with the exception of the stormwater retention basin and the soil borrow and stockpile area (Figure 2-3), the entire Site is now located above and outside of the 500-year floodplain of the Missouri River (Figure 2-9).[3]

The Earth City Flood Control and Levee District operates and maintains a levee and stormwater management system in order to protect the Earth City development from Missouri River floods with a recurrence interval greater than 500 years (commonly referred to as a 500-year flood). As the Earth City levee system is located between the Missouri River and the Site, this levee system also acts to protect the Site from a 500-year flood. No flooding of the Site or the adjacent Crossroads Property occurred in 1993 or 1995 during the 500- and 300-year flood events that occurred in those years, respectively.

[3] The Federal Emergency Management Agency (FEMA) prepares Flood Insurance Rate Maps (FIRM) for many portions of the country. These maps are available online through FEMA's Map Service Center site (http://msc.fema.gov). The area of the West Lake Landfill is on FIRM Map Number 29189C0039K dated February 4, 2015 (FEMA, 2015). The FIRM map (Figure 2-9) indicates that the entire West Lake Landfill Site is outside the 0.2-percent annual chance (500-year) floodplain.

2.2 Nature and Extent of Radionuclide and Chemical Occurrences in OU-1

This section summarizes the origin and general nature and extent of occurrences of RIM in waste materials in Areas 1 and 2 and the Buffer Zone/Crossroads Property. The occurrence, distribution and volume of RIM in Areas 1 and 2 has been the subject of extensive field investigations, sampling and laboratory analyses, and engineering evaluations, as summarized in the OU-1 Soil Boring/Surface Soil Investigation Report (McLaren/Hart, 1996a), the OU-1 Remedial Investigation Report (EMSI, 2000), the OU-1 Feasibility Study (EMSI, 2006), EPA's Record of Decision for OU-1 (EPA, 2008), the Supplemental Feasibility Study (EMSI et al., 2011), the Bridgeton Landfill Thermal Isolation Barrier Investigation Phase 1 Report (FEI et al., 2014), the Comprehensive Phase 1 Report (EMSI et al., 2016a), and the RI Addendum (EMSI, 2016b). Information regarding the nature and extent of non-radionuclide chemical occurrences in soil/waste material in OU-1 is also presented to assess the potential for occurrences of hazardous waste within the landfill materials.

2.2.1 Occurrences of Radionuclides in Areas 1 and 2

Radiological constituents in OU-1 Areas 1 and 2 occur in soil materials that are intermixed with and interspersed within portions of the overall matrix of landfilled refuse, debris and fill materials and unimpacted soil and quarry spoils in Area 1 and Area 2. In some portions of Areas 1 and 2, radiologically-impacted materials are present at the surface; however, the majority of the radiological occurrences are present in the subsurface beneath these two areas. At the Buffer Zone/Crossroads Property, the radiologically-impacted materials are found in surface soil believed to have been carried by erosion from the Area 2 berm prior to growth of the current onsite vegetation. See additional discussion in Section 2.2.5, below.

In general, the primary radionuclides detected at levels above background concentrations at the Site are part of the uranium-238 decay series. Thorium-232 and radium-224 isotopes from the thorium-232 decay series are also present above background levels but at a lesser frequency and at much lower activity levels.

2.2.2 Source of the Radionuclides

The NRC reported (1976, 1988) that disposal of radioactive materials mixed with soil occurred at the West Lake Landfill in 1973. Reportedly, approximately 8,700 tons of leached barium sulfate residues (LBSR) were mixed with approximately 39,000 tons of topsoil from a site located at 9200 Latty Avenue in Hazelwood, MO (the Latty Avenue Site) and transported to the West Lake Landfill over a three-month period from July 16 through October 9, 1973 (EPA, 2008; NRC, 1976 and 1988; and RMC, 1982). The LBSR was derived from uranium ore processing for the production of uranium metal from 1942 to 1957 under contracts with the Manhattan Engineering District (MED) and the Atomic Energy Commission (AEC) at the Mallinckrodt Chemical Works facility in St. Louis, known today as the St. Louis Downtown Site (SLDS).

Prior to 1966, these materials were stored by the AEC on a 21.7-acre tract of land (now known as the St. Louis Airport Site or SLAPS) in what was then an undeveloped area of north St. Louis County (EPA, 2008, NRC, 1988, and RMC, 1982). The LBSR, along with certain uranium processing residuals, reportedly were moved from SLAPS to the nearby Latty Avenue Site in 1966 (NRC, 1988). Most of the uranium and radium had previously been removed from the LBSR in multiple extraction steps (EPA, 2008 and NRC, 1988), and the LBSR reportedly contained only approximately 0.05% to 0.1% of uranium (NRC, 1976 at page 2).

Over time, the radiologically-impacted materials within Areas 1 and 2 have been intermixed within portions of the overall matrix of landfilled solid waste materials, debris and fill materials, and unimpacted soil and quarry spoils in portions of Area 1 and Area 2. Use of soil mixed with LBSR as landfill cover, combined with the placement and compaction of additional MSW and other soil material both during and after placement of RIM-containing materials, and the subsequent natural decomposition, consolidation, and settlement of the MSW over the years, have also resulted in RIM being dispersed and intermixed within portions of the overall matrix of MSW in Areas 1 and 2. As a result, the Site contains areas comprised of both radiologically-impacted and non-radiologically-impacted materials that cannot be visually distinguished, and both of which are intermixed with solid waste materials.

2.2.3 Criteria for Defining RIM Occurrences

EPA previously determined for purposes of evaluating “complete rad removal” alternatives (EPA, 2010) that RIM would be defined based on the criteria set forth in EPA’s regulations (40 CFR Part 192) promulgated pursuant to the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA) as modified by subsequent EPA guidance on the use of these regulations at CERCLA sites. Specifically, EPA’s Scope of Work for the Supplemental Feasibility Study (EPA, 2010) indicated that “complete rad removal” was defined to mean attainment of risk-based radiological cleanup levels specified in OSWER Directives 9200.4-25 and 9200.4-18 (EPA, 1998 and 1997a). These directives provide guidance as to the use of the UMTRCA soil cleanup criteria as remediation goals at CERCLA sites.

Based on these criteria, EPA has established a conservative definition of RIM at the Site based on the application of criteria for unrestricted (*i.e.*, residential) land use.[4] In particular, EPA has determined that RIM at the Site will be defined as any material containing combined Ra-226 plus Ra-228 or combined Th-230 plus Th-232 at levels greater than 5 pCi/g above background (EPA, 2010). The EPA previously identified that this criterion would allow for unrestricted (*i.e.*, residential) use of the Site relative to radionuclide occurrences for purposes of identifying RIM at the Site. Based on the uranium remediation goal of 50 pCi/g established for the SLDS and SLAPS in the RODs for those sites (USACOE, 1998, and EPA, 2005, respectively), for purposes

[4] As noted in Section 2.1.4, above, use of the Site for residential purposes is inconsistent with the presence of municipal solid wastes within a landfill, regardless of the presence (or absence) of radionuclides within those wastes.

of identifying RIM at the Site, the criteria of 50 pCi/g plus background total uranium will be used to identify RIM. Evaluation of background levels and the associated criteria that would allow for unrestricted use was previously performed for the SFS (EMSI et al., 2011) and was also discussed in detail in the RI Addendum (EMSI, 2016b).

Based on the Site background values presented in the RI Addendum and the SFS, the criteria to be used to identify RIM are as follows:

- Ra-226 plus Ra-228 = 7.9 pCi/g[5]
- Th-230 plus Th-232 = 7.9 pCi/g
- Combined uranium (U-234 plus U-235 plus U-238) = 54.5 pCi/g

These values were used to identify the Site soil/waste that would be included within the definition of RIM for purposes of the FFS, and in particular, for the purpose of identifying the materials included within the scope of the “complete rad removal” alternative.

2.2.4 Occurrences of RIM in Areas 1 and 2

Radionuclides (specifically, Th-230, Ra-226, and U-238) have been identified as primarily present in soils at two distinct and separate areas at the Site. These two areas have been designated by EPA as Radiological Area 1 (Area 1) and Radiological Area 2 (Area 2) (Figure 2-3). Area 1 encompasses an approximately 17.6-acre portion of the Site located immediately to the southeast of the main access road to the Site. Area 2 encompasses an approximately 47.8-acre portion of the Site along the northern boundary of the West Lake Landfill property (Figure 2-3).

Procedures used to identify RIM occurrences based on the results of the field investigations and laboratory testing are detailed in Section 6.3 of the RI Addendum (EMSI, 2016b). The RIM occurrences in Areas 1 and 2 are provided in Tables 2-1 and 2-2, respectively.

The minimum, average and maximum identified thickness of the RIM intervals in Areas 1 and 2 based on the results of the field investigations and laboratory testing were as follows:

	Area 1	Area 2
Minimum RIM thickness (ft)	0.2	1
Average RIM thickness (ft)	4.3	7.4
Maximum RIM thickness (ft)	19	25

[5] Total radium Derived Concentration Guideline Level (DCGL) = 1.3 pCi/g Ra-226 + 1.6 pCi/g Ra-228 + 5 pCi/g radium cleanup level = 7.9 pCi/g total radium

The depths to the top of the identified intervals containing RIM in Area 1 average approximately 28 ft bgs (average elevation of 450.0 ft amsl), ranging from 0 (at the surface) to 89 ft bgs (elevations ranged from 425.4 to 470.5 amsl)[6]. The base of the RIM intervals occurs at an average depth of 32 ft bgs (average elevation of 446.0 amsl), ranging from 5 to 96 ft bgs (elevations ranging from 420.3 to 462.3 amsl). Part of the reason for these depths is that the landfill materials in the southern portion of Area 1 were buried beneath additional landfilled waste that was placed in that area in approximately 2002-2003 in conjunction with disposal in the above-grade portion of the North Quarry portion of the Bridgeton Landfill.

The average depth to the top of the intervals identified as containing RIM in Area 2 ranges from 0 (at the surface) to 42.5 ft bgs (elevations ranged from 434.9 to 486.5 ft amsl). The base of the RIM intervals occurs at depths ranging from 1 to 49.5 ft bgs (elevations from 428.3 to 484.5 ft amsl).

2.2.5 Estimated Volume of RIM and Overburden Material

A geostatistical evaluation of the extent and volume of RIM using an IK approach was performed by S.S. Papadopoulos & Associates (SSPA). Specifically, the extent of RIM within OU-1 Areas 1 and 2 was estimated in three dimensions (3D) using indicator kriging (IK). The IK method is commonly used to identify regions of the subsurface that exhibit properties that exceed one (or more) defined threshold criterion – typically a concentration – and as such, is well-suited to delineating RIM. In the case of a single threshold, sample results are indexed according to whether they exceed (index=1) or fall below (index=0) the threshold value. The transformed indicators are interpolated using kriging, resulting in a continuous 3D distribution of values ranging between zero and one that, in the simplest case, reflect the probability that the criterion is exceeded at the corresponding location. All indicator kriging calculations were completed using a recent release of the Fortran-based Geostatistical Library (GSLIB: Deutsch and Journel, 1992) program IK3D, compiled with dynamic memory allocation. A more complete description of the methods and results obtained by the IK evaluations is included in Appendix B.

The data available to estimate the extent of RIM include (a) thorium and radium obtained from laboratory analysis of landfill materials; and (b) a comparatively larger number of vertically continuous gamma and alpha recordings obtained during downhole logging or logging of drill core sample material. The reported values of thorium and of radium comprise direct measurements of the quantity of interest, and as such are referred to here as “hard” data. In contrast, measurements of gamma and alpha radiation are indirect indicators of the presence, and likely relative concentration of, radiological constituents including (but not limited to) thorium and radium: as such, radioactivity counts are referred to here as “soft” data. Indicator kriging

[6] Note that the borings used to define RIM were drilled before construction of the Non-Combustible Cover removal action construction activities, and therefore the reported depth intervals discussed in this section do not reflect placement of an additional eight (8) inches (or in some areas, an even greater thickness) of material over portions of Areas 1 and 2 in 2016.

enables such "soft" data to be incorporated in the estimate of the primary "hard" variable under the assumption that the "soft" quantity exhibits a correlation with the "hard" quantity.

The interpolation grid used for the kriging was defined to provide estimates of the presence or absence of RIM on a vertical and horizontal discretization suitable for evaluating combined Ra-226 plus Ra-228 or combined Th-230 plus Th-232 values greater than 7.9 pCi/g (the EPA defined value for identification of RIM). The grid size was selected based upon UMTRCA regulations, resulting in a grid defined by square blocks of side-length 10 meters (32.8 feet) and thickness 0.15 meters (0.5 feet) consistent with the criteria specified in 40 CFR § 192.12a for cleanup of land containing residual radioactive materials.

The areal extent of RIM (*i.e.,* material containing combined radium or combined thorium activities greater than 7.9 pCi/g) based on results of the IK for Area 1 is 6.4 acres (Figure 2-10). The estimated extent of RIM in Area 2 is 22.9 acres (Figure 2-11). Details regarding the methods used to perform the IK and the results obtained are presented in Appendix B.

In order to meet the schedule for preparation of the FFS, SSPA provided results of the IK in May 2016 (referred to in the SSPA report contained in Appendix B as "Initial Best-Estimates"). These results were used for characterization of the extent and volume of RIM in the RI Addendum. The results of these evaluations were also used to develop excavation and grading plans (Appendix M), cost and schedule estimates, and risk evaluations for the complete and partial excavation alternatives for the FFS. After further review of the initial IK results, SSPA revised its analyses to better reflect the Site data, which resulted in slight modifications to the estimated RIM volumes (SSPA, 2016a). Specifically, the updated best-estimates were 4.3% larger for Area 1, 3.2% lower for Area 2, and 1.9% lower overall compared to the initial best-estimates. Given the timing of these revisions and the schedule constraints associated with preparation of the draft FFS, these revised values of the RIM volumes (referred to in the SSPA report contained in Appendix B as "Updated Best-Estimates") have not been incorporated into the evaluations contained in this draft FFS. Moreover, these variations are within the estimate level of precision of the volume calculations.

Based on the geostatistical evaluations, the initial best-estimate total volumes of RIM contained in Areas 1 and 2 were estimated to be as follows:

Area 1 RIM	46,200 bank cubic yards (bcy)
Area 2 RIM	220,000 bcy
Total RIM	266,200 bcy

A "bank cubic yard" refers to the volume of an in-place, undisturbed material such as soil or refuse. Conversely, a "loose cubic yard" refers to a volumetric measurement of material when it is in a loose state after it has been excavated. When material is excavated, it typically swells relative to its in-place volume. For example, a "loose cubic yard" of soil will typically occupy 20 to 30 percent more volume than a "bank cubic yard" of soil, and a "loose cubic yard" of refuse may occupy up to 60 percent more volume than a "bank cubic yard" of refuse. For purposes of estimating quantities in the SFS, it was assumed that a "loose cubic yard" of combined overburden and RIM (matrix of soil and refuse) in Areas 1 and 2 would occupy 50 percent more volume than a "bank cubic yard".

Based on the geostatistical estimate of the depths and extent of RIM in Areas 1 and 2, the volume of non-radiological overburden soil and waste materials (including material directly above the RIM plus material that would need to be removed to lay back the excavation sidewalls) that would have to be removed to allow for excavation of the RIM was estimated to be as follows:

Area 1 overburden	702,000 bcy
Area 2 overburden	493,000 bcy
Total overburden	1,195,000 bcy

Additional information and supporting calculations used to estimate the extent and volumes of RIM above levels that would allow for unrestricted use, as well as the uncertainties associated with the estimates, are presented in Appendix B and discussed in Section 5.

2.2.6 Radiological Characterization of the RIM

The primary radionuclides detected in Areas 1 and 2 at levels above background concentrations are part of the U-238 decay series. The uranium decay series includes Th-230, Ra-226, and Rn-222, which are the primary radionuclides of concern at the Site. Th-232 and Ra-228 isotopes from the thorium decay series were also present above background levels but at a lesser frequency and relatively lower activity levels than the radionuclides in the U-238 decay series. A total of 218 radium analyses and 213 thorium analyses (including investigative samples, field duplicate samples, and laboratory duplicate analyses) are available for Area 1, and 144 radium and thorium results are available for Area 2, from the OU-1 RI, Phase 1, and Additional Characterization investigations. Table 2-3 summarizes the radium, thorium and uranium results for samples obtained from Area 1 while Table 2-4 summarizes the results for samples obtained from Area 2.[7]

[7] Although the analytical results from the additional samples collected by Cotter are included on Tables 2-3 and 2-4, these data have not been included in the evaluation of the statistical estimates of radium and thorium levels in Areas 1 and 2, as certain of those samples are still being analyzed. The Cotter data were collected in part to "help determine the presence of radiological materials with chemical compositions diagnostically different from LBSR." (Arcadis, 2015a and b). Consequently, collection of samples by Cotter was heavily biased toward collection of samples with the highest levels of radium and thorium at the Site with the goal of "identification and evaluation of any non-LBSR material[.]" (Arcadis, 2015a and b). Furthermore, in response to some questions from EPA with regard to the ratio of the Th-230 and Ra-226 reported for several of the Cotter samples, EPA has requested that the remaining materials associated with these samples be provided to EPA for re-analysis to verify the results (EPA, 2016b). Therefore, until this issue is resolved, the Cotter data will be reported but not integrated into the overall evaluations of the nature of the radiological occurrences in RIM.

The total number of results, and the average, maximum, and estimated 95% UCL values (based on results for a non-parametric distribution as calculated using ProUCL 5.0 – see additional discussion below) for the radium and thorium data sets are provided on Table 2-5. For purposes of these calculations, only the original sample results have been used, and therefore field duplicate results and lab duplicate results were not considered in these calculations.

It should be noted that although an average value is presented in Table 2-5, the data sets were not normally distributed and therefore, an arithmetic average is not an appropriate measure of central tendency of the data sets. Similarly, the 95% UCL values listed on Table 2-5, although based on a non-parametric distribution and estimation technique, are also not considered to be appropriate based on the distribution of the data sets.

Review of the data sets indicates that these data represent two separate populations (that is, the data represent a bimodal distribution) that have a small degree of overlap. As discussed in the RI Addendum (EMSI, 2016b), weighted mean values and weighted 95% upper confidence limits were calculated based on the percentages of data values contained within each subpopulation. The resultant values are provided on Table 2-5.

Regardless of whether the data are treated as a single population or as bimodal mixture of two populations, the values provided on Table 2-5 support the conclusion that the RIM is primarily characterized by elevated levels of Th-230 and Ra-226, and that, with the exception of a few values, most of the Th-232 and Ra-228 values are close to or similar to background values. There is also a relatively close correlation between the Ra-226 and Th-230 results obtained from each area. Furthermore, review of the data indicates that for all of the results that are greater than the unrestricted use criteria (*i.e.*, 7.9 pCi/g combined Ra-226 + 228 or combined Th-230 + 232), the Th-230 activities are greater than the Ra-226 activities.

2.2.7 Radionuclide Decay and In-Growth

Review of the data indicated that for all of the results that are greater than the unrestricted use criteria (*i.e.*, 7.9 pCi/g combined Ra-226 + Ra-228 or combined Th-230 + Th-232), the Th-230 activities are greater than the Ra-226 activities. These analytical data indicate that the Ra-226 activities are not in equilibrium with the Th-230 activity levels and consequently the levels of Ra-226 at the Site will increase over time. Over time, the activity concentrations of Ra-226 will grow into that of its parent, Th-230.

The arithmetic average values of the Th-230 and Ra-226 data for the Area 1 and Area 2 soil/waste samples (see Section 2.2.6) were used to estimate the anticipated in-growth of Ra-226 from decay of Th-230 over time. These values were used to estimate the average amount of Ra-226 that would be present in Area 1 and Area 2 in 1,000 years. Accounting for the in-growth of Ra-226 due to the decay of Th-230 results in an estimated average Ra-226 activity level of 1,337 pCi/g in Area 1 and 6,882 pCi/g in Area 2 in 1,000 years (Tables 2-6 and 2-7). The expected increases in the Ra-226 levels in Areas 1 and 2 owing to decay of Th-230 over time are graphically presented on Figures 2-12 and 2-13.

The projected increase in Ra-226 levels over time will result in both increased radiation levels and increased radon gas generation over time. Design of a landfill cover included within the scope of the ROD-selected remedy, or a cover associated with any of the other remedial alternatives, will need to consider the projected increase in radium over time and the associated increases in gamma radiation and radon emanation that will also occur over time. The projected increase in radiation and radon levels over time was addressed as part of the risk characterization included in the Baseline Risk Assessment and Updated Baseline Risk Assessment (Auxier & Associates, 2000 and 2016a), and was considered as part of the conceptual design of the remedial alternatives and potential long-term risks evaluated in the prior SFS and in this FFS, as described further in Sections 5 and 6.

2.2.8 Principal Threat Wastes

In accordance with the NCP, EPA expects that treatment will be the preferred means by which to address the principal threats posed by a site, wherever practicable. Because one of the purposes of the FFS is to provide a thorough evaluation of potential “complete rad removal” and partial excavation alternatives relative to the ROD-selected remedy, it is conservatively assumed that principal threat wastes may be present within OU-1. Therefore, potential treatment technologies are evaluated in Section 4 of this FFS. As discussed in Section 4, the evaluation of potential treatment technologies takes into account both the presence of the RIM and the expected further in-growth of radionuclides in the RIM due to radioactive decay and disequilibrium.

2.2.9 Radiological Occurrences on the Buffer Zone and Crossroads Property

During the RI (EMSI, 2000), radionuclide occurrences in surface soil were identified in the southern portion of what at that time was property owned by Ford Motor Credit (referred to in the RI as the Ford Property and now known as the Buffer Zone), located immediately to the west of Area 2 (Figure 2-3).

Reportedly, after completion of landfilling activities in Area 2, but prior to establishment of a vegetative cover over the landfill berm, erosion of soil from the landfill berm resulted in the transport of radiologically-impacted materials from Area 2 onto the adjacent former Ford Property (EMSI, 2000). The landfill berm and the adjacent properties were subsequently re-vegetated by natural processes such that no evidence of subsequent erosion or other failures were present at the time of the RI. Based on the results of sampling performed during the RI, occurrences of radionuclides were found in surficial (6 to 12 inches or less) soil at the toe and immediately adjacent to the landfill berm. The overall distribution and surficial nature of the occurrences of radiologically-impacted soil on the former Ford Property was determined to be consistent with historic, erosional transport of soil from the Area 2 slope onto the surface of the former Ford Property.

Based on an estimated areal extent of 196,000 square feet and a presumed 6-inch thickness, the volume of radiologically-impacted materials located on the former Ford Property was estimated to be 3,600 cubic yards (EMSI, 2000 and 2006a).

In November 1999, third parties scraped the vegetation and surface soil on Crossroads Lot 2A2 and the Buffer Zone to a depth of approximately 2 to 6 inches. These areas were covered with gravel to allow for parking of tractor-trailers. The removed materials were piled in a berm along the southern boundary of the Buffer Zone, adjacent to the northwestern boundary of the Site. A small amount of removed materials was also placed in a small pile on the Crossroads Property near the base of the landfill berm along the east side of Lot 2A1 (Figure 2-14).

In February 2000, additional surface soil samples were collected from the disturbed area and submitted for laboratory testing. Only one sample (RC-02) obtained from the Buffer Zone, below and adjacent to the area of the former landfill berm slope failure, contained radionuclides (Th-230) above levels that would allow for unrestricted use (Table 2-8). The remainder of the samples contained either background levels of radionuclides or levels above background but within levels that would allow for unrestricted use. The results of the additional soil sampling indicated that most of the radiologically-impacted soil that had previously been present on the Buffer Zone and Lot 2A2 of the Crossroads Property had been removed and placed in the stockpiles. Evaluation of the soil sampling results obtained prior to and after the 1999 disturbance indicates that approximately one acre of the Buffer Zone still contained some radionuclides above unrestricted use levels. Inspection of the area in May 2000 indicated that native vegetation had been re-established over both the disturbed area and the stockpiled materials. The presence of native vegetation over these materials was determined to be sufficient to prevent windblown or rainwater runoff of these materials.

A 2004 inspection of this area indicated that additional soil removal/regrading had been performed on the remaining portion of the Crossroads Property and the adjacent Buffer Zone property. These activities appear to have resulted in removal of the soil stockpiles created during the previous regrading activity, removal of any remaining soil on Lot 2A2 and the Buffer Zone not scraped up during the 1999 event, and placement of gravel over the entirety of Lot 2A2 and much of the Buffer Zone. According to AAA Trailer, all of the soil removed during the July 1999 grading work and the May 2003 gravel layer installation was placed in the northeastern corner of the Buffer Zone (terra technologies, 2004). Respondents installed a fence between the Buffer Zone and Crossroads Property to prevent any future disruption of the Buffer Zone by AAA Trailer or any other party.

Because no sampling has been performed since the most recent (May 2003) grading work conducted by AAA Trailer, the levels and extent of radionuclides, if any, that may remain in the soil at the Buffer Zone and Crossroads Property are unknown. Additional soil sampling to determine current conditions with respect to radionuclide occurrences in the Buffer Zone and Crossroads Property soil will be conducted as part of implementation of the selected remedy for this area.

2.2.10 Occurrences of Non-Radiological Chemical Constituents in Soil/Waste

Although the primary focus of the OU-1 RI field and laboratory investigations was on radionuclide occurrences, investigation of occurrences of non-radiological, chemical constituents was also performed during the RI. The soil/waste samples collected by McLaren/Hart as part of the soil boring program (McLaren/Hart, 1996a) were analyzed for the following non-radiological constituents:

- Priority pollutant metals and cyanide;
- Total petroleum hydrocarbons (TPH);
- Volatile Organic Compounds (VOCs);
- Semi-Volatile Organic Compounds (SVOCs); and
- Pesticides and poly-chlorinated biphenyls (PCBs).

As part of the OU-1 RI field investigation and laboratory analyses, 43 soil samples from 28 borings were analyzed for VOCs, SVOCs, pesticides and PCBs, and TPH. Twelve of these borings were located in Area 1 and 16 were located in Area 2. Seventeen of the soil samples analyzed for organic compounds were collected from Area 1 borings and 23 were collected from Area 2 borings. There were also three field duplicates, for a total of 43 soil samples analyzed for organic compounds. Of the 43 samples collected and analyzed for non-radiological constituents, 15 were of surface soils, including five from Area 1 and 10 from Area 2.

In addition, 37 soil samples from 25 borings were analyzed for the 12 priority pollutant metals: antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, thallium, and zinc. Cyanide analyses were also performed on these samples. Nine of these borings were located in Area 1 and 16 were located in Area 2. Eleven of the soil samples analyzed for trace metals were collected from Area 1 borings and 23 were collected from Area 2 borings. There were also three field duplicates for a total of 37 soil samples analyzed for trace metals. Additional detailed information is contained in the Soil Boring/Surface Soil Investigation Report (McLaren/Hart, 1996a).

The only other non-radiological results are for samples collected during the Phase 1D investigation of Area 1, the Additional Characterization of Areas 1 and 2, and the Cotter investigation.[8] These samples were analyzed for Target Analyte List (TAL) trace metals, inorganic parameters including pH, calcium, magnesium, sodium, potassium, alkalinity, chloride, fluoride and sulfate, and three transition metals: scandium, niobium and tantalum. A total of 138 soil samples were collected by these investigations, including 69 samples plus seven duplicate samples from Area 1 and 54 samples plus eight duplicate samples from Area 2.

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[8] As described further in Sections 4.4.8 and 4.5.6 of the RI Addendum, Cotter conducted additional investigations in Areas 1 and 2 as part of the Phase 1 and Additional Characterization sampling efforts.

A summary of the results of the non-radiological analyses (both organic and non-organic) are presented in Section 8 of the RI Addendum (EMSI, 2016b). Overall, the occurrences and concentrations of the various chemical constituents are consistent with the disposal of MSW. Disposal operations at the West Lake Landfill date back to the 1950s and predate the adoption of federal or state regulations prohibiting the disposal of hazardous wastes in solid waste landfills. In addition, during the time period in which wastes were disposed of at the Site, certain household products frequently contained substances that are now regulated as hazardous waste. Accordingly, there is a potential that some of the waste materials at the Site could display the characteristics of hazardous wastes.

The potential for occurrences of hazardous wastes within Areas 1 and 2 exhibiting the toxicity characteristic (TC) was evaluated by comparing the maximum levels of the 40 designated chemical constituents detected in any of the RI or subsequent investigation (Phase 1D, Additional Characterization or Cotter Investigation) soil/waste samples to the maximum concentration of contaminants using the Toxicity Characteristic Leaching Procedure (TCLP) established under the Resource Conservation and Recovery Act (RCRA) (40 CFR Part 261.24) and the Missouri state hazardous waste regulations (10 CSR 25-4.261). Section 1.2 of the TCLP provides that if the total analysis of a waste demonstrates that toxic characteristics are present only at concentrations below their respective regulatory levels, the TCLP need not be run. For wastes with no free liquids, this is accomplished by multiplying the TC regulatory limit by 20 (to reflect the 20x weight ratio of extraction fluid to solid in the TCLP protocol) for comparison to the respective constituent concentrations. The results of these comparisons are presented on Table 2-9.

Based on these comparisons, the possibility exists that some of the waste materials contained in Areas 1 and 2 could be classified as hazardous wastes based upon the presence of TC metals, or their benzene, chloroform, or 1-4 dichlorobenzene concentrations. However, this possibility can only be verified by subjecting representative samples to the TCLP for those constituents, since the screening was compared to the highest single value (not necessarily the representative concentration), and the chemical form and/or attenuation by the solid matrix may preclude significant leachability under the procedure. RCRA regulatory authorities do not apply to wastes legally placed into a disposal unit prior to RCRA's effective date unless the wastes are excavated or removed from the disposal unit. Further waste classification is not necessary unless and until such excavation occurs.

2.2.11 Asbestos Containing Materials in Soil/Waste

Identification of, or testing for, regulated asbestos containing materials (RACM) was not included in the scope of the RI field investigations or the subsequent investigations. Review of the RI soil boring logs (Appendix B-1 of the RI Addendum) does not indicate that pipe insulation, transite panels or other materials that may represent RACM were encountered during drilling; however, as stated above, identification of such materials was not part of the scope of the RI field investigations. Individuals responsible for performance of the Phase 1C, Phase 1D, Additional Characterization and Cotter investigations were required to complete asbestos awareness training and were therefore conscious of the potential for asbestos. No indications of potential RACM were noted during these field investigations. However, because the RI field investigations did not include procedures to identify the presence of RACM, no definitive information exists from the RI investigations regarding the presence of RACM in Areas 1 and 2.

2.3 Radionuclide Occurrences in Air

Radionuclides can be transported to the atmosphere either as a gas (in the case of the various radon isotopes) or as fugitive dust (in the case of the other radionuclides). This section summarizes the results of radon flux measurements from the surfaces of Areas 1 and 2 and measurements of radon levels in air along the perimeters of Areas 1 and 2. It also summarizes the results of radionuclide analyses of fugitive dust samples collected from Areas 1 and 2 during the OU-1 RI and from along the perimeters of Areas 1 and 2 during 2015-2016.

2.3.1 Radon Flux and Radon in Atmospheric Air

Radon gas is discharged into the atmosphere as a result of the decay of radium. No standard for radon emissions directly applicable to the Site have been established. In 40 CFR Part 61, EPA established a standard of an average of 20 pCi/m^2s for radon emissions from uranium mill tailings from a number of samples (generally 100) collected from the surface of the tailings in a statistically unbiased fashion. Although this standard is directly applicable only to uranium mill tailings, it does represent a health-based standard derived by EPA.

Radon flux measurements were conducted at the Site during the RI investigation using the Large Area Activated Charcoal Canisters (LAACC) method presented in Method 115, Appendix B, 40 CFR Part 61 (EMSI, 1997a). The LAACC method involves placing a canister on the surface of the Site in a designated area and then allowing radon to collect on charcoal within the canisters for a period of 24 hours. Based on the radon flux measurements obtained during the RI[9], the average radon flux from Area 1 is 13 pCi/m^2s, which is below the EPA standard for uranium mill tailings. The average radon flux for Area 2 is 28 pCi/m^2s. This average is above the EPA uranium mill tailings standard; however, this value is due solely to the results obtained from two locations (WL-209 and WL-223). The results obtained from these two locations represented the vast majority of the radon flux found in Area 2 during the OU-1 RI. The average flux for all other portions of Area 2, excluding these two locations, was only 0.94 pCi/m^2s, which is approximately 5% of the allowable flux for uranium mill tailings piles.

Radon flux emissions from the surfaces of Areas 1 and 2 were also measured in 2016 after completion of construction of the non-combustible cover over those portions of Areas 1 and 2

[9] Radon flux was measured rather than concentration because no structures are present in either Area 1 or Area 2 that would result in the buildup of radon concentrations. Instead, the potential transport pathway is the migration of the gas from the Site to the atmosphere.

where RIM previously existed at the ground surface. The arithmetic mean value of the results was 0.061 pCi/m^{2}s, which is far below the UMTRCA standard of 20 pCi/m^{2}s.

Radon that is emitted from the surface of Areas 1 and 2 is subject to natural dilution and dispersion processes active in the atmosphere. As noted above, radon flux measurements were taken directly at the ground surface and within the confined space of each LAACC. Under natural conditions, radon emissions from the Site are immediately dispersed by atmospheric movement as the gas migrates from the ground surface, resulting in far less exposure to the potential receptors than was measured using the LAACCs. Measurement of radon levels in atmospheric air were conducted at the 13 air monitoring stations installed in 2015 and operated to obtain baseline air monitoring data for the Site (Auxier and EMSI, 2014 2016a, 2016b, and 2016c). Recorded radon concentrations were all less than 0.4 pCi/L during the first quarterly (12-week) monitoring event (May through August 2015), ranged from less than 0.4 up to 0.7 pCi/L in the second quarterly event (September through November 2015), and ranged from less than 0.4 up to 0.6 pCi/L during the third quarterly event (October 2015 through January 2016). Table 2-10 presents a summary of the perimeter air monitoring results for radon obtained through January 2016.

EPA has established a standard under UMTRCA (40 CFR § 192.02 (b)(2)) for radon outside an UMTRCA-regulated disposal facility. The standard specifies that control of residual radioactive materials shall be designed to provide reasonable assurances that releases of Rn-222 from residual radioactive material to the atmosphere will not increase the annual average concentration of Rn-222 in air at or above any location outside the disposal site by more than one-half picocurie per liter (0.5 pCi/L). The radon levels measured at the Site (Table 2-10) meet this standard.

EPA also performed air monitoring at five off-site stations, four of which were located in the vicinity of the West Lake Landfill and one (EPA station 5) that was located in St. Charles, MO. EPA designated station 5 as a reference (or background) station, because it is frequently upwind of the Site and was located further away from the Site than the other stations but still within the general vicinity so as to be representative of the North St. Louis County and east St. Charles County area (TetraTech, 2016 and 2015b). For the period from April 25, 2015 through February 17, 2015, EPA reported radon levels at its reference (background) station ranging from 0.11 to 1.45 pCi/L, with a median value of 0.30 pCi/L (TetraTech, 2015e). The values measured at the 13 perimeter air monitoring stations are similar to the levels obtained from the EPA reference (background) station, and if the 0.3 pCi/L median value from the EPA reference station was considered to be background (instead of the 0.4 pCi/L value EPA has indicated is typically present in outdoor air), the results from 13 perimeter air monitoring stations at the Site are all within 0.5 pCi/L of the median result obtained by EPA at its reference station.

2.3.2 Fugitive Dust Sampling

Fugitive dust monitoring was conducted at one location in Area 1 and one location in Area 2 during the OU-1 RI field investigations. Sampling for fugitive dust was performed at locations that contained some of the highest radionuclide concentrations in surface soil samples. Based on the monitoring results, as well as the presence of the prior vegetative cover and the subsequent rock cover over Areas 1 and 2, atmospheric transport of radionuclides in fugitive dust does not appear to have been, or currently be, a significant pathway for offsite migration (EMSI, 2000).

After the OU-1 RI sampling in 1996, the surface areas of Areas 1 and 2 became heavily vegetated, and inert fill was placed over portions of the surface, thereby reducing the potential for fugitive dust emissions at the Site. This reduction is confirmed by the absence of increased levels of radionuclides in the fugitive dust samples collected from around the perimeters of Areas 1 and 2 in 2015 and 2016, as described below. In addition, those portions of Areas 1 and 2 where RIM was previously present at the ground surface were covered in 2016 (after development of the most recent air monitoring results available) with rock/roadbase material as part of the construction of the non-combustible cover over these areas, thereby further reducing the potential for emissions of radionuclides in fugitive dust.

Measurements of radionuclides in fugitive dust (particulate samples) have been obtained at the 13 air monitoring stations installed in 2015 and operated to collect baseline air monitoring data for the Site (Auxier and EMSI, 2014, 2016a, b and c). Air particulate samples are collected every 28 days and submitted for analysis. Each sample is analyzed for Gross Alpha and Gross Beta levels. The results of the first three quarters (May 2015 through January 2016) of on-site monitoring for gross alpha and gross beta are summarized on Tables 2-11 and 2-12. The results obtained during the first three quarters of operation of the perimeter air monitoring program were compared to the results obtained from the EPA off-site monitoring program over the period from May 2014 through February 2015 (Auxier and EMSI, 2016a, b, and c). Overall, the gross alpha results obtained from the 13 on-site stations are similar to or slightly higher than the results obtained from EPA's five off-site stations.[10] The gross beta results obtained from the 13 on-site stations are similar to the gross beta results obtained from the EPA off-site monitoring locations.

For the first quarter of sampling (May through July 2015), the May and June 2015 particulate samples were analyzed for isotopic thorium, uranium, and by gamma spectroscopy. Particulate results from September and December 2015 (the middle of each respective three-month monitoring period) were also submitted for isotopic analysis and gamma spectroscopy. As expected, the isotopic and the gamma spectroscopy results demonstrate only naturally-occurring radioactive materials. Statistics for Th-230, U-238, and combined radium results (the sum of actinium-228 [for Ra-228] and Bi-214 [for Ra-226] from gamma spectrometry) for each station in pCi/m^3 for May, June, September, and December 2015 are presented on Tables 2-13, 2-14, and 2-15. The results of on-site monitoring for U-238, Th-230, and combined radium were also compared to the results obtained from the EPA off-site monitoring program over the period from May 2014 through February 2015 (Table 2-16).

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[10] Whether this difference is statistically significant cannot be determined until additional on-site data are obtained (sampling is ongoing at this time). The differences may reflect dust levels, seasonal conditions (pollen levels), differences in precipitation (*i.e.*, soil moisture), or differences in the total particulate levels between the period covered by EPA's air monitoring program and the period covered by the on-site air monitoring program.

In almost all cases, the isotopic uranium and thorium and combined radium results obtained from the 13 on-site stations are lower than the results obtained from EPA's five off-site stations. The isotopic results were converted to µCi/ml and compared to 10 CFR 20 Appendix B Effluent Limits. The results are well below the applicable effluent limits (Auxier and EMSI, 2016a, b, and c).

2.4 Radionuclides in Stormwater, Surface Water and Sediment

Radionuclides present in Areas 1 and 2 could potentially be transported to other portions of the Site or to offsite areas via precipitation runoff from the Site. Transport via rainwater runoff could include both dissolved phase transport and suspended phase transport within the flowing runoff water. Potential impacts to permanent surface water bodies, as well as the actual or potential receptors of any offsite migration of radionuclides, are summarized below. A more detailed discussion can be found in Section 7.2 of the RI Addendum (EMSI, 2016b).

It should be noted that this section discusses sampling results performed in 1995-1997 as part of the OU-1 field investigations – before inert fill material was placed on the surface of Areas 1 and 2, and before the recent (2016) installation of a non-combustible cover over areas where RIM is present at the ground surface. All of these actions would serve to greatly reduce and, ultimately, likely eliminate the potential for radionuclide transport in surface water. This conclusion is supported by results of the recent stormwater monitoring activities (discussed below) conducted in conjunction with installation of the non-combustible cover.

Current surface water runoff patterns for Areas 1 and 2 are presented on Figure 2-15. All runoff from Area 1 ultimately flows into the perimeter drainage ditch located along the northeast side of the landfill adjacent to St. Charles Rock Road (the Northeast Perimeter Drainage Ditch), which then flows into the surface water body located north of Area 2 (the North Surface Water Body).

Runoff from the northern (majority) portion of Area 2 flows into one of two closed topographic depressions created by the presence of the perimeter berm located at the top of the landfill slope. Runoff from the southeastern portion of Area 2 flows to the northeast where it enters the Northeast Perimeter Drainage Ditch and subsequently flows into the North Surface Water Body. Runoff from the southernmost portion of Area 2 eventually flows to the southeast along the internal road that provides access to Area 2 and down to the drainage ditch located on the north side of the Site access road, from where it also flows to the Northeast Perimeter Drainage Ditch. Runoff from the southwestern portion of Area 2 flows as overland flow onto the Buffer Zone where it ponds, unless sufficient water accumulates such that the water reaches the western portion of the Buffer Zone where it can flow overland into a culvert that conveys stormwater to the large Earth City stormwater basin located adjacent to Area 2 and the AAA Trailer property.

Rainwater runoff (stormwater) samples were collected in 1995 by McLaren/Hart and in 1997 by EMSI during the OU-1 RI field investigations at four locations in Area 1 and six locations in Area 2 (Weirs 1 through 10, as depicted on Figure 2-15). Review of the rainwater runoff results indicates that radium levels above the drinking water standard were only present in the sample from Weir 9. Specifically, the Ra-226 level detected in the unfiltered sample obtained in April 1996 from this location was 8.85 pCi/L compared to the drinking water standard of 5 pCi/L.[11] Subsequent sampling of rainwater runoff from this location in May 1997 indicated that the combined Ra-226 (0.32 pCi/L) and Ra-228 (<0.87 pCi/L) did not exceed or even come close to the drinking water standard of 5 pCi/L.

Stormwater samples were also collected in 2016 during construction of the non-combustible cover over surface RIM in Areas 1 and 2. With one possible exception, all of these samples contained only background levels of radium and uranium. The reported activity concentrations of combined Ra-226 plus Ra-228 for these samples were all less than the radium drinking water standard of 5 pCi/L. Total uranium results were all less than 20 pCi/L (estimated equivalency to 30 µg/L drinking water standard), except for one sample from NCC-002 obtained on April 13, 2016, which was reported to contain 30 pCi/L of combined uranium isotopes. Subsequent stormwater samples were analyzed for total uranium as a metal and were below the 30 µg/L standard.

During the OU-1 RI field investigations, McLaren/Hart in 1995 and EMSI in 1997 collected samples of permanent surface water adjacent to the Site into which runoff from the Site may flow. The two surface water bodies adjacent to the Site are the North Surface Water Body[12] and the Earth City Flood Control Channel.[13] The surface water sampling locations associated with these two water bodies are shown on Figure 2-15. Analytical results for these samples did not exceed the drinking water MCL of 5 pCi/L for gross alpha. Further, none of the radium sample results exceeded the radium drinking water MCL of 5 pCi/L.

Sediment sampling was conducted in 1995, 1997, and 2016 at locations depicted on Figure 2-15. Results of the 1995 and 1997 sediment sampling and analysis indicated that Th-230, Ra-226 and Pb-210 were present in sediments above EPA Preliminary Remediation Goals (PRG) at Weirs 1, 2 and 3 in Area 1 and at Weirs 5, 6, 7 and 9 in Area 2.

Additional sediment samples were obtained from SED-1, SED-2 and SED-4 in 2016 in conjunction with the Additional Characterization of Areas 1 and 2. Only Th-230 (14.7 pCi/g) in the sample from SED-4 exceeded the unrestricted use standards; however, radionuclides were not detected in these samples at levels above the EPA PRGs for outdoor workers (19.8 pCi/g for Th-230). In response, additional sediment samples were also obtained in 2016 from the

[11] However, the filtered sample obtained from this location during the same sampling event contained only 0.80 pCi/L, indicating that the majority of the Ra-226 detected in the unfiltered sample was present as suspended sediment. Due to high MDA levels, the Ra-228 results for this sampling event did not provide any meaningful data (for purposes of comparison to the MCL).

[12] The North Surface Water Body is currently located partially onsite and partially on offsite property owned by STL Properties LLC (the former Emerson Electric property), and its composition has changed over time. During the RI investigations, the North Surface Water Body was located primarily onsite. Subsequently, the portion that is located on the Site became overgrown and silted and is now primarily swamp, except during periods of rainfall, when water ponds in this area.

[13] Based on topographic conditions, it does not appear that runoff from Areas 1 or 2 could enter the Flood Control Channel.

Northeast Perimeter Drainage Ditch at the location of SED-4 and at approximately 100-foot increments 100, 200 and 300 feet to the north of SED-4. Analytical results for these samples did not detect the presence of any radionuclides at levels above the unrestricted use criteria.

The northern portion of Area 2 is characterized by a landfill slope/berm of approximately 20 to 30 feet average height. Scouring and erosional transport of soil via rainwater runoff from the landfill berm slope down onto the adjacent former Ford Property reportedly occurred a year or two after disposal activities in Area 2 ceased. This historic erosional scour resulted in transport of soil, some of which contained radionuclides, from Area 2 down onto the adjacent former Ford Property where it meets the toe of the landfill berm. This runoff and erosion was subsequently stopped through the construction of runoff diversion berms and natural re-vegetation of the landfill slope.

Analytical results from soil samples collected from the former Ford Property during the OU-1 RI field investigation indicated that past transport of radionuclides onto the former Ford Property was limited to the upper 6 inches of soil. The current extent of radionuclide occurrences on the former Ford Property (now the Buffer Zone and Crossroads Lots 2A1 and 2A2) are unknown because these areas were graded after the most recent samples were collected from these areas; however, all of these areas are currently covered with rock and or pavement. (See prior discussion in Section 2.2.9).

2.5 Groundwater Conditions

This section briefly summarizes the results of the most recent groundwater sampling events at the Site as of the writing of this FFS.

Sampling of all of the groundwater monitoring wells at the Site (up to 85 wells per event) was conducted as part of four comprehensive groundwater sampling events performed in 2012-2013. The following results were obtained:

- Generally, only background levels of uranium and thorium were detected in groundwater during these events.
- Certain wells at the Site contained combined total radium at levels greater than the MCL (5 pCi/L) during all four of the 2012-2013 sampling events.
- Overall, no spatial correlation between occurrences of radium at levels greater than the MCL and Areas 1 and 2 could be identified.
- No contiguous area of radium occurrences indicative of a plume of groundwater contamination was present.
- The most probable source of the radium occurrences in bedrock groundwater around the North and South Quarry portions of the Bridgeton Landfill is release of naturally-

occurring radium in the bedrock units, or release of radium that was adsorbed onto iron and manganese oxides and hydroxides which have become soluble under reducing conditions associated with anaerobic (oxygen-deficient) decomposition of the MSW in the landfill.

- Based on the relatively low solubility of radionuclides in water and their affinity to adsorb onto the soil matrix, leaching of radionuclides into groundwater and subsequent transport in groundwater to off-site areas does not appear to be a significant migration pathway.

Additional evaluations of the potential for leaching and vertical transport of radionuclides in the landfill mass are currently being conducted.

Brief descriptions of the geology and hydrogeology of the Site are provided in subsections 2.5.1 and 2.5.2. More detailed information on the geology and hydrogeology is set forth in the RI Addendum (EMSI, 2016b) and the OU-1 and OU-2 RI reports (EMSI, 2000 and Herst & Associates, 2005).

The nature and extent of radiological and chemical constituent occurrences in groundwater near Areas 1 and 2 are described in Sections 2.5.3 and 2.5.4 below. Additional information regarding the nature and extent of contamination associated with Areas 1 and 2 is presented in the OU-1 RI Addendum report (EMSI, 2016b).

EPA has previously indicated that groundwater conditions at the Site will be separately characterized as part of a new Operable Unit (OU-3).

2.5.1 Geology

The bedrock geology of the Site area consists of Paleozoic-age sedimentary rocks overlying Precambrian age igneous and metamorphic rocks (EMSI, 2000). The Paleozoic bedrock is overlain by unconsolidated alluvial and loess deposits of recent (Holocene) age (EMSI, 2000).

The depth to bedrock and the thickness of the alluvial deposits increases to the west of the Site where the thickness of alluvium (depth to bedrock) was reported to be 120 feet (Herst & Associates, 2005).

2.5.2 Hydrogeology

Alluvial deposits of varying thickness are present beneath Areas 1 and 2 (See Section 5.5.1 of the RI Addendum, EMSI 2016b). The landfill debris varies in thickness from 5 to 56 feet in Areas 1 and 2, with an average thickness of approximately 36 feet in Area 1 and approximately 30 feet in Area 2. The underlying alluvium increases in thickness from east to west beneath Area 1. The alluvial thickness beneath the southeastern portion of Area 1 is less than 5 feet (bottom elevation of 420 feet AMSL), while the thickness along the northwestern edge of Area 1 is approximately 80 feet (bottom elevation of 370 feet AMSL). The thickness of the alluvial deposits beneath Area 2 is fairly uniform at approximately 100 feet (bottom elevation of 335 feet AMSL). Water level measurements performed during the RI indicated that the water level elevations beneath, and adjacent to, Areas 1 and 2 were consistent with only approximately one-half foot of variability in the water levels beneath these areas during any given set of measurements. Seasonally, the water levels varied by approximately 5 feet beneath and adjacent to Areas 1 and 2 from approximately 429 feet AMSL in April 1995 to 434 feet AMSL in July 1995. These water level elevations corresponded to depth-to-groundwater in these areas of at least 35-40 feet bgs and generally nearer to 50 feet bgs beneath Areas 1 and 2. Consequently, groundwater was generally encountered beneath Areas 1 and 2 in the underlying alluvium near or below the base of the landfill debris.

The regional direction of groundwater flow is generally northward within the Missouri River alluvial valley, parallel or sub-parallel to the river alignment. The RI data indicate that only a very small amount of difference (less than one foot) exists in the water table surface beneath the Site, making interpretations of the directions of groundwater flow based only on water level data difficult. Based on the water level data, the direction of groundwater flow beneath Area 1 during the RI appeared to be generally to the south toward the Bridgeton Landfill. Water level elevations beneath Area 2 displayed areal differences of less than one foot indicating the presence of a relatively flat water table. Based on the groundwater levels, the direction of groundwater flow beneath Area 2 is expected to be to the west/northwest toward the Missouri River.

There are no public water supply wells near the Site. Well inventories presented in the RI report (EMSI, 2000) and in the RI for OU-2 (Herst & Associates, 2005) indicate that the nearest private well reportedly used as a drinking water source is located one mile to the north of the Site (Foth & Van Dyke, 1989), and that the closest registered well is located approximately one mile northeast of the Site. This well was reportedly drilled to a depth of 245 feet, which indicates a bedrock completion. Regional groundwater flow in the bedrock near the Site is to the northwest, towards the Missouri River. Accordingly, the nearest registered well is not downgradient of the Site. The closest registered well that appears to be completed in alluvium is approximately 2.5 miles south (upgradient) of the Site.

An updated evaluation of the locations of water supply wells was performed by USGS during the performance of the 2012-2013 comprehensive groundwater sampling events. Information regarding the locations of water supply wells is provided in the RI Addendum and the associated figures. Overall, the wells located to the north and west of the Site (*i.e.*, downgradient) are used for industrial and commercial purposes such as irrigation, construction, and dewatering (levee system operations). None of the wells are used to provide domestic or community (potable) water supplies.

Detailed discussions of the hydrogeology of the alluvial groundwater and bedrock groundwater are presented in the RI Addendum (EMSI, 2016b) and the OU-1 and OU-2 RI reports (EMSI, 2000 and Herst & Associates, 2005).

2.5.3 Occurrences of Radionuclides in Groundwater

Groundwater sampling and analysis was performed during 1995, 1996 and 1997 as part of the 2000 RI and during 2004 in conjunction with the FS. To date, the most comprehensive groundwater data sets for the Site were developed during the site-wide groundwater sampling events conducted in August 2012 and April, July, October, and November 2013.[14] The focus of the discussions presented in this section is largely on the results obtained from the 2012/2013 comprehensive groundwater sampling events. A comparison of the results obtained by the 2012/2013 events to results obtained during the earlier RI and FS events is presented in the RI Addendum (EMSI, 2016b).

Radionuclide water quality results are discussed in terms of radium isotopes, thorium isotopes, and uranium isotopes. Because radium isotopes are the primary radionuclides of concern (in terms of general occurrences in groundwater, mobility, and potential health risks), the majority of the discussion of the radionuclide water quality results is focused on occurrences of radium in groundwater.

It should be noted that both Ra-226 and Ra-228 are naturally occurring (EPA, 2006b and 2002 and Focazio, et al., 2000). Background levels of naturally-occurring Ra-226 in groundwater are expected to range from 1 to 5 pCi/L, and background levels of naturally-occurring Ra-228 in groundwater are expected to range from 1 to 7 pCi/L. However, Ra-226 levels as high as 35 pCi/L and Ra-228 levels as high as 26 pCi/L have been reported for samples obtained from wells located to the south (upgradient) and away from the disposal units at the Site, and more particularly upgradient of Areas 1 and 2.

EPA has established (40 CFR Part 141) an MCL of 5 pCi/L for combined Ra-226 plus Ra-228 in drinking water supplies. Although this standard is not applicable to groundwater that is not used for drinking water, it was determined by EPA (2008a) to be a potentially relevant and appropriate requirement for evaluation of groundwater quality. Therefore, the combined radium results from the recent groundwater monitoring events have been compared to 5 pCi/L.

A graphical display of the results of the comparisons of the combined total (unfiltered samples) radium results to the radium MCL is shown on Figure 2-16. A graphical display of the results of the comparisons of the combined dissolved (filtered samples) radium results to the MCL is shown on Figure 2-17. The overall distribution of wells that contain combined total and/or combined dissolved radium levels greater than the MCL indicates that a mechanism other than leaching to and migration within groundwater from Areas 1 and 2 is responsible for these radium occurrences.

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[14] In addition to the four events requested by EPA, two additional sampling events were conducted to obtain samples from eight new monitoring wells that were installed by Bridgeton Landfill, LLC in October 2013. These eight wells were sampled in November 2013 and February 2014.

2.5.4 Occurrences of Chemical Constituents in Groundwater

The most extensive program of groundwater sampling and chemical analyses conducted were those associated with the four comprehensive groundwater sampling events conducted in August 2012 and April, July and October 2013. During these events, up to 85 monitoring wells located throughout the entire Site were sampled and submitted for chemical analyses, including VOCs, trace metals, inorganic parameters and during the first event, SVOCs.

2.5.4.1 Volatile Organic Compounds in Groundwater

The groundwater samples collected from all of the Site wells during the 2012 – 2013 comprehensive groundwater monitoring events were analyzed for 49 different VOCs. Most of these VOCs were not detected in any of the groundwater samples. The primary VOCs that were detected in some of the groundwater monitoring wells included benzene and related hydrocarbon compounds (toluene, ethyl benzene, xylenes, methyl tert-butyl ether, and cumene), chlorobenzene and other chlorinated benzenes (1,4-dichlorobenzene), and vinyl chloride and related chlorinated solvents (1,2-dichloroethene). Of these, only benzene, chlorobenzene and vinyl chloride were detected at concentrations above their respective groundwater standards (5 µg/L for benzene, 100 µg/L for chlorobenzene and 2 µg/L for vinyl chloride).

Benzene was the most commonly detected VOC. Benzene has been detected at concentrations greater than its MCL of 5 µg/L in three distinct areas of the Site, as shown on Figure 2-18.

Chlorobenzene was detected in 24 to 25 monitoring wells during each of the 2012 – 2013 groundwater monitoring events (Figure 2-19). Chlorobenzene was detected in only two monitoring wells (PZ-112-AS and LR-105) at concentrations greater than its MCL of 100 µg/L (Figure 2-19).

Vinyl chloride was detected in 4 to 10 wells during each event (Figure 2-20). Vinyl chloride was detected in only four monitoring wells at concentrations greater than its MCL of 2 µg/L during some but not all of the 2012 – 2013 groundwater monitoring events (Figure 2-20).

Overall, VOC occurrences in groundwater at the Site are isolated and do not indicate the presence of an extensive area or plume of VOC contamination. Most of the benzene in the groundwater is near the South Quarry portion of the Bridgeton Landfill and the southern portion of the Inactive Sanitary Landfill.

2.5.4.2 Semivolatile Organic Compounds in Groundwater

The August 2012 groundwater samples were analyzed for SVOCs. Very few SVOCs were detected. The most commonly detected SVOC was 1,4-dichlorobenzene, which was detected in

11 of the 73 monitoring wells that were sampled and analyzed for SVOCs. The highest detected concentration of 1,4-dichlorobenzene was 19 µg/L in LR-105, which is less than the corresponding Missouri water quality standard of 75 µg/L. Overall, SVOCs were detected in only a few groundwater samples from the Site and generally at levels below their respective drinking water standards.

2.5.4.3 Trace Metals

Most of the trace metals were detected in most of the groundwater samples; however, many of the trace metals were not detected at concentrations greater than their respective MCLs or were only detected in the total fraction samples at concentrations above the MCLs, possibly indicating that their presence is due to inclusion of suspended sediment/colloidal matter in the unfiltered samples. The primary trace metals of interest that were detected in the groundwater monitoring wells include arsenic, iron, manganese, and barium.

2.5.4.3.1 Arsenic

Figure 2-21 presents a graphical summary of the locations where total (unfiltered) arsenic was detected above its MCL of 10 µg/L. The highest levels of total arsenic were reported for samples obtained from wells PZ-114-AS and S-82 near Area 1 and in wells PZ-302-AS and PZ-304-AS located on the west side of the Inactive Sanitary Landfill.

Figure 2-22 presents a graphical summary of the locations where dissolved arsenic was detected above its MCL of 10 µg/L. The highest levels of dissolved arsenic were reported for samples obtained from the same wells as those that contained high concentrations of total arsenic (*e.g.*, PZ-114-AS, PZ-302-AS, PZ-304-AS, and S-82).

2.5.4.3.2 Iron

Occurrences of total and dissolved iron at levels above its MCL (300 µg/L) were found throughout the Site area (Figures 2-23 and 2-24). The highest levels of iron were generally detected near the Inactive Sanitary Landfill and Area 1. The iron in the groundwater at the Site is consistent with the presence of reducing conditions associated with MSW decomposition in landfill settings.

2.5.4.3.3 Manganese

Occurrences of total and dissolved manganese at levels above its MCL (50 µg/L) were found throughout the Site area (Figures 2-25 and 2-26). The highest levels of manganese were generally detected near the Inactive Sanitary Landfill, between the Closed Demolition Landfill and Area 2, near Area 1, beneath the hauling company yard to the east of the North Quarry portion of the Bridgeton Landfill, and near the southern corner of the South Quarry portion of the Bridgeton Landfill.

The occurrences of manganese in groundwater at the Site are, similar to iron, consistent with the presence of reducing conditions associated with decomposition of MSW.

2.5.4.3.4 Barium

Occurrences of total and dissolved barium at levels above its MCL (2,000 µg/L) are summarized on Figures 2-27 and 2-28.

As shown, three wells (D-3, D-85, and PZ-113-AD) contained barium in the total fraction (unfiltered) samples at concentrations greater than its MCL of 2,000 µg/L during the 2012-2014 events. All three of these wells are near Area 1. Three other wells (PZ-112-AS, I-73, and PZ-304-AS) contained total barium above its MCL during some, but not all, of the 2012-2013 monitoring events. No other wells displayed total barium levels above its MCL.

Six wells contained dissolved barium levels above its MCL during some, but not all four, of the 2012-2013 monitoring events, including D-3, PZ-113-AD and PZ-112-AS near Area 1; I-73 and MW-1204 near the South Quarry portion of the Bridgeton Landfill; and PZ-304-AS along the west side of the Inactive Sanitary Landfill.

None of the groundwater samples obtained from wells located around Area 2 ever detected barium at concentrations greater than its MCL.

2.5.4.4 Inorganic Constituents

Results obtained for two inorganic constituents, sulfate and chloride are summarized in this section. Additional information regarding occurrences of inorganic constituents is presented in the RI Addendum (EMSI, 2016b).

2.5.4.4.1 Sulfate

Only four wells contained sulfate at concentrations above its MCL (250 µg/L): wells D-12 and S-10 in Area 2, well MW-102 on the west side of Area 2, and well PZ-204A-SS on the southwest side of the South Quarry portion of the Bridgeton Landfill (Figure 2-29). Of these, sulfate was reported at concentrations above its MCL during all 2012-2013 events for wells S-10 and D-12 and during the last two 2013 events for wells MW-102 and PZ-204A-SS.

2.5.4.4.2 Chloride

Chloride is a common constituent of landfill leachate. The highest levels of chloride were detected in wells I-73 (1,700 mg/L in July 2013), MW-1204 (1,400 mg/L in October 2013), and LR-105 (930 mg/L in April 2013). Occurrences of chloride at concentrations greater than its MCL of 250 mg/L were detected in nine of the 85 wells sampled during all 2012-2013 events (Figure 2-30). Chloride was detected at concentrations greater than its MCL during one or more, but not all four, events in 14 additional wells (Figure 2-30). Occurrences of chloride above the MCL were generally found in wells located around the South Quarry portion of the Bridgeton Landfill, the west side of the Inactive Sanitary Landfill, around Area 1, and along the east and south sides of Area 2 (Figure 2-30).

2.5.5 Possible Radionuclide and Chemical Contributions to Groundwater from Areas 1 and 2

The results of the 2012–2013 groundwater monitoring activities clearly indicate that Areas 1 and 2 are not contributing either uranium or thorium to the groundwater. This is not unexpected given the very low solubility of thorium and the low solubility of uranium, especially under reducing conditions, which often occur in and around MSW landfills.

Evaluation of potential radium contributions to groundwater from Areas 1 and 2 is influenced by the presence of higher levels of radium in upgradient bedrock wells. All of the radium results obtained from alluvial monitoring wells located within or downgradient of Areas 1 and 2 were less than or similar to the radium levels observed in bedrock and alluvial monitoring wells located upgradient or upgradient/cross-gradient from Areas 1 and 2. This observation is consistent with the conclusion offered by the USGS that "there is not a strong spatial association of monitoring wells surrounding or downgradient of RIM areas with elevated radium concentrations as might be expected if RIM areas were releasing substantial quantities of radium to the groundwater." (USGS, 2014, p. 43).

With the possible exception of benzene occurrences in the southwestern portion of Area 1 (*i.e.*, wells D-14, I-4, and PZ-112-AS), chlorobenzene in PZ-112-AS, and vinyl chloride occurrences in the southwestern portion of Area 2 (*i.e.*, wells I-9 and D-93), there are no VOC impacts to groundwater beneath or immediately downgradient of Areas 1 and 2. The majority of wells in or around Areas 1 and 2 were either non-detect for VOCs or contained trace levels of VOCs (less than their respective MCLs).

Occurrences of arsenic, iron, manganese, barium and sulfate were detected in groundwater throughout the Site and reflect dissolution of these substances from the landfilled wastes and/or possibly enhanced dissolution of these substances from naturally-occurring minerals within the alluvial and bedrock units due to the presence of reducing conditions associated with waste decomposition within the landfills. The monitoring data do not indicate that Areas 1 and 2 are contributing significantly greater amounts of trace metals or inorganic constituents than occur in other landfill areas at the Site, or at other offsite landfills.

2.6 Baseline Risk Assessment

To be provided in a subsequent submittal.

3 POTENTIAL ARARS AND REMEDIAL ACTION OBJECTIVES

This section of the FFS describes environmental laws which may represent potentially applicable or relevant and appropriate requirements (ARARs) for remedial actions for OU-1. This section also describes additional requirements associated with offsite disposal. Remedial action objectives (RAOs) to be addressed by the remedial alternatives are also presented in this section. Cleanup levels that would allow for unrestricted use of the Site relative to radionuclide occurrences are developed in this section based on EPA's directives regarding chemical-specific ARARs and Site-specific risk-related factors. Cleanup levels associated with partial excavation alternatives identified by EPA (EPA, 2015a) are also discussed.

3.1 Potentially Applicable or Relevant and Appropriate Requirements

CERCLA remedial actions must be analyzed for compliance with ARARs. ARARs are divided into three categories (EPA, 1988):

- Chemical-specific ARARs;
- Location-specific ARARs; and
- Action-specific ARARs.

Compliance with ARARs is one of the criteria used to evaluate potential remedial alternatives in an FS. Descriptions of ARARs, the criteria used to identify whether a regulation contains potentially applicable or relevant and appropriate requirements for remedial actions for OU-1, and identification of potential ARARs for OU-1 are provided in the FS and SFS reports (EMSI, 2006 and EMSI et al., 2011). The following sections provide additional evaluation of ARARs as they relate to the ROD-selected remedy, the "complete rad removal" and the partial excavation alternatives. In addition, this section addresses additional ARARs evaluation specified by EPA in the SOW.

3.1.1 Potential Chemical-Specific ARARs

Chemical-specific ARARs include those laws and requirements that regulate the release to the environment of materials possessing certain chemical or physical characteristics, or containing specified chemical compounds. Evaluations of potential chemical-specific ARARs for West Lake Landfill OU-1 are presented in the FS and SFS reports (EMSI, 2006 and EMSI et al., 2011). The results of these evaluations are summarized on Table 3-1 and are discussed below. No additional chemical-specific ARARs have been identified as a result of work performed for this FFS or relative to the additional evaluations of the "complete rad removal" and partial excavation alternatives.

3.1.1.1 Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings

The FS report (EMSI, 2006) includes an evaluation of the health and environmental protection standards promulgated under the Uranium Mill Tailings Radiation Control Act (UMTRCA) (40 CFR Part 192) for potential chemical- and action-specific requirements. Because the UMTRCA standards only apply to certain designated uranium mill tailings sites, they are not applicable to the Site. The UMTRCA standards may nonetheless represent potentially relevant and appropriate requirements for remedial actions at the Site.

The UMTRCA regulations establish specific standards for waste disposal units containing residual radioactive material and for land outside of such waste disposal units that has been contaminated with radionuclides as a result of uranium processing or waste disposal activities. Standards associated with management of a tailing pond or waste disposal unit are evaluated for potential relevance with respect to the solid waste disposal units in Areas 1 and 2, while standards associated with occurrences of radionuclides in land outside of a waste disposal unit (such as the Buffer Zone and Crossroads Industrial Park) are evaluated relative to areas outside of the Areas 1 and 2.

Specifically, the FS and SFS addressed requirements relative to the standards for radon emissions from closed tailing impoundments (40 CFR Part 192 Subpart A), standards for cleanup of contaminated land and buildings (40 CFR Part 192 Subpart B), and groundwater protection standards (40 CFR Part 192 Subparts A and B). Additional discussion of these standards as they relate to the ROD-selected remedy and the “complete rad removal” and partial excavation alternatives is presented below.

3.1.1.1.1 Radon Emissions Standards – 40 CFR § 192.02(b)

The UMTRCA regulations establish standards of release of radon to the atmosphere from residual radioactive material (40 CFR § 192.02(b)). Specifically, these standards state that control of residual radioactive materials and their listed constituents shall be designed to:

> (b) Provide reasonable assurance that releases of radon-222 from residual radioactive material to the atmosphere will not:
>
> (1) Exceed an average release rate of 20 picocuries per square meter per second, or
>
> (2) Increase the annual average concentration of radon-222 in air at or above any location outside the disposal site by more than one-half picocurie per liter.

Section 192.02(b)(1) further states that the average release rate specified therein “ shall apply over the entire surface of the disposal site and over at least a one-year period.”

These standards may potentially be relevant and appropriate chemical-specific criteria for radon emissions from Areas 1 and 2, and also represent potential performance criteria for the design of a cover system for Areas 1 and 2 included in the ROD-selected remedy and the partial excavation alternatives.

Radon monitoring was performed as part of the RI for OU-1 (see prior discussion in Section 2.3.1). These results indicate that the overall radon emission from Areas 1 and 2 (21.8 pCi/m^2/s based on the average of 50 test locations) slightly exceeded the 20 pCi/m^2/s radon emission flux standard as a result of the presence of three high value samples. Additional radon flux monitoring was performed as part of the construction of a non-combustible cover over Areas 1 and 2 and demonstrated that the average radon flux from these areas both individually and collectively meets the UMTRCA radon emission standard. In addition, monitoring performed along the margins of Areas 1 and 2 has demonstrated that under current conditions the radon emission rate from these areas meets the UMTRCA standard of no more than 0.5 pCi/L increase in radon levels in air outside of Areas 1 and 2 (see prior discussion in Section 2.3.1). Furthermore, an evaluation of the design and thickness of a landfill cover associated with the ROD-selected remedy and the partial excavation alternatives necessary to meet the 20 pCi/L and 0.5 pCi/L standards in the future based on the anticipated level of radium in-growth over time has been performed as part of the evaluation of potential remedial alternatives as discussed in Section 6 of this FFS.

Remedial actions involving placement of an engineered cover pursuant to the ROD-selected remedy or the partial excavation alternatives should be designed to meet the radon emission standard promulgated under UMTRCA. Because this standard applies to design, monitoring after disposal is not required to demonstrate compliance with this standard. However, due to the anticipated increase in radium expected to occur over time from decay of thorium, the design of an engineered cover should be based on projected future radium activity levels and associated radon generation instead of the currently observed radon flux levels.

The UMTRCA radon standards relative to any occupied or habitable building (40 CFR § 192.12(b)(1)) represent potentially relevant and appropriate requirements for radon monitoring relative to occupied buildings. Specifically, the objective of the remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed a 0.02 Working Level (WL) (40 CFR § 192.12(b)(1)). In any case, the radon decay product concentration (including background) shall not exceed a 0.03 WL (40 CFR § 192.12(b)(1)). A Working Level is a unit of measure for documenting exposure to radon decay products, which are termed "daughter products" or simply "daughters." One Working Level is defined as any combination of short-lived daughters in one liter of air which will ultimately release 1.3 x10^5 MeV (million electron volts) of alpha by decay through polonium-214. One Working Level is equal to approximately 200 pCi/L.

3.1.1.1.2 Standards for Cleanup of Contaminated Land – 40 CFR § 192.12(a)

Requirements relative to standards for cleanup of land contaminated with residual radioactive materials from an inactive uranium processing site (40 CFR § 192.12(a)) are evaluated as potentially relevant and appropriate chemical-specific ARARs in the FS (EMSI, 2006). These standards state that:

> Remedial actions shall be conducted so as to provide reasonable assurance that, as a result of residual radioactive materials from any designated processing site:
>
> (a) The concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than—
>
> (1) 5 pCi/g, average over the first 15 cm of soil below the surface, and
> (2) 15 pCi/g, averaged over 15 cm thick layers of soil more than 15 cm below the surface.

OSWER Directive 9200.4-25, titled "Use of Soil Cleanup Criteria in 40 CFR Part 192 as Remediation Goals for CERCLA Sites" (EPA, 1998a) (the CERCLA UMTRCA guidance) discusses the potential applicability, relevance and appropriateness, and use of the soil cleanup standards established pursuant to UMTRCA at CERCLA sites. Pursuant to the CERCLA UMTRCA guidance, EPA has determined that the surface soil standard for cleanup of soil at UMTRCA sites (5 pCi/g plus background for combined Ra-226 plus Ra-228 or combined Th-230 plus Th-232) would only be applicable to cleanup of uranium mill tailings at the 24 uranium mill tailing sites designated under Section 102(a)(1) of UMTRCA (Title I sites). The West Lake Landfill Superfund Site is not a Title I site and therefore these standards are not applicable to any remedial actions at the Site. In addition, the UMTRCA standards apply to "land," which is defined in the regulations as any surface or subsurface land that is not part of a disposal site and is not covered by an occupiable building (40 CFR § 192.11(b)). Therefore, these requirements are not relevant or appropriate to the solid waste disposal units within OU-1 Areas 1 and 2.

Further, the UMTRCA standards are not relevant and appropriate requirements for remedial actions related to Areas 1 and 2 because they do not address specific conditions which are sufficiently similar to conditions at the Site. The UMTRCA mine tailings standards for cleanup of land and buildings contaminated with residual radioactive materials established pursuant to 40 CFR § 192.12(a) were not developed or intended to address conditions at solid waste disposal units. As indicated in the CERCLA UMTRCA guidance, "[t]he purpose of these standards [is] to limit the risk from inhalation of radon decay products in houses built on land contaminated with tailings, and to limit gamma radiation exposure of people using contaminated land." The Site is a solid waste landfill that is subject to controls on future land use which will prevent the construction of houses or other inhabitable structures over the waste materials within Areas 1 and 2, regardless of whether radiologically-impacted materials are present or not. Institutional controls to restrict residential use of the property have previously been developed and implemented by the owners of the various parcels of land that comprise the Site, including OU-1, OU-2 and other portions of the Site. In addition, implementation of institutional controls to restrict future use of solid waste disposal sites is required by the Missouri Solid Waste Regulations (10 CSR 80-3.010(20)(C)2.C.II). Further, even if a "complete rad removal" alternative were to be implemented, non-radiological waste materials would still remain onsite, thereby requiring institutional controls as required for RCRA Subtitle D landfills which would prevent construction of houses or other inhabitable structures on the Site (EPA SOW, 2010b). Therefore, the standards established pursuant to 40 CFR § 192.12(a) do not address situations sufficiently similar to those present within the solid waste management units at the Site, so the standards are neither relevant nor appropriate. However, the FS concluded that the portion of these regulations addressing cleanup levels for offsite impacted soil may be potentially relevant and appropriate criteria for remedial action, if any, involving excavation of radiologically-impacted soil on the Buffer Zone/Crossroads Property.

The CERCLA UMTRCA guidance further indicates that for CERCLA sites where subsurface contamination exists at a level between 5 pCi/g and 15 pCi/g averaged over areas of 100 square meters, conditions are not considered to be sufficiently similar to an UMTRCA site to warrant use of the UMTRCA subsurface soil standard of 15 pCi/g over background as a relevant and appropriate requirement. Instead, EPA recommends 5 pCi/g as a suitable subsurface cleanup level so long as a site-specific risk assessment demonstrates that 5 pCi/g is protective. EPA further notes that when the UMTRCA subsurface cleanup standards are found to be relevant and appropriate requirements for a CERCLA site, the 5 pCi/g standard should be applied to both the combined levels of radium-226 and radium-228, and to the combined level of thorium-230 and thorium-232, in order to provide reasonable assurance that the preceding radionuclides in the series would not be left behind at levels that would permit the combined radium activity to build up to levels exceeding 5 pCi/g after completion of the response action.

Finally, and as stated in the CERCLA UMTRCA guidance, the standards established pursuant to 40 CFR § 192.12(a) do address cleanup of so-called "vicinity" sites at which cleanup to unrestricted use is authorized for specified off-site properties. Because these "vicinity" sites are related solely to the 24 UMTRCA Title I sites, the standards established for vicinity sites are not applicable to any remedial actions at the West Lake Landfill. Overland gamma surveys and surface soil sampling of Area 2 indicated that soil containing radionuclides eroded from the surface of Area 2 and was deposited on the surface of the adjacent Buffer Zone and a portion of the Crossroads Industrial Park. Subsequent site development of the Crossroads Industrial Park resulted in regrading and placement of surface soil previously located on Lots 2A1 and 2A2, which are owned by Crossroad Properties, LLC (Crossroad), onto the Buffer Zone. Current conditions relative to occurrences of radionuclides at the Buffer Zone and Crossroad Lots 2A1 and 2A2 are unknown but are to be the subject of additional investigation and sampling as part of the ROD-selected remedy for OU-1. Remaining occurrences of radionuclides, if present, on these properties would represent a condition that may be sufficiently similar to the conditions associated with the "vicinity" sites addressed by the UMTRCA regulations. Therefore, the standards established pursuant to 40 CFR § 192.12(a) potentially may represent relevant and appropriate requirements for remedial actions that may be taken to address radionuclides in soil at the Buffer Zone/Crossroads Property.

3.1.1.1.3 Groundwater Protection Standards – 40 CFR 192 Subparts A and B

The concentration limits established under the groundwater protection standard of the UMTRCA regulations (40 CFR § 192.02(c)(3)) present potentially relevant and appropriate standards for groundwater quality at the Site. With only two exceptions, none of the hundreds of measurements of uranium concentrations in groundwater obtained during the 1995 – 1997 RI, 2004 FS and the 2012-2013 groundwater sampling events approached the UMTRCA standard of 30 pCi/L for uranium. The first exception was the total fraction uranium result from well S-53 obtained in April 2013, after a long period over which this well had not been sampled. Neither the associated dissolved sample nor the subsequent two (July 2013 and October 2013) total and dissolved samples from this well contained uranium activities close to the UMTRCA standard. The other exception was the first total fraction sample obtained from newly installed well PZ-211-SD in November 2013. Again, neither the contemporaneous dissolved fraction sample nor the subsequent total or dissolved fraction samples from this well in February 2014 displayed uranium activities levels near the UMTRCA standard. The groundwater monitoring data indicate that upon proper development and continued sampling of the monitoring wells, the uranium levels in groundwater at the Site meet the UMTRCA standard.

As previously discussed in Section 2.5.3 and in more detail in the RI Addendum, wells containing total (unfiltered samples) and dissolved (filtered samples) combined radium (Ra-226 plus Ra-228) levels greater than the UMTRCA standard were identified throughout the Site including at locations upgradient and distant from Areas 1 and 2. The overall broad distribution of wells containing combined total and dissolved radium levels greater than the MCL, including occurrences in areas of the Site that are upgradient or cross-gradient of Area 1 and 2, indicates that another mechanism, beyond leaching to and migration in groundwater from Areas 1 and 2, is responsible for these radium occurrences. The most likely mechanism responsible for the broad distribution of radium at the site is mobilization of naturally-occurring radium from the soil and rock in response to the presence of reducing conditions associated with decomposition of the landfilled wastes.

Concentrations of trace metals in groundwater were previously discussed in Section 2.5.4. Occurrences of arsenic, iron, manganese, barium and sulfate were detected throughout the Site and reflect dissolution of these substances from the landfilled wastes and/or possibly enhanced dissolution of these substances from naturally-occurring minerals within the alluvial and bedrock units due to the presence of reducing conditions associated with waste decomposition within the landfills. The monitoring data do not indicate that Areas 1 and 2 are contributing significantly greater amounts of trace metals or inorganic constituents than occur in other landfill areas onsite or at other offsite landfills.

Based on the presence of radioactive materials at OU-1 and the potential for leaching trace metals to groundwater, the groundwater protection standards (40 CFR §§ 192.02(c)(3) and (4)) and monitoring requirements (40 CFR § 192.03) of the UMTRCA regulations are potentially relevant and appropriate to the ROD-selected remedy and the partial excavation alternatives.

3.1.1.2 Other Potential Chemical-Specific ARARs

Other potential chemical-specific ARARs are identified and evaluated in the FS (EMSI, 2006) and are summarized on Table 3-1. Some of these ARARs were determined to be potentially applicable or relevant and appropriate to OU-1, and in particular to the ROD-selected remedy and partial excavation alternatives. These include the following:

- The National Emissions Standards for Hazardous Air Pollutants (NESHAPs) standards for radon-222 emissions (40 CFR Part 61 Subpart T);

- The Missouri Radiation Regulations for Protection Against Ionizing Radiation (19 CSR 20-10.040); and

- Missouri Maximum Contaminant Levels (10 CSR Division 60 Chapter 4)

3.1.1.2.1 National Emissions Standards for Hazardous Air Pollutants

The NESHAPs include standards for radon-222 emissions to ambient air from designated uranium mill tailings piles that are no longer operational. Specifically, these standards provide that radon-222 emissions from inactive uranium mill tailings piles should not exceed 20 $pCi/m^2/s$ (40 CFR Part 61 Subpart T). Because West Lake Landfill OU-1 is not a designated uranium mill tailings site, this requirement is not applicable. Insofar as a portion of the waste materials in West Lake Landfill OU-1 do emit radon, however, the NESHAP standards are potentially relevant and appropriate to the ROD-selected remedy and the partial excavation alternatives.

The “complete rad removal” with off-site disposal alternative includes removal of all RIM above the cleanup standards from Areas 1 and 2 and from the Buffer Zone/Crossroads Property, if necessary, such that additional engineering and institutional controls would not be required due to the radiological content of Areas 1 and 2. As the RIM would be disposed offsite, there would be no RIM left at the Site above the cleanup standards. Therefore, the radon NESHAP is not considered to be a relevant and appropriate requirement for this alternative.

3.1.1.2.2 Nuclear Regulatory Commission Standards for Protection Against Radiation

The Nuclear Regulatory Commission (NRC) Standards for Protection Against Radiation (10 CFR Part 20) apply only to persons licensed by the NRC to use or handle nuclear materials under certain, defined circumstances. *See* 10 CFR § 20.1002. Since no licenses have been issued by NRC for the West Lake Landfill, Part 20 is not applicable.

However, Part 20 contains standards for protection against radiation, certain subparts of which may, under certain circumstances, represent potentially relevant and appropriate requirements for OU-1.

Subpart D to Part 20 contains radiation dose limits for members of the public, who are located beyond the licensee's restricted area. Because there is no license for the West Lake Landfill, there is no restricted area. Therefore, the limits in Subpart D are not generally relevant or appropriate. However, if one were to consider the Site boundary for OU-1 as a surrogate for the restricted area, then the limits in Subpart D might be viewed as relevant and appropriate during the course of a remedial action for purposes of identifying non-occupational radiation dose limits.

Subpart C to Part 20 contains occupational radiation dose limits. Occupational doses are defined as the dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to radiation. Occupational doses do not include doses received as a member of the public (i.e., people in locations beyond the restricted area, or people within the restricted area whose jobs do not involve exposure to radiation). Because there is no license for the West Lake Landfill, there is no restricted area. Therefore, the limits in Subpart C are not generally relevant or appropriate. However, if one were to view the Site boundary for OU-1 as a surrogate for the restricted area, then the limits in Subpart C might be viewed as relevant and appropriate during the course of a remedial action for purposes of identifying occupational radiation dose limits. In such case, various protective measures required by Part 20 and NRC guidance may also apply, such as establishment of radiation monitoring and protection programs to control occupational doses within limits. *See, e.g.*, 10 CFR 20 Subpart F (survey and monitoring requirements for individual exposures), Subpart H (respiratory protection and controls), and Subpart J (caution signs and other warning labels). As a precaution, these protective measures previously have been implemented at the Site, and will be continue to be performed as part of the ROD remedy phase.

Finally, depending on the nature of the remedy, the waste disposal requirements set forth in 10 CFR Subpart K may be relevant and appropriate (if, for example, certain treatment methods are used to address the radionuclides within OU-1, or if radionuclide-impacted soils are shipped offsite for treatment or disposal).

3.1.1.2.3 Missouri Maximum Contaminant Levels

EPA has established MCLs and Maximum Contaminant Level Goals (MCLGs) pursuant to the Safe Drinking Water Act (40 CFR Part 141, Subparts F and G). Implementation of the requirements of the Safe Drinking Water Act in Missouri has been delegated to the State of Missouri and is the subject of regulations promulgated by the MDNR.

These regulations (10 CSR Division 60 Chapter 4) establish MCLs for public drinking water systems. Because the Site does not operate a public drinking water system, these regulations are not applicable to the remedial actions under consideration for OU-1. Because groundwater beneath the Site is part of a larger alluvial aquifer which could potentially be used for drinking water by private and/or public wells outside of the Site, these regulations, while not directly applicable, are potentially relevant to the remedial actions evaluated under this FFS. These regulations are potentially relevant and appropriate for remedial actions for OU-1 insofar as they identify MCLs for certain chemicals in drinking water, and some of the chemical constituents that are the subject of these regulations have been detected in one or more groundwater monitoring wells located within or adjacent to Areas 1 and 2. The MCLs provide numerical standards against which the groundwater monitoring results obtained as part of the remedial action can be evaluated to assess the overall protectiveness of the remedy and the effectiveness of the various remedy components.

3.1.2 Potential Location-Specific ARARs

Location-specific ARARs are those requirements that relate to the geographical or physical location of the site or remedial action rather than the nature of the contaminants or the actions being taken. The FS (EMSI, 2006) includes evaluations of potential location-specific ARARs. The results of these evaluations are summarized on Table 3-2. The significant location-specific ARARs identified in the FS are those related to floodplain management and the site selection standards of the Missouri Solid Waste Management regulations regarding proximity to airport runways and floodplains. The requirements of these regulations are discussed below.

3.1.2.1 Floodplain Management

Executive Order 11,988, 40 CFR § 6.302(b), and the Missouri Governor's Order 82-19 relative to floodplain management are identified in the FS (EMSI, 2006) as potential location-specific ARARs relative to floodplain management (Table 3-2 in the FS). The Buffer Zone and Crossroads Property are located within the historic floodplain of the Missouri River. These areas are currently protected by the engineered Earth City levee and flood control system. As discussed in Section 2.1.6 and shown on Figure 2-9, other than the OU-2 stormwater retention basin and on-site soil borrow and stockpile area, the entire West Lake Landfill site (including all of the disposal areas) is outside the 0.2-percent annual chance (500-year) floodplain.

The goal of floodplain mitigation is to lessen the potential impact floods have on people, property and the environment. Impacts can occur due to forces of water causing damage to location-specific or project-specific structures and/or to the overall functions of the floodplain, which may include the flood-holding capacity of the floodplain, fish and wildlife habitat values of the floodplain, water quality functions of the floodplain, or other hydrological processes (*e.g.*, groundwater recharge). The nature of potential mitigative measures depends on the nature of the potential impacts that could occur. For example, with respect to location- or project-specific structures, flood-protection techniques such as elevation of critical structures, application of rip-rap armoring, or other measures to reduce impacts of flooding on project structures may be appropriate mitigation measures. Mitigation of potential impacts to the overall functions of a floodplain could also include construction and operation of stormwater detention basins to offset reductions in flood-holding capacity or water quality functions of a floodplain, or designation of open/natural areas to offset habitat loss from construction in a floodplain.

Because the Site is located outside of the 0.2-percent annual chance (500-year) floodplain, no mitigative actions would be required unless the remedial action (1) impacts the base floodplain, (2) indirectly supports floodplain development, or (3) is a critical action. Critical actions are those for which even a slight chance of flooding would be too great. Remedial actions for OU-1 are not expected to impact the base floodplain or indirectly support floodplain development. In the event of a failure of the Earth City Levee system (which provides protection from flood events with a recurrence interval greater than 500 years), floodwaters could reach the Buffer Zone and Crossroads Property[15]. Due to the distance from the river, such floodwaters would not be expected to be high energy, but instead would be nearly stagnant and without the velocity and energy capable of resulting in significant erosion of these areas.

3.1.2.2 Missouri Solid Waste Management Regulations – Site Selection

The Missouri Solid Waste Regulations contain site selection standards that apply to new or operating landfills (10 CSR 80.3.010(4)). Some of the site-selection standards also apply to horizontal expansions of existing landfills. The solid waste site-selection standards address landfills located in proximity to airports, within 100-year floodplains, within wetlands, within seismic impact zones, and within unstable areas. The site selection criteria also specify site condition information required for design and operation plan submittals and requirements relative to the base elevation of a landfill liner to the depth of groundwater.

Because Areas 1 and 2 are neither new nor operating landfills, these requirements are not considered applicable to remediation of Areas 1 and 2. Although these standards are not applicable to Areas 1 and 2, certain of them are considered to be potentially relevant and appropriate to Areas 1 and 2. In particular, the regulatory requirements relating to airport safety and floodplains are potential ARARs for the ROD-selected remedy, the partial excavation alternatives, and the “complete rad” removal alternatives because regrading or excavation of wastes within Areas 1 and 2 is a component of each of these alternatives. These potential ARARs are described below.

3.1.2.3 Missouri Solid Waste Management Regulations – Floodplains

The Missouri Solid Waste Regulations contain requirements for landfills located within floodplains (10 CSR 80-3.010(4)(B)2). Specifically, owners/operators of sanitary landfills located in 100-year floodplains must demonstrate to MDNR that the sanitary landfill would not restrict the flow of the 100-year flood, reduce temporary water storage capacity of the floodplain, or result in washout of solid waste so as to pose a hazard to public health or the environment. Areas 1 and 2 are not within the 100-year floodplain, and therefore this standard is not applicable and neither relevant nor appropriate to actions taken in Areas 1 and 2.

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[15] It is expected that any radiologically-impacted soil that may remain on these properties would be removed as part of the implementation of any remedial action taken for OU-1.

3.1.2.4 Missouri Solid Waste Management Regulations – Seismic Impact Zones

The solid waste regulations require that sanitary landfills located in seismic impact zones shall generally not be located within 200 feet of a fault that has had displacement in Holocene time (10 CSR 80-3.010(4)B.4). Landfills located within seismic impact zones must demonstrate that all containment structures (e.g., liners, final covers, leachate collection systems and surface water control systems) are designed to resist permanent cumulative earthquake displacements greater than 6 inches resulting from the maximum credible Holocene time earthquake event's acceleration versus time history (10 CSR 80-3.010(4)B.5).

The St. Louis area is part of the New Madrid Seismic Impact Zone and therefore these requirements are potentially applicable to the design of the final cover system for Areas 1 and 2 under all of the alternatives. There is no indication that any Holocene-age faults are present at the Site. Extensive geologic mapping of the quarry walls in the area of the inactive Bridgeton Sanitary Landfill did not identify the presence of any faults in that area.

3.1.2.5 Missouri Solid Waste Management Regulations – Unstable Areas

The Missouri solid waste regulations require that sanitary landfills located in unstable areas demonstrate that the landfill design ensures that the integrity of the structural components of the sanitary landfill will not be disrupted (10 CSR 80-3.010(4)B.6). Minimum factors to be considered in determining whether an area is unstable include the following:

- areas where on-site or local rock or soil conditions may result in failure or significant differential settlement;
- on-site or local geologic or geomorphologic features; and
- on-site or local human-made features or events (both surface and subsurface).

None of these features are known or currently expected to be present in the area. Therefore this requirement is not applicable, relevant or appropriate.

3.1.2.6 Missouri Solid Waste Management Regulations – Plans

The Missouri solid waste regulations require that design and operations plans for new sanitary landfills include maps showing initial and proposed topographies at specified scales and contour intervals, and maps showing land use and zoning within one quarter mile including specific features listed in the regulations (10 CSR 80-3.010(4)B.7). The regulations also require a description of project post-closure land use and evaluations of the characteristics and quantity of available on-site soil with respect to its suitability for sanitary landfill operations. Because these regulations address new sanitary landfills, they are not applicable to the existing Areas 1 and 2, nor are they relevant or appropriate for the remedial alternatives.

3.1.2.7 Missouri Solid Waste Regulations – Airport Safety

The Missouri Solid Waste Regulation requirements for airport safety apply to new or existing municipal solid waste landfills or lateral expansions that are located within 10,000 feet of the end of any airport runway used by turbojet aircraft or within 5,000 feet of any airport runway end used by only piston-type aircraft (10 CSR 80-3.010(4)(B)1). Landfills or landfill expansions located within these areas must demonstrate that the units are designed and operated so as to pose no bird hazards to aircraft.

Portions of the Site, including a portion of Area 1, are located within approximately 9,166 feet of the end of Lambert-St. Louis International Airport's Runway 11-29 (Figure 2-8). Because Area 1 is located in an inactive/closed portion of the Site, these requirements are not applicable. Insofar as the intent of the regulations is to control bird hazards, however, these requirements potentially may be relevant to remedial activities that could result in the exposure of previously placed refuse which could attract birds and therefore present a potential hazard to aircraft. Consequently, these regulations potentially may be relevant and appropriate to excavation and regrading activities that may be performed in Area 1 under the ROD-selected remedy, and for the excavation and regrading activities required for the "complete rad removal" and partial excavation alternatives.

3.1.2.8 FAA Guidance

The Federal Aviation Administration (FAA) has developed guidance to address safety issues associated with aircraft bird strikes (Appendix A). The FAA also issued a Record of Decision (the Lambert Airport ROD) (FAA, 1998) (Appendix A) for federal actions related to improvements at Lambert-St. Louis International Airport (Lambert), including construction and operation of a new air carrier length runway (then designated 12W/30W, now known as Runway 11/29). The FAA ROD included requirements relative to proximity of the proposed new runway to the existing Bridgeton Sanitary Landfill. In 2003, the FAA, EPA and other agencies also entered into a Memorandum of Understanding (the FAA MOU) (Appendix A) addressing aircraft-wildlife strikes. These advisories, decision document, and memorandum are not cleanup standards, standards of control, or other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law and therefore are not ARARs. Likewise, because the FAA guidance, Lambert Airport ROD, and FAA MOU are not legally binding, they therefore are not potential ARARs. They do, however, represent to-be-considered (TBC) criteria relative to the potential remedial actions at the Site.

In its Lambert Airport ROD (Appendix A), the FAA noted that the end of the proposed runway would be located within 10,000 feet of a then-existing active landfill (the Bridgeton Landfill) and therefore would not be consistent with FAA's current runway siting guidelines without mitigation. The decision document indicated that at its closest point, the Bridgeton Landfill is located approximately 9,166 feet west of the northwest end of proposed Runway 12W/30W.

This is not consistent with FAA's runway siting guideline of 10,000 feet, which was developed to protect aircraft from potential bird strikes.

The FAA decision document states:

> "STLAA will attempt to develop an agreement with the operator of the landfill to implement one of the following options:
>
> - Re-prioritize the landfill utilization plan so that the subject portion (i.e., that portion within the FAA's 10,000-foot radius of incompatibility) of the landfill is utilized first;
>
> - Require that STLAA be able to direct available fill that cannot be reasonably recycled from the construction projects to the subject portions of the landfill;
>
> - Require that organic waste be capped in the landfill before the new runway is opened and that only clean fill (such as construction materials) be placed in the subject portions of the landfill once the runway is operational.
>
> Should it not be practical to completely fill the subject landfill through the above measures, the STLAA will purchase an easement from the landfill operator which will provide the operator compensation for any lost revenue associated with the unused excess capacity. Any plan to convert or close the landfill must provide for a one-year bird-repelling program. Repelling efforts will begin 6 months before opening of the new runway and continue for a minimum of 6 months thereafter. The program will be in effect from dawn until dusk.
>
> (FAA ROD, September 30, 1998, pp 42 – 43).

Pursuant to an agreement between Bridgeton Landfill, LLC and the City of St. Louis (among other parties) on behalf of the STLAA, the Bridgeton Landfill ceased accepting waste materials prior to the opening of Runway 11/29.

FAA Advisory Circular AC 150/5200-34A dated January 26, 2006, "Construction or Establishment of Landfills Near Public Airports," contains guidance on complying with Federal statutory requirements regarding the construction or establishment of a new municipal solid waste landfill (MSWLF) near public airports (Appendix A). This advisory only applies to a new MSWLF constructed or established after April 5, 2000, near an airport that received Federal grants (under the Airport and Airway Improvement Act of 1982 as amended, 49 U.S.C. § 47101, et seq.) and primarily serves general aviation aircraft and scheduled air carrier operations using aircraft with fewer than 60 passenger seats. This advisory requires a minimum separation distances of six statute miles between a new MSWLF and a public airport as measured from the closest point of the airport property boundary to the closest point of the MSWLF property boundary. Because no new landfill cells are included within the scope of the remedial alternatives considered in this FFS, this guidance does not provide any criteria that would affect any of the anticipated remedial actions.

FAA Advisory Circular AC 150/5200-33B, dated August 28, 2007, "Hazardous Wildlife Attractants On or Near Airports," provides guidance on certain land uses that have the potential to attract hazardous wildlife on or near public-use airports (Appendix A). This circular recommends against locating a MSWLF within the separation distances identified below:

1. Airports serving piston-powered aircraft – 5,000 feet
2. Airports serving turbine-powered (jet) aircraft – 10,000 feet
3. Protection of approach, departure and circling airspace – 5 statute miles

These separation distances are to be maintained between the Air Operations Area (AOA) and the nearest point to the hazardous wildlife attractant. The AOA is defined as any area of an airport used or intended to be used for landing, takeoff, or surface maneuvering of aircraft which includes such paved or unpaved areas that are used or intended to be used for the unobstructed movement of aircraft in addition to its associated runway, taxiways, or apron. With respect to landfills, the separation distances should be measured from the closest point of the AOA to the closest planned MSWLF cell (AC 150/5200-33B, p. 4). The FAA strongly recommends against allowing a waste disposal operation to be located within 10,000 feet of a jet aircraft runway if the material contains putrescible waste or has the potential to attract wildlife that could threaten air traffic.

The FAA, EPA, and other agencies developed and signed the FAA MOU to address risks that aircraft-wildlife strikes pose to safe aviation (Appendix A). Because this MOU is not a standard, requirement, criteria or limitation under Federal or State environmental laws, it does not represent a potential applicable or a potentially relevant and appropriate requirement; however, it may represent a "to be considered" criterion (TBCs). Specific aspects of this MOU that could be considered as part of potential remedial actions at the Site include the following:

Paragraph M – Agree to cooperate with the airport operator to develop a specific wildlife hazard management plan for a given location when a potential wildlife hazard is identified.

Paragraph O - Agree that information and analyses relating to mitigation that could cause or contribute to aircraft-wildlife strikes should, whenever possible, be included in documents prepared to satisfy the National Environmental Policy Act (NEPA).

EPA and representatives of Bridgeton Landfill, LLC previously met with the STLAA to discuss the remedial actions at the Site and to obtain STLAA input on the remedial alternatives included in the SFS. The STLAA sent a letter to EPA regarding the potential remedial actions under consideration for the Site (included in Appendix A). It is anticipated that additional meetings with the STLAA will occur as the project progresses. It is also anticipated that any remedial work plan would require development of a plan to mitigate hazards to aircraft operations that may be posed by bird populations at the Site during implementation of remedial actions, and that such a plan will be provided to the STLAA for review and input. These actions should meet the objectives of Paragraph M of the FAA MOU. Evaluation of potential risks associated with bird hazards to aircraft and evaluation of potential mitigation measures for aircraft-bird hazards as part of the detailed analysis of alternatives in the FFS addresses the objectives of Paragraph O of the FAA MOU.

3.1.2.9 Airport Negative Easement and Restrictive Covenants

Although not part of a promulgated Federal or State standard and therefore by definition not an ARAR or a TBC standard or criteria, use of the Site is subject to additional constraints relative to airport safety. As previously discussed, in August 2005, the Bridgeton Sanitary Landfill stopped receiving waste pursuant to an agreement with the airport owner, the City of St. Louis, to reduce the potential for birds to interfere with airport operations. As part of this closure plan, a Negative Easement and Declaration of Restrictive Covenants Agreement (Restrictive Covenant) (Appendix A) was recorded against the majority of the West Lake Landfill Site, including all of Area 1, most of Area 2, and all of the soil borrow/stockpile area (Appendix A). Paragraph 1 of the Restrictive Covenant imposes the following restrictions upon the Site:

> There shall be no new or additional depositing or dumping of municipal waste, organic waste, and/or putrescible waste (municipal waste, organic waste and putrescible waste hereinafter collectively referred to as “Putrescible Waste”) above, upon, on, or under the Property beginning as of August 1, 2005 and continuing in perpetuity, unless and until such time as this Agreement is terminated or canceled by St. Louis in accordance with the terms set out in paragraph 3 below. For purposes of this Agreement, “Putrescible Waste” shall mean solid waste that contains organic matter capable of being decomposed by micro-organisms and of such a character and proportion as to be capable of attracting or providing food for birds. For purposes of this Agreement, “Putrescible Waste” shall not include construction waste or demolition waste.

Section 4 of the Restrictive Covenant states that the agreement shall end only if and when the City of St. Louis chooses in its sole and absolute discretion to abandon its negative easement. Consequently, although the Restrictive Covenant is not an ARAR, construction and operation of any new engineered disposal cell would violate the terms of this recorded land use covenant.

On September 7, 2010, representatives of Bridgeton Landfill, LLC and the EPA met with representatives of the St. Louis Airport Authority and the U.S. Department of Agriculture to follow up on concerns raised that the Restrictive Covenant entered into between landfill owners and STLAA would prohibit construction of the “on-site cell” evaluated as part of the SFS. The EPA provided a summary of the alternatives considered in the SFS. STLAA and USDA stated that an excavation remedy would create risks that they could not even calculate, and that monitoring and management of risks created by wildlife would be impossible. STLAA noted that under the ROD-selected remedy, the Site will present no risk to human health or the environment and said that creating new risks by implementing an excavation remedy did not seem advisable. STLAA further stated that an excavation remedy would necessitate FAA review and likely result in objections from airlines as well as the FAA. STLAA was particularly concerned that either excavation alternative would take years to perform.

The EPA asked whether the airport's concerns would be alleviated by excavation of only Area 2 (outside the 10,000-foot range). STLAA's response was no: the entire area is within the Restrictive Covenant and subject to FAA review if "new landfilling operations" were to occur. In particular, STLAA explained that construction of an on-site disposal cell would not qualify as an expansion or change to an existing landfill because the Bridgeton Sanitary Landfill was already in closure mode, but would instead constitute "new operations" at the Site and therefore would trigger FAA review. STLAA stated that it could not predict the changes that any excavation activities would cause to the migratory patterns of birds and could not take the risk that such changes would increase the local bird population. STLAA stated that its 2006 letter, submitted during the public comment period on the ROD for Operable Unit I, still reflected its position.

Notes of this 2010 meeting were provided to the EPA and are included in Appendix A.

By letter dated September 20, 2010 (Appendix A), the City of St. Louis provided written comments on the SFS Work Plan. The letter identified the Site as a hazardous wildlife attractant for the airport. The City stated that the excavation ("complete rad removal") alternatives would adversely affect wildlife mitigation measures taken by the airport to protect aircraft from bird strikes, thereby placing the City in violation of the FAA ROD and its requirement that such mitigation efforts be undertaken and maintained. The City also stated that implementation of the excavation alternatives would violate the Restrictive Covenant.

3.1.3 Potential Action-Specific ARARs

Action-specific ARARs are technology-based requirements that define handling, treatment, disposal, and other procedures triggered by the type of remedial action under consideration. These requirements generally set performance or design standards for specific activities related to the management of wastes. Evaluations of potential action-specific ARARs are presented in the FS report (EMSI, 2006) and are summarized on Table 3-3. Table 3-3 also lists additional potential action-specific ARARs related to the "complete rad removal" and partial excavation alternatives. The potential action-specific ARARs associated with the ROD-selected remedy and the "complete rad removal" and partial excavation alternatives are discussed below.

3.1.3.1 Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings

Part 192 of Title 40 of the Code of Federal Regulations provides for Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings pursuant to UMTRCA. Subpart A of these UMTRCA regulations contains standards for the control of residual radioactive materials from inactive uranium processing sites. As previously discussed, the UMTRCA regulations only apply to designated Title I sites and therefore are not applicable to West Lake Landfill. However, those portions of these regulations that provide for closure performance standards may potentially be relevant and appropriate to remedial actions for OU-1. Specifically, 40 CFR § 192.02 states that "[c]ontrol of residual radioactive materials and their listed constituents shall be designed to: (a) be effective for up to one thousand years, to the extent reasonably achievable, and, in any case, for at least 200 years[.]" In addition, 40 CFR § 192.02(d) requires that "[e]ach site on which disposal occurs shall be designed and stabilized in a manner that minimizes the need for future maintenance." For UMTRCA tailings piles, the longevity consideration is typically addressed through use of natural materials for construction and often includes placement of a rock armoring layer over the upper surface of the tailings pile capping system to reduce the potential for erosion.

In developing this requirement, EPA was concerned with long-term hazards relating to misuse by humans or disruption by natural phenomena. While large volumes of uniform sand-like tailings from uranium mining activities piled on the ground or in impoundments may be of concern due to misuse by humans (for example, use of tailings as construction or fill material), Areas 1 and 2 contain radiological contamination mixed with solid waste, construction and demolition debris and other wastes contained within an even larger volume of solid waste. It is highly unlikely that old garbage and debris of these types would be misused by humans. Furthermore, the solid waste regulations require the upper portion of a landfill cover system consist of a vegetative layer that supports grass that through evapotranspiration can intercept and reduce potential for infiltration of precipitation. A grass cover also can be periodically mowed to prevent establishment of woody vegetation that could damage or otherwise reduce the functionality of the landfill cover system.

Therefore, the ultimate question is which type of capping system – UMTRCA or solid waste – is the more appropriate for Site conditions. Areas 1 and 2 each consist of over a million yards of MSW – within which exists a smaller amount of MSW mixed with radionuclide-containing material. The fact that the majority of the materials are solid waste, including the RIM itself, suggests that the more appropriate cap design would reflect the solid waste closure criteria. However, the presence of RIM and its unique (relative to the overall MSW) characteristics of emitting gamma radiation and radon, indicate that additional measures, such as those developed for UMTRCA tailing piles, could also be appropriate. The approach included in the ROD-selected remedy reflects the key design components of both sets of regulations. Specifically, the ROD-selected remedy includes a hybrid cover system that is based on the MSW design criteria but incorporates additional measures to address gamma emissions and radon generation, including the projected emissions that will occur as a result of radium ingrowth over time from decay of thorium. By their very nature, MSW landfills require long-term inspection, maintenance and monitoring. To further address longevity considerations and long-term hazards relating to potential disruption of the disposal Site by natural phenomena, the ROD-selected remedy incorporates a concrete debris or a rock material layer to restrict bio-intrusion and erosion into the underlying landfilled materials, to act as a marker layer indicating the presence of human-derived, non-natural materials, and to increase the overall longevity of the landfill cover.

3.1.3.2 Missouri Solid Waste Management Regulations

The ROD-selected remedy was developed and selected to provide engineered containment of the solid wastes and RIM contained in Areas 1 and 2. Because these areas contain solid wastes, the RCRA Subtitle D regulations and the MDNR Solid Waste Management Regulations represent the primary standards for design and implementation of a containment remedy. Specifically, the landfill cover design, gas control measures, maintenance, groundwater monitoring, and corrective action criteria of these regulations are potentially relevant and appropriate.

Evaluation of these solid waste management criteria as potential ARARs relative to the evaluation of remedial alternatives for OU-1, including the remedial alternative that ultimately became the ROD-selected remedy, is presented in the FS report (EMSI, 2006). In particular, the FS report presents an extensive discussion of the final grading and cover requirements for solid waste landfills as potentially relevant and appropriate requirements for construction of new landfill covers over Areas 1 and 2. In the ROD (EPA, 2008a), EPA provided an evaluation of solid waste regulations as potential ARARs, including how they would apply to the ROD-selected remedy. These evaluations will not be repeated in this FFS.

The final grading and final cover requirements of the Missouri Solid Waste regulations are not applicable to remedial alternatives for OU-1, because they apply only to existing sanitary landfills that are closed after October 9, 1991. However, the Solid Waste regulations would be relevant and appropriate to regrading and design and construction of final cover over Areas 1 and 2 as part of the ROD-selected remedy or the partial excavation and “complete rad removal” alternatives. EPA determined that the 5% minimum sloping requirement under the Solid Waste regulations was not appropriate for the ROD-selected remedy (see ROD at p. 50). The ROD required the selected remedy to include final grades of at least 2% and less than 25% (unless a stability analysis is performed to support inclusion of steeper slopes, but in no event shall the final slopes exceed 33 1/3%) and final cover of at least two feet (2’) of compacted clay with a coefficient of permeability of 1 x 10^{-5} cm/sec or less overlaid by at least one foot (1’) of soil capable of sustaining vegetative growth (10 CSR 80-3.010(17)(C)(4)). Analysis of these requirements and the basis for use of a minimum slope of 2% for the ROD-selected remedy is provided in the ROD (EPA, 2008a) and the FS (EMSI, 2006). For the partial excavation and “complete rad removal” alternatives, the final grading and cover requirements will likely need to include final grades of at least 5% and less than 25% (unless a stability analysis is performed to support inclusion of steeper slopes, but in no event shall the final slopes exceed 33 1/3%) and final cover of at least two feet (2’) of compacted clay with a coefficient of permeability of 1 x 10^{-5} cm/sec or less overlaid by at least one foot (1’) of soil capable of sustaining vegetative growth (10 CSR 80-3.010(17)(C)(4)).

3.1.3.3 RCRA Subtitle C Regulations

The RCRA Subtitle C requirements relative to identification of hazardous wastes (40 CFR Part 261), packaging, temporary storage, offsite transportation of hazardous wastes (40 CFR Parts 262 and 263), and treatment and disposal of hazardous wastes (40 CFR Part 268), are potentially applicable requirements in the event that hazardous wastes are encountered during implementation of any remedy at the Site.

The RCRA Subtitle C landfill closure design criteria were also evaluated as potential action-specific ARARs for closure of Areas 1 and 2. RCRA landfill closure regulations (40 CFR § 264.310) specify that at final closure of a landfill or cell, the landfill or cell must be covered with a final cover designed and constructed to:

1. Provide long-term minimization of migration of liquids through the closed landfill;
2. Function with minimum maintenance;
3. Promote drainage and minimize erosion or abrasion of the cover;
4. Accommodate settling and subsidence so that the cover's integrity is maintained; and
5. Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.

Per EPA guidance (EPA, 1988 and 1989), RCRA Subtitle C requirements, including closure requirements, are applicable to a Superfund remedial action if the following conditions are met:

- The waste is a RCRA hazardous waste, and either:

- The waste was initially treated, stored, or disposed of after November 19, 1980 (the date upon which the RCRA Subtitle C requirements became effective), or

- The activity at the CERCLA site constitutes treatment, storage, or disposal, as defined by RCRA.

As discussed in Section 2.5.4, the waste materials in Area 1 and 2 are typical MSW and do not contain confirmed amounts of hazardous waste. Regardless, the wastes in Area 1 and 2 were disposed of prior to November 19, 1980 and therefore do not meet the second criterion listed above. To the extent that the remedial actions being considered for Areas 1 and 2 entail consolidation, regrading and capping of the waste within Areas 1 and 2, these actions should not constitute treatment, storage or disposal. Therefore, the RCRA regulations, including the closure requirements, would not be applicable to remedial actions for Areas 1 and 2.

RCRA requirements that are not applicable may nonetheless be relevant and appropriate, based on site-specific circumstances (EPA, 1988 and 1989). The determination of relevance and appropriateness of RCRA requirements is based on the circumstances of the release, including the hazardous properties of the waste, its composition and matrix, the characteristics of the site, the nature of the release or threatened release from the site, and the nature and purpose of the requirement itself. Because the waste materials in Areas 1 and 2 are primarily MSW, there currently is no basis to conclude that these wastes are hazardous or similar to hazardous wastes. Therefore, the RCRA closure requirements would not be relevant. Furthermore, the intent of the RCRA Subtitle C regulations is to minimize migration of liquids through the closed landfill. Requirements to minimize migration of liquids through a closed landfill are also addressed by the RCRA Subtitle D regulations for MSW landfills, which, based on the nature of the materials in Areas 1 and 2, are considered more appropriate requirements than the RCRA Subtitle C regulations. In addition, the primary constituents of concern in Areas 1 and 2 are radionuclides, principally thorium and radium, which are relatively insoluble and therefore relatively immobile as compared to solvents or other types of more mobile constituents addressed by the RCRA Subtitle C regulations. The RCRA Subtitle C regulations are also intended to address closure of smaller areas containing high concentration (hazardous) wastes, and are not considered appropriate for closure of larger, dispersed areas of lower level contamination associated with a MSW landfill (EPA, 1988b). EPA (1988b) has indicated that RCRA covers are generally not appropriate for large municipal landfills where the waste is generally of a lower toxicity, and the Site encompasses an area that bears little resemblance to the discrete units regulated under RCRA Subtitle C. Therefore, the RCRA Subtitle C regulations are not considered to be relevant and appropriate requirements for design and construction of a final landfill cover over Areas 1 and 2.

Furthermore, EPA has indicated that designing closure through the use of a hybrid approach may be more appropriate (EPA, 1989). Hybrid landfill closure is used when residual contamination poses a direct contact threat, but does not pose a groundwater threat. Although EPA has determined that additional evaluations of groundwater conditions will be conducted as part of OU-3, as previously discussed in Sections 2.5.3 and 2.5.4, the groundwater monitoring performed to date has not identified the presence of a plume or contiguous area of groundwater contamination originating from Areas 1 or 2. Hybrid landfill closure entails use of covers, which may be permeable, to address direct contact threat with limited long-term management involving site and cover maintenance and minimal groundwater monitoring coupled with institutional controls (*e.g.*, land-use restrictions or deed notices) as necessary. EPA has directed the FFS consider alternative landfill cover designs. In addition, the landfill cover design included in the ROD-selected remedy is a hybrid MSW cover that has been modified to provide sufficient thickness to protect against gamma radiation and radon emissions.

3.1.4 Additional Requirements Associated with Off-site Disposal

This section discusses additional requirements that would apply to the “complete rad removal” with off-site disposal or partial excavation alternatives. The requirements under CERCLA for compliance with other laws differ for on-site and off-site actions. Importantly, the ARARs provision applies only to on-site actions; off-site actions need only comply with any laws that apply to such an action. In other words, off-site actions need only comply with “applicable” requirements, not with “relevant and appropriate” requirements. Consequently, CERCLA actions involving the transfer of hazardous substances, pollutants or contaminants off-site must comply with applicable Federal and State requirements and are not exempt from formal administrative permitting requirements.

The primary requirements affecting off-site disposal are the CERCLA Off-Site Rule (OSR), requirements associated with transportation of the RIM to an off-site disposal facility, and the waste acceptance criteria associated with each potential off-site disposal facility. These requirements are described below.

3.1.4.1 CERCLA Off-site Rule

Section 121(d)(3) of CERCLA (42 U.S.C.§ 9621(d)(3)) applies to any CERCLA response action involving the off-site transfer of any hazardous substance, pollutant or contaminant (*i.e.*, CERCLA wastes). These principles are interpreted in the off-site rule (OSR) set forth in the NCP at 40 CFR § 300.440. The OSR requires that CERCLA wastes be placed only in a facility operating in compliance with RCRA or other applicable Federal or State requirements. The OSR prohibits the transfer of CERCLA wastes to a land disposal facility that is releasing contaminants into the environment, and requires that any releases from other waste management units at the disposal facility be controlled. The purpose of the OSR is to avoid having CERCLA wastes from site response actions authorized or funded under CERCLA contribute to present or future environmental problems by directing these wastes to management units determined to be environmentally sound (preamble to final OSR, 58 Fed. Reg. 49,200, 49,201, Sept. 22, 1993).

The OSR establishes the criteria and procedures for determining whether facilities are acceptable for the receipt of CERCLA wastes from response actions authorized or funded under CERCLA. The OSR establishes both compliance and release criteria, and establishes a process for determining whether facilities are acceptable based on those criteria. The OSR also establishes procedures for notification of unacceptability, reconsideration of unacceptability determinations, and re-evaluation of unacceptability determinations.

EPA verifies the acceptability of off-site treatment, storage, and disposal facilities (TSDFs) on a frequent basis. Consequently, before any off-site shipment occurs, a verification of current acceptability (VCA) must be obtained from EPA certifying that the proposed receiving facility is operating in compliance with the requirements of CERCLA Section 121(d)(3) and 40 CFR § 300.440. EPA (usually the applicable EPA Regional Office) will determine the acceptability under this section of any facility selected for the treatment, storage, or disposal of CERCLA waste. EPA will determine if there are relevant releases or relevant violations at a facility prior to the facility's initial receipt of CERCLA waste. A facility which has previously been evaluated and found acceptable under this rule is acceptable until the EPA Regional Office notifies the facility otherwise pursuant to § 300.440(d).

3.1.4.2 Off-site Transportation Requirements

Under the "complete rad removal" or partial excavation alternatives, RIM would be excavated and shipped for off-site disposal. It is currently anticipated that the excavated RIM would be loaded directly into intermodal containers which would be hauled by trucks to a local off-site rail loading facility where they would be loaded on rail cars. Once loaded on rail cars, the intermodal containers containing RIM would be shipped via rail directly to the off-site disposal facility or to a rail unloading facility located near the off-site disposal facility, where the containers would be loaded onto trucks and taken to the off-site disposal facility.

Because transportation to an off-site disposal location would constitute an off-site action, the transportation activities would need to comply with both the substantive and administrative requirements of any regulations applicable to transportation of radiologically-contaminated materials. The U.S. Department of Transportation (DOT) has developed regulations for transport of hazardous materials (49 CFR Parts 100 – 178), including specific regulations related to transport of radioactive materials (49 CFR Parts 171 – 180). These include regulations on hazardous materials communications, emergency response information, training requirements and security plans (49 CFR Part 172) which address special provisions, preparation and retention of shipping papers, packaging and container marking, emergency response, security and planning. The regulations contain specific requirements associated with shipment of radioactive materials (e.g., 49 CFR §§ 172.310, 172.436-440, and 172.556). Other regulations (49 CFR Part 173) describe requirements for shipment and packaging that are applicable to shippers, including specific requirements for shipment of radioactive materials. Regulations set forth in 49 CFR Part 174 address shipment by rail and include special handling requirements for radioactive materials (49 CFR § 174.700). Required emergency response information is described in 49 CFR Subpart G (49 CFR § 173.602). The NRC, through a Memorandum of Understanding with DOT, also has promulgated regulations related to transport of radioactive materials (10 CFR Part 71).

Requirements established by rail carriers relative to transport of waste materials or radioactive wastes would also be applicable to the “complete rad removal” and partial excavation with off-site disposal alternatives. Because the specific carriers that might be used to transport the wastes under these alternatives cannot be identified at this time, identification and evaluation of the carrier-specific requirements has not been performed. This evaluation would be completed if necessary as part of design of the “complete rad removal” or partial excavation alternatives that include off-site disposal.
State requirements and fees, including Missouri fees for transport of the RIM (Section 260.392 RSMo), would also potentially be applicable to the “complete rad removal” or partial excavation with off-site disposal alternatives. Review, description and detailed evaluation of these requirements is beyond the scope of this FFS, but would be addressed in detail in planning documents in the event the “complete rad removal” or partial excavation with off-site disposal alternatives were to be implemented.

As of the writing of this draft FFS, four disposal facilities have been identified that could potentially accept RIM from the Site for off-site disposal:

- U.S. Ecology's facility in Grandview, Idaho,
- U.S. Ecology's facility in Wayne, Michigan,
- Energy*Solutions* facility in Clive, Utah, and
- Clean Harbors' Deer Trail facility in Last Chance, Colorado.

Discussions with representatives of potential off-site disposal facilities in conjunction with preparation of the SFS (EMSI et al., 2011) indicated that most of the facilities would provide a turnkey service that includes transport of the RIM from the Site and disposal. These companies provided unit costs for complete turnkey services for waste profiling and acceptance testing, waste transportation (including all related fees and taxes), and waste disposal services (including all related fees and taxes). Under a turnkey service, the disposal company would be responsible for arranging for transport, preparation of waste/shipping manifests, testing the RIM after they are loaded into transportation vehicles/containers, securing vehicles/containers, unloading vehicles/containers, safety and emergency response plans, and all other aspects associated with transport of RIM from the Site to an off-site disposal facility. Additional discussion with U.S. Ecology in conjunction with preparation of this FFS indicated that they would provide turnkey. U.S. Ecology provided updated unit costs for these services for use in preparing this FFS.

3.1.4.3 Waste Acceptance Criteria for Off-site Disposal

Waste Acceptance Criteria (WAC) are established pursuant to the specific permit or license issued to each waste disposal facility and consequently are different for each facility. As part of the evaluation of potential remedial technologies for the "complete rad removal" and the partial excavation alternatives that include off-site disposal, potential off-site disposal facilities were identified. The WAC for the off-site disposal facilities were reviewed as part of the prior SFS evaluation and re-examined as part of the FFS to assess the ability of each facility to accept the RIM. Summaries of the WAC for each off-site disposal facility are presented below. Copies of the WAC provided by each of the facilities are contained in Appendix C.

3.1.4.3.1 U.S. Ecology, Grandview, Idaho

U.S. Ecology - Idaho (USEI) has a RCRA Part B Permit that contains waste acceptance criteria relative to radionuclide levels (Appendix C-1). USEI's WAC are listed in the tables below:

USEI Table C.1: Unimportant Quantities of Source Material Uniformly Dispersed in Soil or Other Media

Status of Equilibrium	Maximum Concentration of Source Material	Sum of Concentrations Parent(s) and All Progeny Present
Natural uranium in equilibrium with progeny	<500 ppm / 167 pCi/g (^{238}U activity)	≤ 3000 pCi/g
Refined natural uranium (^{238}U, ^{235}U, ^{234}U, ^{234}Th, ^{234m}Pa, ^{231}Th,	<500 ppm / 333 pCi/g	≤ 2000 pCi/g
Depleted Uranium (^{234}Th, ^{234m}Pa)	<500 ppm / 169 pCi/g	≤ 2000 pCi/g
Natural Thorium (^{232}Th, ^{228}Th)	<500 ppm / 110 pCi/g	≤ 2000 pCi/g
^{230}Th in equilibrium with progeny	<0.01 ppm / 200 pCi/g	≤ 2000 pCi/g
^{230}Th (with no progeny)	<0.1 ppm / ≤ 2000 pCi/g	
Any mixture of Thorium and Uranium	Sum of ratios <1	≤ 2000 pCi/g

USEI Table C.2: Naturally Occurring Radioactive Material (NORM) Other Than Uranium and Thorium Uniformly Dispersed in Soil or Other Media

Status of Equilibrium	Maximum Concentration of Parent Nuclide	Sum of Concentrations of Parent and All Progeny Present
^{226}Ra or ^{228}Ra with progeny in bulk form	500 pCi/g	≤ 4500 pCi/g
^{226}Ra or ^{228}Ra with progeny in reinforced 1P-1 containers	1500 pCi/g	13,500 pCi/g
^{210}Pb with progeny (Bi & ^{210}Po)	1500 pCi/g	4500 pCi/g
^{40}K	818 pCi/g	N/A
Any other NORM		≤ 3000 pCi/g

USEI is also permitted to accept 11e.(2) mixed waste (Appendix C-1).

3.1.4.3.2 U.S. Ecology, Wayne, Michigan

The US Ecology Michigan facility in Belleville, Michigan (also known as Wayne Disposal), is permitted to accept solid waste, hazardous waste and Naturally Occurring Radioactive Material (NORM) and Technologically Enhanced Radioactive Material (TENORM) waste. US Ecology Michigan has a RCRA Part B Permit that contains waste acceptance criteria relative to hazardous wastes and a NORM/TENORM Waste Addendum that identifies waste acceptance criteria relative to radionuclides (Appendix C-2).

Based on the NORM/TENORM Waste Addendum criteria, US Ecology Michigan can accept generally exempt unimportant quantities (as that term is defined in NRC regulations) of source material uniformly distributed in soil or other media provided the total percentage of uranium and/or thorium (Th-232) is less than 0.05% by weight. US Ecology Michigan can accept source material containing natural uranium and thorium (Th-232) provided the sum of the fractions is less than 1. US Ecology Michigan can accept NORM/TENORM waste that contains less than 50 pCi/g Ra-226 and less than 260 pCi/g Pb-210 or that after treatment or blending meets these criteria.

3.1.4.3.3 Clean Harbors, Deer Trail, Colorado

The Clean Harbors Deer Trail, Colorado facility can only accept materials classified by Colorado Regulations as NORM and TENORM (Appendix C-3). This facility can only accept materials with total activity levels less than 2,000 pCi/g and with total uranium and thorium content less than 500 mg/kg. Ra-226 must be less than 222 pCi/g if it is the only primary radionuclide present. Lead-210 must be less than 666 pCi/g if it is the only primary radionuclide present. In addition, the gamma dose rate must be less than 116 microRoentgens/hour (uR/hr) at the surface of the container. The Deer Trail facility can accept mixed RCRA/NORM wastes, but additional testing of such wastes may be required.

3.1.4.3.4 Energy*Solutions*, Clive, Utah

Energy*Solutions* has an Agreement State Radioactive Materials License issued by the State of Utah that authorizes Energy*Solutions* to receive Class A Low Level Radioactive Waste (LLRW), NORM and Accelerator-Produced Radioactive Material (NARM) waste. Energy*Solutions* also has a separate license to receive and dispose of uranium and thorium mill tailings byproduct material as defined by Section 11e(2) of the Atomic Energy Act, as amended.

Energy*Solutions*' Radioactive Material License allows receipt and disposal of NORM or NARM. NORM/NARM does not include byproduct, source, or special nuclear material and generally contains radionuclides in the uranium and thorium decay series. Because NORM/NARM waste is not considered LLRW, the waste classification regulations do not apply.

The generator or owner must attach to the certification a list of all radiological and non-radiological constituents in the waste and the maximum and average concentrations of such constituents.

3.1.4.3.5 Other Off-site Disposal Facilities

Several other off-site disposal facilities were identified, including the US Ecology facility in Robstown, Texas; the Waste Control Specialists facility in Andrews, Texas; and the Chem-Nuclear Systems facility in Barnwell, South Carolina. Based on the results of the prior EPA evaluation (TetraTech, 2009), subsequent discussions with representatives of these facilities, and review of the permit limitations or WAC for these facilities, it was determined that disposal of RIM from the Site at these facilities was not likely to be acceptable. Factors anticipated to limit acceptance of RIM from the Site include prohibitions on landfilling of radioactive wastes mixed with other materials, limits on the total or specific radionuclide activity levels, and prohibitions on acceptance of wastes generated outside of particular low-level radioactive waste regional compact areas.

Although disposal of soil containing radionuclides may be acceptable at the US Ecology facility in Richland, Washington (Hanford Nuclear Reservation area), disposal of mixed refuse and soil was not likely to be acceptable at this facility. In addition, as this facility was designed to accept higher activity wastes, disposal fees at the Richland facility are substantially higher than those charged by US Ecology at its Grandview, Idaho or Michigan facilities or at the Energy*Solutions* Clive, Utah facility. Both the prior EPA evaluation (TetraTech, 2009) and evaluations made for the SFS determined that disposal of RIM from the Site at the Richland, WA facility would be substantially more expensive than disposal at US Ecology's Grandview, Idaho facility.

3.2 Remedial Action Objectives

RAOs are developed based on contaminants, media of interest, and exposure pathways that permit a range of containment and treatment alternatives to be developed. RAOs are developed based on chemical-specific ARARs and site-specific risk-related factors.

The NCP sets forth a requirement to "establish remedial action objectives specifying contaminants and media of concern, potential exposure pathways, and remediation goals" [40 CFR § 300.430 (e)(2)(i)]. The remedial action objectives (RAOs) are developed based on chemical-specific ARARs and site-specific risk-based cleanup levels, serve as a basis for developing and assessing remedial action alternatives, and describe what the remedial alternatives need to accomplish in order to be protective of human health and the environment. In particular, the development of the RAOs is based on contaminants, media of interest, and exposure pathways that permit a range of containment and treatment alternatives to be developed. Specific remediation goals (RGs) are developed consistent with protective ARARs. If ARARs are not available or are not sufficiently protective due to multiple contaminants or multiple pathways, then RGs are based on site-specific risk-based cleanup levels.

The following RAOs are identified for West Lake Landfill OU-1:

<u>RAOs for Areas 1 and 2</u>

1. Prevent direct contact with landfill contents, including exposure to external radiation;
2. Minimize infiltration and any resulting contaminant leaching to groundwater;
3. Control surface water runoff of contaminants of concern and minimize erosion; and
4. Control and treat landfill gas emissions including radon.

<u>RAO for the Buffer Zone/Crossroads Property:</u>

5. Prevent direct contact with contaminated surface soils or ensure contaminant levels are low enough to allow for unlimited use and unrestricted exposure.

Because the RI/FS, SFS and RI Addendum do not identify groundwater contamination issues associated with the Site, and because neither the ROD-selected remedy nor the excavation options for OU-1 include groundwater remediation, no groundwater RAO is identified or required at this time. Groundwater will be further evaluated separately as part of the anticipated "OU-3" investigations directed by EPA.

3.2.1 Cleanup Levels

This section describes the preliminary remediation goals (PRGs) or "cleanup levels" that are used to define the various remedial alternatives evaluated in the FFS.

3.2.1.1 ROD-Selected Remedy Cleanup Levels

Because the ROD-selected remedy is a containment remedy, no specific cleanup levels would apply. However, for purposes of defining the extent of the engineered landfill cover that would be installed under the ROD-selected remedy, the EPA criteria for unrestricted use (see discussion below) would be used.

3.2.1.2 "Complete Rad Removal" Alternative

EPA has defined (EPA, 2010a) "complete rad removal" to mean attainment of the risk-based radiological cleanup levels specified in OSWER directives 9200.4-25 and 9200.4-18 (EPA, 1998a and 1997a). These criteria are based on the UMTRCA standards (40 CFR Part 192 Subpart B) for cleanup of so-called "vicinity properties" (as opposed to the actual waste disposal units). Although the UMTRCA standards are neither applicable nor relevant and appropriate to the solid waste disposal units at the Site, they do represent standards that have been established by EPA for remediating radionuclide occurrences so as to allow for unrestricted use. EPA has indicated that "[o]ne intent of the 'complete rad removal' alternatives, if implemented, would be to leave disposal areas 1 and 2 in a condition that would not require additional engineering and institutional controls due to their radiological content, if feasible." (EPA, 2010b). The standards established pursuant to 40 CFR Part 192 Subpart B are intended to allow for unrestricted use of land relative to radionuclide occurrences. Although removal of all radionuclides above the UMTRCA standards (as modified by the OSWER Directives) would allow for unrestricted (*e.g.*, residential) use of the Site relative to the presence of radionuclides, the Site would still contain MSW and would still be subject to the solid waste regulations requirements including installation of an engineered landfill cover and institutional controls that prohibit residential land use on an MSW landfill.

The radiological cleanup levels specified in OSWER directive 9200.4-25 are total Ra-226 + Ra-228 greater than 5 pCi/g (above background) and total Th-230 + Th-232 greater than 5 pCi/g (above background). For purposes of performing the evaluations in this FFS for the "complete rad removal" alternative, a cleanup level of 54.5 pCi/g was used for uranium based on the approach established by EPA for development of the uranium remediation goals for the St. Louis Downtown Site (SLDS) [EPA, 1998b] and the St. Louis Airport Site (SLAPS) (EPA, 2005a). Additional discussion regarding the approach used for development of the uranium remediation level is presented in the EPA-approved SFS Work Plan (EMSI, 2010) and in Section 2.8.2.1 of the Record of Decision for SLAPS (EPA, 2005a).

Based on these cleanup levels, the so-called "complete rad removal" alternative would not result in complete removal of all radionuclides from the Site. Rather, this alternative is intended to result in removal of radionuclides to a level such that engineering measures and institutional controls intended to address radionuclide occurrences would no longer be required. EPA's policies pursuant to CERCLA and the NCP do not require removal of all radionuclides. The radionuclide levels that would remain within Areas 1 and 2 under the "complete rad removal" alternative would allow for unrestricted use of the Site and therefore would be protective of human health for reasonably expected future exposure scenarios.

EPA has defined the "complete rad removal" alternative to mean attainment of the risk-based radiological cleanup levels specified in OSWER directives 9200.4-25 and 9200.4-18. These directives provide guidance for establishing protective cleanup levels for radioactive contamination at CERCLA (Superfund) sites. In particular, these directives provide clarification as to the use of the UMTRCA soil cleanup criteria as remediation goals at CERCLA sites. The UMTRCA soil cleanup criteria are based on concentrations above background levels. Similarly, EPA has stated elsewhere that CERCLA cleanup levels are not set at concentrations below natural background levels (EPA, 2002). As a result, the cleanup standards to be used for the development and evaluation of the "complete rad removal" alternative are background-based standards. Determination of background levels is an important part of the development of the soil cleanup levels for the "complete rad removal" alternative.

As with any set of data, background values are subject to variability. By definition, the mean background value represents the central tendency of the background data set, but does not incorporate any measure of the variability of the background data set. Values greater than the mean value may nonetheless be representative of background conditions. Therefore, some measure of the variability of the background data is necessary to define the uncertainty associated with the mean of the background values. A common type of value for the interval around an estimate is a "confidence interval." A confidence interval may be regarded as combining an interval around an estimate with a probabilistic statement about the unknown parameter. Confidence intervals are based on the standard deviation of the data set and published statistical values defining population distributions.

Background concentrations of the various isotopes of radium, thorium and uranium are presented in Section 6.2 of the RI report (EMSI, 2000). These background concentrations were determined using analytical results from samples collected at four background locations. In order to account for the variability in the background results, the representative background values used in the RI are the mean values of the four results plus two standard deviations. Use of two standard deviations reflects the critical value of 1.96 used to calculate the 95% confidence limit for a normally distributed population with a large number (greater than 30) of sample results. Specifically, through repeated sampling, the true mean value is expected to fall within a range defined by two times the standard deviation 95% of the time. For smaller sample sizes, the critical values are larger. In the case of a sample set consisting of four data values, the critical value would be 2.35. Therefore, use of a value of two is a reasonable, yet slightly conservative (more protective), method of estimating the variability of the background values.

The mean background concentrations and the mean background concentrations plus two standard deviations were presented in the RI report (EMSI, 2000) and are listed below:

Parameter	Mean of the background sample results	Standard deviation of the background sample results	Mean value plus two standard deviations
Radium-226	1.06	0.12	1.30
Radium-228	1.65	0.36	2.37
Thorium-230	1.51	0.47	2.45
Thorium-232	0.90	0.33	1.55
Uranium-238	1.33	0.46	2.24
Uranium-235	0.39	0.38	1.15
Uranium-234	1.47	0.63	2.73

All values reported as pCi/g

Collection of additional background samples to provide a larger data set for use in estimating background values, or incorporation or use of background values obtained from other studies conducted in the general area of the Site (such as SLAPS) may provide a better estimate of the background values, but these efforts are outside the scope of – and are not necessary for – completion of this FFS.

Each of these radionuclides is a member of either the U-238 or the Th-232 decay chains. The short-lived members of these chains normally are in equilibrium with longer-lived progenitors in the same chain. For example, Th-232 and Ra-228 are members of the Th-232 decay series and should be in equilibrium with each other. Examining the results listed above, it can be seen that they are noticeably different. These differences likely result from variations in the analytical results obtained from the four samples, combined with the effects of averaging the results and incorporation of two standard deviations about the results to address the overall variability of the sample results.

In order to address the difference in activity levels of the parent and daughter radionuclides for purposes of the FFS, the representative background concentration for all short-lived members of a decay chain were set to the lowest value calculated for any member in the chain. This is a small adjustment that results in a slightly lower derived concentration guideline (DCGL). In the case of the Th-232 series, the background concentration of all members of the Th-232 series was set to 1.55 pCi/g for this FFS. Applying this same logic to the remaining radionuclides, the background values to be used for series nuclides in this evaluation are as follows:

- Radium-226 = 1.3 pCi/g
- Radium-228 = 1.55 pCi/g
- Thorium 232 = 1.55 pCi/g (parent of Ra-228)
- Thorium-230 = 1.3 pCi/g (parent of Ra-226)
- Uranium-238 = 2.24 pCi/g (parent of U-234)
- Uranium 234 = 2.24 pCi/g (parent of Th-230)

These values are comparable to the following background values identified for SLAPS (EPA, 1998b):

- Radium-226 = 2.8 pCi/g
- Radium-228 = not identified
- Thorium 232 = not identified
- Thorium-230 = 1.9 pCi/g
- Uranium-238 = 1.4 pCi/g
- Uranium 234 = not identified

The resultant cleanup levels are the sum of the representative background concentrations and the appropriate risk-based remediation concentrations listed in the OSWER directives (*i.e.*, 5 pCi/g plus background). Based on the Site background values presented in the RI and RI Addendum (EMSI, 2000 and 2016a), the Site cleanup values would be as follows:

- Radium-226+228 = 7.9 pCi/g[16]
- Thorium-230+232 = 7.9 pCi/g

[16] Total radium DCGL = 1.3 pCi/g radium-226 + 1.6 pCi/g radium-228 + 5 pCi/g radium cleanup level = 7.9 pCi/g total radium

- Total uranium = 54.5 pCi/g

These cleanup values were used to identify the Site soils that would be included with the scope of the "complete rad removal" alternative and that would otherwise be used to define the extent of any hybrid landfill cover that may be included within the scope of the ROD-selected remedy or the partial excavation alternatives.

A uranium remediation goal of 50 pCi/g is equivalent to a mass-based uranium concentration of 71 mg/kg. EPA's current non-carcinogenic screening level for uranium is 3,500 mg/kg for commercial/industrial uses and 230 mg/kg for residential exposures (https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-may-2016). Consequently, cleanup of uranium to 50 pCi/g plus background should not pose any non-carcinogenic risks. Therefore, the cleanup level (54.5 pCi/g) derived for the West Lake Landfill OU-1 by use of the same approach used for the SLAPS, which is part of the North St. Louis sites, for potential carcinogenic risks should not present unacceptable non-carcinogenic risks and represents the more conservative cleanup target.

3.2.1.3 Partial Excavation Alternatives Cleanup Levels

EPA directed three potential partial excavation alternatives for evaluation in the FFS (EPA, 2015a):

1. Partial Excavation 1,000 pCi/g – Excavation of all soil/waste containing combined radium (radium-226 plus radium-228) or combined thorium (thorium-230 plus thorium-232) with activity levels greater than 1,000 pCi/g;

2. Partial Excavation 52.9 pCi/g – Excavation of all soil/waste containing combined radium or combined thorium with activity levels greater than 52.9 pCi/g down to a total depth of 16 feet beneath the 2005 topographic surface; and

3. Partial Excavation Based on Expected Land Use – Partial excavation of all soil/waste containing combined radium or combined thorium with activity levels greater than a risk-based level to be developed based on the reasonably anticipated future land use of the Site.

The 1,000 pCi/g value is based in part on the criterion used in the original 2006 FS to define potential "hot spots." It is also the risk-based level associated with commercial/industrial land use, which is the reasonably anticipated future land use of the Site (Auxier & Associates, 2016b).

EPA did not provide a rationale for the 52.9 pCi/g or the 16-foot depth below the 2005 topographic surface criterion in the SOW (EPA, 2015a).

4 TECHNOLOGY SCREENING

The technology screening process in a CERCLA FS involves identifying General Response Actions (GRAs) that may be applicable for development of remedial alternatives based on the site characterization results and the RAOs established for the site or the operable unit. Potential remedial action technologies associated with each GRA that may be applicable to addressing the site characterization results and satisfying the RAOs are first identified and screened based on technical implementability. The resultant technologies are then evaluated based on anticipated effectiveness, implementability, and relative cost to identify the most applicable technologies. These technologies are then combined to develop remedial action alternatives for the FS.

In identifying potential GRAs and technologies, EPA's expectations with respect to developing appropriate remedial alternatives should be considered. These expectations are included in the National Contingency Plan (NCP) at 40 CFR §300.430(a)(iii), specifically:

- EPA expects to use treatment to address the principal threats posed by a site, wherever practicable. Principal threats for which treatment is most likely to be appropriate include liquids, areas contaminated with high concentrations of toxic compounds, and highly mobile materials;

- EPA expects to use engineering controls, such as containment, for waste that poses a relatively low long-term threat or where treatment is impracticable;

- EPA expects to use a combination of methods, as appropriate, to achieve protection of human health and the environment. In appropriate site situations, treatment of the principal threats posed by a site, with priority placed on treating waste that is liquid, highly toxic or highly mobile, will be combined with engineering controls, as appropriate, for treatment residuals and untreated waste;

- EPA expects to use institutional controls such as water use and deed restrictions to supplement engineering controls as appropriate for short- and long-term management to prevent or limit exposure to hazardous substances, pollutants, or contaminants;

- EPA expects to consider using innovative technology when such technology offers the potential for comparable or superior treatment performance or implementability, fewer or lesser adverse impacts than other available approaches, or lower costs for similar levels of performance than demonstrated technologies; and

- EPA expects to return usable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.

Because of the presence of radionuclides in the waste material in Areas 1 and 2 of OU-1 at the West Lake Landfill Superfund Site, EPA's Technology Reference Guide for Radioactively Contaminated Media (EPA, 2007) is used as a reference for technologies that can effectively treat environmental media at radioactively contaminated sites. This guidance document states that the special characteristics of radioactive material in a waste constrain the technologies available to address site characterization results and satisfy RAOs. These special characteristics should be considered in light of the NCP's preference for treatment. The Technology Reference Guide for Radioactively Contaminated Media states:

> [U]nlike non-radioactive hazardous waste, which contains chemicals alterable by physical, chemical, or biological processes to reduce or destroy the hazard, radioactive waste cannot be similarly altered or destroyed. Since destruction of radioactivity is not an option, response actions at radioactively contaminated sites must rely on measures that prevent or reduce exposure to radiation.
>
> The concepts of "Time, Distance and Shielding" are used in radiation protection. Increasing the distance from radioactive material, increasing the shielding between the radioactive material and the point of exposure, and/or decreasing the time of exposure to radioactive material will rapidly reduce the risk from all forms of radiation. The concept of time as used in waste stream management and remediation has an additional meaning. Time allows the natural radioactive decay of the radionuclide to take place, resulting in reduction in risk to human health and the environment. Therefore all remediation solutions involve either removing and disposing of radioactive waste, or immobilizing and isolating radioactive material to protect human health and the environment.

EPA's reference guide includes 13 treatment technologies that can potentially be applied to radioactively-contaminated solid media. Descriptions of these technologies are included in Section 4.3.

Previously, GRAs were identified and technologies were screened and evaluated and used to develop the remedial alternatives in the FS (EMSI, 2006). To address the two "complete rad removal" alternatives evaluated in the Supplemental Feasibility Study (SFS) (EMSI et al., 2011) some technologies that were screened-out or not retained in the FS were revisited, and additional technologies from the Technology Reference Guide for Radioactively Contaminated Media (EPA, 2007) were evaluated relative to the development of the two "complete rad removal" alternatives. Because EPA has eliminated the "complete rad removal" with on-site disposal alternative from further consideration and added partial excavation alternatives for the FFS evaluations, the technologies that were previously evaluated in the FS (EMSI, 2006) and the SFS (EMSI et al., 2011) were re-examined. EPA also identified additional technologies for consideration in the FFS (EMSI, 2016a) such as volume separation/volume reduction techniques and apatite/phosphate-based treatment, which are also evaluated in this section.

4.1 Technologies Evaluated in the FS Report

The results of the technical implementability screening and evaluation of technologies previously conducted for the Site are presented in Figures 4-1 and 4-2 of the FS (EMSI, 2006). GRAs and retained technologies and process options within the technologies included:

General Response Action	Remedial Technology	Process Options
No Action		
Institutional Controls	Access Restrictions	• Fences and guards
	Proprietary Controls	• Deed restrictions • Deed notices • Easements • Covenants • Groundwater use restrictions
Monitoring	Long-term Performance Monitoring	• Groundwater, surface water, and sediment monitoring
Containment	Surface Controls/Diversions	• Diversion/collection, grading, swales and berms, and vegetation to isolate storm water from Areas 1 and 2
	Surface Water/ Sediment Control Barriers	• Sediment traps, sedimentation basins
	Dust Controls	• Revegetation, capping
	Capping and Covers	• Soil, clay, and vegetation; asphalt or concrete; synthetic membrane material; and multilayer, multimedia material
Physical Treatment/Pre-Treatment following Removal	Solids Separation	• Soil sorting and screening
Removal	Excavation	• Backhoe, bulldozer, scraper, and front-end loader
	Disposal	• Off-site disposal in licensed facility • On-site disposal on Area 2 (for surface soil from Buffer Zone/Crossroad property)

4.2 Additional Technology Evaluations/Revisit Previously Eliminated Technologies

In its January 11, 2010 letter and accompanying Statement of Work (SOW) for the SFS (EPA, 2010), EPA identified two "complete rad removal" alternatives to be developed and evaluated in the SFS:

- Excavation of radioactive materials with off-site commercial disposal of the excavated materials ("complete rad removal" with off-site disposal alternative); and

- Excavation of radioactive materials with on-site disposal of the excavated materials in an on-site engineered disposal cell with a liner and cap if a suitable location outside the geomorphic flood plain can be identified ("complete rad removal" with on-site disposal alternative).

Development and evaluation of the "complete rad removal" alternatives required amendment of several remedial technologies and process options included in the FS, and inclusion in the SFS of a few technologies that were screened out in the FS. These technologies and process options are listed below and presented on Figure 4-1.

Figure 4-1 is a graphical presentation of the technical implementability screening of remediation technologies and process options and provides a brief description for each of the potential technologies. In addition to the volume separation/volume reduction techniques and apatite/phosphate-based treatment volume/size reduction technology, the following technologies and process options were added to the technical implementability screening in this FFS to potentially be considered as components of the "complete rad removal" and partial excavation alternatives. Long-term performance monitoring and short-term monitoring during construction – two specific process options under the "monitoring" GRA that were discussed in general in the FS – are described in more detail in this section. Technical implementability screening comments are also included for each technology on Figure 4-1.

General Response Action	Remedial Technology	Process Options
Monitoring	Long-term performance monitoring Short-term monitoring during construction	• Landfill and radon gas monitoring • Perimeter environmental media air monitoring • Work zone monitoring • Excavation guidance/ clearance monitoring • Waste acceptance monitoring • Post cover construction radon flux monitoring
Containment	Land encapsulation	• On-site: new cell • Off-site licensed facility
	Cryogenic Barriers	• Subsurface cryogenic barrier
	Vertical Barriers	• Slurry wall

General Response Action	Remedial Technology	Process Options
		• Grout curtain • Sheet pile cutoff wall
Physical/Chemical Treatment	Solidification/ Stabilization	• Cement solidification / stabilization • Chemical solidification / stabilization
	Chemical Separation	• Solvent/chemical extraction
	Physical Separation	• Dry soil separation • Soil washing • Flotation
	Vitrification	• In-situ vitrification • Ex-situ vitrification
	Apatite/Phosphate-Based Treatment	• Mixing/injection of crystalline minerals with wastes or groundwater
Biological Treatment	Phytoremediation	• Phytoextraction • Phytostabilization
Removal	Physical Separation	• Dry soil separation • Rotating screen – Trommel • Radiological Segregation/Separation
	Transportation (hauling of wastes and construction material)	• On-site off-road trucks • Off-site on-road trucks • Rail
	Disposal	• Off-site disposal in a licensed facility
Nuisance Control Technologies	Storm Water Management	• Best Management Practices (BMPs) to route runon around working areas • BMPs to minimize waste exposure to direct precipitation • Enclose excavation with temporary structure • BMPs to collect, detain, treat, and release runoff
	Bird Nuisance Mitigation	• BMPs: excavation, staging, soil/tarp covers • Enclose excavation with temporary structure • Grids over exposed refuse • Visual deterrents

General Response Action	Remedial Technology	Process Options
		• Auditory frightening devices • Chemical frightening agents or toxicants
	Fugitive Dust/Odor Control	• Best management practices to cover excavation and stockpile areas during non-working periods • Use of water spray/misting, foam or chemical agents to minimize dust generation and control odors • Use of a temporary building over excavation or waste sorting/loading areas

4.3 Descriptions of Additional Technologies

The technologies and process options that were added in the SFS or the FFS to be considered as potential components of the “complete rad removal” and partial excavation alternatives are described and discussed in the following subsections.

4.3.1 Monitoring

Environmental monitoring is a technology used to assess the levels of chemical or radiological constituents in environmental media at a site.

4.3.1.1 Long-term Performance Monitoring

In addition to long-term groundwater and surface water monitoring, samples of landfill gas and radon could be collected at landfill gas monitoring probes installed around the periphery of those areas where solid waste and radionuclides would still be present after implementation of the remedy. Landfill gas monitoring is a potential component of the ROD-selected remedy and the complete and partial excavation alternatives if sufficient landfill gas is expected to be generated post-remediation to require such monitoring.

4.3.1.2 Short-term Monitoring During Construction

Short-term monitoring activities that might be required during implementation of any of the alternatives could include perimeter environmental media air monitoring, work zone monitoring, excavation guidance/clearance monitoring, waste acceptance monitoring, and post-cover construction radon flux monitoring. A detailed monitoring plan would be developed as part of RD of the selected remedy.

Perimeter and local area environmental media air monitoring would use fixed monitoring stations containing low volume air samplers to collect airborne particulates and organic vapor samples for analysis of VOCs and radionuclide activity; continuous radon monitors; and radiation dosimeters. Air quality would be monitored during construction of the remedy. Concentrations of chemicals and radionuclides would be measured in areas where non-remediation workers might congregate and at the fence line. These measured air concentrations would be compared to air quality objectives for the remedy to assure that non-remediation workers who might be present in other portions of the Site, as well as members of the general public, would not be exposed to radiation from the remediation activities. It is anticipated that the air quality objectives for the remedy would be health-based standards designed to satisfy State (10 CSR, Chapter 6) and Federal (40 CFR Part 61) requirements.

Regarding remediation workers, work zone monitoring activities would involve surveillance of working conditions during remediation. Air quality would be monitored in work areas and the breathing zone surrounding individual workers using fixed and portable air samplers. Air samples would be analyzed for a variety of potential RIM constituents, including radionuclides in particulate form, radon, radon daughters, along with asbestos, selected metals such as arsenic, lead and chromium, and explosive gases. Ambient radiation would be monitored using hand-held radiation detectors and personal dosimeters issued to individual workers. Remediation workers would participate in a medical monitoring program.

Excavation guidance/clearance monitoring would involve the use of walkover field radiological survey equipment and solids sampling to identify impacted materials above cleanup levels and to guide excavation equipment. To document that RIM has been removed, clearance monitoring would include final walkover radiological scans of exposed faces and bases of excavated areas as well as sampling of soil/MSW at the base of excavations.

If excavated RIM would be disposed off-site, waste acceptance monitoring would entail scanning each load of material removed from the Site to verify that the radiological waste acceptance criteria of the facility where the RIM would be disposed is met. The material would also be inspected and tested as necessary to determine whether the waste materials contain or could be classified as hazardous wastes or contain asbestos. Discussions with potential disposal facilities indicate that the facilities would conduct these inspections and testing, including providing the necessary personnel and equipment, as such testing is a requirement of their RCRA permits.

After construction is complete for the final cover systems associated with the ROD-selected remedy or the partial excavation alternatives, Large Area Activated Charcoal Canisters would be used to measure radon flux of the cover surface.

4.3.2 Containment

Because most radionuclides require long-term management, remedies for radioactively-contaminated sites usually employ containment technologies. Containment technologies are designed to isolate contaminated materials to prevent exposure to humans and the environment. Some containment technologies are designed to prevent horizontal contaminant migration, some to prevent vertical migration, and others to prevent any form of migration. Four containment technologies are included in the Technology Reference Guide for Radioactively Contaminated Media: capping and covers (containment in place); land encapsulation (excavation and disposal, on-site or off-site); cryogenic barriers (containment in place); and vertical barriers (containment in place) (EPA, 2007).

4.3.2.1 Capping and Covers

A contaminated area can be capped by placing low permeability surface seal barriers such as caps and covers on top of the area. Capping of soil and waste could effectively limit airborne emissions and reduce precipitation-enhanced percolation, infiltration, and leaching. An engineered landfill cover consisting of natural materials such as soil, clay and vegetation layers is the primary type of landfill cap considered for OU-1. The description and discussion of this technology were included in the FS (EMSI, 2006).

The standard RCRA Subtitle D (solid waste) landfill cover system may need to be enhanced as necessary to provide additional thickness for gamma shielding and/or radon attenuation, to prevent bio-intrusion by burrowing animals, and to provide some type of marker layer to identify the presence of waste materials. In addition, a geosynthetic liner such as a geosynthetic clay liner (GCL) may be incorporated into the cover design if needed, to provide for an even lower permeability layer to further reduce radon emissions and further restrict precipitation infiltration.

4.3.2.2 Land Encapsulation: New On-Site Cell

Land encapsulation is a well-proven and readily implementable containment technology that is generally used at the disposal stage of radioactive waste management. Land encapsulation can either occur on-site or off-site if the waste is transported to an off-site land encapsulation facility (EPA, 2007).

This technology was described in the SFS in conjunction with evaluation of the “complete rad removal” with on-site disposal alternative; however, at the direction of EPA, an alternative consisting of on-site disposal in a new engineered cell is no longer being considered for the Site.

Therefore, technologies that were associated solely with this alternative that were presented, described and evaluated in the SFS are not discussed in this FFS.

4.3.2.3 Cryogenic Barriers

Cryogenic barriers provide containment and reduce the mobility of radionuclide contaminants by freezing contaminated subsurface soils to create an ice barrier around a contaminated zone. Rows of freeze pipes are inserted in an array outside and beneath the contaminated zone and the array of pipes connected to a refrigeration plant. Coolants typically consist of salt water, propylene glycol or calcium chloride. Cryogenic barriers are considered a good application for the containment of short-lived radionuclides such as tritium. Both a full-scale field test and full-scale demonstration project of this technology have been performed in the Oak Ridge, TN area (EPA, 2007a).

4.3.2.4 Vertical Barriers

A vertical barrier is a containment technology that is installed around a contaminated zone to assist in confining radioactive waste and any contaminated groundwater that might otherwise flow from a site. To be effective, vertical barriers should be constructed such that the bottom of the barrier is keyed into a relatively impermeable natural horizontal barrier (i.e., a groundwater aquitard), such as a clay zone or bedrock, to limit groundwater flow. The vertical barrier technology is often used where the waste mass is too large to practically treat and where soluble and mobile constituents pose an imminent threat to a drinking water source (EPA, 1992b). Vertical barriers are frequently used in conjunction with a surface cap to produce an above- and below-grade containment structure (EPA, 1988b). Vertical barriers can include slurry walls, grout curtains, and sheet pile cutoff walls.

4.3.2.4.1 Slurry Wall

Slurry walls consist of a vertically excavated trench filled with a slurry mix of soil, bentonite and water, or cement, bentonite and water. The slurry is pumped into the trench as the trench materials are being excavated, which provides short-term stability of the trench to prevent collapse of the side walls during excavation and, once completed, provides a barrier to groundwater flow. Soil-bentonite slurry walls have a wider range of chemical compatibility and a lower permeability than cement-bentonite slurry walls or walls with other slurry compositions, but soil-bentonite slurry walls have lower shear strength and are subject to more settlement over time.

4.3.2.4.2 Grout Curtain

Grout curtains are thin vertical grout walls constructed by pressure-injecting grout directly into the soil at closely-spaced intervals around the waste mass. The spacing is designed so that each "pillar" of grout intersects the next, thus forming a continuous wall or curtain (EPA, 1988b). Grout curtains are generally used at shallow depths (*i.e.*, less than 30 to 40 feet). Grouting materials can include hydraulic cements, clays, bentonite, silicates, and polymers (sometimes preferable because they are impermeable to gases and liquids, resist radiation, and perform well in acidic and alkaline environments).

4.3.2.4.3 Sheet Pile Cutoff Wall

Sheet pile cutoff walls are used for excavation stability and to control groundwater flow. Sheet pile cutoff walls are constructed by driving interlocking steel or high density polyethylene (HDPE) sheets into the ground. The joints between individual sheets are typically plugged with clay slurry for steel sheets or an expanding gasket for HDPE sheets. Sheet pile cutoff walls have not been demonstrated as a containment barrier at a radionuclide-contaminated site (EPA, 2007).

Although the use of sheet piling to stabilize excavation side slopes could potentially reduce the amount of material that may need to be removed, obstructions and uncertain geotechnical properties within the waste mass could greatly impact the implementability of this technology. In addition, even if it were implementable, the use of sheet piling is expected to increase the overall construction schedule and add significant costs. Consequently, the potential benefit of using sheet piling does not appear to be commensurate with the additional construction risks, cost, and schedule extension. Application of the sheet pile technology for excavation stabilization is not considered to be implementable or cost effective for Areas 1 and 2.

4.3.3 Physical/Chemical Treatment

The Technology Reference Guide for Radioactively Contaminated Media (EPA, 2007) includes six physical and chemical treatment technologies that can potentially be used to effectively treat wastes from radioactively-contaminated sites: solidification/stabilization, chemical separation, physical separation, vitrification, soil washing, and column and centrifugal flotation. Physical separation is discussed in Section 4.3.5.2 in conjunction with other physical removal related technologies. In addition, per the SOW for the FFS, apatite/phosphate based treatment technologies are also reviewed in this section.

4.3.3.1 Solidification/Stabilization

Solidification/stabilization technologies reduce the mobility of hazardous and radioactive contaminants in the environment through both physical and chemical processes. The goal of the solidification/stabilization process is to limit the spread of radioactive material via leaching, and to "trap" and contain radionuclides within a densified and hardened soil mass that has a high structural integrity. In stabilization, chemical reactions are induced between the stabilizing agent and contaminants. Solidification does not involve chemical interaction or chemical bonding between the contaminants and the solidification agent, but bonds them mechanically.

Solidification/stabilization can be employed in-situ or ex-situ. In-situ techniques use auger/caisson and injector head systems to apply agents to soils in-place, while ex-situ techniques involve excavating the contaminated materials and machine-mixing them with the solidifying agent. Ex-situ processes typically involve disposal of the resultant materials.

Solidification/stabilization techniques can involve either microencapsulation or macroencapsulation. Microencapsulation involves thorough and homogeneous mixing of small waste particles (typically 0.08 inches or less) with a liquid binder that then solidifies to form a solid, monolithic final waste form. Individual waste particles are coated and surrounded by the solidified binder to provide mechanical integrity and act as a barrier against leaching of contaminants. Macroencapsulation involves packaging large pieces of waste or containers of waste not suitable for processing by microencapsulation and surrounding the package with a layer of clean binder material. The binder forms a protective layer around the waste that provides structural support, prevents dispersion, and helps reduce migration of contaminants. EPA defines macroencapsulation as being appropriate for immobilizing low-level radioactive debris waste with dimensions greater than or equal to 2.5 inches (EPA, 2007).

Cement solidification/stabilization processes involve the addition of cement or a cement-based mixture, while chemical solidification/stabilization involves adding chemical reagents including thermoplastic polymers (asphalt bitumen, paraffin, polyethylene, polypropylene, modified sulfur cement), thermosetting polymers (vinyl ester monomers, urea formaldehyde, epoxy polymers), and other proprietary additives. Cement solidification/stabilization is best suited to highly porous, coarse-grained, low-level radioactive waste in permeable matrices, while chemical solidification/stabilization is better suited to fine-grained soil with small pores (EPA, 2007). After an extensive search of the literature, EMSI could not find an application of the solidification/stabilization technology to MSW.

4.3.3.2 Chemical Separation

Chemical separation using solvent/chemical extraction is an ex-situ chemical separation technology that separates hazardous contaminants from soils, sludges, and sediments to reduce the volume of hazardous waste that must be treated. The resulting process residuals require further treatment, storage, or disposal. Solvent/chemical extraction involves excavation and transferring soil to equipment that mixes the soil with a solvent. Solvents that have been used to remove radionuclide contaminants include complexing agents such as ethylenediaminetetraacetic acid (EDTA); inorganic salts; organic solvents; and sulfuric, hydrochloric, and nitric mineral acids. Use of water alone as the solvent is referred to as soil washing – see Section 4.3.3.3.

Solvent/chemical extraction equipment processes contaminated soil either in batches for dry soil or as a continuous flow for pumpable waste. When the contaminants have been sufficiently extracted, the solvent is separated from the soil and is either distilled in an evaporator or column or removed from the leachate by precipitation. Distilled vapor consists of relatively pure solvent that is recycled into the extraction process. The liquid residue, which contains concentrated contaminants, undergoes further treatment or disposal. If the contaminants are precipitated, the sludge is dewatered with a filter press.

Not all radionuclides and solvent will be removed from the contaminated soil during the chemical extraction process, requiring further processing if the remaining concentrations are not below levels such that the soil can be returned to its original location. Results from 22 studies indicate contaminant removal rates using the solvent/chemical extraction process of 13% to 100% for soils contaminated with radioactive waste and heavy metals (EPA, 2007). Two studies (one pilot-scale and one full-scale) using sodium carbonate/sodium bicarbonate solution for uranium extraction achieved removal efficiencies of between 75% and 90% (EPA, 2007). A solvent/chemical extraction field demonstration project treating soil containing Ra-226 and Th-232 showed removals of 60% to 67% and 73% to 76%, respectively (EPA, 2007).

Soil properties such as particle size, pH, partition coefficient, ion exchange capacity, organic content, moisture content, and contaminant concentrations and solubilities are factors that affect the efficiency and the operability of solvent/chemical extraction (FRTR, 2002). Bench-scale testing is required. Soils with high clay, silt, or organic content might cause dewatering problems in the contaminated waste stream. Debris greater than 2.4 inches in diameter typically must be removed prior to processing, and chemical extraction is not practical for soil with more than 6.7% organic material. If multiple radionuclides or metals are targeted for removal, multiple solvent extraction steps may be required using multiple solvents. Interference from thorium could limit the application of EDTA in removing radium when both radionuclides are present (EPA, 1995).

4.3.3.3 Soil Washing

Soil washing is a process in which water, with or without surfactants, is mixed with contaminated soil and debris to produce a slurry feed. This slurry feed flows through a scrubbing process to segregate contaminated fine soil particles (silts and clays) from granular soil particles. Contaminants are generally bound more tightly to the fine soil particles and not to larger-grained sand and gravel. Separation processes such as mechanical screening are needed to divide excavated soils into the coarse- and fine-grained fractions, and for dissolving or suspending contaminants in the slurry feed wash. The sand and gravel fraction is generally passed through an abrasive scouring or scrubbing action to remove surface contamination. The fine fraction can be separated further in a sedimentation tank, sometimes with the help of a flocculating agent. The output streams of these processes consist of clean granular soil particles, contaminated soil fines, and process/wash water, all of which need to be tested for contamination. Soil washing is effective only if the process transfers the radionuclides to the wash fluids or concentrates them in a fraction of the original soil volume. In either case, soil washing must be used with other treatment technologies, such as precipitation, filtration and/or ion exchange, to recover the radionuclides. Clean soil (sands and gravels) can be returned to the excavation area, while the contaminated soil fines and process water are further treated and/or disposed.

Soil washing is most effective when the contaminated soil consists of less than 25% silt and clay and at least 50% sand and gravel; soil particles should be between 0.01 to 0.08 inches in diameter for optimum performance (EPA, 2007). Soil characteristics including particle size distribution, moisture content, ion exchange capacity, and contaminant concentrations and solubilities are factors that impact the efficiency and operation of the soil washing process. Despite many bench- and pilot-scale tests, soil washing has not been fully demonstrated as a technology for reducing the volume of radionuclide-contaminated soil (EPA, 2007). There also are no known treatability tests or applications of this technology to MSW.

4.3.3.4 Flotation

Flotation separates the radionuclide-contaminated soil fraction (usually the fine soil particles such as silts and clays) from the clean soil fractions (usually the large granular soil particles and gravel) in order to reduce the volume of soil requiring treatment or disposal. During flotation, radionuclide-contaminated soil is pretreated to remove coarse material and then mixed with water to form a slurry. A flotation agent (a chemical that binds to the surface of the contaminated soil particles to form a water repellant surface) is then added to the solution. Small air bubbles are then passed through the slurry. These air bubbles adhere to the floating particles, transport them to the surface, and produce a foam containing the radionuclide-contaminated soil particles. The foam is mechanically skimmed from the surface or allowed to overflow into another vessel. Residual radionuclide-contaminated soil fines and foam require further testing and treatment and/or disposal. After dewatering and drying, the clean soil can then be returned to the excavation area (EPA, 2007).

Soil-specific site considerations such as particle size and shape distribution, radionuclide distribution, soil characteristics (clay, sand, silt, and organic content), specific gravity, chemical composition and mineralogical composition can impact the effectiveness of flotation. Flotation is most effective at separating soil particles in the 0.0004 to 0.004 inch size range. For soils that include a wider range of particle sizes, flotation can sometimes be part of a treatment train (e.g., soil washing). Although mining industry operations have consistently and successfully segregated metal-containing fines from soil using this process, the flotation technology has not been fully demonstrated for reducing the volume of radionuclide-contaminated soil (EPA, 2007). The effectiveness of floatation technology is dependent upon the degree to which the technology concentrates the radionuclide-contaminated soil/waste fraction.

4.3.3.5 Vitrification

Vitrification involves heating contaminated media to extremely high temperatures, then cooling them to form a solid mass. Upon cooling, a dense glassified mass remains, trapping the radioactive contaminants in a solid, inert form. The process can be applied to contaminated soil, sediment, sludge, mine tailings, buried waste, and metal combustibles. Although mobility is greatly reduced for contaminants trapped within the vitrified mass, the radioactivity of the radionuclide contaminants is not reduced. EPA has designated vitrification as a Best Demonstrated Available Technology (BDAT) for high level radioactive waste (EPA, 2007).

Vitrification can be performed both in-situ and ex-situ. Traditional in-situ vitrification uses a square array of four graphite electrodes that allows a melt width of approximately 20 to 40 feet and a potential treatment depth of up to 20 feet. Multiple locations, referred to as settings, can be used for remediation of a larger contaminated area. The electrode array is lowered progressively, as the melt grows, to the desired treatment depth. Depending on the amount and types of organics and metals (*e.g.*, mercury, lead, and cadmium) present in the soil or waste mass which may volatilize, offgas treatment may be required.

In the ex-situ configuration, waste is fed to a furnace (*e.g.*, joule-process heating; plasma; electric arc; microwave; and coal-, gas- or oil-fired cyclone furnace) on either a batch or continuous feed basis. The ex-situ vitrified mass is then disposed off-site or returned to the area where the waste was excavated.

In-situ vitrification should generally not be used on waste or contaminated soils with organic contents higher than 10 percent by weight or highly reactive materials. To effectively immobilize radionuclides and heavy metals, soils should have greater that 30 percent glass-forming materials (*i.e.*, SiO_2). The waste and/or contaminated media must have sufficient alkali content (*i.e.*, Na_2O, Li_2O, and K_2O) to ensure the proper balance between electrical conductivity and melting temperature. Void volumes and percentages of metals, rubble, and combustible organics (*e.g.*, methane in landfill gas) need to be considered, as soils and waste that contain greater than 55 percent inorganic debris and/or rubble are difficult to treat with in-situ vitrification (EPA, 1997). The process is also not applicable to soils or waste containing sealed containers such as drums, tanks, or paint cans since pressurized gases will be released and may disrupt the melt (EPA, 2007). No information was identified regarding the potential applicability or previous application of this technology to MSW.

4.3.3.6 Apatite/Phosphate-Based Treatment

The EPA SOW (EPA, 2015b) required an evaluation of the potential feasibility of using apatite/phosphate-based treatment technologies for treatment of radionuclides in soil or groundwater. This section presents a summary of the evaluation of the apatite treatment technology. Additional details regarding this evaluation are presented in Appendix D.

Apatite is an isomorphic mineral. Specifically, apatite is a group of crystalline mineral compounds that have different chemical compositions but identical crystalline structures. Consequently, precipitation of apatite can result in incorporation of other elements into the mineral's crystalline structure. In an isomorphic mineral, certain ions or molecules will enter into the crystal-lattice of a mineral solid without causing any marked change in the crystal morphology or other physical properties of the mineral. For simplicity, this process reflects two ions having similar but not equal atomic radii and the same charge, with the smaller ion being preferentially concentrated in the early formed specimens of a crystallizing mineral series.

Relative to the radionuclides at the Site, apatite or other phosphate-based materials or solutions would be added to groundwater containing radionuclides or to the solid phase materials containing the radionuclides in sufficient quantities and under appropriate geochemical conditions necessary to promote apatite crystallization. Such crystallization may result in incorporation of Site-related radionuclides such as thorium, radium and uranium into the apatite crystals. Incorporation of radionuclides into the crystalline matrix would reduce the potential for leaching of such radionuclides.

Radium and thorium, and to a lesser extent uranium, are the major radionuclides of concern at the Site relative to potential leaching to groundwater. Thorium is known to be highly insoluble and uranium is relatively insoluble under reducing conditions such as those that occur at MSW landfills. Neither of these radionuclides has been detected in dissolved-phase groundwater at levels above background. Therefore, radium would be the key constituent for treatment using apatite materials. Based on an extensive review of the literature regarding the use of apatite and/or other phosphate-based materials for treatment of radionuclides and metals in water, soil, sediments, tailings and landfill leachate (EMSI, 2016c), there is known applicability for treatment of groundwater containing strontium, uranium, and some metals, but no known applications for treatment of radium or thorium in groundwater.

There is no demonstrated application of use of apatite and/or other phosphate-based materials for treatment of MSW. Uncertainty exists as to whether apatite formation can be initiated synthetically under field conditions associated with MSW, including whether apatite solids or solutions can be delivered and homogeneously distributed within an overall heterogeneous matrix of MSW, which in the case of Areas 1 and 2 have been shown to be in generally unsaturated conditions (EMSI, 2016b and EMSI, 2000). DOE technical representatives with extensive experience with bench- and pilot-testing of apatite under various geochemical conditions have expressed concerns about unintended consequences that could result from physical disturbance or modification of the geochemical conditions within the Site from application of apatite-based treatment technologies (Thompson and Wellman, 2012).

4.3.4 Biological Treatment

Biological treatment of radioactively-contaminated soils, sediments, and sludges involves stabilization of the contaminants in-place and/or removal via plant root systems. Phytoremediation is the use of plant systems to remove, transfer, stabilize, or destroy contaminants in soils, sediments and sludges. The contaminants are transferred to various parts of the plant, including the shoots and leaves, where they can be harvested. The mechanisms of phytoremediation applicable to solid media include enhanced rhizosphere biodegradation, phytoextraction, phytodegradation and phytostabilization.

Because radionuclides do not biodegrade, the mechanisms applicable to remediation of radionuclides are phytoextraction and phytostabilization (FRTR, 2002). Phytoremediation is limited to shallow soils and sediments. Because growth of plants can be affected by climatic or seasonal conditions, this technology may not be applicable in areas with cold climates and short growing seasons.

Phytoextraction (also known as phytoaccumulation), is the uptake of contaminants by plant roots and the translocation/accumulation of contaminants into plant shoots and leaves. Phytoextraction will produce a harvested biomass residual waste that must be further treated and/or disposed as a radioactive waste. For phytoextraction to be effective, the root system of the selected plants should be able to penetrate the entire contaminated zone, and to be cost-effective, the rate of plant uptake must be greater than one percent of the plant's weight per harvest and the time to complete the remediation process must be between two and 10 years. Phytoextraction has been pilot-tested to remove low levels of cesium and strontium from contaminated soils and sediments (EPA, 2007). EPA (2007) indicated that phytoremediation is applicable to uranium, cesium, strontium and cobalt in solids but that application of this technology is limited to shallow soils, that this technology is best suited to sites with lower levels of contamination only slightly above cleanup levels, and that this process can take several years or more for implementation. EPA (2007) further indicated that this technology has not been fully demonstrated for radioactive contamination in solids. EPA identified a bench scale demonstration for removal of thorium from soil but indicated that based on testing and field trials, the most promising candidates for phytoextraction appeared to be cesium-137 and strontium-90 (EPA, 2007). No information was identified regarding the potential applicability or prior application of this technology for removal of radium (EPA, 2007).

Phytostabilization is the production of chemical compounds by plants to immobilize contaminants at the interface of roots and soil. Contaminant transport in soil, sediments, or sludges can be reduced through absorption and accumulation by roots; adsorption onto roots; precipitation, complexation, metal valence reduction in soil within the root zone; or binding into organic humic matter through the process of humification. Although considerable research has been conducted on phytostabilization of metals, little research or field testing has been performed regarding phytostabilization of radionuclides (Pivetz, 2001).

Phytoextraction and phytostabilization all require the root systems of the plants to extend down through the zone of contamination. RIM in Areas 1 and 2 occurs at depths ranging 0 to 89 feet bgs in Area 1 and 0 to 42.5 feet bgs in Area 2. Therefore, application of phytoremediation technologies would require growing large trees on the surface of Areas 1 and 2 which is inconsistent with the objectives of the recently implemented non-combustible cover and would also be inconsistent with the ARARs associated with the Missouri solid waste regulations which require development of grasses and shallow rooted vegetation as part of a landfill cover.

4.3.5 Removal

Several removal technologies may be considered as components of alternatives to address the site characterization results, as well as to satisfy the RAOs associated with OU-1 at the West Lake Landfill. Removal technologies considered include excavation, physical separation, transportation, off-site disposal, and stormwater management.

4.3.5.1 Excavation

Excavation construction equipment includes back- and track-hoes, bulldozers, scrapers, and front-end loaders. This equipment would be used for cutting and filling of waste and fill materials to achieve surface grades, to excavate and move filled waste material, and to construct new site features such as stormwater retention/conveyance and cover systems.

4.3.5.2 Physical Separation

Physical separation technologies are a class of treatment in which radionuclide-contaminated media are separated into clean and contaminated fractions by taking advantage of the physical properties of the contaminants. These technologies work on the principle that radionuclides are associated with a particular fraction of a media which can be separated based on size and other physical attributes. In solid media such as soil or sediment, most radioactive contaminants are associated with smaller particles, known as soil fines (*i.e.*, clays and silts). Physical separation of the contaminated media into clean and contaminated fractions could potentially reduce the volume of contaminated media requiring further treatment and/or disposal.

4.3.5.2.1 Dry Soil Separation

Dry soil separation segregates radioactive particles from clean soil particles. The simplest application involves screening and sieving soils to separate finer fractions, such as silt and clay, from coarser fractions of the soil. Since most contaminants tend to bind to the fine fraction of a soil either chemically or physically, separating the finer portion of the soil can concentrate the contaminants to a smaller volume of soil for subsequent treatment or disposal (FRTR, 2002).

Radiological constituents at OU-1 Areas 1 and 2 occur in soil materials that are intermixed with and interspersed within the overall matrix of landfilled refuse, debris, fill materials, and soil and quarry spoils. Therefore, before a dry soil separation process could be considered, the interstitial soil materials would need to be separated from the other landfilled materials using a solids separation process. Solids separation processes can include hand picking for large bulky items and hazardous materials such as propane tanks; magnetic separation for ferrous metals and contaminants associated with ferrous metals; eddy current separation for non-ferrous metals (*e.g.*, inducing an electric current to separate aluminum cans from other recyclables); air classification for papers and plastics; and various fixed, vibrating, or rotating screens.

4.3.5.2.2 Rotating Screen – Trommel

Trommel (revolving cylindrical sieve) screens are commonly used during landfill mining and reclamation (LFMR) projects to separate materials by size, with the soil fraction passing through the screen. Metal conveyor flights on the inside surface of the screen direct the non-soil fraction to the discharge end of the rotating cylinder. The size and type of screen used depends on the end use of the recovered material.

During LFMR projects, trommel screens are typically used downstream in series with a shear shredder with the recovered soil fraction directed to one side of the trommel. If the radiologically-impacted soil were to be separated from the landfilled waste materials, one or more mobile diesel-driven trommels would be used downstream of a shear shredder. A 1 to 1½-inch trommel screen size would likely be chosen to recover the most soil while passing through small pieces of metal, plastic, glass, and paper. This configuration of shear shredder and trommel in an LFMR pilot-test application is shown in Figure 4-2.

A comb and shaft shear shredder uses counter-rotating multi-edged knives or hooks rotating at a slow speed with high torque to shred materials fed into the inlet hopper. Shear shredders are employed prior to trommel screens in LFMR projects for three primary reasons:

- An approximate 30 percent volume reduction in waste material is achieved by shredding all filled material to a uniform 6 to 8-inch minus size. Separated material that is returned to the landfill is more easily compacted and takes up less volume than the original in-place waste material. It should be noted that very large landfilled objects such as white goods and steel beams, etc. are “hand-picked” from the waste stream prior to shredding.

- Shredding pretreatment breaks up pockets and clumps of organic and matted materials and soil; dislodges smaller materials that may be ‘hidden” in among the larger materials; and pulverizes materials such as brick, concrete block, large chunks of concrete that contain rebar, and mattresses to provide a stream of more uniformly-sized material such that fines and the soil fraction of the waste can be more easily separated.

- Shear shredding reduces the size of materials (primarily from construction/remodeling and demolition of utilities, structures, and roads, including rebar and other pieces of steel, dimensional lumber and columns/beams, plumbing fixtures and piping, recycled asphalt, and electrical wiring and components) that would tend to clog, get hung up in, and increase the wear on the trommel screen and flights.

The benefits or impacts of using a shear shredder prior to a trommel screen relative to maximizing separation of radiologically-impacted soil from solid wastes typically is evaluated as part of a pilot test during RD prior to full-scale implementation. A pilot-test would require at least seven to nine months to perform, including at least three months to develop, review, approve, and finalize a work plan, one to two months for equipment mobilization and field testing, two months for lab testing, and one to two months for data evaluation and reporting.

4.3.5.2.3 Radiological Segregation/Separation

A refinement of the dry soil separation process uses radiation detectors to further separate materials (EPA, 2001, Patteson, 2000, Patteson, Maynor and Callan, 2000, Thermo Nutech,1998, and Cummings and Booth, 1996). For this method, radionuclide-contaminated soil is first excavated and screened to remove large rocks and debris. Large rocks are crushed and placed with soil on a conveyor belt, which carries the soil under radiation detectors that measure and record the level of radiation in the material. Radioactive batches of material on the conveyor belt are tracked and mechanically diverted through automated gates, which separate the soil into contaminated and clean segments. The radioactive materials then receive further treatment and/or disposal. This technology would require extensive pilot-testing to determine the appropriate screening criteria to be used to segregate the material, and to demonstrate the implementability, cost, and potential effectiveness of the technique.

This system is best suited to sort any dry host matrix that can be transported by conveyor belts (EPA, 2003) and which is contaminated with no more than two radionuclides with different gamma energies (DOE, 1998). Large debris should be removed before processing the soil and large rocks, concrete, or asphalt must be crushed before being placed on the conveyor belt. Screening to size the feed material to diameters of less than 0.5 inches is desirable and material greater than approximately 1.5 inches in diameter cannot be processed without crushing. Optimal soil moisture content is between 5 and 15 percent (DOE, 1999).

Several case studies of application of this technology are available (EPA, 2001, Patteson, 2000, Patteson, Maynor and Callan, 2000, Thermo Nutech, 1998, and Cummings and Booth, 1996). Review of these case studies indicates that applications of this technology have been used for sorting of soil containing depleted uranium, natural uranium, plutonium or Cesium-137. Most of these applications involved use of the ThermoRetec (formerly Thermo Nutech) segmented gate system (SGS) which consists of a mobile, radiological soil assay system with motorized conveyor belts, a variable belt speed motor controller, air actuated segmented gates, a radionuclide assay computer system and two sets of radiation detector arrays, deployed across a 32-inch wide assay conveyor. Contaminated soil is fed into the SGS processing plant where oversized material (typically 1.5 inches) is removed. The remaining soil is conveyed at a constant speed beneath the detector arrays that are linked to a control computer which toggles pneumatic diversion gates located at the end of the sorting conveyor. Contaminated material that exceeds the criteria for radioactive materials is diverted to a separate conveyor from that used to convey non-contaminated material. The SGS is designed for detection of gamma-ray emitting radionuclides using NaI detectors; however, it can also be modified to detect some beta-emitting radionuclides (Patteson, 2000).

Advantages of the SGS are that it physically surveys the entire volume of soil processed and typically reduces the volume of soil requiring treatment or disposal by 50% to 90% (Patteson, 2000). Dry decontamination has been proven effective for free release of the system so generation of secondary waste is limited to personnel protective equipment (Patteson, 2000). A disadvantage of the SGS is that it is limited to gamma -emitting radionuclides. It is also limited to analyses of a maximum of two radionuclides with different gamma energies at a time (Patteson, 2000). Soil cannot be sorted for unknown radionuclides, so prior knowledge of the primary radioactive contaminants is required (Patteson, 2000). Material greater than 1.5 inches cannot be processed without pre-crushing (Patteson, 2000). The radioactive contaminants must also be heterogeneously distributed within the suspect soil.

A detailed summary of several case studies is presented in Patteson (2000). The SGS has been used at Sandia National Laboratories where, through initial processing and subsequent reprocessing, it was used to sort 662 cubic yards of soil contaminated with depleted uranium with a resulting volume reduction of 99% relative to a cleanup criteria of 540 pCi/g. Soil processed through the SGS was separated into contaminated (average uranium activity of 406.5 pCi/gm) and uncontaminated soil (average activity of 4.2 pCi/g). At the Pantex Plant in Amarillo, Texas, the SGS system was also tested for use in processing soil containing depleted uranium. A total of 294 cubic yards were processed through the SGS with a resultant volume reduction of only 38.5% relative to a cleanup criteria of 50 pCi/g. The SGS system was tested for sorting 333 cubic yards of plutonium contaminated soil at the Tonopah Test Range in Nevada using varying set-point values to activate the sorting gates with results ranging from 4% to 99% reduction. The SGS was used to process 2,526 cubic yards of soil containing natural uranium at the Los Alamos National Laboratory where it achieved separation efficiencies ranging from 75% to over 99% for separation points of 50 to 65 pCi/g. The SGS was also used at the Idaho National Engineering and Environmental Laboratory (INEEL) to process soil containing cesium-137. Only 442 cubic yards were processed before the project was terminated because it did not achieve the expected volume reduction. EPA reports that the system only achieved a 3% volume reduction (EPA, 2001).

As discussed above, the SGS is designed for detection and sorting of gamma-emitting radionuclides. A soil sorter process such as the segmented gate system that uses gamma radiation to identify contaminated soil is likely to have difficulty identifying soil with a Th-230 concentration that would allow for unrestricted use (*e.g.*, 5 pCi/g plus background) due to the lower gamma emissions associated with thorium decay. Experience gained through investigations (EMSI, 2016b) and the non-combustible cover removal actions indicate that Th-230 is the dominant and most widespread radionuclide at the Site. The NRC (1988) stated that "[b]ecause the controlling radionuclide (Th-230) has no characteristics that make it easy to measure quantitatively in place, as can be done for Ra-226 with its decay products, the large but variable ratio of Th-230 to Ra-226 and its decay products makes the delineation of cleanup more difficult." The presence and overall dominance of Th-230 in the waste material greatly restricts the use of gamma radiation detection-based systems for automatically or even manually sorting RIM from non-RIM waste containing low levels of primarily non-gamma-emitting radionuclides. Therefore, it is likely this technology will not be effective for the "complete rad removal" or possibly even the 52.9 pCi/g criteria partial excavation alternative. Due to the general correlation between radium and thorium occurrences at higher levels (EMSI, 2016b), this technology may have some application relative to the partial excavation alternative based on the 1,000 pCi/g criteria.

4.3.5.3 Transportation

Hauling of waste material on- and off-site would be conducted using on-road and off-road trucks, rail, or a combination of trucks and rail. Delivery of clean fill, liner and cover materials, and other materials and equipment associated with construction of the selected remedy also would be accomplished with a variety of trucks.

4.3.5.3.1 Hauling of Wastes and Construction Materials – On-site, Off-road and Off-site, On-road Trucks

Hauling of waste material by truck would be conducted off-site with on-road trucks and on-site with off-road trucks. Various off-site, on-road "highway" trucks would be used to haul clean fill material to the Site, haul waste material from the Site directly to a waste disposal facility, or haul waste material to a truck-to-rail transloading location where it would be transferred from the trucks to rail cars for subsequent rail hauling. If hauled off-site via trucks, wastes with radionuclides must be placed in appropriate containers and USDOT requirements for shipping must be met.

Highway trucks are equipped with tires suitable for long distances on flat surfaces and are used for transporting loose material such as sand, gravel, rock, asphalt, soil or waste materials on roads and highways to and from construction sites, quarries, borrow pits, landfills, and waste disposal facilities. Typical configurations include the standard dump truck (truck chassis with dump body mounted to the truck frame); the semi-trailer or tractor-trailer equipped with flat-bed and bottom-, end-, and side-dump cargo trailers; and the transfer dump truck that pulls a separate dump (or "pup") trailer. Semi-trailer trucks equipped with flatbed or end-dump trailers as well as transfer trucks with pup trailers are typically used to haul waste material from a site to a truck-to-rail transloading operation at a rail spur location. Hauling of waste to a transloading facility can also be performed using 32 cubic yard (20 ton) capacity DOT Industrial Packaging (IP)-1 metal intermodal containers (see 49 CFR Subparts A and B and 49 CFR § 173.410 for IP design requirements for low specific activity (LSA) materials) that can be placed on a flatbed truck, which can be hauled directly to a waste disposal facility via truck or taken to a rail loading facility and transferred directly to flatbed railcars.

On-site, off-road dump trucks or "haul trucks" resemble heavy construction equipment and are used strictly off-road for mining and heavy dirt or other construction materials hauling projects. These vehicles employ large diameter off-road patterned rubber tires and can have large payload capacities. There are two primary forms: the rigid frame and the articulated frame or "Yuke."

4.3.5.3.2 Hauling of Waste Material - Rail

Hauling of waste material via rail is typically accomplished with 110-ton capacity gondola cars (railroad car with an open top but enclosed sides and ends, for transporting bulk commodities) or with DOT IP-1 intermodal containers that can be stacked onto flatbed railcars. Wastes hauled off-site to an off-site licensed facility via rail must be shipped in appropriate containers and USDOT requirements for shipping must be met.

If waste material is loaded directly into gondola cars, rigid lids are locked onto the open top prior to transport. Waste material can also be placed into 10 or 35 cubic yard IP-1 soft-sided shipping containers (bags), with the bags then loaded onto flatbed semi-trailers and trucked to a truck-to-rail transloading operation at a rail spur location where the containers are off-loaded from the flatbed into gondola cars. Nine to ten 10 cubic yard bags will fit in a standard sidewall height (5½ feet) gondola car. Four 35 cubic yard bags can be loaded into a larger volume 148 cubic yard gondola. After the gondola cars are filled with soft-sided shipping containers, rigid lids or secured tarps are placed over the top of the car prior to shipment. After the railcars arrive at an off-site disposal facility, the contents are either discharged directly at the facility using a rotary car dumper or “excavated” from the gondolas and transferred to trucks at a rail transfer facility and subsequently hauled to the disposal facility.

Metal intermodal containers have a hinged top and one end of the container is also hinged. After a liner has been placed in the container, the waste material is loaded into the top of the container, the top is secured and the container is lifted onto a flatbed trailer and hauled to a truck-to-rail transloading operation at a rail spur location, where the container is lifted off of the flatbed and stacked with other intermodals onto a flat railcar. At the off-site disposal facility, intermodal containers are lifted off of the railcar onto a truck, transported to the disposal cell, and the contents are discharged into the disposal cell through the hinged end of the container.

4.3.5.4 Disposal at an Off-Site Licensed Facility

The SFS evaluation included contacting low-level radioactive waste disposal facilities that could potentially accept the bulk debris-type of waste material to be excavated from the West Lake Landfill OU-1 areas. These facilities include the Energy Solutions facility in Clive, Utah; the US Ecology facilities in Grand View, Idaho and Robstown, Texas; the Waste Control Specialists facility near Andrews, Texas; and the Clean Harbors Deer Trail facility near Last Chance, Colorado. After the SFS was completed, US Ecology opened an additional facility in Wayne, Michigan and therefore US Ecology was also contacted regarding this facility.

As discussed in Section 3, prior to disposal, the waste material excavated from the Site would have to meet the waste acceptance criteria (WAC) of the respective disposal facility. A preliminary evaluation of the WAC for the various facilities relative to the activity of the RIM material indicates that only four – the US Ecology, Grand View, ID; US Ecology, Wayne, MI; Energy Solutions, Clive, UT; and Clean Harbors Deer Trail, CO facilities – could accept waste material from the Site. The locations of these facilities relative to the St. Louis, Missouri area are shown on Figure 4-3. Figure 4-3 also includes the various railroad lines that serve the areas where the various off-site disposal facilities are located. Because of the long distances between the facilities and the Site, rail transfer would be the most likely method of transporting waste materials for the "complete rad removal" with off-site disposal alternative; however, hauling by truck is also a potentially viable method for transportation of waste to the US Ecology, Wayne, MI facility (Figure 4-3).

Descriptions of these disposal facilities and the proposed methods of transportation of waste material from the Site are provided below. In addition to being permitted to accept low-level radioactive waste, each of these facilities is permitted to accept hazardous waste and low-level radioactive/hazardous mixed wastes if these wastes are encountered in Areas 1 and 2.

US Ecology: Grand View, Idaho. This 160-acre disposal facility (included within a 1,000 acre privately-owned buffer zone) is located 70 miles southeast of Boise in the Owyhee Desert, approximately 10 miles northwest of Grand View, ID. It has a permit from the State of Idaho to accept RCRA, NORM, TENORM, NRC, and mixed waste (Part B Permit # IDD073114654). Information for the facility can be found at http://www.americanecology.com/grand_view.htm. The link to a photo gallery showing the facilities and nearby rail transfer facility is: http://www.americanecology.com/grand_view_photo_gallery.htm.

Wastes are received at the US Ecology-Idaho facility by truck directly and by rail via their 130-car rail transfer facility located in Simco, Idaho, 36 miles from the disposal facility. Wastes shipped by rail are trucked from the rail transfer facility to the disposal facility. US Ecology has indicated that excavated material from the Site would be either: (1) loaded directly into bag-lined gondola cars if a rail spur could be extended across St. Charles Rock Road onto the Site; or (2) loaded into 35 cubic yard IP-1 DOT bags or 32 cubic yard IP-1 metal intermodal containers that would be placed on a semi-trailer, transported to a truck-to-rail transloading operation at a potential future leased rail spur located near the Site (assuming one could be located), and then loaded into gondola or flatbed rail cars in the case of the intermodal containers. Under either a direct-to-rail or truck-to-rail loading procedure in St. Louis, the bagged, excavated material in the gondola cars would be hauled by rail to the rail transfer facility east of Grand View, ID, then transferred from the gondola cars to transfer trucks with pup trailers and trucked the final 36 miles to the US Ecology facility for disposal.

The specific rail routes that would be followed from a potential future rail spur extended onto the Site or a truck-to-rail transloading operation at a potential future leased rail spur located near the Site to the US Ecology Grand View, ID facility are as follows: Burlington Northern Santa Fe (BNSF) from Bridgeton, MO to Kansas City, MO; then the Union Pacific from Kansas City, MO to Simco, ID. This route transits through the major cities of Bridgeton, MO, Kansas City, MO, Atchison, KS, Marysville, KS, Hastings, NE, North Platte, NE, Cheyenne, WY, Green River, WY, Salt Lake City, UT, Pocatello, ID, and Nampa, ID.

Approximately 2.5 million tons of waste material containing radionuclides, including 2 million tons of USACE FUSRAP waste containing uranium, radium, and thorium soils and debris, have been disposed at the Grand View, ID facility. Material containing radionuclides from SLAPS

[634,000 tons], Latty Avenue [69,000 tons], and Denver Radium OU-8 (Shattuck Chemical) [243,000 tons] sites have also been disposed at this facility.

The WAC and RCRA Part B permit for this facility are included in Appendix C-1.

US Ecology: Wayne, Michigan. This 450-acre treatment and disposal facility is located approximately 30 miles west of downtown Detroit adjacent to Interstate 94 in Van Buren Township, Wayne County, MI (just northwest of Belleview, MI): 49350 N I-94 Service Drive, Belleville, MI 48111. US Ecology-Michigan operates the largest (by volume) stabilization and treatment facility in North America with the ability to process hazardous and non-hazardous materials through stabilization, chemical oxidation/reduction, deactivation, microencapsulation and other permitted technologies. The facility manages more than 600 federal and state waste codes, employs a Regenerative Thermal Oxidation (RTO) system, and is the only commercial hazardous waste landfill in Michigan and the only landfill in EPA Region V with a TSCA approval to accept PCB contaminated wastes. It is permitted to accept solid waste, RCRA hazardous waste, and NORM and TENORM wastes under RCRA permits EPAID#MID000724831 (Treatment) and EPAID#MID048090633 (Landfill), which contain waste acceptance criteria relative to hazardous wastes. The NORM/TENORM Waste Addendum identifies waste acceptance criteria relative to radionuclides. The co-located solid waste transfer facility and processing plant (Michigan Disposal Waste Treatment Plant [MDWTP]) operates under the Michigan Department of Environmental Quality license number 9411. Information for the facility can be found at: https://www.usecology.com/Locations/All-Locations/US-Ecology-Michigan.aspx

Wastes are received at the US Ecology-Michigan facility by truck directly (lined and covered end/side-dump semi trailers or 32 cubic yard IP-1 metal intermodal containers placed on a semi-trailer) and indirectly by rail. Wastes shipped by rail are transported in intermodal containers placed on flatbed railcars to a spur location near the US Ecology-Michigan facility (e.g., in Romulus, MI or the large switching yard in Melvindale, MI). At the spur location, the intermodals are transferred from the railcars onto semi-trailers and trucked from the rail spur transfer location to the disposal facility.

Because the US Ecology-Michigan facility is only 520 miles from the Site, US Ecology has indicated that wastes from the Site would most likely be transported by truck to this facility. The specific truck route that would be followed from the West Lake site to the US Ecology-Michigan would most likely be: Interstate 270, then Interstate 70 from Bridgeton, MO to Dayton, OH, then Interstate 75 from Dayton, OH to the intersection with Interstate 275 just north of Monroe, MI, then Interstate 275 to Interstate 94 at Romulus, MI, then Interstate 94 to Van Buren Township, MI. This route transits through the major cities of Bridgeton, MO, St. Louis, MO, Terre Haute, IN, Indianapolis, IN, Dayton, OH, and Toledo, OH.

The specific rail routes that would be followed from a truck-to-rail transloading operation at a potential future leased rail spur located near the Site (assuming one could be located) to the US Ecology-Michigan facility would be: Norfolk Southern from Bridgeton, MO to St. Louis, MO; then CSX from St. Louis, MO to a spur location near the US Ecology-Michigan facility. This route transits through the major cities of Bridgeton, MO, Saint Louis, MO, Terre Haute, IN, Indianapolis, IN, Sidney, OH, Toledo, OH, and Wayne, MI.

The WAC and RCRA Part B permit for this facility are included in Appendix C-2.

Energy Solutions: Clive, Utah. The 439-acre Energy Solutions Clive site is located in Utah's West Desert, approximately 75 miles west of Salt Lake City and about three miles south of Interstate 80, Exit 49. Information for the facility can be found at http://www.energysolutions.com/?id=OTkw. A video of the facilities at the Clive site can be found under the Media Room tab at this website. The facility is authorized to receive Class A LLRW, NORM/NARM, Class A Mixed LLRW (i.e., radioactive and hazardous), 11e.(2) Byproduct Material, and Special Nuclear Material based on concentration limits under Radioactive Material License (RML) Number UT 2300249, as amended, and 11e.(2) Byproduct Material License Number UT 2300478, as amended. The facility has a separate license to receive and dispose of uranium and thorium mill tailings byproduct material as defined by section 11e.(2) of the Atomic Energy Act of 1954, as amended.

The Clive, UT facility receives waste shipped via bulk truck, containerized truck, enclosed truck, bulk railcars, rail boxcars, and rail intermodals. The disposal site is accessed year-round by the Union Pacific Railroad at Energy Solutions' 10 miles of private siding. A covered railcar rotary dumper and covered railcar decontamination facilities are also located at the disposal facility.

Energy Solutions has indicated that excavated material from the Site would be either: (1) loaded directly into gondola cars if a potential future rail spur could be extended across St. Charles Rock Road onto the Site; (2) loaded into 10 cubic yard IP-1 DOT bags, with the bags placed on a flat bed semi-trailer and transported to a truck-to-rail transloading operation at a potential future leased rail spur located near the Site (assuming one could be located), and then loaded into gondola rail cars; or (3) bulk loaded into 25 cubic yard intermodal containers, with the intermodal containers then placed on a flat bed semi-trailer and transported to a truck-to-rail transloading operation and multiple intermodal containers stacked onto flat railcars. The gondolas or intermodal containers would be transported via rail directly to the Clive, UT facility for disposal at the Energy Solutions facility.

The specific rail routes that would be followed from a potential future rail spur extended onto the Site or a truck-to-rail transloading operation at a potential future leased rail spur located near the Site to the Energy Solutions Clive, UT facility are as follows: Norfolk Southern (NS) from Bridgeton, MO to Kansas City, MO; then the Union Pacific from Kansas City, MO to Clive, UT. This route transits the major cities of Bridgeton, MO, Kansas City, MO, Atchison, KS, Marysville, KS, Hastings, NE, North Platte, NE, Cheyenne, WY, Green River, WY, Ogden, UT, Salt Lake City, UT, West Wendover, NV, and Clive, UT. Note that Energy Solutions uses a different rail route from Bridgeton, MO to Kansas City, MO than US Ecology.

Large volumes of soil and waste materials with low-levels of radionuclides have been disposed at the Clive facility from the following projects: DOE – Fernald, OH Closure; DOE – Rocky Flats, CO Closure; DOE – Mound, OH OU-1 Landfill Closure; DOE Columbus Closure;

USACE Maywood, NJ FUSRAP sites; USACE St. Louis FUSRAP sites; and Denver Radium, CO CERCLA site.

The WAC for this facility is included in Appendix C-3.

Clean Harbors (Deer Trail) – Last Chance, Colorado. This 325-acre treatment, storage, and land disposal facility is located in a rural area approximately 75 miles east of Denver and is licensed to accept NORM and TENORM wastes and debris, as well as landfillable mixtures of RCRA and NORM wastes under Colorado Department of Public Health and Environment Radioactive Materials License Number Colo. 1101-01 and Colorado RCRA Part B Permit renewed 2005, No. CO-05-12-21-01. A Fact Sheet for this facility can be downloaded from the Clean Harbors website at the following link: http://cleanharbors.com/locations/index.asp?id=55.

Wastes are received at the facility by truck directly and by rail via a trans-loading point located in Sterling, Colorado, approximately 73 miles from the disposal facility. Clean Harbors has indicated that Site wastes would be either: (1) loaded directly into lined gondola cars if a potential future rail spur could be extended across St. Charles Rock Road onto the Site, or (2) loaded into end-dump semi-trailers, transported to a truck-to-rail transloading operation at a potential future leased rail spur located near the Site (assuming one could be located), and discharged from the end-dump semi-trailers into lined gondola cars. The gondola cars would be hauled by rail to the trans-loading point in Sterling, transferred from the gondola cars to semi-trailer trucks, and trucked the 73 miles to the Deer Trail facility for disposal.

The specific rail routes that would be followed from a potential future rail spur extended onto the Site or a truck-to-rail transloading operation at a potential future leased rail spur located near the Site to the trans-loading point located in Sterling, CO for the Clean Harbors (Deer Trail) facility are as follows: NS or BNSF from Bridgeton, MO to Kansas City, MO; then the Union Pacific from Kansas City, MO to Sterling, CO. This route transits through the major cities of Bridgeton, MO, Kansas City, MO, Atchison, KS, Marysville, KS, Hastings, NE, North Platte, NE, Julesburg, CO, and Sterling, CO.

The Rocky Mountain Low Level Radioactive Waste Compact has designated Deer Trail as the Low Level Waste Facility for Colorado, New Mexico, and Nevada. Wastes from other states may be disposed at Deer Trail but an Application for Waste Import must be made to the Rocky Mountain Low Level Radioactive Waste Board and an application fee paid. DOE FUSRAP wastes have been disposed at the Deer Trail facility.

The WAC for this facility is included in Appendix C-4.

4.3.6 Nuisance Control Technologies

Technologies for stormwater management, bird nuisance and fugitive dust and odor emissions mitigation were also screened. These technologies are discussed further below.

4.3.6.1 Storm Water Management

During construction of the selected remedy, storm water management will be addressed by minimizing storm water flow into the working areas (also referred to as run-on); by minimizing the surface area of disturbed ground that is exposed to direct precipitation; and by properly detaining and treating, if necessary, runoff that has contacted the working areas. A Storm Water Management Plan that incorporates appropriate diversion, conveyance, detention, and treatment measures would be prepared as part of the remedial design and implemented during the remedial action to ensure that appropriate effective measures are taken to limit run-on, minimize waste contact with precipitation, and manage and monitor runoff in accordance with applicable regulations and a stormwater management plan (as necessary).

Applicable technologies that could be employed for storm water management include:

- Use of Best Management Practices (BMPs) such as diversion ditches, earthen berms, and culverts to divert storm water around the disturbed or working areas so as to prevent its contact with exposed waste material.

- Use of BMPs such as selective excavation, staging, daily soil cover or tarps, and covering truck loads during transportation to minimize the area of waste exposed to direct precipitation. In some cases, temporary sumps and pumps may also be used to augment conveyance of direct precipitation into run-on diversion ditches.

- Use of temporary structures (*e.g.*, a tensioned fabric frame structure) erected above and around excavation and/or waste sorting/loading areas to shield waste from contact with direct precipitation. A temporary enclosed structure would require construction of a relatively flat foundation system (e.g., spread footings, drilled piers, driven piles, or grade beams) to support the predicted loads. The maximum width of commercially-available structures is approximately 200 feet, with a typical maximum width of 160 feet due to the significant increase in the size of the trusses and other structural components required for spans greater than 160 feet and the commensurate increase (approximately 50%) in the unit costs for larger spans. Therefore, for excavations with widths greater than 140 feet, a temporary structure would need to be moved multiple times, with each move involving excavation and earthwork to prepare the next area and install a new foundation prior to disassembling and reassembling the structure. The geotechnical properties of buried refuse in Areas 1 and 2 would likely not support the loads induced by a temporary structure without an elaborate foundation system or localized ground improvement to strengthen the foundation materials. Concerns about relocating such a structure would not apply to its potential use for shielding of waste sorting/loading activities as these activities could be established in a single central area that would be used throughout implementation of potential remedial actions.

- Use of BMPs to collect, detain, treat, and release runoff as required by Missouri storm water regulations. These BMPs would include the use of sumps, pumps, pipelines, lined impoundments and/or temporary storage tanks to collect, convey, and detain stormwater that has contacted waste material. If treatment is necessary, any radionuclides would likely be precipitated with the particulates in the storm water and would be removed via gravity settling within a detention or stormwater pond or tanks and filtration to meet direct or indirect (*i.e.*, to a Publically-Owned Treatment Works [POTW]) discharge limits. Radon gas would be removed via liquid-phase granular activated carbon (LPGAC) adsorption, if necessary. In addition, conventional flow control devices such as a morning-glory spillway within, or fixed weir at, an outlet of a detention pond could be used to limit discharge rates to those of the design storm[17] or as allowed by State regulations.

4.3.6.2 Bird Nuisance Mitigation

Because the waste materials in Areas 1 and 2 would be regraded as part of the ROD-selected remedy or subjected to excavation under either the partial or "complete rad removal" alternatives, the nuisance attraction to and congregation by birds at and above the affected areas could be problematic unless effectively controlled. The main concern would be the potential for increased bird strikes to aircraft approaching and departing from Lambert-St. Louis International Airport.

Ongoing research by the US Department of Agriculture Animal and Plant Health Inspection Service (USDA, 2008) and the National Wildlife Research Center (NWRC, 2008) into bird control mechanisms at landfills, as well as practical experience by landfill operators, offer control strategies that may help mitigate bird congregation above and within excavation areas. If needed, an avian management plan that incorporates appropriate measures would be prepared by a qualified wildlife expert as part of the remedial design process to ensure that appropriate effective measures are taken during excavation to cost-effectively limit bird congregation in order to protect approaching and departing aircraft from increased risk of bird-strikes. Potential control strategies include:

- Use of BMPs based on practical experience by landfill operators. These BMPs would include the use of selective excavation and staging of waste material to minimize the area of exposed waste at any given time, and using daily cover consisting of soil or a tarp placed over the exposed waste.

- Removal of food sources by covering exposed refuse with a temporary structure (e.g., a tensioned fabric frame structure).

- Erecting grids over exposed refuse to prevent bird access using stainless steel wire, monofilament, or Kevlar line placed above the working area in parallel lines or in spoke configurations. Parallel spacings of between 10 and 50 feet have been effective for most gulls such as those that nest in Missouri. Lines would be placed above the maximum height of working equipment, which would be approximately 15 feet above the original ground elevations for Areas 1 and 2, assuming scrapers and/or bulldozers are initially used. Lines

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[17] The design storm represents the maximum rate at which stormwater can be discharged from the Site.

would need to be placed at higher levels when excavators and loaders are employed. Line length would depend on the strength of the wire/filament used and available space for support poles. The size of open excavations may limit the constructability of wire or monofilament grids.

- Use of predator birds such as falcons or visual deterrents such as effigies of predator birds.

- Use of auditory "frightening" devices such as pyrotechnics, propane exploders, bird alarm calls, or sound generators that produce noise that is irritating to birds.

- Use of chemical frightening agents or toxicants such as the EPA-registered gull toxicant DRC-1339 and/or Avitrol®. Effective full-scale and long term application information regarding either chemical on gulls at landfills is not available in the literature. Use of chemical frightening agents or toxicants does not address the concern regarding congregating birds within the flight path of aircraft.

4.3.6.3 Fugitive Dust and Odor Control

Waste materials in OU-1 would be regraded during construction of the cover components under the ROD-selected remedy and excavated under the partial excavation or "complete rad removal" alternatives. Fugitive dust and odor could be generated during excavation, regrading, and final cover construction; as a result of construction vehicles or trucks operating on or traversing the Site; and from the staging of wastes and other construction materials. Methods for control of fugitive dust could include implementation of BMPs; misting/spraying of water or foams on exposed excavation surfaces, staged materials, and roads; enclosing the areas of excavation within a temporary structure; and enclosing excavated waste within a temporary structure during waste sorting and loading prior to transporting of waste off-site, as discussed further below.

- Use of BMPs based on practical experience of landfill operators and construction contractors. These would include the use of selective excavation and staging of waste material to minimize the area of exposed waste at any given time, temporary staging excavated waste in as small an area as practicable, daily covering of exposed waste using soil or tarps, and rapid re-covering of exposed waste whenever practicable.

- Fugitive dust, and to some extent odor, can be controlled through misting and spraying of exposed and staged wastes and permanent and temporary construction roads at the Site with water. Temporary misting systems would be set up above and around staged wastes. Water would be sprayed on exposed waste if the waste is dry and dust is generated during excavation. Water trucks with spray applicators would be used to spray roads to minimize dust generation. Viscous water-based non-hardening foams would be sprayed on exposed and staged waste to suppress fugitive dust and odor. Acrylic copolymer resin foams that penetrate the road surface to eliminate or reduce repeated watering can be applied to roads for dust and erosion protection.

- A temporary structure (see description and discussion above in Section 4.3.6.1 and in Section 4.4.1.1 below) could be erected above and around an excavation and/or waste staging area such that any fugitive dust or odor would be contained within the structure.

- For the partial excavation and "complete rad removal" alternatives, excavated waste that would be staged and sorted prior to shipment off-site for disposal could be enclosed within a temporary structure (*e.g.*, a tensioned fabric frame structure). Loading of trucks or intermodal containers for transport of RIM to the off-site disposal facility would also be performed in this structure. The structure would include a concrete floor working surface and be sized to house an appropriate volume of staged RIM to allow an uninterrupted rail transportation schedule. The structure would include ventilation and emissions control facilities to reduce/eliminate fugitive dust and odor concerns associated with staged waste. Workers inside the structure would wear appropriate PPE.

4.4 Implementability Screening of Remediation Technologies and Process Options

Potential remedial action technologies and process options that may be applicable to address the Site characterization results and satisfy the RAOs are described in Section 4.3 and are also summarized in Figure 4-1. The technologies are screened based on technical implementability in Figure 4-1. The following remedial technologies and process options were eliminated from further consideration based on the rationale discussed in the Implementability Screening Comments column in Figure 4-1.

General Response Action	Remedial Technology	Process Options
Containment	Land Encapsulation Cryogenic Barriers Vertical Barriers	• On-site: New cell • Subsurface cryogenic barrier • Slurry wall • Grout curtain • Sheet pile cutoff wall
Physical/Chemical Treatment	Chemical Separation	• Solvent/chemical extraction
	Physical Separation	• Soil washing • Flotation
	Vitrification	• In-situ vitrification • Ex-situ vitrification
Biological Treatment	Phytoremediation	• Phytoextraction • Phytostabilization
Removal	Storm Water Management Bird Nuisance Mitigation	• Enclose excavation with temporary structure • Enclose excavation with temporary structure

General Response Action	Remedial Technology	Process Options
		• Chemical frightening agents or toxicants

Implementability screening comments in addition to those provided on Figure 4-1 for the use of a temporary structure to enclose an excavation for stormwater management or bird nuisance mitigation and the dry soil separation physical treatment process are provided below.

4.4.1 Implementability Comments: Temporary Structure and Dry Soil Separation Process

Discussions of additional factors affecting the potential implementability of temporary structures and physical separation technologies are provided below.

4.4.1.1 Temporary Structure

Use of a temporary enclosure to protect an exposed excavation from contact with stormwater or for a potential bird mitigation strategy was eliminated because the other potential process options would provide adequate stormwater controls or bird nuisance mitigation without the significant disadvantages (summarized below) of using a temporary enclosure. A temporary enclosed structure would require construction of a foundation system (e.g., spread footings, drilled piers, driven piles, or grade beams) to support the predicted loads (in particular, wind loads) on the structure. The foundation alignment must also be relatively flat from side-to-side and end-to-end. Because the topography of the Site is variable, with slopes for drainage control, considerable earthwork would be necessary to prepare an area for foundation construction in advance of erecting the enclosed structure. This would likely include over-excavation for the foundation system that would support the structure. All of this earthwork would be performed without protective cover. In addition, the maximum width of commercially-available structures is approximately 250 feet, with a reasonable maximum width of only 160 feet. The width of RIM areas to be excavated, plus layback for overburden, is estimated to range from 250 feet to 1,050 feet. Thus, temporary structures would need to be moved many times, with each move involving excavation and earthwork to prepare the next area and installation of a new foundation prior to disassembling and reassembling the structure. Finally, the geotechnical properties of the buried refuse would likely not support the loads induced by the structure without an elaborate foundation system or localized ground improvement to strengthen the foundation materials.

Beyond the construction difficulties, other complications would include (1) provision of proper ventilation inside the structure to protect workers from potential accumulation of radon, methane, hydrogen sulfide, heavy equipment exhaust, dust, and ambient heat, (2) provision of "explosion-proof" electrical conduit and fixtures within the structure because of the potential presence of landfill gas when wastes are excavated, (3) worker safety risk from assembling, disassembling, lifting, then reassembling the 30-40 foot tall structures, (4) durability of the structure for multiple moves, and wear and tear on the components causing the likelihood for ongoing replacements, maintenance and repair of the structure and associated construction delays, and (5) the need for construction of temporary drainage controls around the structure each time it is moved.

Overall, use of enclosed structures over the excavation areas, where they can be applied, would add considerable time to the remediation schedule because each move would necessitate a new foundation, removal of fabric, disassembly of the structure, crane lifts, reassembly, demobilization and remobilization of electrical and ventilation equipment, removal of old foundations, and construction of new drainage controls. Capital and O&M costs associated with the structures, mobilizing them to the Site, assembly/disassembly/reassembly, demobilizing them from the Site, foundations, capital and operating costs for electrical and ventilation equipment, and the additional carrying costs for the project due to schedule delays would be prohibitive.

Use of a temporary rigid frame fabric structure erected in a fixed location for use as a facility within which excavated RIM would be staged prior to being transported to a licensed off-site disposal facility was retained as a remedial technology/process option for fugitive dust and odor control. RIM excavated from Areas 1 and 2 would be trucked from the excavation into one side of the “RIM staging/loading” building via articulated on-site construction trucks and be staged in the middle of the building for potential blending and subsequent loading into intermodals for transportation off-site. Lined intermodals transported on flat-bed highway trucks would be loaded with RIM and tarped/covered on the opposite side (“intermodal loading” side) of the RIM staging/loading building. Staging and loading of RIM in an enclosed structure would prevent precipitation from contacting excavated RIM, prevent bird access, and contain odor that would be associated with excavated MSW. Based on the estimated volumes of RIM to be excavated under the complete rad removal and partial excavation alternatives (see discussion in Section 5), for costing purposes it is assumed that a 200 ft by 400 ft building would be constructed on approximately four acres of land within the Site on an area that has not been landfilled (i.e., within OU-2). The building would be equipped with an air emissions/odor control system. For costing purposes, it is reasonably assumed (based on professional judgment) that between three and four building volume air changes per hour would be necessary and that emissions control would include vessels filled with activated carbon specifically developed to remove hydrogen sulfide as well as activated carbon developed to remove volatile organic compounds.

4.4.1.2 Dry Soil Separation

Although it is expected that use of the shear shredder/trommel equipment would be effective at separating the majority of soil from the non-soil solid waste, the degree of separation that may be achieved by this technology is uncertain. Prior applications of this technology have been focused on separating the bulk of the soil volume from an overall matrix of landfill wastes in order to implement waste-to-energy or waste composting operations or to recover the soil for reuse. These applications were not designed or expected to recover 100% of all of the soil in a landfill and were not concerned with the fractions of soil that were contained in or adhered to the segregated refuse. These applications also were not concerned with the creation of additional fine-grained fractions that would become mixed with the recovered soil as a result of use of a shear-shredder prior to a trommel. Consequently, the effectiveness of this technology at separating RIM (and only RIM) from the overall mass of solid wastes could not be determined without performance of a full-scale pilot-test.

In Areas 1 and 2 of the Site, residual soil containing radionuclides that adheres to or is otherwise contained in the refuse after performance of waste segregation using a trommel screen could still produce processed waste exceeding the levels that would allow for unrestricted use. As a result, the effectiveness of this technology cannot be determined without performing a pilot-test. . Furthermore, although a trommel includes an exterior brush (Figure 4-2) to remove debris that may otherwise become entangled in the rotating screen, there would still be instances in which laborers would have to enter the screen and physically remove wire, rebar, plastic, wood, or other entangled debris. During these events, workers would be exposed to increased radiation emitted by RIM that adheres to or otherwise remains in the trommel. The frequency and duration of physical removal of debris cannot be estimated at this time; however, it is clear that use of a trommel would create an additional mechanism for worker exposures to the RIM. Consequently, the potential effectiveness and implementability of this technology relative to segregation of RIM from non-RIM cannot be assessed without performing a pilot test.

Depending upon the production rate and dependability of the solids separation equipment, inclusion of a solids separation step as part of a process used for excavation and disposal of the RIM could become a factor relative to the daily production rates and project duration. In addition to the additional activities requiring workers and resultant exposures, use of such equipment is expected to extend the overall project schedule and increase the potential or amounts of stormwater accumulation, airborne emissions, bird or other vector impacts due to a possible increase in the overall schedule.

In order to evaluate this technology, full-scale pilot testing of the shear shredder/trommel screen solids separation equipment for volume reduction would be required using representative material from Areas 1 and/or 2. Pilot testing is typically performed prior to LFMR projects in order to assess screening and trommel equipment sizing, estimate production rates, determine the fraction of soil that can be separated from the filled material using varying trommel screen opening sizes (and therefore maximizing the amount of soil that can be removed), and obtain an indication of the type of material that was filled (*e.g.*, construction and demolition debris such as bricks, concrete and rebar, dimensional lumber and/or MSW). Of particular interest in conducting pilot testing of material from Areas 1 and 2 would be obtaining an estimate of the degree of RIM volume reduction that could be achieved, assessing the moisture content of the filled material, and determining the fraction of soil that would be contained in or adhered to the segregated refuse.

Assuming pilot test results show that the radiologically-impacted soil fraction of RIM could be separated from the overall matrix of landfilled refuse, debris and fill materials, and unimpacted soil and quarry spoils using the revolving cylindrical sieve trommel technology, then additional dry soil separation technologies might be considered to further reduce the volume of radiologically-impacted soil. However, if results of pilot-testing indicate that the non-soil fraction of RIM that would be discharged out the end of the trommel exhibited radionuclide concentrations greater that those that would allow for unrestricted use, then the soils separation process would not be effective in reducing the volume of RIM that would be addressed under the "complete rad removal" alternative.

This technology, alone or possibly in combination with an SGS, may be effective for the partial excavation alternative based on the 1,000 pCi/g criterion. However, the additional costs required to implement this technology may not be supported by the overall lower volume of RIM to be excavated and disposed off-site under this alternative. The effectiveness of this technology relative to the partial excavation alternative based on the 52.9 pCi/g and 16-ft depth criteria cannot be ascertained from the available information and would require pilot-testing to determine the degree of separation that could be achieved.

4.5 Evaluation of Remediation Technologies and Process Options

Potential remedial action technologies that may be applicable to address the Site characterization results and satisfy the RAOs are described in Section 4.3 and are also summarized in Figure 4-1. The technologies are screened based on technical implementability in Figure 4-1. The resultant technologies are then evaluated in Figure 4-4 based on anticipated effectiveness, implementability, and relative cost to identify applicable technologies that might be used as components of the remedial action alternatives.

Ordinarily in the CERCLA FS process, technologies identified in the technology screening step as being potentially applicable to site characterization results and RAOs are combined to develop remedial alternatives. The remedial alternatives are then screened, if necessary, and subjected to a detailed analysis using nine prescribed evaluation criteria. In the case of this FFS, EPA stipulated the alternatives to be developed and evaluated (EPA, 2015b). Therefore, the step of combining technologies to develop alternatives and screening the alternatives is unnecessary and could result in the elimination of one or more of the alternatives that EPA determined must be evaluated in this FFS.

In addition to the technologies identified in the original FS report (EMSI, 2006) as being potentially applicable to the media and contaminants at the Site, the various technologies identified in this section as potentially applicable have been included as appropriate within the alternatives specified by EPA (2015b) for this FFS. Specifically, the following additional technologies or process options were included: short- and long-term monitoring; capping and covers; disposal in an off-site licensed facility; physical/chemical treatment including solidification/stabilization and soil separation; excavation; temporary structure to enclose a material handling area; storm water management; fugitive dust/odor control, bird nuisance mitigation; and truck and truck and rail transportation.

5 REMEDIAL ACTION ALTERNATIVES

This section provides descriptions of the remedial alternatives evaluated in this FFS, including the ROD-selected remedy, the "complete rad removal" alternative, and two partial excavation alternatives. As part of preparation of this FFS, preliminary, conceptual-level designs were developed for each of the alternatives in order to prepare estimates of the costs of construction, operation, maintenance and monitoring; construction schedules for each alternative; and to evaluate the alternatives relative to the criteria specified in the NCP as described in Section 6. In addition to the conceptual designs of the alternatives, general procedures to be used for materials handling, surface water control, and methane gas management were also developed and are described in this section of the FFS.

5.1 Remedial Alternatives Previously Evaluated

This is the third evaluation of potential remedial alternatives for OU-1 of the Site. Prior evaluations of remedial alternatives were performed for the FS (EMSI, 2006) and SFS (EMSI et al., 2011).

5.1.1 Remedial Alternatives Evaluated in the FS

A range of remedial alternatives addressing waste materials and contaminated soil present in OU-1 was developed for, and evaluated in, the FS (EMSI, 2006). These alternatives were developed in accordance with EPA's guidance on Presumptive Remedy for CERCLA Municipal Landfill Sites (EPA, 1993b) and "Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites" (EPA, 1991b). These guidance documents establish containment as the presumptive remedy for CERCLA municipal landfills. Part of the presumptive remedy approach for CERCLA municipal landfills includes a decision with respect to characterization and/or treatment of "hot spots," which represent discrete, accessible areas within the overall landfill that contain principal threat wastes which are large enough such that remediation would reduce the threat posed by the overall site but small enough that it is reasonable to consider removal (EPA, 1993b). An evaluation of potential occurrences of "hot spots" in Areas 1 and 2 was performed as part of the original (2006) FS and is included as Appendix E to this FFS. Based on the nature and extent of the radiological materials present within OU-1, the evaluation concludes that the additional risks involved with a hot spot removal significantly exceed the risks of leaving the waste in place per the ROD-selected remedy.

The remedial alternatives developed in the FS address containment of the wastes (landfill alternatives) and management of radiologically-impacted soil on the Buffer Zone/Crossroad property (former Ford property). Detailed descriptions of the six landfill and four Buffer Zone/Crossroad property alternatives are presented in the FS report (EMSI, 2006).

The remedial alternatives developed and evaluated in the FS (EMSI, 2006) to address containment of the waste materials present in Areas 1 and 2 consisted of the following:

Areas 1 and 2 Landfill Alternatives

- Alternative L1 – No Action
- Alternative L2 – Cover Repair and Maintenance, Additional Access Restrictions, Additional Institutional Controls, and Monitoring
- Alternative L3 – Soil cover to address gamma exposure and erosion potential
- Alternative L4 –Regrading of Areas 1 and 2 (minimum slope of 2%) and installation of a Subtitle D cover system
- Alternative L5 – Regrading of Areas 1 and 2 (minimum slope of 5%) and installation of a Subtitle D cover system
- Alternative L6 – Excavation of material with higher levels of radioactivity from Area 2 and regrading and installation of a Subtitle D cover system

EPA (2008a) determined that all of the landfill alternatives except the No Action Alternative (Alternative L1) would protect human health and the environment by limiting exposure to the Site's contaminants through engineering means and land use controls. Due to the inclusion of engineering controls, EPA (2008a) determined that the landfill cover alternatives (Alternatives L3, L4, L5 and L6) offer much more reliable protection than Alternative L2, which is more reliant on land use controls. EPA (2008a) also determined that the more sophisticated design of a multi-layer landfill cover with infiltration barrier (Alternatives L4, L5 and L6) would provide greater overall protection than the soil cover (Alternative L3). In addition, EPA (2008a) determined that Alternatives L4, L5 and L6 comply with all ARARs while alternatives L2 and L3 do not meet the basic cover design requirements found in the Missouri Solid Waste Rules for sanitary landfills (10 CSR 80-3.010) and therefore do not meet the NCP threshold criterion of compliance with ARARs.

In addition to the presence of RIM in Areas 1 and 2, the FS also developed remedial alternatives to address historic erosion of the landfill berm along the west side of Area 2 and the resultant deposition of radiologically-impacted soil on the surface of the Buffer Zone/Crossroad property (formerly termed the Ford property). The remedial alternatives developed in the FS (EMSI, 2006) to address management of contaminated soil on the Buffer Zone/Crossroad property are as follows:

Buffer Zone/Crossroad Property (former Ford property) Remedial Alternatives

- Alternative F1 – No Action
- Alternative F2 – Institutional and Access Controls

- Alternative F3 – Capping and Institutional and Access Controls

- Alternative F4 – Soil Excavation and Consolidation in Area 2

EPA (2008a) determined that all of the alternatives for the Buffer Zone/Crossroad property, except Alternative F1 (No Action), are protective of human health and the environment and would comply with ARARs.

Detailed evaluations of the six landfill and four Buffer Zone/Crossroad property alternatives relative to the nine criteria specified in the NCP are presented in the FS report (EMSI, 2006).

EPA subsequently issued a Proposed Plan that identified alternatives L4 and F4 as the preferred alternatives. After holding several public meetings and obtaining public comments, EPA selected these alternatives, with the addition of rock armoring along the toe of the north and northwest boundaries of Area 2 to protect against potential erosion in the event of flooding from failure of the Earth City flood control system (levees and pumping) as the remedy for OU-1.

5.1.2 Remedial Alternatives Evaluated in the SFS

In a January 11, 2010, letter (EPA, 2010) and accompanying SOW, EPA requested that the Respondents prepare an SFS to evaluate two complete rad removal alternatives. For purposes of the SFS, EPA identified two "complete rad removal" alternatives that EPA directed be developed and evaluated in addition to the ROD-selected remedy:

1. Excavation of radioactive materials with off-site commercial disposal of the excavated materials (referred to as "complete rad removal" with off-site disposal alternative in the SFS); and

2. Excavation of radioactive materials with on-site disposal of the excavated materials in an on-site engineered disposal cell with a liner and cap if a suitable location outside the geomorphic flood plain could be identified (referred to as "complete rad removal" with on-site disposal alternative in the SFS).

EPA indicated (EPA, 2010) that "complete rad removal" was defined to mean attainment of risk-based radiological cleanup levels specified in OSWER Directives 9200.4-25 and 9200.4-18.

These three alternatives (ROD-selected remedy plus two "complete rad removal" alternatives) were evaluated in the SFS (EMSI et al., 2011).

5.1.3 Remedial Alternatives Evaluated in the Final FS

EPA's SOW for the RI Addendum and FFS identifies three partial excavation alternatives and two other remedial alternatives which, in addition to the No Action Alternative, results in the following six remedial alternatives to be evaluated in the FFS:

1. 2008 ROD-Selected Remedy (Former Alternative L4 and Alternative F4) – Containment consisting of regrading and installation of a new landfill cover and other remedial components for the landfill, and consolidation of any radiologically-impacted soil that may remain on the former Ford property (now known as the Buffer Zone and Crossroads Lot 2A2) into the containment areas in Area 1 and 2 prior to placement of additional fill and construction of the new landfill cover.

2. No Action – Required by the National Contingency Plan (NCP) and RI/FS guidance to provide a baseline against which all of the other alternatives are evaluated[18];

3. Partial Excavation 1,000 pCi/g – Excavation of all soil/waste containing combined radium (Ra-226 plus Ra-228) or combined thorium (Th-230 plus Th-232) with activity levels greater than 1,000 pCi/g[19];

4. Partial Excavation 52.9 pCi/g – Excavation of all soil/waste containing combined radium (Ra-226 plus Ra-228) or combined thorium (Th-230 plus Th-232) with activity levels greater than 52.9 pCi/g down to a total depth of 16 feet beneath the 2005 topographic surface[20];

5. Partial Excavation Based on Expected Land Use – Partial excavation of all soil/waste containing combined radium (Ra-226 plus Ra-228) or combined thorium (Th-230 plus Th-232) with activity levels greater than a risk-based level to be developed based on the reasonably anticipated future land use of the Site;[21] and

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[18] The SOW identifies an alternative No. 3 "Leaving all RIM in place on-site." Subsequent discussions with EPA indicated that this alternative was the No Action Alternative.

[19] In all cases evaluated in the Baseline Risk Assessment, Th-230 and Ra-226 (plus decay products) accounted for more than 95% of the risk to the target receptors. Other radionuclides are co-located with Ra-226 and Th-230 and are projected to produce risks to the future groundskeeper receptor of $<10^{-7}$. Remediation of the Th-230 and Ra-226, by themselves, would reduce the total risks from RIM to below 10^{-4}. Any remediation of Ra-226 and thorium-226 would also lower the negligible risks from these ancillary radionuclides still further.

[20] The SOW indicates that the Respondents have the ability to propose in the Work Plan for the RI Addendum and Final FS a different depth to be used for this alternative. However, it is premature to propose an alternative depth at this time. In the event that an alternative depth interval reflective of the actual site data is identified during evaluation of the data during preparation of the RI Addendum and FFS reports, the Respondents will seek concurrence from EPA at that time.

[21] The evaluation performed by Auxier (as set forth in the June 2016 "Risk to Industrial user of Operable Unit 1 prepared by Auxier & Associates, Inc.") identified an industrial-risk-based level of approximately 1,000 pCi/g (after rounding). Alternatives No. 2 and No. 4 are therefore, for all intents and purposes, currently the same alternative.

6. Full Excavation with Offsite Disposal – Excavation of all soil/waste containing combined radium (Ra-226 plus Ra-228) or combined thorium (Th-230 plus Th-232) with activity levels greater than 7.9 pCi/g;

The EPA definition of the "complete rad removal" alternative is based on combined radium and combined thorium activities as specified in OSWER Directive No. 9200-4.18 and 9200-4.25. In addition to combined radium and combined thorium, the combined uranium activity will also be considered as appropriate. However, based on the prior SFS evaluations of the "complete rad removal" alternatives, uranium was not found to be a driver for identification of RIM because any locations/depth intervals that contained uranium above its criteria for "complete rad removal" (54.5 pCi/g) also contained radium and/or thorium activity levels greater than their respective criteria for unrestricted land use. In addition, no uranium equivalent criteria were identified by EPA for the partial excavation alternatives; therefore, these alternatives are based solely on the combined radium and combined thorium activity levels. As noted above, use of the combined radium and combined thorium activity levels to define the materials to be included in the scope of the partial excavation alternatives should also result in inclusion of any materials with commensurate uranium activity.

5.2 No Action Alternative

No additional engineering or institutional controls would be implemented under the no action alternative and no monitoring would be performed. Per the NCP, a no action alternative is required and serves as a baseline for evaluation of the other alternatives.

5.3 ROD-Selected Remedy

Upon completion and EPA acceptance of the FS (EMSI, 2006) in June 2006, EPA developed a Proposed Plan (EPA, 2006a) and initiated a public comment period that opened on June 14, 2006 and remained open until December 29, 2006 (EPA, 2008). EPA subsequently re-opened the public comment period in March 2008 and closed this additional public comment period on April 9, 2008 (EPA, 2008). During these periods, EPA held three separate public meetings on June 26, 2006, September 14, 2006, and March 27, 2008 (EPA, 2008).

Based on the results of the RI and FS evaluations and the comments received during the various public meetings and comment periods, EPA prepared a Record of Decision (ROD) that identified the remedial actions that EPA selected for OU-1 (EPA, 2008).

The major components of the ROD-selected remedy for OU-1 (EPA, 2008) are as follows:

- Installation of a landfill cover meeting the Missouri closure and post-closure care requirements for sanitary landfills, including enhancements consistent with the standards for uranium mill tailing sites (*i.e.*, armoring layer and radon barrier);

- Consolidation of radiologically-contaminated surface soil from the Buffer Zone/Crossroad Property to the containment area;
- Application of groundwater monitoring and protection standards consistent with requirements for uranium mill tailing sites and sanitary landfills;
- Control of surface water runoff;
- Gas monitoring and control including radon and decomposition gas as necessary;
- Institutional controls to prevent land and resource uses that are inconsistent with a closed sanitary landfill site containing long-lived radionuclides; and
- Long-term surveillance and maintenance of the remedy.

Prior to construction of the landfill cover, the areas will be brought up to grade using placement of inert fill and regrading of existing material as determined in the RD. Final grades will achieve a minimum slope of two percent.

The ROD (EPA, 2008) indicated that the landfill berm around Area 2 would be regraded through placement of additional clean fill prior to placement of the landfill cover, resulting in an estimated 100 lateral feet of additional material between the current landfill toe and the toe at completion of the RA. The ROD (EPA, 2008) indicated that in this area, the landfill is built over the geomorphic flood plain that is now protected by the Earth City Levee.[22] In the unlikely event of levee failure during a 500-year flood event, the lowermost two feet of the toe of the landfill cover at the northwestern end of the Site could be impacted by the water. The Site is more than a mile from the river and no high-energy water would be expected. The flood protection needs of the toe of the landfill will be evaluated in design and appropriate bank protection methods will be used, *e.g.*, rock rip rap apron. The vertical height of the flood protection feature will include a margin of safety over the 1993 (500-year) flood level. Figure 12-1 in the ROD displays a conceptual cross-section of the Selected Remedy and indicates the approximate flood level at the toe of the landfill.

The ROD requires any radiologically-contaminated soil on the Buffer Zone/Crossroad Property to be consolidated in the area of containment (Areas 1 or 2) prior to placement of fill material or construction of the cover. It is anticipated that construction of the landfill cover will require the toe of the landfill berm to be regraded and extended over the impacted area on the Buffer Zone/Crossroad Property. The precise nature and extent of contaminated soil is uncertain because grading of the Buffer Zone/Crossroad Property occurred after collection of the most recent set of soil sample data.[23] Gamma scans and soil sampling will be used to support the RD

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[22] These areas were subsequently filled such that the surface elevations of these areas are now located outside of the 500-year flood plain (FEMA, 2015).

[23] Sampling conducted on the Buffer Zone/Crossroad Property in February 2000 (after site soils had been scraped to a depth of approximately 1 to 2 feet) indicated that with the exception of a single sample, all of the samples

and document the existing conditions. Any soil outside the footprint of the landfill will meet remediation goals that support unlimited use and unrestricted exposure and will be subject to verification sampling. Any excavation of contaminated material will include dust suppression and work place monitoring to ensure there is no release of fugitive dust.

The ROD requires landfill cover, gas control, runoff control, long-term groundwater monitoring, and post-closure inspection and maintenance to meet (at a minimum) the relevant and appropriate requirements found in the Missouri Solid Waste Rules for sanitary landfills. Consistent with the requirements for uranium mill tailing sites, the ROD requires the proposed landfill cover to incorporate a rubble or rock armoring layer to minimize the potential for biointrusion and erosion and increase longevity. The landfill cover will also be designed to provide protection from radioactive emissions, *i.e.*, gamma radiation and radon. Figure 12-2 of the ROD shows a conceptual cross-section of a sanitary landfill cover that has been augmented to include a crushed concrete or rock biointrusion layer. Figure 12-3 of the ROD plots the cover thickness necessary to shield a person on the surface of the cover from gamma exposure.

The ROD requires surface drainage diversions, controls, and structures to be designed and constructed to expeditiously route stormwater runoff to the water drainage systems, which are presently subject to state National Pollution Discharge Elimination System permits.

Landfill gas characterization during the RI indicated the sporadic presence of decomposition gases, *e.g.*, methane, and radon. Radon gas needs only to be detained for a few days until it decays to its solid progeny, and a landfill cover designed to act as a diffusion barrier is generally sufficient to control radon. However, decomposition gases must be handled differently. Typically, gas generation in municipal solid waste increases for the first five or six years after placement in the landfill and then declines thereafter. Because these areas have been inactive for at least 30 years[24], decomposition gas generation is relatively low and expected to decline. However, even at low generation rates, placement of the landfill cover creates the potential for these gases to be trapped and accumulate under the cover. To prevent pressure build up under the landfill cover and/or lateral migration, the ROD states that gas control systems may be required. Gas control measures may involve passive venting or active collection. The need for and nature of the gas control measures will be evaluated and defined as part of the RD. The plans for the control and/or treatment of landfill gas will consider the presence of radon and be developed accordingly.

The ROD requires the landfill cover system to be routinely inspected and maintained to ensure the integrity of the remedy over time. In addition to surveillance of the physical remedy, the periodic site inspections will include administrative functions such as monitoring of institutional

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displayed radionuclide levels of less than 5 pCi/g above background. Based on these data, the total extent of the area on the Buffer Zone/Crossroad property that may still contain radionuclides at levels greater than 5 pCi/g above background in February 2000 was estimated to be approximately one acre. For evaluation of remedial alternatives in the FS, it was assumed that soil containing radionuclides at levels above those suitable for unrestricted use remained on the Buffer Zone/Crossroad property.

[24] In light of the passage of time since issuance of the ROD, these areas have now been inactive for an even longer period of time.

controls and coordination with key stakeholders, including the Earth City Levee District regarding management of the flood control system. See Section 5.1 of the ROD (EPA, 2008) for a description of the levee maintenance program.

The ROD requires the O&M Plan[25] to be developed and submitted for approval as part of the RD/RA process. The O&M Plan is to cover all the long-term remedy management functions including groundwater monitoring plans, site inspection, maintenance and repair, institutional control monitoring and enforcement, five-year reviews, notification and coordination, community relations, health and safety, emergency planning, activity schedules, reporting, etc.

The detailed descriptions of the engineering components, groundwater monitoring objectives and institutional controls components of the ROD-selected remedy are summarized below along with additional information and details developed during preparation of this FFS.

5.3.1 Engineering Components of the ROD-Selected Remedy

The ROD-selected remedy includes both engineered and non-engineered components. The engineered components of the ROD-selected remedy include:

- Regrading of the existing landfill surface to comply with minimum and maximum slope angles pursuant to the Missouri Solid Waste Rules;
- Surveying and removal of radiologically-impacted soil from the Buffer Zone/Crossroad Property;
- Construction of a multi-layered, engineered landfill cover over Areas 1 and 2;
- Installation of rock armoring for flood protection along the toe of the northern portion of Area 2;
- Installation of stormwater/surface water runoff management structures;
- Landfill gas monitoring and, if needed, installation and operation of a landfill gas control system;
- Long term inspection and maintenance of the engineered components of the remedy; and
- Environmental monitoring during and after construction of the remedy.

[25] Operations and Maintenance (O&M) Plan is referred to elsewhere in this report as the OM&M (Operations, Maintenance and Monitoring) Plan.

5.3.1.1 Regrading of the Landfill Surface for the ROD-Selected Remedy

Prior to construction of the landfill cover, the surfaces of Areas 1 and 2 would be recontoured to meet the applicable slope requirements using placement of inert fill and regrading of existing material as determined in the RD. Final grades would achieve a minimum slope of two percent (2%) and a maximum slope of twenty-five percent (25%). Final grades would be achieved through placement of additional material, regrading of existing waste materials or a combination of the two. The specific procedures to be used would be determined as part of RD based on site constraints, minimization of the amount of material to be moved or placed, other design requirements, health and safety considerations, cost and other factors as appropriate.

As part of the development of the SFS, a preliminary evaluation of potential alternative regrading designs was developed and evaluated. The specific options examined included:

1. Use of a fill-only approach to regrading the interior portions of Areas 1 and 2;

2. Elimination of the stormwater basins in the northern corner of Area 1 and in the Buffer Zone that were included in the scope of the ROD-selected remedy described in the Remedial Design Work Plan (RDWP);

3. Construction of a 10-ft-high perimeter earthen berm/access road embankment (*i.e.* starter berm) with an external slope angle of 40 degrees along the northern (adjacent to the landfill access road), eastern (adjacent to St. Charles Rock Road) and western (adjacent to the transfer station) portions of Area 1 and the northern (adjacent to Crossroads property and St. Charles Rock Road) and western (adjacent to Crossroads property, Buffer Zone, and Old St. Charles Rock Road) portions of Area 2 so as to reduce the amount of waste excavation required for these areas; and

4. Use of a 3:1 (33⅓ %) slope for that portion of the final landfill cover along the perimeter of Area 2. This would require the completion of a detailed slope stability analysis (as discussed in Section 6.2.1.2.1).

Evaluation of these options as part of preparation of the SFS (EMSI et al., 2011) indicated that excavation of portions of the toe of the landfill in Areas 1 and 2 and construction of a perimeter (starter) berm composed of clean fill material (Option 3 above) is the best approach for achieving the required surface grades while minimizing the amount of waste regrading that needs to be performed. Additional details regarding the various grading options and the results of the prior evaluations are presented in Section 5.2.1.1 and Appendix E of the SFS (EMSI et al., 2011). Based on these evaluations and discussion with EPA, it was determined that the starter-berm (Option 3) would be used for purposes of the SFS evaluations.

Under this approach an approximately ten-foot-high starter berm would be constructed along portions of the outer boundaries of Areas 1 and 2. Construction of the starter berm would require excavation of waste materials present at the toe of the landfill in these areas. These materials would be replaced by earthen material that would provide the base for a perimeter access road and perimeter drainage features, incorporate rock armoring for flood control to the extent required, and through use of steeper side slopes for the soil/rock material (in contrast to those allowed for waste materials) would result in greatly reducing the amount of waste material that would need to be regraded under the ROD-selected remedy. Detailed design and agency approval of the starter berm approach would be performed as part of the RD phase; however, based on initial agency comments, it was determined that incorporation and use of the starter berm approach for the ROD-selected remedy was appropriate for the SFS evaluations.

Based on the results of the SFS evaluations, the use of a starter berm has been incorporated into the evaluation of the ROD-selected remedy in the FFS.

5.3.1.2 Management of Materials During Recontouring

It is anticipated that any waste that is excavated (cut) to create space for construction of the starter berm or as needed to regrade the surface of Areas 1 and 2 to meet the minimum and maximum slope requirements would immediately be placed in another portion of Area 1 or 2 and therefore no temporary stockpiling of excavated waste would be required for implementation of the ROD-selected remedy. In the event that temporary stock-piling of some of the regraded waste material is necessary, it is anticipated that such stockpiling would be performed on other portions of Areas 1 and 2.

The amount and duration of any waste material stockpiling would be minimized. Any stockpiled waste material would be managed to control odors. For example, these materials would be covered with tarps, soil cover or foams/chemical agents to suppress odor emissions and reduce the potential for windblown debris and dust, vectors (*e.g.*, rodents and birds), and precipitation infiltration. All stockpiles of waste materials or imported construction materials would be managed to prevent dust emissions and stormwater impacts. They could be covered with tarps and would be located away from drainage courses and stormwater drop inlets so as to reduce windblown erosion and sediment runoff. Sediment netting, berms, straw bales, or equivalent measures would be employed to reduce sediment runoff from the stockpile(s) to the adjacent areas, as well as to prevent run-on contact with exposed waste. Water, tarps or other forms of dust suppression would be used to prevent wind erosion of soil stockpiles. The construction contractor would be responsible for ensuring that the stockpiles are stabilized from wind erosion at night and during non-construction days. A plan for stockpiling of waste materials including identification of actual or potential areas for temporary stockpiles, temporary covers, runon-runoff controls, ongoing inspection and maintenance requirements, and other factors would be developed as part of the RD. A Stormwater Pollution Prevention Plan (SWPP) would be prepared prior to commencement of construction activities and would provide a detailed plan for the location and maintenance of the stockpiles.

Application of a temporary cover (*e.g.*, clean soil or other means) to the landfill surfaces being regraded at the end of each workday would help to mitigate odors during non-working periods. This would also reduce radiological exposures to potentially exposed non-radiological workers in the vicinity, and would reduce the attractiveness of the exposed waste to birds and vermin. As such, the conceptual design of the ROD-selected remedy includes application of daily cover and the volume of additional soil to be added as a result of placement of daily cover has been incorporated into design of the grading plans and cost estimates for the ROD-selected remedy (Appendices M and K).

Much of the area requiring re-contouring is outside the area covered by the Negative Easement. Even in those portions subject to the Negative Easement, the re-contouring activity would not be prohibited since the Negative Easement mandates that the facility at all times "comply with all applicable federal, state and local laws and regulations regarding proper landfill cover." Because the re-contouring is necessary to comply with the slope requirements of the Missouri Solid Waste regulations, it is consistent with the terms of the Negative Easement.

The nuisance attraction to and congregation by birds at and above the Site if its contents are exposed could be problematic unless effectively controlled. If necessary, an avian management plan that incorporates best management practices (BMPs) such as daily soil cover and/or tarping, visual and auditory frightening devices, or wire or monofilament grids positioned over exposed refuse to prevent bird access, could be prepared and implemented prior to and during regrading of waste containing municipal refuse. In addition, for regrading required for the ROD-selected remedy, the area of regrading will be minimized and immediate replacement utilized as much as possible in order to minimize potential exposure of waste.

5.3.1.3 Removal of Radiologically-Impacted Soil from the Buffer Zone/Crossroads Property

A design-phase investigation would be performed to evaluate the nature and extent of occurrences of radionuclides beneath Lot 2A2 of the Crossroads property and the Buffer Zone (Figure 2-14). This design-phase survey would only apply to the Buffer Zone/Crossroads Property and would be performed in accordance with the requirements of the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (EPA, DOE, NRC, DOD, 1997). The remediation control and waste characterization surveys for the Buffer Zone/Crossroads property are discussed in Section 3.2.1.1 of Appendix G.

Any radiologically contaminated soil on the Buffer Zone/Crossroads Property would be removed and consolidated in the area of containment (Areas 1 or 2) prior to placement of fill material or construction of the cover over that portion of the Site. The precise nature and extent of contaminated soil on the Buffer Zone/Crossroads Property is uncertain due to grading activities conducted in these areas after the latest set of samples were obtained. Any soil outside the boundaries of the Site would need to meet remediation goals that support unlimited use and unrestricted exposure and would be subject to verification sampling. Excavation of contaminated material would include dust suppression and monitoring (see Appendix G) to ensure there is no release of fugitive dust.

5.3.1.4 Engineered Landfill Cover for the ROD-Selected Remedy

The extent of the new engineered landfill cover included as part of the ROD-selected remedy is presented on Figure 5-1. Figure 5-2 presents a profile of the new engineered landfill cover that would be installed under the ROD-selected remedy and would consist of the following layers (from top to bottom):

- A one-foot thick layer of soil capable of sustaining vegetative growth;
- A two-foot thick infiltration layer of compacted USCS CL, CH, ML, MH, or SC soil-type with a coefficient of permeability of 1 x 10^{-5} cm/sec or less; and
- A two-foot thick bio-intrusion/marker layer consisting of well-graded rock or concrete/asphaltic concrete rubble.

Specifically, the landfill cover to be installed over Areas 1 and 2 would consist of (from bottom to top): 2 feet of rock consisting of well-graded pit run rock and/or concrete/asphaltic rubble ranging from sand sized up to 6 inches such that upon placement would contain minimal void spaces; 2 feet of compacted clay or silt that when compacted at optimum moisture content possesses a coefficient of permeability of 1 x 10^{-5} cm/sec or less; and 1 foot of soil suitable of supporting vegetative growth. The thicknesses of these layers are based on the requirements of the Missouri Solid Waste Rules and the description of the cover system included in the ROD.

In accordance with direction from EPA on October 12, 2012 (EPA, 2012), December 9, 2015 (EPA, 2015c), and August 4, 2016 (EPA, 2016c), the FFS is to include an evaluation of an alternative landfill cover design as set forth in the Revised Work Plan for Alternative Cover Design (EMSI, 2014c), which EPA approved on September 9, 2014. An evaluation of alternative landfill cover design was performed and documented in the January 27, 2015 "Evaluation of Alternative Landfill Cover designs (EMSI, 2015c), which indicated that, as a substitute for the 2-foot compacted clay/silt liner (CCL) included in the ROD-selected remedy cover description, a geosynthetic clay liner (GCL) could instead be implemented at the Site and could provide greater effectiveness at minimizing infiltration at comparable cost. EPA indicated (EPA, 2016c) that this option should be included in the FFS. Therefore, evaluation of the ROD-selected remedy includes both a 2-foot CCL and a 2-foot soil layer that incorporates a GCL (Figure 5-2).

Additionally, as part of this FFS, detailed calculations were performed to select a design cover thickness that meets the remedial action objective for control of radon gas and to ensure that the cover provides sufficient shielding from gamma radiation (Appendix F). Consistent with the UMTRCA requirements and EPA's Office of Superfund Remediation and Technology Innovation (OSRTI) May 2009 memorandum (EPA, 2009b), these evaluations were performed using the updated radium-226 and thorium-230 concentrations and the results of radon flux testing recently completed as part of the construction of the non-combustible cover over portions of Areas 1 and 2 to predict the expected levels of radon, radium and thorium that would result from 1,000 years of thorium and radium decay, radium ingrowth and radon generation.

Measured radon flux values indicate current radium-226 concentrations produce radon-222 emanations that are currently less than 10% of the regulatory limit of 20 $pCi/m^2/s$, averaged across OU-1 (EMSI, 2016b). Using standard ingrowth equations, it was determined that the average future concentration of radium-226 after 1,000 years of ingrowth would not increase radon-222 emissions above the 20 $pCi/m^2/s$ mark, regardless of cover design. From this it was concluded that a cover over the affected soil is not needed to meet radon-222 criteria. Placing any cover, such as the one required during landfill closure by MDNR, would reduce already acceptable radon-222 emanations further, making the considered designs insensitive to radon-222 radon emission criteria.

Since radon-222 emission criteria would be satisfied by all cap designs, the cap thickness will be governed by surface exposures from gamma radiation penetrating the cap. These calculations were performed on the aged radium-226 inventory using the gamma pathway in EPA's web-based risk calculator for radionuclides[26], and the design specified in the ROD,[27] which is based on the Missouri Solid Waste Regulations (CSR 80-3.010(17)(C)(4)(A)) cover design requirements for closure of unlined solid waste landfills, with the additional enhancement of a 2-ft concrete rubble/rock layer, as described above. This cap design was found to provide sufficient protection from surface radiation exposures throughout the 1,000 simulation.

Results of these evaluations indicated that the ROD-specified cover design would have sufficient thickness and characteristics to be protective against gamma radiation and radon emissions in both Areas 1 and 2 (Appendix F). Additional evaluations of the cover design may be performed during the RD phase to further verify that the design of the landfill cover complies with the applicable and relevant and appropriate requirements of other environmental regulations. The design of the landfill cover, as well as the gas control, runoff control, long-term groundwater monitoring, and post-closure inspection and maintenance components, would at a minimum meet the relevant and appropriate requirements found in the Missouri Solid Waste Rules for sanitary landfills. Consistent with the requirements for uranium mill tailing sites, the landfill cover would also incorporate a rubble or rock armoring layer to minimize the potential for biointrusion and erosion and increase the overall longevity of the cover. The landfill cover would also be designed to provide protection from radioactive emissions (*i.e.*, gamma radiation and radon). Figure 5-2 shows a conceptual cross-section of a sanitary landfill cover that has been augmented to include a crushed concrete or rock biointrusion layer.

A significant amount of earthen material would need to be obtained from an off-site source and delivered to the Site for use in constructing the new landfill cover. Specifically, it is anticipated that all of the final cover system components, materials for construction of the bio-intrusion layer, low permeability soil (clay) layer, and vegetative layer, will need to be purchased and delivered to the Site. FS level design projections determined that approximately 820,000 loose cubic yards of soil material will be required from off-site sources for implementation of the ROD-selected remedy.

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[26] Provided on https://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search.

[27] A minimum thickness of 2 feet of compacted clay with a coefficient of permeability of 10^{-5} cm/sec. or less, overlain by a soil layer (minimum thickness of 1 foot) capable of sustaining vegetative growth.

There are several options for how this material could be managed. Depending upon the relative rates of landfill cover construction compared to the anticipated rate of delivery of the various soil materials, the required materials could be delivered directly to the work area and incorporated into cover construction, thereby avoiding the need to stockpile the materials. If the rate of material delivery does not match the rate of material required for landfill cover construction, then stockpiling may be necessary or advantageous to help prevent construction delays. The time required to deliver the necessary materials needed for construction of the new landfill cover represents a significant portion of the anticipated total construction schedule (Appendix J). As such, in order to shorten the anticipated duration of construction activities for the ROD-selected remedy, it may be advantageous to import and stockpile the required materials in advance of the time they are needed for cover construction. Subject to Site owner/operator approval, these materials could be stockpiled on inactive portions of the Site such as the on-site soil borrow stockpile area (subject to requirements associated with OU-2 construction schedules), the Closed Demolition Landfill, and/or on portions of Areas 1 and 2 not contemporaneously subject to regrading (Figure 5-3). The feasibility, implementability, costs, and impacts to construction schedules associated with stockpiling of materials are addressed as part of the detailed evaluation of the ROD-selected remedy.

5.3.1.5 Rock Armoring/Flood Protection of the Toe of the Landfill

Portions of the Site were developed over the geomorphic flood plain, but these areas were subsequently filled such that the surface elevations of these areas are now located outside of the 500-year flood plain (FEMA, 2015). These areas are further protected by the presence of the 500-year levee and supporting flood control system of the Earth City Levee District. In the unlikely event of levee failure during a 500-year flood event, it is possible that flood waters could reach the lowermost approximately two feet of the toe of the landfill cover at the northwestern edge of Area 2. Because the Site is located more than 1.3 miles from the Missouri River, no high energy water flows would be expected if flood waters reached the Site. The flood protection needs of the toe of the landfill would be evaluated in more detail in the RD, and appropriate bank protection methods would be incorporated as necessary (*e.g.*, a rock rip-rap apron). The vertical height of the flood protection feature would be a subject of design phase evaluations but is expected to include a margin of safety over the 1993 (500-year) flood level. As indicated in the May 2009 memorandum from EPA's Office of Superfund Remediation and Technology Innovation (EPA, 2009b), flood control measures should meet or exceed design standards for a 500-year storm event under the assumption that the existing levee system is breached.

5.3.1.6 Stormwater Management/Surface Water Runoff Control

Management of stormwater during and after construction would be addressed in the Storm Water Pollution Prevention Plan (SWPP) that would be prepared during RD of the selected remedy. During construction, it is anticipated that:

- Temporary berms and/or ditches would be constructed as needed at the downstream edge of the existing landfill cover or the edges of any interim daily cover in excavation areas, to direct stormwater away from open excavations;

- Other practices may include installation of silt fencing and sedimentation barriers; slope minimization; stabilization of temporary waste stockpiles; use of plastic tarps, mulching, or hydro-seeding on areas not being actively graded or completed and that would be exposed for extended periods (*i.e.*, longer than 45 days); construction and stabilization of stormwater ditches and down chutes; and planting of permanent native vegetative cover when construction is complete. Additional prevention measures would include performing heavy equipment fueling and storing any hazardous materials in designated areas, as well as parking vehicles and locating waste stockpiles away from stormwater drainage points;

- Stormwater that contacts the existing surfaces of Areas 1 and 2, daily cover soil during regrading or excavation in Areas 1 and 2, and the surfaces of cover material as the covers over Areas 1 and 2 are being constructed would be managed as non-contact stormwater and directed off-site via the existing stormwater drainage system; and

- Stormwater that contacts exposed waste during regrading activities would be considered contact stormwater, requiring treatment and/or disposal as discussed below. Any accumulated contact stormwater would be pumped out of the low points in depressions created by the excavation and backfilling activities using portable pumps and directed via a new pipeline to a series of tanks (*e.g.*, frac tanks).

The stormwater tank farm would be sized to accommodate the maximum historical 24-hour rainfall over the anticipated maximum area of exposed waste. Accumulated stormwater would be pumped out of the tanks at a steady flow rate and directed to treatment equipment prior to discharge to the Metropolitan St. Louis Sewer District (MSD) in accordance with MSD procedures and discharge limitations. It is assumed that treated stormwater could be introduced to the MSD sanitary sewer system using the force main that is currently used to convey leachate from the Bridgeton Landfill or via tie-in to an MSD manhole in the vicinity of the West Lake Landfill. Representatives of MSD were contacted during preparation of the SFS, at which time they indicated a willingness to accept perched water/leachate encountered during construction, and stormwater generated during construction, subject to their standard approval procedures and discharge limitations. MSD has in the past accepted or is currently accepting similar waters from the Weldon Springs, SLAPS, and SLDS sites.

Given the variability of the waste, it is not possible to predict the quality of the stormwater that could come in contact with exposed waste during regrading at this time. It is anticipated that any radionuclides would be associated with particulates in the stormwater and might include isotopes of uranium and radium, radon-222 and various radon decay products, and potassium-40. It is not anticipated that there would be a significant amount of alpha activity actually dissolved in the stormwater, and as such removal of particulates should be sufficient for treatment of the stormwater.

For purposes of preparing cost estimates for the alternatives in this FFS, it is assumed that 0.2 acres of exposed waste (based on an assumption that the total area of exposed waste at any given time would be approximately 20 acres and that the majority [99%] if this area would be covered by tarps, daily cover or other means) would be subjected to an 8.8 inch rainfall (maximum 24-hour rainfall for August 1946; NOAA, 2011) over a 24-hour period and that this stormwater would be pumped to the stormwater tank farm. This volume of stormwater would be pumped out of the tank farm, treated, and discharged to the MSD sanitary sewer system. Treatment would consist of bag filtration to remove particulates and liquid-phase granular activated carbon (LPGAC) to polish the filtered stormwater and remove any remaining radon and organics. Because any radionuclides that may be present in stormwater would most likely be associated with suspended sediment, it is assumed that these treatment processes would be sufficient to meet the discharge criteria. Two treatment trains would be provided for redundancy and in order to have a back-up system available at all times. It is anticipated that the treatment facilities would be located in a building adjacent to the tank farm. Used filter bags and exhausted LPGAC would be tested and disposed at the appropriate facility according to the analytical test results.

5.3.1.7 Landfill Gas Monitoring and Control

The presence and levels of landfill gas would be monitored both during and after construction of the ROD-selected remedy. Measures to control potential accumulations and/or migration of explosive or toxic gases would be taken as needed both during and after construction.

As part of RD, specifications for a Methane Gas Emergency Monitoring and Action Plan would be prepared. The contractor selected to perform the remediation would be required to provide a detailed plan that meets those specifications and they would be required to incorporate both methane gas monitoring procedures and emergency response actions into their operational Health and Safety Plan. Methane gas monitoring would be performed in any and all areas where waste materials are exposed or where methane could potentially occur or accumulate. In the event that methane monitoring indicated the presence of methane concentrations which exceed the standard permitted by the Plan in any of the work areas, all work in that area would be immediately stopped and all personnel and equipment would be immediately withdrawn from the area. Methane monitoring would continue to be performed along the margins of the subject area to identify the extent of the area containing the methane exceedance and to assess changes in methane levels over time. In the event that the methane levels declined to below the clearance level of the Plan, work in the area could proceed subject to the results of ongoing and continuous methane monitoring demonstrating that the results remain at the acceptable level. In the event that methane levels again rose above the trigger level, work would again be stopped until the levels declined at which point one or more of the following mitigation procedures could be deployed:

- Work in the subject area could be delayed until methane levels dissipate on their own;

- Equipment could be used to remotely open up and aerate the waste materials to enhance dissipation of the methane; and/or

- Industrial fans could be brought to the work area to dissipate any methane occurrences.

A post-construction landfill gas monitoring program would be developed during the RD phase and implemented as part of the long-term monitoring program. The need for and scope of the landfill gas monitoring program, including the exact number and locations of gas monitoring points and measurement frequency, would be determined in the RD documents for the selected remedy for OU-1. Final landfill gas monitoring well locations and spacing would be based on geologic conditions and proximity to property boundaries and adjacent features. Section 3.1.2 in Appendix G discusses the assumed number and location of sub-surface landfill gas monitoring probes to be installed as part of the post-construction baseline monitoring program for the ROD-selected remedy. Long-term landfill gas monitoring is described in Section 4.1.2 of Appendix G.

Installation and operation of a landfill gas extraction system is included as a contingent action for the ROD remedy, in the event that the perimeter landfill gas or radon monitoring indicate that lateral migration of either explosive gases or radon is occurring along the Site boundary. This would be evaluated by comparing the landfill gas or radon levels at the perimeter of Areas 1 and 2 under the ROD-selected remedy, to the appropriate performance standards. Due to the overall age of the landfill waste, along with the relatively low levels of methane detected during the RI (EMSI, 2000), high levels of methane are not expected to occur in Areas 1 and 2.

If it is determined that a contingent landfill gas control system is necessary, it is expected that such a system would consist of either passive or active gas control wells, and in the event that an active gas control system is determined to be necessary, a gas extraction blower and offgas treatment system (a landfill gas flare or granular activated carbon adsorption in the case of radon) would also be required. A contingent landfill gas control system would be implemented in accordance with the substantive requirements standards established by the MDNR Solid Waste Management regulations (10 CSR 80-3(14)(C)(5)), the Missouri Statutes (Chapter 643 RSMo) and corresponding rules and regulations governing air quality, and the UMTRCA regulations (40 CFR Part 192). Operation of a landfill gas extraction and treatment system would include monitoring of the emissions from any vents, pipes, or flares that discharge to the atmosphere. Results of this monitoring would be compared to the substantive requirements of the above-cited regulations and/or to a site-specific risk-based value.

5.3.1.8 Management of Subsurface Liquids During Construction

It is not anticipated that groundwater will be encountered during regrading of the waste materials under the ROD-selected remedy. The potential does exist that perched layers/lenses of leachate may be encountered during waste regrading; however, the additional investigations conducted in 2013 – 2015 did not encounter any leachate or perched water in Area 1 or 2. Any perched liquid that may be encountered during implementation of the ROD-selected remedy would be pumped into temporary holding tanks (*e.g.,* frac tanks), tested to determine whether treatment or pre-approval by MSD prior to discharge is required, and then would be discharged to MSD after authorization is granted. In the event that this liquid cannot be discharged to MSD, it would be hauled to an offsite disposal facility.

5.3.1.9 Regulated Materials Management During Construction

As part of RD, a regulated materials identification and classification plan would be developed to address procedures to be employed in the event that suspected hazardous wastes or regulated asbestos containing material (RACM) are encountered during implementation of the ROD-selected remedy. Components of this plan would include training of the Site health physicists in procedures and criteria to be used to identify potential hazardous wastes or RACM that may be encountered during waste regrading. The contractor's construction manager (CM), health physicist (HP), and construction quality assurance officer (CQAO) would be instructed on the requirements for compliance with 40 CFR Part 61.154(j), 10 CSR 10-6.241, and St. Louis County Ordinance 612.530, all of which pertain to excavating/disturbing asbestos. Specifically, the HP and/or CQAO would complete the required MDNR Certification; Missouri State Certificate for Asbestos-Related Occupations. The materials identification plan would also address procedures to be used for segregation, stockpiling and testing of possible hazardous wastes or RACM and procedures to be used for on-site or off-site disposal of the materials based on the results of the testing.

In the event testing of suspected hazardous wastes indicates that such materials are hazardous waste, these materials would need to be identified, classified, manifested and shipped to an off-site hazardous waste facility for treatment (*e.g.*, solidification, stabilization, micro- or macro-encapsulation, incineration, etc.) in accordance with the Land Disposal Restrictions and associated Universal Treatment Standards of the RCRA Hazardous Waste regulations, and corresponding Missouri regulations. If any identified hazardous wastes also include radionuclides above levels that would allow for unrestricted use, these waste materials would need to be treated and disposed of as "Mixed Wastes" in a RCRA permitted disposal cell at one of the radioactive waste disposal facilities identified in Section 4.3.5.4 of this FFS (U.S. Ecology Idaho, U.S. Ecology Michigan, Energy*Solutions*, or Clean Harbors-Deer Trail). In the event that RACM is encountered during remedy implementation, this material would need to be managed and disposed in accordance with applicable state regulations (see discussion in Section 3).

5.3.1.10 Long-Term Operations, Maintenance and Monitoring for the ROD-Selected Remedy

Long-term operations, maintenance and monitoring (OM&M) activities would be performed upon completion of the remedy construction. An operations, maintenance and monitoring plan (OM&M Plan) would be developed and submitted for approval as part of the RD/RA process. The OM&M Plan would cover all the long-term remedy management and monitoring functions including groundwater monitoring plans; site inspection, maintenance and repair; notification and coordination; community relations; health and safety; emergency planning; activity schedules; reporting; etc. In practice, the OM&M Plan may be developed as a compilation of more focused plans.

Under the ROD-selected remedy, RIM would remain on-site, and accordingly, the post-closure operations, maintenance and monitoring period would likely exceed the 30-year period specified in the Missouri Solid Waste Rules for a solid waste landfill. For purposes of this FFS, cost estimates for both 30 years and 1,000 years of OM&M have been developed as part of the detailed analysis of alternatives (Section 6).

The final landfill cover system would be routinely inspected and maintained to ensure the integrity of the remedy over time. The inspections would focus on identifying any erosion of the landfill cover, the condition and coverage of vegetation on the landfill cover, the presence of material, vehicle, or equipment storage, vehicle tracks, burrowing animals, or any other activities that could affect the integrity of the landfill cover. Periodic mowing or brush-hogging of the vegetative cover would also be performed as part of long-term OM&M in order to control weed and woody plant growth on the landfill cover and to provide for an aesthetically pleasing appearance of the landfill area.

Inspections would also be performed to assess the integrity and overall condition of the perimeter security fencing around Areas 1 and 2. Any impacts to the integrity of the fence caused by activities on adjacent properties, snow accumulation, or other factors would be repaired. Any trash, debris, or woody vegetation that may accumulate along the fence would also be removed.

The various stormwater management structures (detention and sedimentation basins, diversion berms and ditches, runoff ditches and let-down structures, etc.) would be inspected for damage or the presence of erosional features or excessive sediment accumulation. Repairs to these features would be made as necessary.

In addition to surveillance of the physical remedy, the periodic site inspections would include administrative functions such as monitoring of institutional controls and coordination with key stakeholders, including the Earth City Levee District regarding management of the flood control system.

5.3.1.11 Environmental Monitoring for the ROD-Selected Remedy

The ROD-selected remedy would include monitoring activities that would be performed during and after construction of the remedy. The exact scope of this monitoring would be developed as part of the RD effort, but a preliminary description of the scope of potential monitoring activities was necessary to assess the anticipated effectiveness of a monitoring system as well as to provide the bases for estimated monitoring costs. The scope of potential monitoring activities is provided as Appendix G (Conceptual Bases for Costs of Occupational and Environmental Monitoring Associated with each Remedial Alternative) and includes monitoring activities with a limited duration that would be performed during construction (short-term monitoring), post-construction baseline monitoring, and longer duration monitoring activities performed following remedy construction (long-term monitoring).

Short-term monitoring activities that would be performed during construction of the ROD-selected remedy (and the other remedial alternatives) were divided into two categories: (1) health-based monitoring; and (2) remediation control monitoring. Data quality objectives (DQOs) would be different for each category of short-term monitoring activity. Health-based monitoring activities would be designed to evaluate potential emissions and human exposures that may occur during construction of a given alternative. The remediation control monitoring program would be designed to guide the construction contractor during construction of the ROD-selected remedy. Both of these categories of monitoring and survey activities would be limited to the period of construction. Short-term monitoring activities are described in Section 3 of Appendix G.

Post-construction baseline monitoring would be conducted to confirm that the remedial action was completed as designed and to provide initial post-construction values that could be compared to long-term monitoring results. Post-construction baseline monitoring activities are described in Section 4 of Appendix G.

Long-term monitoring activities are described in Section 5 of Appendix G and include landfill gas, groundwater, and surface water as well as annual post-construction site inspections that would be conducted after remedy construction to verify that the constructed remedy was performing as designed.

Four types of radiological surveys would be conducted to guide the minor cut and fill operations in Areas 1 and 2, to guide the excavation and relocation of RIM from the Buffer Zone/Crossroad Property onto Area 2, and to obtain regulatory approval that final cover placement over Areas 1 and 2 would meet design criteria. These methods of remediation control monitoring for the ROD-selected remedy are described in Section 3.2.1 in Appendix G.

5.3.2 Non-Engineered Components of the ROD-Selected Remedy

In addition to the various engineered components of the ROD-selected remedy, non-engineered activities including implementation, maintenance and monitoring of institutional controls and periodic reviews by EPA and MDNR of the effectiveness and protectiveness of the remedy would be performed.

5.3.2.1 Institutional Controls Included in the ROD-Selected Remedy

Land use restrictions would be maintained and/or implemented for OU-1 to limit future uses and to prevent any allowable future uses from impacting the effectiveness or integrity of the remedial action, taking into consideration the presence of long-lived radionuclides. The restrictions must be maintained until the remaining hazardous substances are at levels allowing for unlimited use and unrestricted exposure. Due to the presence of long-lived radionuclides at OU-1, the restrictions would need to be maintained indefinitely. The existing Negative Easement and Restrictive Covenants on the West Lake Landfill (Appendix A) would also remain applicable as institutional controls.

The following long-term use restrictions would potentially apply within the boundary of the cover systems for Areas 1 and 2:

- Prevent development and use for residential housing, schools, childcare facilities, or playgrounds;
- Prevent development and use for industrial or commercial purposes such as manufacturing, offices, storage units, parking lots, or other facilities that are incompatible with the function or maintenance of the landfill cover;
- Prevent construction activities involving drilling, boring, digging, or other use of heavy equipment that could disturb vegetation, disrupt grading or drainage patterns, cause erosion, or otherwise compromise the integrity of the landfill cover or manage these activities such that any damage to the cover is avoided or repaired;
- Prevent use of groundwater under these areas (for any purpose other than monitoring); and
- Provide for access necessary for continued maintenance, monitoring, inspections, and repair.

Property use restrictions have already been implemented at the Site through the placement of institutional controls on the individual parcels as discussed in Section 2.1.4. Design and implementation of any additional institutional controls that may be necessary would be addressed as a component of the RD planning process. Where appropriate, multiple mechanisms or a layered approach would be used to enhance the effectiveness of the institutional control strategy. Access controls such as fences and gates would also be used to support the use restrictions.

At the Site, the affected properties are privately owned and the use restrictions must be maintained for an indefinite period of time. Therefore, recorded covenants would be used because they generally run with the land and are enforceable. The Missouri Environmental Covenants Act (MECA), Mo. Rev. Stat.§ 260.1012, et seq., specifically authorizes environmental covenants and authorizes the State to acquire property interests for the purpose of ensuring long term compliance with such covenants. An environmental covenant pursuant to MECA is a potential instrument for use at the Site because such covenants are specifically designed to support use restrictions at contaminated sites.

The Site has been listed by MDNR on the State's Registry of Confirmed, Abandoned, or Uncontrolled Hazardous Waste Disposal Sites in Missouri (Uncontrolled Sites Registry). The registry is maintained by MDNR pursuant to the Missouri Hazardous Waste Management Law (Mo. Rev. Stat. § 260.440). Sites listed on the registry appear on a publicly-available list. A notice is filed with the County Recorder of Deeds and notice must be provided by the seller to any potential buyers of the property. Parties are not permitted to change the use of a listed site without approval of MDNR.

The OM&M Plan would contain procedures for surveillance, monitoring, and maintenance of the institutional controls. The OM&M Plan would provide for notice to EPA and the State of any institutional control violations, planned or actual land use changes, and any planned or actual transfers, sales, or leases of property subject to the use restrictions.

EPA has stated that financial assurance will be required to provide for operation, maintenance and monitoring of the remedy after construction.

5.3.2.2 Five Year Reviews

The ROD-selected remedy would also include performance of a 5-year review by EPA as required by Section 121 of CERCLA and the NCP. The specific questions to be addressed by each Five Year Review include the following:

1. Is the remedy functioning as intended by the decision documents?

2. Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection still valid?

3. Has any other information come to light that could call into question the protectiveness of the remedy?

EPA and/or the State would perform a Five Year Review at a minimum of every five years after completion of the Record of Decision for the Site or, if determined by EPA to be necessary, at more frequent intervals. The Five Year review would include an overall statement regarding the protectiveness of the remedy.

5.4 "Complete Rad Removal" Remedial Action Alternative

This section of the FFS describes the RIM volumes to be addressed under the "complete rad removal alternative, RIM excavation procedures and associated activities; short-term, post-construction, and long-term monitoring associated with the "complete rad removal" alternative; and describes the specific components of the "complete rad removal" with off-site disposal alternative. Final grading, capping and closure of Areas 1 and 2 after RIM removal are also described.

Activities associated with the "complete rad removal" alternative would include the following components:

- Excavation and stockpiling of overburden in OU-1 Areas 1 and 2 in order to access the RIM;
- Excavation of RIM from the OU-1 Areas 1 and 2 that contains radionuclides above levels that would allow for unrestricted use relative to the presence of radionuclides;
- Survey and identification of the presence and extent of radiologically-impacted soil on the Buffer Zone and Crossroad property;
- Excavation of any soil from the Buffer Zone and/or Crossroad property that contains radionuclides at levels greater than those that would allow for unrestricted use;
- Loading, transport, and disposal of the RIM and impacted soil at an off-site disposal facility;
- Regrading of the remaining solid waste materials within Areas 1 and 2 to meet the minimum (5%) and maximum (25%) slope criteria;
- Installation of a landfill cover meeting the Missouri closure and post-closure care requirements for sanitary landfills over Areas 1 and 2;
- Design, installation and maintenance of surface water runoff controls;
- Groundwater monitoring consistent with the requirements for sanitary landfills;
- Landfill gas monitoring and control, as necessary;

- Institutional controls to prevent land and resource uses that are inconsistent with a closed sanitary landfill site; and

- Long-term surveillance and maintenance of the landfill cover in Areas 1 and 2.

Per EPA's December 9, 2015 letter and attached SOW (EPA, 2015a), the FFS is to include a "complete rad removal" alternative consisting of excavation of RIM with off-site commercial disposal of the excavated materials. EPA previously indicated (EPA, 2010) that "complete rad removal" was defined to mean attainment of risk-based radiological cleanup levels specified in OSWER Directives 9200.4-25 and 9200.4-18.

Although this alternative has been termed "complete rad removal," it must be recognized that implementation of this alternative would not result in complete removal of all radionuclides from the Site, but instead would remove radionuclides from Areas 1 and 2 to the degree feasible such that additional engineering and institutional controls would not be required based on the radiological content of these areas. Because these areas would still contain solid wastes after removal of the radiologically-impacted materials, regrading, capping and establishment of institutional controls related to the presence of solid wastes would still be required.

Several components of this alternative have been addressed above in the ROD-selected remedy and will not be repeated here. The following subsections address excavation, loading and transport of RIM and impacted soil for disposal at an off-site facility.

5.4.1 RIM Volumes for the "Complete Rad Removal" Alternative

As previously discussed in Section 2.2.5, the total volumes of RIM contained in Areas 1 and 2 were estimated based on geostatistical evaluations (Appendix B) as follows:

Area 1 RIM (7.9 pCi/g criteria)	46,200 bank cubic yards (bcy)
Area 2 RIM (7.9 pCi/g criteria)	220,000 bcy
Total RIM (7.9 pCi/g criteria)	266,200 bcy

The volumes of non-radiological overburden soil and waste materials that would have to be removed to allow for excavation of the RIM were estimated to be as follows:

Area 1 overburden (7.9 pCi/g criteria)	702,500 bcy
Area 2 overburden (7.9 pCi/g criteria)	493,200 bcy
Total overburden (7.9 pCi/g criteria)	1,195,700 bcy

Figures 5-4 and 5-5 display the extent of RIM that would be excavated from Areas 1 and 2 under the "complete rad removal" alternative.

Removal of all of the RIM containing combined radium or combined thorium levels greater than 7.9 pCi/g would require removal, stockpiling and ultimately replacement of a large part of the above-grade mass of the North Quarry portion of the Bridgeton Landfill in order to access the RIM in that portion of Area 1 that lies beneath the above-grade portion of the North Quarry (*e.g.*, RIM in the vicinity of boring 1D-7). In addition, the Bridgeton Transfer Station, LLC solid waste transfer station building would need to be relocated to allow for removal of RIM located in close proximity to the transfer station (*e.g.*, GCPT 1-2, GCPT 1C-2R, and GCPT 1C-6, GCPT 1C-6T, GCPT 1C-6T1, and boring 1C-6). The only usable space for relocation of the transfer station is the area currently occupied by Simpson Asphalt pursuant to a 99-year lease, which would require buyout of the Simpson lease.

A discussion of the methods and supporting calculations used to estimate the extent and volumes of RIM above levels that would allow for unrestricted use, as well as the non-radiological overburden soil and waste materials that would have to be removed to allow for excavation of the RIM, is included in Section 2.2.5 and is further described in Appendix B.

It should be recognized that the RIM and overburden volume estimates were performed to a feasibility-study level of accuracy, and there is a high degree of uncertainty in these quantities. The levels and distribution of radionuclide activity within the RIM is known to be highly variable due to the inherent heterogeneity of the waste as well as the variable locations where RIM is concentrated. Uncertainty also arises from the limits on the accuracy of the existing site topographic mapping, which is based on aerial photogrammetry without ground control, producing, at best, a topographic surface with a tolerance of approximately one foot. In addition, past subsurface investigations of the Site were focused on providing information on the general nature and extent of occurrences of RIM. This site characterization information was determined to be sufficient to characterize the potential risks posed by the Site and to identify and evaluate potential remedial alternatives (EMSI et al., 2011). However, the intent of the prior investigations was not to accurately define the three-dimensional extent of the RIM for detailed quantity estimates. Consequently, precise estimates of the amounts and volumes of overburden materials that would need to be removed to access the RIM, the actual volumes and configurations of the RIM, and the relative amounts and distributions of soil and waste materials within the RIM cannot be made at this time. For purposes of this FFS evaluation, the estimated volume of RIM is the single largest uncertainty affecting the estimated costs and schedule for the "complete rad removal" alternative.

5.4.2 RIM Excavation and Associated Activities

This section describes the various activities associated with the "complete rad removal" alternative. Activities associated with regrading and installation of a new landfill cover over Areas 1 and 2 after removal and off-site or on-site disposal of the radioactively-impacted materials in Areas 1 and 2 are described in Section 5.3.5.

5.4.2.1 RIM Excavation Procedure and Sequencing

The RIM excavation process would be performed in a systematic manner in order to allow for efficient removal of the RIM and to minimize excavation quantities to the extent practicable. The remainder of this subsection describes the RIM excavation process. The logistics of RIM excavation sequencing in an affected area is illustrated on Figure 5-6. As shown, a grid-system would be marked in the field in an affected area. Using field radiological monitoring supplemented by on-site laboratory and/or off-site laboratory data, health physics (HP) technicians would guide the excavator operator where to remove materials in a progressive manner from grid-to-grid, removing a specified layer thickness from each grid. The radiological surveys that would be conducted to guide excavation of RIM are described in Section 3.2.2.1 of Appendix G.

As thin layer excavation progresses within the affected area, the HP technicians would follow the excavator at a close but safe distance to survey the surface. It is assumed that Ra-226 and its radioactive progeny will serve as a suitable surrogate for the activity for the initial excavation activities because the survey equipment would be able to detect < 3 pCi/g in the top few centimeters. The excavation would continue across the edge of the suspected RIM zone as guided by the radiation surveyors. It is anticipated that HP technicians could conduct periodic small-scale hand excavations when measurements indicated the presence of RIM just beneath the surface. If the RIM zone was judged to be relatively thin, these hand excavations could be used to attempt to verify the RIM thickness.

If overburden material is present, the excavator would remove the overburden and the survey technicians would screen the material to ensure no RIM was present. If no RIM is present, an additional layer of material would be removed and the area resurveyed. If additional RIM is encountered, field gamma surveys would be used to guide the removal of RIM. If the survey does not identify gamma signatures indicative of radioactivity above levels that would allow for unrestricted use in a particular excavation area where RIM is anticipated to occur, the survey technicians would direct the excavation to continue to another grid width while the analytical results of soil/waste samples are obtained to determine if all of the RIM above unrestricted use criteria has been removed.

During the excavation and surveying in the RIM zones, some soil or soil/debris could be collected and analyzed in an on-site or off-site analytical laboratory to validate the field survey measurements. Determination of whether to use an on-site laboratory, off-site laboratory, or both to support RIM excavation activities would be evaluated as part of RD based on analytical detection limits, turnaround time for lab results, cost and other factors. Regardless of which method is used to guide the excavation activities, samples would be collected from any areas of RIM excavation that are determined in the field to contain radionuclide activities below those that would allow for unrestricted use, for laboratory confirmation. If an on-site laboratory is used to make this determination, a specified percentage of the samples would also be sent to an off-site laboratory to independently verify the results obtained by the on-site laboratory.

As stated above, field surveys and measurements would need to be augmented with laboratory analyses from an on-site or off-site laboratory in order to verify that thorium levels were below the unrestricted use criteria. As noted by the NRC (1988), thorium does not possess characteristics that make it easy to measure quantitatively in place, as can be done for Ra-226 and associated decay products that have an identifiable gamma signature. Therefore, laboratory analyses are the only method for determining thorium levels. Because Th-230 is the controlling radionuclide at the Site, guidance of the excavation activities for the "complete rad removal" alternative can be generally guided by field measurements but ultimately will be directed by the results of laboratory analyses which will increase both the time required for and cost of excavation activities.

The shaded area in Figure 5-6 is a hypothetical scenario that portrays the zone of RIM and the potential approach to excavation along the edge of the RIM zone. Ideally, the excavation would continue along the edges of the RIM zone until the extent of the zone was delineated and the uncontaminated soil/debris on top of it removed. Conditions of the materials surrounding the RIM might limit how to proceed once the RIM zone was identified. The decision as to how to proceed would be made by the construction manager with input from the HP technicians.

The process of excavating the RIM would continue laterally and with depth, following a similar procedure as described above. If possible, the excavator would remain outside the RIM zone and reach into the RIM zone to lift out the RIM. The excavator would still remain on the uncontaminated surface reaching out with the bucket to excavate RIM soil/debris. HP technicians would follow the excavation to verify the absence of radioactivity above levels that would allow for unrestricted use.

For areas where RIM may be present in a thicker or deeper band, it could be necessary to move the excavator into the RIM zone. Efforts would be undertaken to limit direct contact between the RIM and the excavator. A set of wooden tracks or construction mats placed in front of the excavator tracks or a platform for the tracks would be considered.

As RIM is excavated, the nuisance attraction to, and congregation by birds at and above the excavation could be problematic unless effectively controlled. An avian management plan that incorporates use of excavation BMPs such as daily soil cover and/or tarping, visual and auditory frightening devices, or wire or monofilament grids positioned over exposed refuse to prevent bird access, would be prepared prior to and implemented during excavation of the RIM.

5.4.2.2 Material Handling

It has been estimated that approximately 46,200 and 220,000 bank cubic yards of RIM would be excavated from Area 1 and Area 2, respectively, under the "complete rad removal" alternative. In addition, it is estimated that approximately 702,500 and 493,200 bank cubic yards of non-RIM waste overburden would require excavation from Area 1 and Area 2, respectively, to access the RIM waste for the "complete rad removal" alternative. In order to access the underlying RIM waste, this non-RIM overburden material would be removed and temporarily stockpiled at the Site.

Characterization data generated during the RI and supplemental investigation phases of this project (EMSI, 2016b) indicated that the materials expected to be encountered during the excavation would consist of:

- Solid waste consisting of varying amounts of household wastes, commercial/industrial wastes, and construction and demolition debris;
- Daily/intermediate soil cover, including some soil that has been mixed with leached barium-sulfate residues; and
- Final soil cover, possibly including some soil that has been mixed with leached barium-sulfate residues.

The levels and distribution of radionuclide activity within the RIM is known to be highly variable. Consequently, precise estimates of the amounts and volumes of overburden materials that would need to be removed to access the RIM, the actual volumes and configurations of the RIM, and the relative amounts and distributions of soil and waste materials within the RIM cannot be made at this time. Until actual excavation were to commence and field screening and visual observation begin, the extent and volume of overburden and RIM that would be removed under the "complete rad removal" alternative can only be estimated using the available data.

As discussed in Section 4, physical separation of the soil and solid waste is a technology that can potentially reduce the amount of waste material that would have to be transported and disposed off-site under the "complete rad removal" with off-site disposal alternative. As discussed in Section 4, although physical separation has been used to separate soil from refuse in old landfills, it has never been used to separate radiologically-impacted material from solid waste. Consequently, the degree to which this technology could effectively separate all or most of the soil, such that the remaining solid waste materials would not contain radionuclides at levels greater than those that would allow for unrestricted use, is unknown. Therefore, this technology, although a proven application for "mining" of old landfills, has never been applied and its performance has never been tested or demonstrated for the type of application associated with the "complete rad removal" alternative. Pilot-scale testing of the degree of separation and resultant radionuclide activity levels within the separated fractions (*i.e.*, garbage and soil) as well as other factors such as dust generation and air quality of the generated dust, worker maintenance activities and resultant radionuclide exposure levels to workers and the community, among others, would need to be evaluated through performance of a pilot-scale test as part of RD activities before a determination of the potential applicability, effectiveness, impacts and costs of this technology could be made. Pilot testing would include mobilizing a trommel unit to the Site, excavating several test tracts, and performing physical separation using the trommel and testing the result separated materials for radioactivity levels. Particulate samples would also be collected in order to examine potential dust emissions. Performance of a pilot test, evaluation of the test results, and, if appropriate, integration of this technology as part of the remedial action would therefore increase the time and cost required for completion of the RD phase for this alternative.

5.4.2.3 Material Stockpiling

As previously noted, excavation of the RIM under the “complete rad removal” alternative would require removal and stockpiling of non-RIM waste materials that overlie the RIM (overburden wastes). For the “complete rad removal” alternative, excavated non-RIM overburden waste would be temporarily stockpiled adjacent to the excavation(s) or elsewhere on-site until areas containing RIM had been completely excavated and cleared of radiation, and final samples confirm that all materials with radionuclide activities above levels that would allow for unrestricted use had been removed. Subsequently, the non-RIM overburden waste would be placed back into the excavations upon completion of the RIM removal activities. As discussed previously, approximately 702,500 and 493,200 bank cubic yards of non-RIM waste overburden would need to be excavated from Area 1 and Area 2, respectively, in order to implement the “complete rad removal” alternative.

For the “complete rad removal” alternative, a significant amount of earthen material would also need to be delivered on-site and stockpiled for use in construction of the final landfill cover over Areas 1 and 2 once the RIM were removed. The overall preference would be to stockpile the required construction materials on portions of Areas 1 and 2 that would not be subject to excavation or that would not be contemporaneously subject to excavation activities. However, due to the limited size of Areas 1 and 2 and the extensive amount of excavation associated with the “complete rad removal” alternative, it is likely that implementation of the “complete rad removal” alternative would require some stockpiling of materials (non-RIM waste and/or cover construction materials) outside of Areas 1 and 2. Figure 5-3 illustrates potential locations where stockpiles could be established. These locations potentially include the surface of the northern portion of Area 2 (during performance of excavation in Area 1) and on top of the Closed Demolition Landfill. These locations appear viable for this preliminary feasibility-level evaluation, but their actual locations would vary depending on the results of the detailed design and in consideration of issues such as the final excavation layouts, limits, and procedures; discussions/agreement with the Site owner and operator; and potential interference with existing utilities, roads, vehicular traffic patterns, or structures.

The low permeability soil and vegetative cover material for the cover to be placed over Areas 1 and 2 after RIM removal would be purchased and delivered to the Site. A portion of this soil would be stockpiled to avoid delay in construction activities. A bio-intrusion layer is not included as part of the cover for the “complete rad removal” with off-site disposal alternative. FS-level design projections determined that approximately 1,280,000 loose cubic yards of soil material would be required from outside sources. These materials could be stockpiled on the Closed Demolition Landfill, on portions of Areas 1 and 2 not contemporaneously subject to RIM excavation, and/or the current on-site soil stockpile area (subject to requirements associated with implementation of the OU-2 remedy). Potential stockpile areas are shown on Figure 5-3.

Stockpiled non-RIM waste material would be managed to control odors. For example, these materials would be covered with tarps, soil cover or foams/chemical agents to suppress odor emissions and reduce the potential for windblown debris and dust, vectors, and precipitation infiltration. The stockpiles would be managed to prevent dust emissions and stormwater impacts; for example, by applying water or other dust suppressants, and by strategically locating the stockpiles away from Site drainage features to the extent possible. A plan for stockpiling of waste materials including identification of actual or potential areas for temporary stockpiles, temporary covers, runon-runoff controls, ongoing inspection and maintenance requirements, and other factors would be developed as part of the RD. A Storm Water Pollution Prevention Plan (SWPPP) would be prepared prior to commencement of construction activities and would provide a detailed plan for the location and maintenance of the stockpiles.

While the non-RIM overburden waste is excavated and stored on-site, the nuisance attraction to, and congregation by birds at and above, the excavation and non-RIM overburden waste stockpiles could be problematic unless effectively controlled. An avian management plan that incorporates use of excavation BMPs such as daily soil cover and/or tarping, visual and auditory frightening devices, or wire or monofilament grids positioned over exposed refuse to prevent bird access, would be prepared prior to and implemented during excavation of the non-RIM overburden waste.

5.4.2.4 Radiological Surveys during RIM Excavation

Based on evaluations conducted in preparation of the prior SFS, it is expected that eight types of radiological surveys would be conducted to guide the excavation and verify that the RIM had been removed during and after the RIM excavation process. These surveys are described in detail in Section 3.2.2.1 of Appendix G. Excavation surveys and verification sampling would be performed during and upon completion of excavation activities in each area, as described in Section 5.4.2.1 and Appendix G.

5.4.2.5 Application of Daily Soil Cover

In order to minimize odors, vectors, windblown debris, and precipitation infiltration, a nominal thickness of six (6) inches of soil would be applied as daily cover over grading, excavation, waste stockpile, and waste placement areas. Daily cover would be applied to the stockpiles of non-RIM waste overburden material as well as the RIM excavation areas.

For cost purposes, the daily cover is assumed to be soil because it is the most conventional and widely used material for this purpose. The amount of daily cover included for each of these activities was estimated to be equal to 10% of the volume of the waste materials subject to daily cover. This value is based on professional experience with the development of design and operations plans for solid waste landfills and monitoring of in-place waste and soil volumes during landfill development. The actual amount of soil required for use as daily cover would be a function of the size and configuration of the various cut and fill areas, waste excavation areas, and overburden stockpiles that would be subject to daily cover under each of the remedial alternatives addressed by the FFS as well as the physical configuration of the material to be covered. The amount of soil required for daily cover is also a function of equipment operator expertise, and desired production rates. Considering all of these factors, the actual amount of soil required could be slightly less (as low as 8%) than the 10% estimated in this FFS or substantially more (as much as 20%) than the amount included in this FFS.

Application of daily cover to the waste excavation areas would increase the volumes and mass of the RIM-impacted waste materials to be addressed in the “complete rad removal” and partial excavation alternatives. Daily cover placed over the RIM excavation areas would mix with and become part of the volume of RIM, therefore increasing the volume and mass of RIM that would be sent for off-site disposal.

It may be possible to place tarps or foam over the non-RIM and RIM excavation areas and non-RIM overburden stockpiles under the “complete rad removal” and partial excavation alternatives in lieu of using soil as the daily cover material. The ability to use tarps or foam in place of soil as a daily cover material would be a function of the size and configuration of the various areas requiring cover, the ability of the tarps and foam to withstand wind loads, potential worker exposures during placement and removal of the tarps and/or foam, and various other factors that can only be evaluated and/or tested during design or possibly during the initial stages of implementation of a remedial action at the Site.

To the extent that application of daily soil cover alone proves insufficient to address the nuisance attraction to and congregation by birds at and above the excavation, additional measures may need to be taken. These measures could include some or all of the technologies identified in Section 4, including minimization of areas of exposed wastes, use of tarps or additional thickness of daily cover material over areas of exposed waste, placement of wire or monofilament grids positioned over exposed refuse to prevent bird access, and/or implementation of visual deterrents (simulated predators) or frightening devices (noise makers) to deter bird activity.

5.4.2.6 Removal of Radiologically-Impacted Soil from the Buffer Zone/Crossroad Property

With the exception of the ultimate disposition of such soil, identification, characterization and removal of soil on the Buffer Zone or Crossroad Property that contains radionuclide levels above those that would allow for unrestricted use would be performed in the same manner as was previously described for the ROD-selected remedy (see Section 5.2.1.2). Under the “complete rad removal” with off-site disposal alternative, any such soil would be disposed off-site.

5.4.2.7 Management of Subsurface Liquids During RIM Excavation

It is not anticipated that groundwater would be encountered during excavation of RIM. Pockets of perched leachate present in the waste mass may be encountered during implementation based on the extent and depths of excavation associated with the “complete rad removal” and partial excavation alternatives. Leachate, if any, that may be encountered during remedy implementation would be pumped into temporary holding tanks (*e.g.*, frac tanks), tested to determine treatment requirements, if any, with the test results submitted to MSD for approval for discharge to MSD, and subsequently treated, if and as necessary, prior to discharge to MSD. In the event that this liquid cannot be discharged to MSD, it would be hauled to an offsite disposal facility.

It is not expected that groundwater will be encountered during RIM excavation, based on a comparison of typical measured Site groundwater elevations to the anticipated bottom of the anticipated excavations for Areas 1 and 2.

5.4.2.8 Regulated Materials Management During RIM Excavation

Management of suspected hazardous wastes or RACM encountered during implementation of the "complete rad removal" and partial excavation alternatives would be conducted in the same manner described in Section 5.2.1.8 for the ROD-selected remedy.

5.4.2.9 Radiological Surveys after RIM Excavation

Final status surveys that would be conducted for completed RIM excavation areas and for the unexcavated areas involved with the movement and handling the RIM and overburden storage locations are described in Section 3.2.2.2 of Appendix G.

5.4.3 Loading and Transportation of RIM to an Offsite Disposal Facility

RIM that would be excavated from Areas 1 and 2 and the Buffer Zone/Crossroad property under the "complete rad removal" alternative would be hauled to one of the off-site disposal facilities described in Section 4.3.7. Because of the long distances between the Site and any off-site disposal facility, the large volume of RIM estimated to be excavated under the "complete rad removal" alternative, and considerations related to effectiveness, safety, and cost, direct hauling of RIM to the disposal facility using trucks was eliminated as a transportation technology for all of the offsite disposal facilities with the possible exception of U.S. Ecology's Wayne Disposal facility in Michigan. For all of the offsite disposal facilities, with the possible exception of U.S. Ecology Michigan, RIM would be hauled to the disposal facilities via rail.

As described in Section 4.3.5, there are several methods for containment of waste material for rail transport, including:

- RIM loaded directly into gondola cars, if a potential future rail spur could be extended onto the Site;

- RIM loaded into an open 35 cubic yard soft-sided U.S. DOT Industrial Packaging (IP)-1 shipping container bag that had been placed in an end-dump semi-trailer, the bag closed and trucked to a truck-to-rail transloading operation at a leased rail spur location near the Site (assuming a location could be identified during the design phase), the trailer backed onto a transload ramp, and the bag dumped into the gondola car;

- RIM could be placed into 10 cubic yard soft-sided IP-1 shipping container bags located near the excavation area, the bags loaded onto flatbed semi-trailers with a forklift or crane and trucked to a truck-to-rail transloading operation at a leased rail spur location near the Site; and the containers off-loaded from the flatbed and into gondola cars with a forklift or crane; or

- RIM could be loaded into a lined metal intermodal container with a secured lid and the intermodal container would be lifted onto a flatbed trailer and hauled to a truck-to-rail transloading operation at a leased rail spur location where the containers would be lifted off of the flatbed and stacked with other intermodals onto a flat railcar.

Loading of the intermodal containers at the Site would occur within an enclosed structure equipped with dust, odor and vapor emission control equipment (Figure 5-7). Conceptually, the RIM staging and loading building is anticipated to be constructed in the current Bridgeton Landfill surplus/reclaimed material and equipment storage ("boneyard") area (Figure 5-8). Trucks arriving at the Site carrying empty intermodal containers would be first weighed and then would enter one (the "intermodal loading") side of the building. A liner would be placed in the intermodal container and the truck would pull forward to the center of the building where RIM would be placed in the lined intermodal container by a front-end loader. The loading of RIM would be supervised by a representative of the disposal facility to ensure that the material meets the disposal facility's waste acceptance criteria. Upon completion of the RIM loading, the truck would pull to the far end of the "intermodal loading" side of the building where the outer portions of the liner would be placed over the top of the RIM and the container would either be covered with a tarp or alternatively if equipped with a metal lid, the lid would be placed over the top and sealed before the truck exits the building. The truck would then exit the building where it would be scanned for radioactivity and decontaminated if necessary. The truck would then proceed to the scale to be weighed and the waste manifest would be completed prior to leaving the Site. The truck would then transport the intermodal containers of RIM to a truck/rail transloading facility where the intermodal containers would be loaded onto flat rail cars for transport to the waste disposal facility. The RIM staging and loading building would be equipped with air emissions controls consisting of exhaust blowers that would discharge air through sulfur dioxide odor control media and vapor phase granular activated carbon media (Figure 5-7).

For the "complete rad removal" with off-site disposal alternative, determination of the containment method for rail transport would be made as part of the RD effort. Extending a rail spur onto the Site, if possible, and loading RIM material directly onto railcars would reduce material handling steps, reduce risks associated with the intermediate step of transporting RIM via trucks to a leased rail spur location near the Site, and probably reduce transportation costs.

Extending a spur would likely require the following activities and facilities, as shown on Figure 5-8:

- Purchase or long-term lease of portions of the PM Resources, Inc. and CP III Properties, LLC properties located across St. Charles Rock Road from the Site entrance (Figure 5-8);
- Approvals to construct a rail spur across private property located to the east of St. Charles Rock Road, across St. Charles Rock Road, and along the access roads to the existing solid waste transfer station and asphalt plant operations at the Site;
- A new switch and tie-in to the existing spur located on CP III Properties, LLC property;
- Removal of trees and brush in the wooded area between the tie-in and St. Charles Rock Road;
- Assessment of whether the wooded area is a designated wetlands and, if so, obtaining approvals and potential wetlands mitigation;
- Laying of flat track in the cleared area between the tie-in and St. Charles Rock Road;
- Installation of an electrically-gated and signed crossing and flat track across St. Charles Rock Road (Missouri State Highway 180) including appropriate coordination with and approval from local and state authorities;
- Installation of flat track on the Site on surfaces that have not been landfilled, including north of and along the Site access road, between the OU-2 Closed Demolition and Inactive Sanitary Landfills to OU-1 Area 1, and parallel tracks to the west of the asphalt plant area[28];
- Two switches on the tracking within the Site;
- Renegotiation of the long-term lease for the asphalt plant, which leases land south of the solid waste transfer facility and whose property would be impacted by the on-site spur;
- Installation of a reinforced concrete (estimated as at least a 100 ft by 100 ft area) loading platform at the edge of Area 2 where excavated RIM would be placed by articulated trucks and then loaded into gondola rail cars with front-end loaders.[29]

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[28] It is assumed that two sets of tracks would extend onto the Site to provide enough room for switching and staging of empty gondola cars during simultaneous loading of gondola cars, to maximize the volume of RIM that could be removed per day.

[29] It is anticipated that the loading platform would be placed in one permanent location adjacent to Area 2 and the smaller volume of RIM from Area 1 would be transported via articulated on-site trucks to the loading platform.

- Installation of a tensioned fabric frame structure over the loading platform such that loading of rail cars can be performed regardless of weather conditions;

- Installation of a scale within the loading platform structure; and

- Purchase of a "trackmobile" (small rail locomotive) to be used to move empty and loaded gondola rail cars around on-site.

A detailed evaluation of the above issues (including whether an on-site rail spur extension is technically or economically feasible) is beyond the scope of this FFS, and would need to be conducted during the RD phase.

Based on discussions with U.S. Ecology, it was decided that for the purposes of FFS evaluations of the "complete rad removal alternative" it would be assumed that excavated RIM would be loaded into 30 cubic yard lined metal intermodal containers. The intermodal containers would be hauled via flatbed truck to a truck-to-rail transloading operation at a rail spur location within a 10-mile radius of the Site. The intermodal containers would be loaded onto flatbed rail cars at the transloading facility for shipment to one the off-site disposal facilities described in Section 4.3.7.

5.4.4 Stormwater and Landfill Gas Monitoring and Control

In addition to the surfaces that stormwater could contact under the ROD-selected remedy, stormwater under the "complete rad removal" alternative could contact: (1) exposed waste during excavation of overburden and RIM from Areas 1 and 2; (2) daily cover soil that has been placed over areas of exposed overburden or RIM after excavation; and (3) surfaces of cover material as the covers over Areas 1 and 2 are being constructed.

Stormwater management for the "complete rad removal" alternative would be performed in the same manner as was described in Section 5.3.1.6 for the ROD-selected remedy except for possible variations in the locations and size of the stormwater control structures owing to the greater area of disturbance and creation of topographic depressions during construction of the "complete rad removal" alternative and the greater period of stormwater management resulting from the longer duration required for implementation of the "complete rad removal" alternative.

Landfill gas monitoring and control during construction would be performed in the same manner as was described in Section 5.3.1.7 for the ROD-selected remedy. Long-term monitoring of landfill gas monitoring along the perimeters of Areas 1 and 2 would performed in the same manner as was described in Section 5.3.1.7 for the ROD-selected remedy except that radon monitoring would not be required.

Installation and operation of a landfill gas extraction system as described above for the ROD-selected remedy is also included as a contingent action under the "complete rad removal" alternative in the event that the perimeter landfill gas monitoring indicates that lateral migration of explosive gases is occurring along the Site boundary. This would be evaluated by comparing the landfill gas levels at the perimeter of Areas 1 and 2 under the "complete rad removal" alternative to the appropriate performance standards. Due to the overall age of the landfill waste, along with the relatively low levels of methane detected during the RI (EMSI, 2000), high levels of methane are not expected to occur in Areas 1 and 2.

5.4.5 Final Grading and Engineered Landfill Cover

As only the RIM would be removed, waste materials would still remain on-site in Areas 1 and 2. Regrading and construction of a final cover would be performed for Areas 1 and 2 as described in Section 5.3.1.4 above with the exception that the final grades would be a minimum of 5% and the final cover installed for the "complete rad removal" alternative would not include the additional two-foot thick rock/rubble biointrusion layer. Long-term inspection and maintenance of the final cover would be required.

After RIM had been removed from Areas 1 and 2, only waste materials below the appropriate rad screening level would remain in these areas. The presence of waste materials would require a final RCRA Subtitle D cover to be constructed over these areas. MDNR regulations (and in particular, 10 CSR 80-3.010(17)(C)(4)(A)) would govern the requirements for the landfill cover over Areas 1 and 2.

In order to safely access and remove RIM as described previously, it would be necessary to temporarily excavate and stockpile solid wastes (overburden wastes) that currently lie on top of the RIM. Once removal of RIM over the levels permitted for unrestricted use has been verified, this overburden waste material would be returned to the excavated areas. These wastes would then be graded and a new Subtitle D landfill cover installed. It is envisioned that the overburden wastes would be suitable for backfilling into the excavations of Areas 1 and/or 2, which would aid in the proper regrading of the excavations and promote positive drainage from the two areas. The design criteria specified for MSW landfills (*e.g.*, minimum 5% and maximum 25% slopes) would also apply to design of the final grades for any waste materials that would remain after excavation of the RIM.

Consistent with MDNR regulations for existing solid waste landfills without liners (10 CSR 80-3.010(17)(C)(4)(A)), the cover for Areas 1 and 2 would consist of the following layers (from top to bottom):

- 1-ft vegetative soil; and
- 2-ft compacted clay layer (10^{-5} cm/sec).

The uppermost one (1) ft soil layer would have to be capable of sustaining vegetative growth. It would typically be composed of a soil with sufficient organic content and permeability to allow vegetative growth. USCS soil types such as OH and OL are often found suitable for this end use. The United States Department of Agriculture (USDA) soil taxonomy system would also be referenced and used to aid in identifying suitable vegetative layer soils.

The two (2) ft compacted clay layer would consist of a USCS CL, CH, ML, MH, or SC soil-type with characteristics such that a compacted permeability 1 x 10^{-5} cm/sec or less could be achieved during construction.

5.4.6 Long-Term Operations, Maintenance and Monitoring and Non-Engineered Components

Long-term OM&M activities and the non-engineered components for the "complete rad removal" alternative would still require post-closure care activities associated with a closed MSW landfill, which would generally be the same as those described in Sections 5.3.1.10 and 5.3.2 for the ROD-selected remedy and described in Section 5.2 of Appendix G for the "complete rad removal" alternative. Because all of the RIM containing radionuclides above levels that would allow for unrestricted use would have been removed from Areas 1 and 2 under the "complete rad removal" alternative, some of the long-term OM&M activities and institutional controls included as part of the ROD-selected remedy should not be necessary for Areas 1 and 2, including:

- Long-term OM&M of Areas 1 and 2 would only need to be performed for a 30-year period;
- Institutional controls required solely for the presence of radionuclides in Areas 1 and 2 would no longer be necessary;
- Monitoring of radon occurrences in landfill gas around Areas 1 and 2 should not be necessary; and
- Performance of five-year reviews.

Financial assurance would be required to provide for operation, maintenance and monitoring of the remedy. Because radionuclides above levels that would allow for unrestricted use would be removed under this alternative, five-year regulatory reviews, as described in Section 5.2.2.2, should not be required for the "complete rad removal" alternative.

Groundwater and landfill gas monitoring of Areas 1 and 2 would also be mandated for a period of 30 years, consistent with the post-closure monitoring requirements for solid waste landfills (10 CSR 80-2.030(4)(A)3.E(I)). Maintenance and monitoring of institutional controls would also be necessary, similar to the requirements described above for the ROD-selected remedy.

5.5 Partial Excavation – Removal of RIM Greater than 52.9 pCi/g within 16-foot Depth

This section describes the partial excavation alternative that includes removal of RIM containing combined radium or combined thorium activities greater than 52.9 pCi/g that is located within 16 feet of the topographic elevation of the 2005 ground surface of Areas 1 and 2. This alternative consists of many of the same components as were previously discussed for the “complete rad removal” alternative, including:

- Excavation and stockpiling of overburden in OU-1 Areas 1 and 2 in order to access the RIM;
- Excavation of RIM from the OU-1 Areas 1 and 2 that contains combined radium or combined thorium activities greater than 52.9 pCi/g that is located within 16 feet of the 2005 topographic surface;
- Survey and identification of the presence and extent of radiologically-impacted soil on the Buffer Zone and Crossroad property;
- Excavation of any soil from the Buffer Zone and/or Crossroad property that contains radionuclides at levels greater than those that would allow for unrestricted use;
- Loading, transport, and disposal of the RIM and impacted soil at an off-site disposal facility;
- Regrading of the remaining solid waste materials within Areas 1 and 2 to meet the minimum (5%) and maximum (25%) slope criteria;
- Installation of a landfill cover meeting the Missouri closure and post-closure care requirements for sanitary landfills over Areas 1 and 2;
- Design, installation and maintenance of surface water runoff controls;
- Groundwater monitoring consistent with the requirements for sanitary landfills;
- Landfill gas and radon monitoring and control, as necessary;
- Institutional controls to prevent land and resource uses that are inconsistent with a closed sanitary landfill site containing radiological materials; and
- Long-term surveillance and maintenance of the landfill cover in Areas 1 and 2.

The primary differences between the 52.9 pCi/g partial excavation alternative and the “complete rad removal” alternative are the higher criteria for excavation of RIM under the 52.9 pCi/g partial excavation alternative (52.9 pCi/g of combined radium or combined thorium as compared to 7.9 pCi/g for the “complete rad removal” alternative) and the imposition of a maximum depth of excavation for the 52.9 pCi/g partial excavation alternative. These differences result in significantly lower volumes of RIM and overburden material to be excavated under the 52.9 pCi/g partial excavation alternative as compared to the “complete rad removal” alternative, and accordingly, a remedy that (comparatively speaking) may be implemented more readily.

5.5.1 RIM Volumes for the 52.9 pCi/g Partial Excavation Alternative

The total volumes of RIM containing combined radium or combined thorium activities greater than 52.9 pCi/g in Areas 1 and 2 that were located within 16 feet of the 2005 topographic surface were estimated based on geostatistical evaluations (Appendix B) and are as follows:

Area 1 RIM (52.9 pCi/g criteria)	20,800 bank cubic yards (bcy)
Area 2 RIM (52.9 pCi/g criteria)	130,000 bcy
Total RIM (52.9 pCi/g criteria)	150,800 bcy

The volumes of non-radiological overburden soil and waste materials that would have to be removed to allow for excavation of the RIM above the 52.9 pCi/g criteria were estimated to be as follows:

Area 1 overburden (52.9 pCi/g criteria)	52,800 bcy
Area 2 overburden (52.9 pCi/g critiera)	198,700 bcy
Total overburden (52.9 pCi/g criteria)	251,500 bcy

Figures 5-9 and 5-10 display the extent of RIM that would be excavated from Areas 1 and 2 under the 52.9 pCi/g partial excavation alternative.

In contrast to the "complete rad removal" alternative, removal of all of the RIM containing combined radium or combined thorium levels greater than 52.9 pCi/g down to a depth of 16 feet below the 2005 topographic elevations would not require removal of the above-grade mass of the North Quarry portion of the Bridgeton Landfill, because RIM within the portion of Area 1 that is located beneath the above-grade portion of the North Quarry is located deeper than 16 feet below the 2005 topographic surface. However, removal of RIM greater than 52.9 pCi/g would require relocation of the Allied Waste solid waste transfer station building to allow for removal of RIM located in close proximity to the transfer station (*e.g.*, GCPT 1-2, GCPT 1C-2R, and GCPT 1C-6, GCPT 1C-6T, GCPT 1C-6T1, and boring 1C-6), as that excavation would affect the stability of the transfer station (Figure 5-9). As previously discussed in Section 5.4.1 relative to the "complete rad removal" alternative, the only usable space for relocation of the transfer station is the area currently occupied by Simpson Asphalt pursuant to a 99-year lease, which would require buyout of the Simpson lease.

A discussion of the methods and supporting calculations used to estimate the extent and volumes of RIM containing combined radium or combined thorium activities greater than 52.9 pCi/g in Areas 1 and 2 that were located within 16 feet of the 2005 topographic surface, as well as the non-radiological overburden soil and waste materials that would have to be removed to allow for excavation of the RIM is further described in Appendix B.

As previously discussed in Section 5.4.1 relative to the “complete rad removal” alternative, the estimates of the RIM and overburden volume associated with the 52.9 pCi/g alternative were developed to a feasibility-study level of accuracy. Therefore, a high degree of uncertainty exists relative to the above-listed estimates for the same reasons cited in Section 5.4.1 relative to the “complete rad removal” alternative. For purposes of this FFS evaluation, the estimated volume of RIM is the single largest uncertainty affecting the estimated costs for all of the excavation alternatives.

All other aspects of the 52.9 pCi/g partial excavation alternative would generally be the same as those previously described for the “complete rad removal” alternative, except that because RIM would be left on-site, the enhanced cap included under the ROD-selected remedy (e.g. the biointrusion/marker layer) would also be included as part of 52.9 pCi/g alternative. The 52.9 pCi/g alternative would require a lesser amount of soil material (1,060,000 loose cubic yards) to be purchased and delivered to the Site for construction of this alternative. In addition, because radionuclides above the unrestricted use criteria would still remain at the Site, five-year review evaluations, groundwater monitoring for radionuclides, and radon gas monitoring would be required for the 52.9 pCi/g partial excavation alternative. Baseline monitoring for measurement of radon gas in landfill gas wells for the partial excavation alternatives is described in Section 4.1.2 of Appendix G and includes measurement of radon gas in landfill gas wells installed along the boundaries of Areas 1 and 2.

5.6 Partial Excavation – Removal of RIM Greater than 1,000 pCi/g

This section provides a description of the partial excavation alternative that includes removal of RIM containing combined radium or combined thorium activities greater than 1,000 pCi/g. As with the 52.9 pCi/g partial excavation alternative, this alternative consists of many of the same components as were previously discussed for the “complete rad removal” alternative including:

- Excavation and stockpiling of overburden in OU-1 Areas 1 and 2 in order to access the RIM;
- Excavation of RIM from the OU-1 Areas 1 and 2 that contains combined radium or combined thorium activities greater than 1,000 pCi/g;
- Survey and identification of the presence and extent of radiologically-impacted soil on the Buffer Zone and Crossroad property;
- Excavation of any soil from the Buffer Zone and/or Crossroad property that contains radionuclides at levels greater than those that would allow for unrestricted use;
- Loading, transport, and disposal of the RIM and impacted soil at an off-site disposal facility;

- Regrading of the remaining solid waste materials within Areas 1 and 2 to meet the minimum (5%) and maximum (25%) slope criteria;
- Installation of a landfill cover meeting the Missouri closure and post-closure care requirements for sanitary landfills over Areas 1 and 2;
- Design, installation and maintenance of surface water runoff controls;
- Groundwater monitoring consistent with the requirements for sanitary landfills;
- Landfill and radon gas monitoring and control, as necessary;
- Institutional controls to prevent land and resource uses that are inconsistent with a closed sanitary landfill site containing radionuclides; and
- Long-term surveillance and maintenance of the landfill cover in Areas 1 and 2.

The primary difference between the 1,000 pCi/g partial excavation alternative and the 52.9 pCi/g partial excavation and the "complete rad removal" alternatives is the higher criteria for excavation of RIM associated with this partial excavation alternative (1,000 pCi/g of combined radium or combined thorium as compared to 7.9 pCi/g for the "complete rad removal" alternative and 52.9 pCi/g for the other partial excavation alternative). The higher criteria associated with the 1,000 pCi/g partial excavation alternative results in a lower volume of RIM to be excavated. However, in contrast to the 52.9 pCi/g partial excavation alternative, which also includes a maximum depth of excavation limited to 16 feet below the 2005 ground surface, the 1,000 pCi/g partial excavation alternative does not include any depth limitation. Therefore, even though the RIM volume associated with this alternative is smaller, the volume of overburden that would need to be removed to allow for removal of RIM greater than 1,000 pCi/g is significantly greater than the volume of overburden associated with the 52.9 pCi/g partial excavation alternative.

5.6.1 RIM Volumes for the 1,000 pCi/g Partial Excavation Alternative

The total volumes of RIM containing combined radium or combined thorium activities greater than 1,000 pCi/g in Areas 1 and 2 were estimated based on geostatistical evaluations (Appendix B) and are as follows:

Area 1 RIM (1,000 pCi/g criteria)	7,100 bcy
Area 2 RIM (1,000 pCi/g criteria)	31,100 bcy
Total RIM (1,000 pCi/g criteria)	38,200 bcy

The volumes of non-radiological overburden soil and waste materials that would have to be removed to allow for excavation of the RIM above the 1,000 pCi/g criteria were estimated to be as follows:

Area 1 overburden (1,000 pCi/g criteria)	387,000 bcy
Area 2 overburden (1,000 pCi/g critiera)	213,600 bcy
Total overburden (1,000 pCi/g criteria)	600,600 bcy

Figures 5-11 and 5-12 display the extent of RIM that would be excavated from Areas 1 and 2 under the 1,000 pCi/g partial excavation alternative.

Similar to the "complete rad removal" alternative, removal of all of the RIM containing combined radium or combined thorium levels greater than 1,000 pCi/g would require removal, stockpiling, and ultimately replacement of a large part of the above-grade mass of the North Quarry portion of the Bridgeton Landfill. However, removal of RIM greater than 1,000 pCi/g is not expected to require relocation of the Allied Waste solid waste transfer station building.

The methods and supporting calculations used to estimate the extent and volumes of RIM above the 1,000 pCi/g criteria, as well as the non-radiological overburden soil and waste materials that would have to be removed to allow for excavation of the RIM, are further described in Appendix B.

Similar to the discussion in Section 5.4.1 relative to the "complete rad removal" alternative, the estimates of the RIM and overburden volume associated with the 1,000 pCi/g alternative were developed to a feasibility-study level of accuracy. Therefore, a high degree of uncertainty exists relative to the above-listed quantities for the same reasons cited in Section 5.4.1 relative to the "complete rad removal" alternative. For purposes of this FFS evaluation, the estimated volume of RIM is the single largest uncertainty affecting the estimated costs for all of the excavation alternatives.

All other aspects of the 1,000 pCi/g partial excavation alternative would generally be the same as those previously described for the 52.9 pCi/g partial excavation alternatives. The 1,000 pCi/g alternative would require the greatest amount of soil material (1,290,000 loose cubic yards) to be purchased and delivered to the Site for construction of this alternative. Ongoing monitoring for radionuclide occurrences in groundwater and potentially measurement of radon gas in landfill gas wells installed along the boundaries of Areas 1 and 2 could be required as part of this alternative. Because this alternative only entails removal of radionuclides above 1,000 pCi/g, radionuclides would still remain at the Site at levels above the unrestricted use criteria. Therefore, five-year review evaluations and radon gas monitoring would be required for the 1,000 pCi/g partial excavation alternative.

6 DETAILED ANALYSIS OF ALTERNATIVES

This section provides a detailed analysis of the No Action alternative, the ROD-selected remedy, the “complete rad removal” alternative, and the two partial excavation alternatives developed in Section 5. The purpose of this detailed analysis is to provide sufficient information to allow for comparisons among the alternatives based on the nine evaluation criteria specified in the National Contingency Plan (NCP) (40 CFR § 300.430).

The detailed evaluation of final alternatives for a remedial action is a two-stage process. This section presents the first stage of evaluation, in which each of the alternatives is assessed against the nine evaluation criteria prescribed by the NCP. This evaluation is based on the conceptual descriptions of the alternatives provided in Sections 5.2 through 5.6.

Section 7 will set out the second stage of the evaluation process, in which the alternatives are compared against each other to identify relative advantages, disadvantages and trade-offs using the nine NCP evaluation criteria. The purpose of the comparative analysis is to provide information for a balanced remedy selection.

The NCP categorizes these nine evaluation criteria into three groups: threshold criteria, primary balancing criteria, and modifying criteria. The evaluation criteria consist of:

Threshold Criteria:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs

Primary Balancing Criteria:

- Long-Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, or Volume through Treatment
- Short-Term Effectiveness
- Implementability
- Cost

Modifying Criteria:

- State Acceptance
- Community Acceptance

Each criterion has its own weight when it is evaluated.

- Threshold criteria are requirements that each alternative must meet to be eligible for selection as the preferred alternative, and include overall protection of human health and the environment and compliance with ARARs (unless a waiver is obtained).[30]

[30] Section 121(d)(4) of CERCLA identifies six circumstances under which ARARs may be waived. An ARARs waivers analysis is outside the scope of this FFS.

- Primary balancing criteria are used to weigh effectiveness and tradeoffs among alternatives. The primary balancing criteria include long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. The primary balancing criteria represent the main technical criteria upon which the evaluation of alternatives is based.

- Modifying criteria include State acceptance and community acceptance. These criteria are evaluated and applied by EPA as part of any decision process that may be undertaken by EPA after completion of the FFS. Accordingly, only the seven threshold and primary balancing criteria are applied in the detailed analysis phase of this section.

6.1 Description of Evaluation Criteria

Specific elements to be considered in the evaluation of the nine NCP criteria are discussed below.

6.1.1 Overall Protection of Human Health and the Environment

This criterion assesses how each alternative provides and maintains adequate protection of human health and the environment. Alternatives are assessed to determine whether they can adequately protect human health and the environment from unacceptable risks posed by contaminants present at the Site, in both the short and long term. This criterion is also used to evaluate how risks would be eliminated, reduced, or controlled through implementation of the remedial activities. Overall protection of human health and the environment draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

6.1.2 Compliance with ARARs

This evaluation criterion is used to evaluate whether each alternative would comply with federal and State ARARs, or, if not, whether invoking waivers to one or more specific ARARs is adequately justified. Other information, such as advisories, criteria or guidance, is considered during the ARARs analysis as “to be considered” elements (TBCs). The considerations evaluated during the analysis of the ARARs applicable to each alternative are presented below. Potential chemical-, location-, and action-specific ARARs for West Lake Landfill OU-1 are discussed in detail in Subsection 3.1.

Chemical-specific ARARs:

- Likelihood that the alternative will achieve compliance with chemical-specific ARARs within a reasonable period of time.
- If it appears that compliance with chemical-specific ARARs will not be achieved, then evaluation of whether a waiver is appropriate.

Location-specific ARARs:

- Determination of whether any location-specific ARARs apply to the alternative.
- Likelihood that the alternative will achieve compliance with the location-specific ARAR.
- Evaluation of whether a waiver is appropriate if the location-specific ARAR cannot be met.

Action-specific ARARs:

- Likelihood that the alternative will achieve compliance with action-specific ARARs.
- Evaluation of whether a waiver is appropriate if the action-specific ARAR cannot be met.

Other criteria and guidance:

- Likelihood that the alternative will achieve compliance with other criteria, such as risk-based criteria.

6.1.3 Long-Term Effectiveness and Permanence

Alternatives are to be assessed for the long-term effectiveness and permanence that they afford, along with the degree of certainty that the alternative will prove successful. The primary components of this criterion are the magnitude of residual risk remaining at the Site after remedial objectives have been met, and the adequacy and reliability of controls (such as containment systems or institutional controls) that may be required to manage that risk. The analysis of each alternative for long-term effectiveness and permanence is presented below.

<u>Magnitude of residual risks</u>:

- Identify remaining risks from treatment residuals and untreated contamination.
- Magnitude of the remaining risks.

The magnitude of residual risk at the completion of remedial activities is evaluated against numerical standards (e.g., cleanup levels or chemical-specific ARARs), or the volume or concentration of contaminants remaining. The characteristics of the residuals remaining are also evaluated, considering their volume, toxicity, mobility, and propensity to bioaccumulate.

Adequacy and reliability of controls:

This criterion requires evaluation of the adequacy and reliability of controls that are used to manage either treatment residuals or untreated materials that remain after attaining remediation goals. This evaluation includes an assessment of containment systems and institutional controls to assess the degree of confidence that they will adequately handle potential problems and provide sufficient protection. Factors to be considered are:

- Likelihood that the technologies will meet required process efficiencies or performance specifications.
- Type and degree of long-term management required.
- Long-term monitoring requirements.
- Operations, Maintenance and Monitoring (OM&M) functions that must be performed.
- Difficulties and uncertainties associated with long-term OM&M functions.
- Potential need to replace technical components of the remedial action.
- Magnitude of threats or risks should the remedial action need replacement.
- Degree of confidence that controls can adequately handle potential problems.
- Uncertainties associated with land disposal of residuals and untreated wastes.

At EPA's direction (EPA, 2015b), the evaluation of long-term effectiveness for the West Lake Landfill Superfund Site also includes evaluation of potential impacts to the alternatives if a tornado were to occur at the Site, the potential effects of climate change, and potential impacts if a subsurface reaction (SSR) were to occur within Area 1 or 2.

6.1.4 Reduction of Toxicity, Mobility or Volume through Treatment

This criterion addresses the anticipated performance of the treatment technologies employed by each alternative in permanently and significantly reducing toxicity, mobility, or volume of hazardous substances. The NCP expresses a preference for remedial actions in which treatment is used to reduce the principal threats at a site through destruction of toxic contaminants, irreversible reduction in contaminant mobility, or reduction of total volume of contaminated media. The considerations evaluated during the analysis of each alternative for reduction of toxicity, mobility, or volume of contaminants are presented below:

(1) Treatment process and remedy:

- Likelihood that the treatment processes address the principal threat, including the materials to be treated.
- Special requirements for the treatment processes.

(2) Amount of hazardous material destroyed or treated:

- Portion (mass) of constituents of potential concern (COPC) that is destroyed.
- Portion (mass) of COPC that is treated.

(3) Reduction in toxicity, mobility, or volume through treatment:

- Degree of expected reduction in the total mass, mobility, volume, or toxicity of contaminants (measured as a percentage of reduction or order of magnitude).

(4) Irreversibility of treatment:

- Degree to which the effects of the treatment are irreversible.

(5) Type and quantity of residuals remaining following treatment:

- Residuals that will remain.
- Quantities and characteristics of the residuals, including persistence, toxicity, mobility, and propensity to bioaccumulate.
- Risk posed by the treatment residuals.

(6) Statutory preference for treatment as a principal element:

- Extent to which treatment addresses the principal threats.
- Extent to which treatment reduces the inherent hazards posed by the principal threats at the site, including the extent to which toxicity, mobility, or volume are reduced either alone or in combination.

6.1.5 Short-Term Effectiveness

Short-term effectiveness considers the ability of each remedial alternative to protect human health and the environment during the construction and implementation phase. The short-term effectiveness evaluation addresses protection prior to meeting the RAOs. The considerations evaluated during the analysis are presented below.

(1) Protection of the community during any remedial action:

- Short-term risks that might be posed to the community during the implementation of an alternative.
- How these risks will be addressed and mitigated.
- Remaining risks, if any, that cannot be readily controlled.

(2) Protection of workers during remedial actions:

- Potential risks to the workers that must be addressed.
- How these risks will be addressed and mitigated and the effectiveness and reliability of measures to be taken.
- Remaining risks, if any, that cannot be readily controlled.

(3) Environmental impacts of any remedial action:

- Potential environmental impacts that are expected as a result of the construction and implementation of the alternative.
- Available mitigation measures, as well as their effectiveness and reliability in minimizing potential impacts.
- Impacts that cannot be avoided, should the alternative be implemented.

(4) Time until RAOs are achieved:

- Time to achieve protection against the threats being addressed.
- Time until any remaining threats are addressed.
- Time until RAOs are achieved.

At EPA's direction (EPA, 2015b), the evaluation of short-term impacts also includes an evaluation of environmental justice considerations.

6.1.6 Implementability

Implementability evaluates the technical and administrative feasibility (i.e., the ease or difficulty) of implementing each alternative, as well as the availability of required services and materials during remedy implementation. The following considerations are evaluated for implementability:

<u>Technical Feasibility</u>

(1) Ability to construct and operate the technology:

- Difficulties associated with the construction.
- Uncertainties associated with the construction.

(2) Reliability of the technology:

- Likelihood that technical problems will lead to schedule delays.

(3) Ease of undertaking additional remedial actions:

- Likely future remedial actions that may be anticipated.
- Difficulty implementing additional remedial actions.

(4) Monitoring considerations with respect to effectiveness of the remedy:

- Migration or exposure pathways that cannot be monitored adequately.
- Risks of exposure, should the monitoring be insufficient to detect failure.

Administrative Feasibility

Coordination with other agencies:

- Steps required to coordinate with regulatory agencies other than EPA to implement the remedy.
- Steps required to establish long-term or future coordination among agencies.
- Ease of obtaining permits for off-site activities, if required.

Availability of Services and Materials

(1) Availability of adequate treatment, storage capacity, and disposal services:

- Availability of adequate off-site treatment, storage capacity, and disposal services.
- Additional capacity that is necessary.
- Whether lack of capacity prevents implementation.
- Additional provisions required to ensure that additional capacity is available.

(2) Availability of necessary and adequate equipment and specialists:

- Availability of necessary equipment and specialists.
- Additional equipment or specialists required.
- Whether there is a lack of equipment or specialists that would prevent implementation.
- Additional provisions required to ensure that equipment and specialists are available.

(3) Availability of prospective technologies:

- Whether technologies under consideration are generally available and sufficiently demonstrated.
- Further field applications needed to demonstrate that the technologies may be used full-scale to treat contaminants.
- When the technology would be available for full-scale use.
- Whether more than one vendor would be available to provide a competitive bid.

6.1.7 Cost

In accordance with the NCP, as well as the "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (EPA, 1988a) and "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study" (EPA, 2000c), estimated capital costs, annual OM&M costs, periodic costs, and present worth costs have been prepared for the ROD-selected remedy, the "complete rad removal" alternative, and the partial excavation alternatives. As specified in the RI/FS guidance (EPA, 1988a), the estimated costs were developed to provide a level of accuracy of +50/-30 percent – that is, the actual costs may be up to 50% higher or 30% lower than the estimated costs.

6.1.7.1 Capital and Operation, Maintenance, and Monitoring Costs

Capital costs include (1) direct costs for labor, equipment, materials, subcontractors, contractor markups such as overhead and profit, and professional/technical services that are necessary to support construction of the remedial action; and (2) indirect capital costs that are not part of the actual construction but are necessary to implement the remedial action (e.g., engineering, legal, construction management, and other technical and professional services). Operation, maintenance, and monitoring (OM&M) costs include annual post-construction costs for labor, equipment, materials, subcontractors, and contractor markups such as overhead and profit associated with activities such as monitoring and maintaining the components of the remedial action. Annual OM&M costs also include expenditures for professional/technical services necessary to support OM&M activities. Periodic costs are those that might occur only once every few years (e.g., five-year reviews, cap/cover repair, and equipment replacement), or expenditures that would occur only once during the entire OM&M period or remedial timeframe (e.g., well abandonment, update of the Institutional Controls (ICs) Plan, and site closeout).

In preparing the cost estimates used in this FFS, quantities for labor, equipment, and materials were developed as discussed in Sections 2 and 5 of this report. Cost data were obtained from a variety of sources including cost estimating guides and references such as unit prices in the latest RS Means Heavy Construction and Sitework & Landscaping Cost Data, RS Means CostWorks First Quarter 2016 digital cost data, site-specific vendor and contractor quotes and discussions, experience with actual costs from similar projects, other historical project costs updated to 2016 costs using the Engineering News Record Construction Cost Index (ENR CCI), and engineering judgment.

As discussed in Section 4, only four disposal facilities (US Ecology's facility in Grandview, Idaho; US Ecology's facility in Wayne, Michigan; the Energy*Solutions* facility in Clive, Utah; and Clean Harbors' Deer Trail facility in Last Chance, Colorado), have been identified that could accept RIM from the West Lake Landfill for off-site disposal.

All of the disposal companies considered in Section 4 of the FFS have experience performing the type of services that would be necessary for implementation of a "complete rad removal" or partial excavation alternative. In particular, US Ecology's Idaho facility has experience relative to excavation, transport and off-site disposal of radiologically-impacted soils from the St. Louis Airport Site (SLAPS), which is geographically close to the West Lake Landfill. The other two disposal facilities have performed similar services for Formally Utilized Sites Remedial Action Program (FUSRAP) and DOE sites, as well as for remedial actions at other Superfund sites that contained radioactively-impacted materials.

Because these turnkey disposal firms performed removal, transportation and off-site disposal services for SLAPS and DOE FUSRAP sites, estimates of the expected costs for transport and disposal of the West Lake Landfill RIM are considered appropriate for preparation of FS-level cost estimates. Each of the identified contractors could provide all coordination involved with leasing a nearby rail spur, waste profiling and acceptance testing, loading and manifesting each truck that leaves the Site, and scheduling gondola car transportation with the respective railroads who own the track along the rail routes between the West Lake Landfill and the disposal facility location. Solely for purposes of preparing the cost estimates for the FFS, the unit costs for the complete "turnkey" services provided by US Ecology were used. For the "complete rad removal" and partial excavation alternatives, this FFS considered unit costs for complete ("turnkey") services for waste classification, transportation, and disposal provided by US Ecology for its Grandview, Idaho facility. Contacting trucking and rail companies to obtain independent estimates of the potential costs of transportation separate from the potential costs for disposal is beyond the scope and level of detail required to prepare FS-level cost estimates. Furthermore, it would be difficult to ascertain the degree of qualifications, capabilities and understanding such transportation firms might have regarding the licensing, permitting, applicable fees, manifesting, placarding, health and safety monitoring, and other aspects of interstate transportation of radioactive wastes. US Ecology provided unit costs for complete turnkey services for waste profiling and acceptance testing, waste transportation (including all related fees and taxes), and waste disposal services (including all related fees and taxes). The information provided by US Ecology is considered appropriate for an FS-level evaluation of potential alternatives. The possible cost impacts of using the Energy*Solutions* facility were previously evaluated as part of the sensitivity evaluation of the cost estimates performed for the SFS (EMSI et al., 2011) and it was determined that use of the Energy*Solutions* facility would result in significantly greater costs.

Estimates for professional/technical services cost elements (project management, RD, construction management, and technical support) were based on the example percentages provided in "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study" (EPA, 2000c) for construction of remedies greater than $10 million. These percentages of total construction cost are 5%, 6%, and 6%, respectively, for project management, remedial design (RD), and construction management. Costs for regulatory oversight were estimated at 5% of the capital costs (exclusive of off-site transportation and disposal costs and contingency costs), and 5% of the long-term OM&M costs.

The factors (*e.g.*, total number of acres to be regraded under the ROD-selected remedy, the volume of RIM to be excavated under the "complete rad removal" and partial excavation alternatives, the total length of fencing, etc.) and the assumptions (e.g., material densities and swell factors, volume of leachate encountered or stormwater generated during construction, excavation efficiency factors, etc.) used to prepare the cost estimates are presented in Appendix K-1.

6.1.7.2 Contingency Costs

A contingency was added as a percentage of the total capital, annual OM&M, and periodic costs to cover unknowns, unforeseen circumstances, or unanticipated conditions that are not possible to evaluate from the data on hand at the time the FS-level cost estimates were prepared. Contingency is composed of two elements: scope and bid.

Scope contingency covers unknown costs due to scope changes that may occur during RD and represents project risks associated with an incomplete design, because design concepts are not typically developed enough during preparation of an FS to identify all project components or quantities. This type of contingency represents costs unforeseeable at the time of the preparation of the FS, as well as conceptual design cost estimate preparation, both of which are likely to become better known as the RD phase progresses. For this reason, scope contingency is sometimes referred to as "design" contingency. In general, scope contingency should decrease as RD progresses and should be near 0% at the 100% design stage. At the early stages of RD (*e.g.*, during the FS stage, which represents 0% to 10% design completion), concepts are not typically developed enough to identify all project components or quantities. Higher scope contingency values may be justified for alternatives with greater levels of cost growth potential. A low percentage for scope contingency indicates an opinion that the project scope would undergo minimal change during design. A high percentage indicates an opinion that the project scope may change considerably between the FS and final design. In accordance with EPA guidance (EPA, 2000c), engineering judgment was used whenever selecting a scope contingency percentage, and the value used was clearly identified in the cost estimate.

For this FFS, scope contingency factors ranged from 10% to 55%, depending upon the degree of certainty or uncertainty associated with each alternative and the remedial technologies that comprise each alternative, and taking into consideration the ranges in FS-level scope contingency percentages listed in Exhibit 5-6 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study" (EPA, 2000c). Exhibit 5-6 of that guidance provides a range of scope contingencies to consider for various remedial technologies. As examples, the following ranges from Exhibit 5-6 were considered and selected for this FFS.

Remedial Technology	Scope Contingency Range from Exhibit 5-6 (%)	Selected Scope Contingency for SFS (%)
Soil excavation	15 – 55	55
Off-site disposal	5 – 15	15
Clay cap	5 - 10	10

The uppermost values for these remedial technologies were selected for use in this FFS due to the high level of uncertainty associated with the scope of each of the remedial alternatives. Factors contributing to the high level of uncertainty for the ROD-selected remedy and the "complete rad removal" and partial excavation alternatives include the following:

- The estimated volume of RIM to be removed under the "complete rad removal" and partial excavation alternatives. As presented in Appendix B of the FFS, the RI data and various interpolation techniques were used to estimate the volume of waste material that might need to be removed, and those estimated volumes then served as the basis for the cost estimates. Costs for excavation and off-site transportation and disposal are directly proportional to the estimated volume of RIM to be excavated, removed or disposed off-site. The data quality objectives (DQOs) for the RI were to develop site characterization data, not to estimate volumes of waste material for RD.

- The assumed unit weight of the existing in-place filled material in Areas 1 and 2 and the assumed waste volume expansion or "swell" factor for the filled material after excavation: Based on experience from other sites and engineering judgment, a unit weight of 1,500 pounds per cubic foot (lbs/cf) and a swell factor of 1.5 were used in this FFS. Swell factors reported for the CERCLA landfill excavation remedial action for OU-1 at the Mound (Miamisburg, OH) site varied from 1.2 to 1.6 (Lee, 2010), while a swell factor of 2 was experienced during excavation of the Tulalip Landfill CERCLA site near Marysville, WA (Richtel, 2010). Assuming a swell factor of 1.3 instead of the 1.5 used in this FFS would result in 13% less volume of RIM that would be disposed off-site under the "complete rad removal" or partial excavation alternatives, while a swell factor of 2.0 would result in 33% more RIM volume than the amount estimated using the 1.5 swell factor.

- The uncertain level of effort for radiation surveying and confirmatory laboratory sample turnaround time and analysis required to guide the excavation of RIM, and the effect of such uncertainties on excavation progress.

- The ability and level of effort required to excavate deeper occurrences of RIM in Area 1 and 2.

- The methods assumed to handle overburden materials so as to minimize "double handling" of the materials during excavation and subsequent replacement have not been fully developed or designed.

- The actual equipment production rates for regrading or excavation of the landfilled wastes in Areas 1 and 2 are uncertain at this time.

- It was not possible to estimate precise volumes of precipitation and resultant contact stormwater that might be generated when precipitation is exposed to waste during regrading activities under the ROD-selected remedy or to waste and RIM during excavation of overburden and to RIM from Areas 1 and 2 under the "complete rad removal" and partial excavation alternatives. Detailed design would be conducted during RD to address management of the types and quantities of stormwater that might be generated during construction of the selected remedy. For purposes of preparing cost estimates for the alternatives evaluated in this FFS, it is assumed that precipitation that contacts wastes and/or RIM during regrading, excavation, or waste re-placement and accumulates in the low point of an excavation or fill would be pumped to a series of storage tanks. Stormwater would be pumped from the tanks to a treatment building, subjected to filtration and liquid phase granular activated carbon (LPGAC) treatment processes, and discharged to the Metropolitan Sewer District (MSD) in accordance with MSD procedures and discharge limitations. Capital and OM&M costs for stormwater collection and on-site treatment are included for each of the alternatives assuming a maximum historical 24-hour rainfall over an anticipated maximum area of exposed waste at any one time of 4 acres, resulting in an estimated stormwater volume of 608,000 gallons. This value is based on an assumption that the majority of the work area would be covered with tarps or other means to reduce the amount of precipitation which comes into contact with the overburden, waste or RIM. Although the same storm event and exposed area were assumed for all of the alternatives, the estimated OM&M costs vary among the alternatives as a result of differences in the estimated construction schedules (*i.e.*, the estimated duration that areas being excavated might be exposed to precipitation) for each alternative.

- Uncertainties regarding the rates at which cover construction materials could be delivered from off-site sources.

- Uncertainties regarding the actual type of materials to be used for cover construction (*e.g.*, the use of "shot rock" from a nearby quarry was assumed for the materials for the biointrusion layer rather than more uniformly sized large rip-rap).

- For the "complete rad removal" and partial excavation alternatives, uncertainties exist regarding: (1) the methods and effectiveness of physically separating the radiological and non-radiological materials during excavation activities; (2) transport relative to the availability and location of a truck/rail transloading facility; (3) the amount of handling of material at a truck/rail transloading facility; (4) which off-site disposal facilities are able to accept the RIM at the time of removal and the capacities and waste acceptance criteria of such facilities at the time of remedy implementation[31]; (5) and the overall validity, duration, and reliability of the verbal quotes received from disposal facility representatives.

Bid contingency represents costs, unforeseeable at the time of estimate preparation, which are likely to become known as the remedial action construction or OM&M proceeds. Bid contingency accounts for changes that occur after a construction or OM&M contract is awarded and represents a reserve for quantity overruns, modifications, change orders, or claims during construction or OM&M. Examples include changes due to adverse weather, material or supply

[31] Although potential disposal facilities were contacted during preparation of the SFS and again during preparation of the FFS with regard to available capacity for municipal solid waste mixed with soil containing radionuclides and their specific Waste Acceptance Criteria (WAC), there is no way to ensure that these facilities would still have sufficient capacity for such material or that such materials would meet the WAC that may be in effect in the future when a remedy for OU-1 may be implemented.

shortages, or new regulations. A bid contingency of 20% was included for all of the alternatives in this FFS, in accordance with the range of bid contingency factors from "A Guide to Developing and Documenting Cost Estimates during the Feasibility Study" (EPA, 2000c).

6.1.7.3 Present Worth and Non-Discounted Constant Dollar Costs

A present worth analysis has been prepared to allow comparison of the estimated costs of each alternative on the basis of a single figure – i.e., a single dollar amount that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the remedial action over its planned life. In accordance with EPA's "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (EPA, 1988a), a 30-year period of performance was used in the development of the present worth analysis. The use of a 30-year period for the present worth analysis is not intended to imply or otherwise provide a basis to limit future site maintenance and monitoring activities to 30 years. The need for, and scope of, continued monitoring and maintenance both within and beyond 30 years would be subject to ongoing evaluation as part of the five-year review process for the Site. For some of the alternatives, radioactively-impacted materials would remain on-site and active beyond 30 years, and monitoring and maintenance activities would likely be required beyond the 30-year period used in the cost estimates. Therefore, for the alternatives in which radioactively-impacted materials would remain on-site, OM&M cost estimates and present worth estimates were prepared for 30-year, 200-year, and 1,000-year periods in accordance with the criteria set forth under the NCP and the UMTRCA regulations.

While the "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (EPA, 1988a) recommends the general use of a 30-year period of analysis for estimating present worth costs during a FS, more recent EPA guidance ("A Guide to Developing and Documenting Cost Estimates During the Feasibility Study" (EPA, 2000c) (FS Costing Guidance)), recommends that for projects with durations exceeding 30 years, the FS should prepare both a present worth analysis using the project duration and a non-discounted constant dollar cash flow over time scenario. In this FFS, both present worth and non-discounted constant dollar cash flow analyses have been developed for all of the alternatives. It should be noted that the 2000 guidance states that "non-discounted constant dollar costs are presented for comparison purposes only and should not be used in place of present value costs in the Superfund remedy selection process."

EPA policy on the use of discount rates for RI/FS present worth cost analyses is stated in the preamble to the NCP (55 Fed. Reg. 8722), in the Office of Solid Waste and Emergency Response (OSWER) Directive 9355.3-20 entitled "Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis" (EPA, 1993a). Based on the NCP and the OSWER directive, a discount rate of 7% should be used in developing present value cost estimates for remedial action alternatives during the FS (EPA, 2000c). According to the FS Costing Guidance: "This specified rate of 7% represents a 'real' discount rate in that it approximates the marginal pretax rate of return on an average investment in the private sector in recent years and has been adjusted to eliminate the effect of expected inflation." It should be noted that the “recent years” cited in EPA’s 2000 guidance appear to refer to pre-NCP timeframe, which would place this period in the 1970s, or, alternatively, prior to issuance of OSWER Directive 9355.3-20 in 1993. Although OMB Circular A-94 is updated on an annual basis, the 7% discount rate contained in the main portion of the circular is not updated on an annual basis (EPA, 2000c). The 7% discount rate has been in use since the initial Superfund legislation was passed in 1980 and likely does not reflect current pre-tax return on an average private sector investment. Regardless, the 7% discount rate has been used in the calculation of present worth costs for the remedial alternatives for purposes of this FFS.

The FS Costing Guidance states that there may be circumstances in which it would be appropriate to consider the use of a lower or higher discount rate than 7% for the FS present value analysis if an explanation for use of the different rate is provided. The U.S. Securities and Exchange Commission (SEC) has determined that the appropriate discount rate to be applied to an environmental remediation liability should be the rate that would produce an amount at which the environmental liability could be settled in an arms-length transaction with a third party (SEC Codification of Staff Accounting Bulletins Topic 5 Miscellaneous Accounting – Y. Accounting and Disclosures Relating to Loss Contingencies Question 1). The SEC further states that the discount rate used to discount cash payments should not exceed the interest rate on monetary assets that are essentially risk-free and have maturities comparable to that of the environmental liability (SEC Codification of Staff Accounting Bulletins Topic 5 Miscellaneous Accounting – Y. Accounting and Disclosures Relating to Loss Contingencies Question 1). Treasury bills are a primary investment tool that is essentially risk-free. According to the latest (February 12, 2016) Office of Management and Budget (OMB) Circular A-94 Appendix C 30-year, the Real Interest Rates on Treasury Notes and Bonds for a 30-year period is 1.5 percent. This rate has also been applied to the present worth analyses.

6.1.8 State Acceptance

This criterion involves technical and administrative concerns that the state may communicate in its comments concerning the alternatives addressed in an FS. State acceptance will initially be evaluated based on comments provided by MDNR on this FFS. A final evaluation of state acceptance will be performed by EPA as part of any decision process that may be undertaken by EPA after completion of the FFS.

6.1.9 Community Acceptance

Community acceptance will be evaluated by EPA as part of any decision process that may be undertaken by EPA after completion of the FFS.

6.2 Detailed Analysis of Alternatives

This section provides a detailed analysis of five potential alternative remedies for the Site: (1) No Action alternative; (2) the ROD-Selected Remedy (regrading and enhanced capping); (3) "complete rad removal"; (4) partial excavation of RIM with activity levels above 52.9 pCi/g located within 16 feet of the 2005 topographic surface; and (5) partial excavation of RIM with activity levels greater than 1,000 pCi/g.[32] Each of these alternatives is assessed against the nine NCP evaluation criteria described above.

6.2.1 No Action Alternative

This section presents the description and detailed analysis of the No Action alternative. Under the No Action alternative, no additional engineering measures[33] would be implemented to reduce potential exposures or control potential migration of COPCs from Areas 1 and 2 and no maintenance would be performed to ensure the integrity of the existing measures. Similarly, no additional institutional controls would be imposed beyond those already in place at the Site, and no additional fencing would be implemented to control land use, access, or potential future exposures to potential receptors at or near Areas 1 and 2. Because the existing institutional controls cannot be removed or modified without the approval of the land owner(s), EPA and MDNR, the existing institutional controls are assumed to remain in effect as part of the No Action alternative. The Site continues to be an active industrial facility to which access is controlled (including fencing and 24-hour security). It is anticipated that the industrial uses currently ongoing at the Site would continue into the future, and it is assumed that the existing fencing and access controls would remain in effect for the No Action alternative. It is also assumed that no monitoring would be conducted under the No Action alternative to identify or evaluate any potential changes that may occur to conditions at Areas 1 and 2 or to contaminant levels or occurrences. As RIM and other wastes would remain on-site, a five-year review would be performed by EPA as part of the implementation of the No Action alternative.

Because the No Action alternative does not include any active engineering measures, this alternative is not consistent with the NCP expectation that engineering controls, such as containment, should be used for waste that poses a relatively low long-term threat or where treatment is impracticable. The No Action alternative serves as the baseline for comparison of the effectiveness of the other alternatives and is therefore evaluated in this FFS, as required by the NCP, EPA's SOW for the RI Addendum and FFS (EPA, 2015b), and EPA's RI/FS guidance documents (EPA, 1988a and 1993b).

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[32] Initial evaluation of a risk-based criterion reflective of the industrial land use at the Site was previously performed (Auxier & Associates, 2016b) and resulted in a criterion of 1,000 pCi/g. Because this value was the same as the value selected by EPA for one of the partial excavation alternatives (EPA, 2015b), a separate alternative was not developed. EPA has indicated that it would like additional evaluations of the industrial risk-based level to be performed. If such evaluations result in identification of a value other than 1,000 pCi/g, an additional partial excavation alternative may be developed and evaluated in a subsequent draft of the FFS.

[33] Prior actions include installation of the non-combustible cover, fencing and signage on Areas 1 and 2.

6.2.1.1 Overall Protection of Human Health and the Environment

Based on the results of the BRA evaluations (Auxier, 2000 and 2016a), conditions associated with OU-1 do not currently pose an unacceptable risk to on-site workers or the off-site community, assuming the existing institutional controls are maintained, monitored and enforced. The BRA analyses indicated that the potential risks posed to a future groundskeeper[34] working in Areas 1 and 2 could be above the generally accepted risk range used by EPA. The BRA evaluations were dependent on the assumed frequency and duration that potential future on-site workers would be present in Areas 1 and 2 at some point in the future. Potential future risks to other on-site workers, off-site commercial building users, a hypothetical off-site farmer, and off-site residents and the general public were within EPA's accepted risk range. As the surface of Areas 1 and 2 is not currently covered by a landfill cover meeting the requirements of the MDNR solid waste regulations, infiltration into and erosion of these areas poses a potential risk to human health and the environment in the future.

The No Action alternative does not provide for monitoring and enforcement of institutional controls which are necessary to ensure overall protection. Additionally, this alternative does not provide for monitoring and maintenance of Areas 1 and 2, which would also be necessary to ensure overall protection. Lastly, this alternative does not address all the pathways identified by the RAOs. Therefore, the No Action alternative is not considered to be protective of human health and, absent appropriate response actions, the Site poses an unacceptable risk over the long term.

6.2.1.2 Compliance with ARARs

Chemical-specific ARARs that may potentially be applicable or relevant and appropriate to OU-1 are the UMTRCA radon emission and groundwater protection standards; the radon NESHAP; the NRC standards for protection against radiation; and the Missouri MCLs for radionuclides, VOCs, inorganic chemicals and other parameters (Table 3-1). The No Action alternative is expected to meet some but not all of these potential chemical-specific ARARs. Overall radon emissions for Areas 1 and 2 were measured and found to be well below the UMTRCA standard and radon NESHAP of 20 pCi/m^2s and the radon standard outside of the Area 1 and 2 disposal areas (see RI Addendum Section 7.1.1.1). Although individual groundwater wells have shown some isolated occurrences of chemical or radiological constituents (*e.g.*, radium) at levels slightly above the UMTRCA groundwater protection standards and the Missouri MCLs, many of these occurrences, including the highest radium activities found in groundwater beneath the Site, were reported in monitoring wells located upgradient of Areas 1 and 2. In addition, the USGS (2014) concluded that that there is not a strong spatial association of monitoring wells surrounding or downgradient of RIM areas with elevated radium concentrations, as might be expected if RIM areas were releasing substantial quantities of radium to the groundwater. EPA has indicated that additional evaluations of groundwater will be conducted in the future as part of the OU-3 RI/FS. Current air monitoring (Auxier and EMSI, 2015a, 2016b and 2016c) and health

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[34] The updated Baseline Risk Assessment (Auxier, 2016a) concluded that a future groundskeeper was the potential receptor with the reasonably-maximum exposure.

and safety monitoring performed during the Phase 1 and additional characterization investigations conducted in 2013, 2014 and 2015 indicate that the conditions in and around Areas 1 and 2 meet the NRC standards for protection against radiation. Although conditions associated with Areas 1 and 2 currently meet all of these chemical-specific ARARs, without installation and maintenance of additional engineering controls, continued compliance with these standards cannot be ensured.

The No Action alternative is expected to meet all of the location-specific ARARs identified in Section 3.1.2 of this FFS.

Because there are no active engineering measures or waste handling, treatment, or disposal activities associated with the No Action alternative, there are no action-specific ARARs for this alternative.

6.2.1.3 Long-Term Effectiveness and Permanence

All current and potential future risks would remain under the No Action alternative. Without monitoring and maintenance of Areas 1 and 2, the No Action alternative would not be effective in meeting the RAOs. As indicated above, future activities such as groundskeeping that may be performed in Areas 1 and 2 could result in potential risk levels to on-site workers above the generally accepted risk range used by EPA for CERCLA actions. Because the surfaces of Areas 1 and 2 do not currently meet the MDNR cover requirements for inactive solid waste landfills, infiltration into, and erosion off of, these areas poses an overall potential risk to human health and the environment in the future.

The existing institutional controls cannot be changed without the agreement of EPA and MDNR; however, by their nature, institutional controls are not considered to be permanent. The No Action alternative does not provide the same degree of long-term effectiveness as would be achieved by active engineered measures. The No Action alternative contains no provisions to stabilize or maintain the physical integrity of the disposal units in Areas 1 and 2, and there are no provisions to monitor and maintain existing institutional or access controls. Therefore, the No Action alternative may not be effective over the long-term at reducing risks to potential future receptors.

6.2.1.4 Reduction of Toxicity, Mobility, and Volume through Treatment

The No Action alternative does not include any treatment measures and therefore there would be no reduction in contaminant toxicity, mobility or volume through treatment associated with this alternative. Similarly, no treatment residuals would be generated by this alternative.

6.2.1.5 Short-Term Effectiveness

Because there are no active remediation measures included in the No Action alternative, it does not pose any unacceptable short-term risks or other adverse impacts. Because no remedial action would be taken under the No Action alternative, no short-term risks to the community or to workers from implementation of this action would occur. Similarly, no environmental impact from construction activities would occur.

The RAOs of (1) preventing direct contact with landfill contents and exposure to radiation; (2) minimizing infiltration and any resulting contaminant leaching to groundwater; (3) controlling surface water runoff and erosion and decreasing the potential for erosion and subsequent transport of RIM; and (4) controlling radon and landfill gas emissions from Areas 1 and 2 would not be met by the No Action alternative.

6.2.1.6 Implementability

Because no active or passive remedial technologies would be implemented under the No Action alternative, there are no technical implementability concerns or issues associated with the No Action alternative. There are no engineering or administrative impediments to implementation of the No Action alternative for Areas 1 and 2.

6.2.1.7 Costs

Because no active or passive engineering measures or monitoring would be performed, the only costs anticipated to be associated with the No Action alternative are costs associated with performance of five-year reviews. A periodic (every 5 years) cost of $35,000 is estimated to perform the activities that would be associated with a five-year review. The estimated present worth costs under the 7% discount rate scenario for performance of five-year reviews over periods of 30 years, 200 years and 1,000 years are estimated to be $82,000, $94,000 and $94,000, respectively. Under the 1.5% discount rate scenario, the 30-, 200-, and 1,000-year present worth costs are estimated to be $165,000, $437,000, and $456,000, respectively. Present worth calculations for the No Action alternative are provided in Appendix K-2.

6.2.2 Regrading and Enhanced Capping (ROD-Selected Remedy)

As discussed in Section 5.3, the ROD-selected remedy consists of the following components:

- Installation of a landfill cover meeting the Missouri closure and post-closure care requirements for sanitary landfills, including enhancements consistent with the standards for uranium mill tailing sites (*i.e.*, armoring layer and radon barrier), and inclusion of flood protection measures along the toe of Area 2.

- Survey and identification of the presence and extent of radiologically-impacted soil on the Buffer Zone and Crossroads Property.

- Excavation of any soil containing radionuclides above levels that would allow for unrestricted use from the Buffer Zone and/or Crossroads Property and consolidation of the excavated soil within Areas 1 or 2.

- Application of groundwater monitoring and protection standards consistent with requirements for uranium mill tailing sites and sanitary landfills.

- Design, installation and maintenance of surface water runoff controls.

- Gas monitoring and control, including radon and decomposition gas as necessary.

- Institutional controls to prevent land and resource uses that are inconsistent with a closed sanitary landfill site containing long-lived radionuclides.

- Long-term surveillance and maintenance of the remedy.

The ROD-selected remedy consists of regrading (cutting and filling) the existing landfill materials along with placement of additional soil or clean fill material (as defined in the Missouri solid waste regulations [10 CSR 80-2.010(11)]) over Areas 1 and 2 to adjust the final grades to achieve minimum slope angles of 2% and maximum angles of 25%. Portions of the landfill berm that contain slopes greater than 25% would be regraded through construction of a perimeter "starter" berm, regrading the existing landfill materials, and/or placing additional material to reduce the slope angles to 25% or less. The method used to regrade the perimeter portions of Areas 1 and 2 would be subject to physical constraints associated with the location of the toe of the landfill relative to the property boundary or adjacent Site features (*e.g.*, the solid waste transfer station access road).

Upon completion of the landfill regrading, a new RCRA Subtitle D-equivalent landfill cover would be constructed over Areas 1 and 2 consistent with the MDNR final cover requirements for operating sanitary landfills without composite liners. The final cover system would encompass approximately 24 acres for Area 1 and 51 acres for Area 2. Although not required for a Subtitle D cover, a layer of well-graded rock or concrete/asphaltic-concrete rubble would be installed immediately beneath the clay layer to minimize the potential for bio-intrusion and erosion, increase the longevity of the landfill cover, and enhance the radon attenuation capability of the cover system. Surface drainage diversions, controls and structures would also be designed and constructed on the surface of or adjacent to the landfill cover as necessary to route non-impacted, uncontaminated stormwater (stormwater that has not contacted the underlying waste materials) off of Areas 1 and 2 onto the adjacent areas of the Site or into off-site storm water drainage systems.

The cover system under the ROD-selected remedy would consist of the following layers (from top to bottom):

- A one-foot-thick layer of soil capable of sustaining vegetative growth;

- A two-foot-thick infiltration layer of compacted, low-permeability clay soil with a permeability coefficient of 1 x 10^{-5} cm/sec or less; and

- A two-foot-thick bio-intrusion/erosion protection layer consisting of well-graded rock or concrete/asphaltic concrete rubble consisting of pieces up to 8 inches in size.

A geosynthetic clay liner (GCL) could be added to or used as a replacement for the two-foot-thick compacted clay layer (CCL). Because installation of a GCL would require placement of a bedding layer and an overlying protective or drainage layer, it has been assumed for purposes of the FFS that the thickness of the infiltration layer would be two feet with or without inclusion of a GCL.

Sampling would be performed to evaluate the presence and extent of radiologically-impacted soil that may still be present on the Buffer Zone/Crossroads Property. To the extent that soil containing radionuclides at levels greater than those which would allow for unrestricted use are present on these areas, this soil would be removed and placed into Area 1 or 2. Based on sampling performed during the RI prior to subsequent regrading and placement of gravel cover by the adjacent property occupant in these areas, it was estimated that radionuclides may be present on approximately 1.78 acres to a depth of one foot, resulting in approximately 2,900 bank cubic yards (bcy) of potentially impacted soil.

The existing institutional controls on Areas 1 and 2 and the Buffer Zone would be maintained, and any modifications or additions to these that EPA determines are necessary would be implemented as needed as part of the ROD-selected remedy. The institutional controls are necessary to ensure that residential uses do not occur at the Site, and that commercial and industrial uses or ancillary uses that could result in unacceptable risks do not occur on Areas 1 and 2 or the Buffer Zone. In addition to prohibiting land uses that could result in potential exposure to waste materials or contaminants in the Site, institutional controls would also limit or prohibit land uses or activities that could disrupt the integrity, performance or longevity of the new landfill cover or other components of the remedy. Landfill gas and groundwater monitoring, as described in Sections 5.3.1.6 and 5.3.1.9, respectively, are also included as part of the ROD-selected remedy. Finally, the ROD-selected remedy calls for long-term inspections and maintenance activities of the engineered components (Section 5.3.1.9) and enforcement of the institutional controls (Section 5.3.2.1).

6.2.2.1 Overall Protection of Human Health and the Environment

The ROD-selected remedy would protect human health and the environment through the use of engineered containment, long-term surveillance and maintenance, and institutional controls on land and resource use. The landfill cover would reduce potential risks from exposure to external gamma radiation or radon gas emissions, and eliminate potential risks associated with inhalation or ingestion of contaminated soils or other wastes, dermal contact with contaminated soils or other wastes, and wind dispersal of fugitive dust.

The cover would prevent users of the Site from exposure to external gamma radiation, primarily through shielding and increasing the distance to the radiation source (*i.e.*, the cover materials would be of sufficient thickness and design to attenuate gamma radiation). For the types of clay soils used for infiltration protection in the construction of final covers, the depth of cover required for gamma radiation shielding is on the order of two feet (60 cm). The total thickness of the final cover required by the ROD-selected remedy would be a minimum of five feet (two feet of biointrusion rock/rubble, two feet of clay soil, and one foot of vegetative soil).

The cover materials would also be of sufficient thickness and design to retard or divert the vertical upward migration of radon. The landfill cover would act as a diffusion barrier, allowing time for the decay of the relatively short-lived radon-222 gas (the half-life for radon-222 is 3.8 days) during migration through the pore spaces of the cover soil. Radon needs only to be detained in the cover materials for a few days in order to decay to its non-radiological progeny, thereby eliminating any significant radon emissions. The radon may also be intentionally vented or diverted to a gas control system. Calculations presented in Appendix F indicate that a clay layer thickness of two feet, combined with a two-foot thick rock/rubble layer and a one-foot thick vegetative layer, would provide sufficient radon attenuation to meet the radon emissions ARAR of 20 picocuries per square meter per second (pCi/m^2s). As discussed in Appendix F, these calculations were based on the increased levels of radium expected to be present at the Site after 1,000 years of in-growth of radium from decay of thorium.

The potential for direct contact with waste materials would be eliminated by placing a barrier (multi-layer landfill cover including bio-intrusion layer) between the waste materials and any potential receptors. Likewise, there would be no potential for the generation of fugitive dust from the waste material as long as the barrier remains in place.

The multi-layer cover would also be designed to minimize infiltration of surface water through the wastes, thereby reducing the potential for leaching of contaminants to the groundwater. This is typically accomplished by promoting surface drainage and using a hydraulic barrier (e.g., a compacted clay layer meeting the specified permeability requirements). These are all conventional functions for landfill cover technologies and are widely used by government and industry to address similar circumstances where contaminated materials must be encapsulated to protect against future potential contact. Long-term maintenance of the cover and monitoring of the groundwater would ensure that the ROD-selected remedy functions as intended.

The ROD-selected remedy also requires monitoring of groundwater quality to ensure that groundwater quality at the perimeter of the Site meets state standards or other ARARs.[35] Monitoring of subsurface occurrences of landfill gas and radon and, if necessary, implementation of contingent landfill gas extraction along the perimeter of Areas 1 and 2 would be performed to ensure that gas migration above regulatory thresholds does not occur beyond the Site perimeter.

Institutional controls (as described above) would ensure that land and resource uses are consistent with permanent waste disposal. The use restrictions reflect the presence of radionuclides at the Site.

6.2.2.2 Compliance with ARARs

The ROD-selected remedy would comply with all ARARs, as explained below.

6.2.2.2.1 Missouri Solid Waste Rules for Sanitary Landfills

Under RCRA Subtitle D, a state may promulgate more stringent regulations for landfills, provided that EPA approves them. Missouri is an approved state for regulating landfills. Missouri's solid waste regulations became effective July 1, 1997 (see 22 Mo. Reg. 1008, June 2, 1997) (the Solid Waste Rules). The Solid Waste Rules establish closure and post-closure requirements for existing sanitary landfills that are closed after October 9, 1991. Although not applicable to the closure of Areas 1 and 2, the Missouri Solid Waste Rules described below are considered relevant and appropriate. The ROD-selected remedy meets these ARARs.

The Solid Waste Rules require cover to be applied to minimize fire hazards, precipitation infiltration, and odors and blowing litter, as well as to control gas venting and vectors, discourage scavenging, and provide a pleasing appearance (10 CSR 80-3.010(17)(A)). Final cover is to consist of at least two feet of compacted clay with a coefficient of permeability of 1×10^{-5} cm/sec or less, overlaid by at least one foot of soil capable of sustaining vegetative growth (10 CSR 80-3.010(17)(C)(4)). Placement of soil cover addresses the requirements for minimization of fire hazards, odors, blowing litter, control of gas venting, and scavenging. Placement of clay meeting the permeability requirement addresses the requirement for minimizing precipitation infiltration. Placement of soil and establishment of a vegetative cover meet the requirement of providing a pleasing appearance. The final cover would prevent Site users from coming into contact with the waste material.

The Solid Waste Rules also contain minimum and maximum slope requirements. Specifically, these regulations require the final slope of the top of the sanitary landfill to have a minimum slope of 5% (10 CSR 80-3.010(17)(B)(7)). MDNR regulations also require that the maximum slopes be less than 25%, unless it has been demonstrated in a detailed slope stability analysis that steeper slopes can be constructed and maintained throughout the entire operational life and post-

[35] After issuance of the ROD in 2008, EPA announced its intention to address groundwater at the Site as part of an entirely separate operable unit (OU-3).

closure period of the landfill. Even with such a demonstration, no active, intermediate, or final slope may exceed 33.33%.

The objective of these requirements is to promote maximum runoff without excessive erosion and to account for potential differential settlement. Because landfilling of Areas 1 and 2 was completed approximately 30 years ago, most compaction of the refuse has taken place and differential settlement is no longer a significant concern. The 5% minimum sloping requirement is greater than necessary and may not be optimal in this case. Therefore, the 5% minimum sloping requirement is not considered appropriate. Sloping specifications would be designed to promote drainage and reduce infiltration of precipitation while minimizing the potential for erosion. It is anticipated that a 2% slope would be sufficient to meet drainage requirements while resulting in a lower potential for erosion. This approach should increase the life of the cover and overall longevity of the remedy compared to a steeper slope, which would be subject to increased erosion potential. The maximum sloping requirements would be met.

The requirements for decomposition gas monitoring and control in 10 CSR 80-3.010(14) are considered relevant and appropriate (Section 3.1.3.2) and would be met. The number and locations of gas monitoring points and the frequency of measurement would be established in RD submittals to be approved by EPA and MDNR. In the event landfill gas is detected at the Site boundaries above the regulatory thresholds, appropriate gas controls would be implemented.

The requirements for a groundwater monitoring program in 10 CSR 80-3.010(11) are considered relevant and appropriate (Section 3.1.3.2.1). The monitoring program must be capable of monitoring any potential impact of the Site on underlying groundwater. The monitoring program would enable the regulatory agencies to evaluate the need for any additional requirements.

The substantive MDNR landfill requirements for post-closure care and corrective action found in 10 CSR 80-2.030 are also considered relevant and appropriate. These provisions provide a useful framework for OM&M and corrective action plans. They require post-closure plans describing the necessary maintenance and monitoring activities and schedules. These requirements would be used in addition to EPA CERCLA policy and guidance on developing robust OM&M and long-term monitoring plans.

6.2.2.2.2 Environmental Protection Standards for Uranium and Thorium Mill Tailings

The Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40 CFR 192 Subpart B) provide standards for land and buildings contaminated with residual radioactive materials from inactive uranium processing sites. The standards were developed pursuant to the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA) (42 U.S.C. § 2022 et. seq.,). Although not applicable, some of the regulations that provide for closure performance standards are considered potentially relevant and appropriate to the ROD-selected remedy for OU-1. Specifically, to address longevity considerations, 40 CFR § 192.02(d) requires that each disposal site "be designed and stabilized in a manner that minimizes the need for future maintenance." For UMTRCA tailings piles, the longevity consideration has often been addressed through placement of a rock armoring layer over the upper surface of the tailings pile capping system. To address longevity considerations for OU-1 and long-term hazards relating to disruption of the disposal site by natural phenomena, the ROD-selected remedy would use a hybridized cover system which incorporates a rock or concrete rubble layer under the clay soil layer to restrict biointrusion and erosion into the underlying landfilled materials.

Three chemical-specific standards of the UMTRCA regulations are considered potentially relevant and appropriate (although not applicable) to OU-1. In particular, the radon emission and groundwater protection standards for closed uranium tailing units are considered to be potentially relevant and appropriate standards for Areas 1 and 2. The unrestricted use standards for soil on vicinity properties are considered to be potentially relevant and appropriate for the evaluation and remediation of any remaining radionuclide occurrences on the Buffer Zone or Crossroads Property. The applicability of these chemical-specific standards to the ROD-selected remedy is discussed further below.

First, Subpart A of the UMTRCA standards provides that control of residual radioactive materials (defined to mean waste in the form of tailings resulting from the processing of ores for the extraction of uranium and other valuable constituents) and their listed constituents shall be designed to provide reasonable assurance that the release of radon-222 from residual radioactive materials to the atmosphere will not exceed an average release rate of 20 pCi/m^2s (40 CFR §192.02 (b)(1)). For inactive sites, this standard can be satisfied by providing reasonable assurance that releases of radon-222 from residual radioactive materials to the atmosphere will not increase the annual average concentration of radon-222 in air at or above any location outside the disposal site by more than one-half of a picocurie per liter (0.5 pCi/L) (40 CFR § 192.02(b)(2)). As discussed in Section 7.1.1.1 of the RI Addendum (EMSI, 2016b), radon flux measurements performed in 2016 demonstrate that Areas 1 and 2 currently meet this standard. The ROD-selected remedy would ensure that the radon emission standard promulgated under UMTRCA continues to be met in the future through placement of clean fill material and construction of the landfill cover. The landfill cover system would be designed appropriately to take into consideration future radon generation resulting from increased radium levels owing to the decay of thorium over time. Evaluations presented in Appendix F indicate that the landfill cover included in the ROD-selected remedy would provide sufficient radon attenuation to ensure such that future surface emissions from Areas 1 and 2 would meet the UMTRCA radon standard.

Second, the UMTRCA regulations establish concentration limits for groundwater protection (see discussion in Section 3.1.1.4). Based on the presence of radioactive materials in OU-1, the groundwater protection standards (40 CFR § 192.02(c)(3) and (4)) and monitoring requirements (40 CFR § 192.03) are relevant and appropriate and would be met. Specifically, regrading of the landfill surface to promote stormwater drainage and installation of an engineered landfill cover under the ROD-selected remedy would greatly reduce the potential for infiltration through, and generation of leachate within, the landfill mass in Areas 1 and 2, thereby preventing infiltration of radionuclides to groundwater.

Third, the standards for cleanup of land and buildings contaminated with residual radioactive materials in Subpart B of the UMTRCA regulations are potentially relevant and appropriate requirements for the remediation of any radiologically-impacted soil that may be present outside of Areas 1 and 2 (*e.g.*, on the Buffer Zone/Crossroads Property). UMTRCA defines "land" to mean any surface or subsurface land that is not part of a disposal site and is not covered by an occupiable building. These soil standards address the remediation of soil contaminated with radium. Specifically, 40 CFR § 192.12(a) states:

> The concentration of Ra-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than:
>
> 1. 5 pCi/g, averaged over the first 15 centimeters of soil below the surface; and
>
> 2. 15 pCi/g, averaged over 15-centimeter-thick layers of soil more than 15 centimeters below the surface.

The EPA has promulgated guidance on the use of these UMTRCA soil standards for CERCLA site cleanups ("Use of Soil Cleanup Criteria in 40 CFR Part 192 as Remediation Goals for CERCLA Sites," OSWER Directive 9200.4-25, February 12, 1998 (the UMTRCA Guidance)). This guidance document was discussed in detail in Section 3.1.1.3 of this FFS. In brief, the UMTRCA Guidance states that the subsurface concentration criterion (15 pCi/g) is not a health-based standard; rather, it was developed for use in limited circumstances that, for most CERCLA sites, are not considered sufficiently similar to UMTRCA sites to warrant use of the 15 pCi/g standard for subsurface soil (EPA, 1998). EPA also determined that although the UMTRCA soil standards were developed for Ra-226, they are also suitable for Ra-228. EPA further determined that the soil standards should be applied to both the combined level of Ra-226 and Ra-228 and the combined level of Th-230 and Th-232. These UMTRCA soil cleanup standards for vicinity properties, as modified by the UMTRCA Guidance, are considered potentially relevant and appropriate criteria for evaluation and cleanup of radionuclides in soil on the Buffer Zone and Crossroads Property. The ROD-selected remedy would satisfy the UMTRCA soil standards through further investigation of radionuclide occurrences in soil outside of Areas 1 and 2 and removal of soil that exceeds these standards, including removal of soil on the Buffer Zone and the adjacent Crossroads Property and consolidation of such soil in Areas 1 and 2.

6.2.2.2.3 National Emissions Standards for Hazardous Air Pollutants (NESHAPs)

EPA's National Emissions Standards for Hazardous Air Pollutants (NESHAPs) include standards for radon-222 emissions to ambient air from designated uranium mill tailings piles that are no longer operational. As discussed in Section 3, the radon-222 NESHAP is considered to be potentially relevant and appropriate. As discussed in Section 7.1.1.1 of the RI Addendum (EMSI, 2016b), radon flux measurements performed in 2016 demonstrate that Areas 1 and 2 currently meet the NESHAP radon standard. The ROD-selected remedy would ensure the radon emission standard continues to be met, through placement of clean fill material and construction of the landfill cover. Evaluations presented in Appendix F indicate that the landfill cover system included as part of the ROD-selected remedy would provide sufficient radon attenuation to ensure that the radon NESHAP standard is met in the future, accounting for future radon generation resulting from increased radium levels owing to the decay of thorium over time.

Additional evaluations to demonstrate the ability of the landfill cover to meet the radon NESHAP may be performed as part of the remedial design.

6.2.2.2.4 Safe Drinking Water Act

40 CFR Part 141 establishes primary drinking water regulations, including maximum contaminant levels (MCLs) pursuant to Section 1412 of the Public Health Service Act, as amended by the Safe Drinking Water Act (SDWA), and related regulations applicable to public water systems. These MCLs apply to public drinking water systems. Missouri regulations (10 CSR 60-4.010 et seq.) also establish MCLs for public drinking water systems (Table 3-1). Consistent with the NCP, MCLs and non-zero Maximum Contaminant Level Goals (MCLGs) are considered potentially relevant and appropriate to all potentially usable groundwater. Regardless of whether groundwater beneath the Site is subsequently determined to be usable for drinking water, regrading of the landfill surface to promote stormwater drainage and installation of an engineered landfill cover under the ROD-selected remedy would greatly reduce the potential for infiltration through, and generation of leachate within, the landfill mass in Areas 1 and 2, thereby preventing infiltration of radionuclides to groundwater.

6.2.2.2.5 NRC Standards for Protection Against Radiation

The NRC Standards for Protection Against Radiation (10 CFR Part 20) contain chemical-specific standards that address radiation protection. These regulations establish dose limits for individual members of the public and for radiation workers and define maximum permissible exposure limits for specific radionuclides in air at levels above background inside and outside of controlled areas. These requirements are considered potentially applicable during implementation of any remedial action. Specifically, to meet these regulations, perimeter air monitoring would be conducted during remedy implementation. Site health and safety plans would address worker protection consistent with these requirements (including perimeter air monitoring); therefore, the ROD-selected remedy would meet this ARAR.

6.2.2.2.6 Missouri Well Construction Code

MDNR has promulgated regulations pertaining to the location and construction of water wells. The Well Construction Code (10 CSR 23-3.010) prohibits the placement of a well within 300 feet of a landfill. These rules should provide protection against the placement of wells on or near the Site. The regulations on monitoring well construction (10 CSR 23-4) would apply to the construction of new or replacement monitoring wells. The ROD-selected remedy would meet this ARAR through enforcement of the existing institutional controls[36] and by adhering to the Well Construction Code requirements for installation of new monitoring wells or abandonment of existing monitoring wells.

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[36] In addition, the deed restrictions currently in place on Areas 1 and 2 and the Buffer Zone (and which are to be maintained in perpetuity as part of the ROD-selected remedy) prohibit the placement of water wells for drinking water or agricultural purposes.

6.2.2.2.7 Missouri Storm Water Regulations

The Missouri regulations governing storm water management at construction sites are set out in 10 CSR 20-6.200 (Table 3-3). A disturbance of greater than one acre or the creation of a storm water point source during construction of the remedy would trigger these requirements. The ROD-selected remedy would meet these requirements through implementation of a Stormwater Pollution Prevention Plan (SWPPP), use of Best Management Practices (BMPs) during construction, installation and maintenance of an engineered landfill cover to prevent stormwater from contacting the waste materials, and construction and maintenance of stormwater diversion and control structures to control runon and runoff and reduced erosion potential as part of the design of the engineered landfill cover.

6.2.2.3 Long-Term Effectiveness and Permanence

These criteria refer to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time. The ROD-selected remedy provides engineered containment in conjunction with long-term monitoring, maintenance, and land use controls designed to be effective over the long term. Because RIM would remain on-site under this remedy alternative, potential risks associated with the RIM would remain. Construction of an engineered cover for Areas 1 and 2 would reduce the potential for exposure from the following potential pathways: external gamma exposure; inhalation of radon gas or dust containing radionuclides or other constituents; dermal contact with impacted materials; and incidental ingestion of soil containing radionuclides or other chemicals. Maintaining the integrity of the engineered cover would protect the underlying RIM from erosion and intrusion. An intact cover provides a reliable method to control exposure of the RIM to surface receptors and mitigates potential migration of radionuclides or chemicals from the covered waste materials.

Long-term site management plans and institutional controls would be robust and durable. Long-term groundwater monitoring (as required under the ROD-selected remedy) would be effective in verifying the remedy is performing as required and groundwater is protected. While not anticipated, even with the loss of institutional controls and long-term management, the landfill cover would still act to passively prevent potential contaminant migration and human exposures for an indefinite period.

By moving the radiologically-impacted soil from the Buffer Zone/Crossroads Property to the Site (and thereby subjecting it to the remedial measures and controls described above), the ROD-selected remedy provides long-term effectiveness and permanence relative to the Buffer Zone/Crossroads Property.

6.2.2.3.1 Magnitude of Residual Risks

The calculated lifetime risks to the reasonably maximally-exposed individual (an on-site groundskeeper) from Areas 1 and 2 after the ROD-selected remedy has been implemented (Appendix H) are as follows:

- Area 1: <1 x 10^{-7} for year 1 and <1 x 10^{-7} for year 1,000; and
- Area 2: <1 x 10^{-7} for year 1 and <1 x 10^{-6} for year 1,000.

These calculated risks are attributable to gamma radiation and radon emissions from the RIM that would remain at the Site after implementation of the ROD-selected containment remedy. Given that the RIM would be capped and thus rendered inaccessible, along with the use of access restrictions and institutional controls, direct contact with RIM and exposure from ingestion, inhalation, or dermal contact with the waste materials would not be expected to occur. Ingestion, inhalation or dermal contact are the primary exposure pathways for any non-radiological COPCs that may also be present in Areas 1 and 2. Because no complete exposure pathway would exist for such materials after completion of the cap construction, the landfill waste materials would not be expected to produce non-carcinogenic effects or carcinogenic risks from non-radiological COPCs.

The calculated risk levels are below EPA's target risk range of 1 x 10^{-6} to 1 x 10^{-4}, and therefore the magnitude of the radiological carcinogenic risk from capped RIM in these two remediated areas is acceptable. These risks do not specifically include potential exposures from non-radiological landfill waste after construction is complete; however, those wastes would also be covered by a cap which would prevent exposures. Additional information regarding the risk assessment calculations is presented in Appendix H.

After soils containing radionuclide concentrations above the cleanup levels are removed from the Buffer Zone/Crossroads Property, residual risks posed by the remaining radionuclide-impacted soil on these properties, if any, should be indistinguishable from variations in background levels.

6.2.2.3.2 Adequacy and Reliability of Controls

The conceptual design of the engineered cover has been developed to provide protection against all potential exposure pathways. Cover construction is based on and relies upon the use of natural materials that would be expected to remain in place and meet performance criteria for at least 200 years, as required by the UMTRCA ARARs. Post-closure inspection and maintenance of the cover, as required by the solid waste regulation ARARs and as routinely performed at thousands of landfills across the country, also would ensure long-term reliability of the landfill cover.

Currently the surfaces of Areas 1 and 2 are not graded to promote drainage of stormwater, but instead are generally flat with several surface depressions which act to increase precipitation accumulation and infiltration through the waste mass. In addition, no engineered landfill cover exists over these areas. Although the non-combustible cover installed over portions of Areas 1 and 2 in 2016 does reduce the potential for erosion of the waste and soil, reduce radon emissions and gamma radiation, and prevent direct contact with the waste and RIM, it does not promote stormwater drainage or reduce the potential for infiltration of precipitation. Even with these limitations, infiltration of precipitation has not resulted in discernible leaching of radionuclides or other chemicals to groundwater. Regrading to promote drainage and installation of the engineered landfill cover included in the ROD-selected remedy would significantly reduce infiltration of precipitation and potential for leaching, providing further protection against potential impacts to groundwater. Modeling of potential landfill covers conducted as part of the Fate and Transport Evaluations (SSPA, 2016b) indicated that inclusion of a GCL would further reduce the potential for infiltration and therefore provide a greater degree of protection against precipitation infiltration and leaching to groundwater. Although a GCL includes synthetic components which may degrade over time, studies of the projected life of geomembranes exposed to air, water and leachate have indicated that the service life of a geomembrane is on the order of hundreds of years, may exceed 700 years, and would probably be on the order of 1,000 years or longer (Marr and Christopher, 2003; Kavazanjian et al., 2006; National Research Council, 2007; Rowe, Rimal, and Sangam, 2009; Rowe and Rimal, 2008; Rowe and Islam, 2009; Rowe and Jones, 2015; and Benson, 2016). The service life of a GCL is influenced by a variety of factors (Rowe and Jones, 2015), including:

1. Loss of bentonite during placement;
2. Lateral movement;
3. Assumption that the geosynthetic component of the GCL is not critical to long-term performance of the bentonite component;
4. Proper installation performance of the seams;
5. No significant long-term loss of bentonite due to internal erosion through the GCL under hydraulic gradients that may occur;
6. Interaction (e.g., cation exchange) with the adjacent soil impact on hydraulic conductivity.

Temperature is an additional factor affecting the service life of a GCL (Stark, Jafari and Rowe, 2012). Inclusion of a GCL in the engineered cover could also create a potential slip surface that could result in a failure (movement or displacement of portions of the cover material) on steeper slopes. This potential could be addressed by limiting use of a GCL to the upper, flatter (2%) slopes of the final grades of Areas 1 and 2 or potentially through inclusion of a drainage layer above the GCL; however, this approach would need to be evaluated during remedial design.

Long-term OM&M would include routine cover and storm water ditch inspection and service, if necessary, to mitigate erosion and, if a landfill gas collection and treatment system is needed, OM&M of such a system. Long-term monitoring would also be implemented to assess compliance with groundwater standards. The performance of these engineering controls would also be re-evaluated during statutory five-year reviews.

Covenant restrictions (Appendix A) have been recorded by each of the West Lake Landfill property owners against their respective parcels and the entire West Lake Landfill (including

Areas 1 and 2) prohibiting residential use (including use as a day care, preschool, or other educational use) and use of groundwater for drinking water. With respect to the parcels of land that comprise OU-1 (including the Buffer Zone), restated and amended restrictive covenants filed in 2016 (Appendix A) also prohibit (1) the installation and use of wells for drinking water; (2) the construction of buildings or other habitable structures for any purpose; (3) the construction of underground pipes/utilities and excavation work (except in conjunction with approved remedial activities); and (4) use of the property for commercial or industrial purposes, including as a storage yard (whether indoor or outdoor).[37] Covenant restrictions cannot be terminated without the written approval of the parcel owners, MDNR, and EPA.

The current covenants and restrictions for Areas 1 and 2 and the Buffer Zone would be adequate to provide protection to human health under the ROD-selected remedy. Permanence of these restrictions is assumed to be adequate for the foreseeable future, as both EPA and MDNR approval are required to remove or modify the restrictions. The adequacy of the restrictions would be continually evaluated during the statutorily-required five-year reviews.

6.2.2.3.3 Climate Change and Potential Impacts of a Tornado

Per EPA's SOW, the FFS is to include a discussion of climate change and vulnerabilities associated with extreme weather events – such as possible flooding or tornadoes – as part of the evaluation of long-term effectiveness. This evaluation should consider any system vulnerabilities to potential climate change in accordance with EPA's "Climate Change Adaptation Technical Fact Sheet: Landfills and Containment as an Element of Site Remediation (EPA, 2014a) and the EPA Region 7 Climate Change Adaption Implementation Plan (EPA, 2014b). EPA also required the FFS to include information and results from the "Evaluation of Possible Effects of a Tornado on the Integrity of the ROD-Selected Remedy" (EMSI, 2013f).

The ROD-selected remedy includes an engineered landfill cover that would be classified as in-situ containment system (EPA, 2014a). Climate change adaptation for a containment system focuses on evaluating the vulnerability of the system to climate change and implementing adaptation measures, when warranted, to ensure the remedy continues to prevent human or environmental exposure to contaminants of concern (EPA, 2014a).

Evaluation of the vulnerability of a containment system to climate change may involve:

- Identifying climate change hazards of concern;
- Characterizing the system's exposure to those hazards of concern;
- Characterizing the system's sensitivity to the hazards of concern; and
- Considering factors that may exacerbate system exposure and sensitivity.

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[37] Construction work and commercial and industrial uses were also previously precluded on Areas 1 and 2 by a Supplemental Declaration of Covenants and Restrictions recorded by Rock Road Industries, Inc. in January 1998 prohibiting the placement of buildings and restricting the installation of underground utilities, pipes and/or excavation upon its property. The 2016 Declaration of Covenants amends and restates the requirements of the May 1997 and January 1998 covenants but otherwise does not alter them.

A climate change exposure assessment identifies climate change hazards of concern for a remediation system in light of a range of potential climate and weather scenarios (EPA, 2014a). EPA identified the following potential climate change impacts for landfills and containment remedies:

- Increased occurrence of extreme temperatures;
- Sustained changes in average temperatures;
- Decreased precipitation and increasing drought;
- Increased heavy precipitation events;
- Increased flood risk; and
- Increased intensity of tornadoes.

EPA indicated that precipitation changes that could degrade cover systems is a specific climate change hazard relative to landfills and containment systems.

A climate change sensitivity assessment evaluates the likelihood for the climate change hazards of concern to reduce the effectiveness of a landfill/containment system. Damage to cover materials and a potential washout of contaminated contents, as well as unexpected and additional costs for repairing or replacing a cover system, are particular concerns for a landfill containment system. Specific containment system components included in the ROD-selected remedy that could be affected by climate change include:

- Physical and water damage to the vegetative layer overlying the low-permeability cover layer;
- Physical and water damage to a GCL layer if such a layer were to be included in the cover system;
- Physical or water damage and reduced access to surface water drainage systems and structures; and
- Physical damage or reduced access to groundwater and landfill gas monitoring wells.

In particular, the vegetative layer could be vulnerable to increased occurrences of extreme temperatures, sustained changes in average temperatures, decreased precipitation, and increases in drought occurrences. Increased temperatures or decreased precipitation/drought could affect the viability of the vegetation (*e.g.*, grasses) on the surface of the landfill cover. Any changes to the overall health of the vegetative cover would be readily identifiable by visual inspection. Therefore, although the vegetative cover may be vulnerable to potentially increased temperatures or drought conditions, the potential for impacts to the vegetative layer could be anticipated and readily identified in advance of any such occurrence.

The CCL – or a GCL layer if such material is included in the design of the landfill cover – could be damaged by periods of extended extreme temperatures or prolonged drought. Potential impacts could include desiccation of the low permeability materials (CCL or GCL) with a resultant increase in permeability, which could lead to increased infiltration of precipitation or increased radon emissions. Such impacts are not considered to be significant because the Site has existed for over 40 years with essentially flat (no grade) surfaces and minimal cover material, thereby maximizing precipitation infiltration. Even with this increased potential for infiltration of precipitation through Areas 1 and 2, the USGS (2014) concluded that that there is not a strong spatial association of monitoring wells surrounding or downgradient of RIM areas with elevated radium concentrations, as might be expected if RIM areas were releasing substantial quantities of radium to the groundwater. EPA has indicated that additional evaluations of groundwater would be conducted in the future as part of the OU-3 RI/FS. In addition, even without significant cover material, the radon emissions from the surfaces of Areas 1 and 2 are far below the UMTRCA and NESHAP standards and are projected to remain below these standards in the future (see prior discussion in Section 2.3.1 and also in RI Addendum Section 7.1.1.1). Therefore, even if desiccation of the low-permeability layer were to occur, the impacts to groundwater quality or radon emissions are not expected to be significant. More importantly, the vegetative layer would show significant signs of stress from increased temperatures/drought prior to the occurrence of any impacts to the underlying low-permeability layer, thereby providing advance notice of a potential impact to the CCL/GCL. Therefore, although the low-permeability layer could potentially be vulnerable to effects of increased temperature or drought, the potential for any impacts could be anticipated and readily identified in advance of any such occurrence. In the event that such impacts were to occur, additional maintenance activities such as temporary irrigation to maintain the grass cover, overseeding with grasses that required less water, placement of additional soil to repair erosion, or other typical cover repair measures would be implemented. Further, such impacts are not expected to result in release of contamination.

Increased heavy precipitation events could result in erosion of the vegetation layer and, if left untended, could result in erosion of the underlying low-permeability layer. Any erosion of the landfill cover would be readily identifiable by visual inspection. Given the overall 5-foot thickness of the landfill cover and the inclusion of the 2-foot thick rock layer in the base of the cover system, stormwater erosion – even under the most severe storm event – is not anticipated to result in erosion down through the entire landfill cover. Heavy precipitation events could impact the integrity or performance of stormwater drainage conveyance structures, including erosion of drainage channels, damage to or bypassing of let-down and erosion control structures and features, or damage to stormwater detention structures. Heavy precipitation events could also temporarily restrict access to portions of the landfill cover, stormwater control structures, and environmental monitoring points, thereby causing delays in implementation of repairs (if any are needed). Therefore, the vegetation layer and stormwater controls are potentially vulnerable to impacts from heavy precipitation events; however, due to the overall thickness and design of the landfill cover, any potential impacts are not expected to result in exposure of the waste material or release of contamination. Furthermore, any impacts that occur could be readily addressed as part of normal maintenance and repair of the landfill cover, including localized regrading, repair and replacement of cover material in response to any damage that may occur.

The ROD-selected remedy is not anticipated to be impacted by flooding that may occur in the area of the Site. As previously discussed in Section 2.1.6, FEMA has determined that, with the exception of the easternmost portions of Areas 1 and 2 (which do not contain waste materials), Areas 1 and 2 are located outside of the 500-year floodplain. In addition, areas to the north and west of Area 2 (*e.g.,* Crossroads Industrial Park and Earth City Industrial Park) that potentially could be subject to flooding by the Missouri River are protected by the engineered levee and stormwater and flood control systems installed to protect the Earth City Industrial Park. Further, the conceptual design for the ROD-selected remedy includes construction of a perimeter (starter) berm along the toe of the entire northern boundary of Area 2 that would result in placement of approximately 25 feet of rock and soil between any possible floodwaters and the landfilled waste. This perimeter berm may be further protected from flooding by placement of rip-rap along the base of the berm. Therefore, although increased occurrences of flooding in the area of the Site may be a potential impact of climate change, the ROD-selected remedy is not expected to be vulnerable to flooding.

An evaluation of the potential impacts of a tornado on the ROD-selected remedy was previously performed and submitted to EPA (EMSI, 2013f). This evaluation concluded that the ROD-selected remedy was not vulnerable to impacts from a tornado. Specifically, a tornado is not expected to damage the vegetative layer, and, even if it did, such an impact is not considered to be significant because it could be easily identified. Further, due to the design and thickness of the engineered cover, any impacts from a tornado are not expected to result in exposure of the underlying waste or release of contamination. A tornado could damage or destroy above-ground infrastructure such as signage, fencing or environmental monitoring equipment; however, such impacts are not expected to be significant because they would be readily identified and easily repaired or replaced. Therefore, the ROD-selected remedy is not considered to be vulnerable to impacts from a tornado.

Although the ROD-selected remedy is not considered to be vulnerable to climate change, implementation of adaptation measures could nevertheless be considered during remedial design. Several aspects of the conceptual design of the ROD-selected remedy already provide a degree of adaptation for climate change. For example, regrading of the surface of Areas 1 and 2 to a 2% slope would reduce the velocity of runoff across these areas. Installation of runoff collection and diversion systems along the base of the above-grade portion of the North Quarry part of the Bridgeton Landfill adjacent to Area 1, as well as along the north sides of the Closed Demolition Landfill and the Inactive Sanitary Landfill adjacent to Area 2, would divert runoff from these areas around Areas 1 and 2 to reduce the potential for impacts from heavy precipitation events. Identification and evaluation of additional adaptation measures can be addressed as part of the design of the engineered landfill cover and stormwater controls in order to increase the overall resilience of these features to heavy precipitation events. For example, use of grass-seed mixtures that are more tolerant of long-term changes in precipitation or temperature, and/or additional soil to increase water storage capacity, could be evaluated as part of the design. Similarly, inclusion of geotextile at the base of the vegetative layer could be considered to minimize the potential for water or wind erosion extending down into the underlying low-permeability layer of the cap. The design grades of the stormwater conveyance structures could be evaluated to provide a balance between the ability to quickly route stormwater away from Areas 1 and 2 while minimizing the stormwater velocity and the associated potential for erosion of the stormwater conveyance structures. Continuous re-evaluation of potential vulnerabilities, system resilience and possible adaptation measures can be included as part of the ongoing inspection and maintenance program.

6.2.2.3.4 Potential Impacts of a Subsurface Heating Event

In December 2010, Bridgeton Landfill, LLC detected elevated temperatures and carbon monoxide levels in the landfill gas extraction system (Bridgeton Landfill, LLC, 2013). Further investigation indicated that the South Quarry portion of the Bridgeton Landfill (which is located within OU-2) was experiencing an exothermic (heat-generating) subsurface reaction or event (Bridgeton Landfill, LLC, 2013). A discussion of this subsurface reaction (SSR)[38] is included in Section 5.7 of the RI Addendum.

Per EPA's SOW, the FFS is to include a discussion of the potential impacts of a subsurface smoldering event (SSE) or other type of subsurface heating event, if one were to occur within (or migrate to) OU-1. A qualitative assessment of the potential impacts of a subsurface heating event on the occurrences of RIM in Areas 1 and 2 and potential impacts on the ROD-selected remedy was previously prepared, submitted to EPA, and revised in response to EPA comments (EMSI, 2014e) (the SSE Impact Study). In addition, the potential for increased release of radionuclides – including via radon and fugitive dust – were further addressed as part of the Isolation Barrier Alternatives Analysis (IBAA) (EMSI, et al., 2014) and as part of the responses to EPA and MDNR comments on this analysis (EMSI, 2015a), both of which were prepared for Bridgeton Landfill LLC. Finally, quantitative calculations and modeling of potential radon and fugitive dust emissions performed on behalf of Bridgeton Landfill LLC were completed in 2016 as part of additional evaluations of a potential isolation barrier (Auxier and EMSI, 2016d and 2016e).

Based on consideration of the conditions and processes known to be associated with subsurface heating events at landfills and the remedy selected by EPA in the 2008 ROD, the following conclusions were reached in the SSE Impact Study as part of the initial qualitative evaluation (EMSI, 2014e):

- The RIM disposed of in West Lake Areas 1 and 2 would not become more or less radioactive in the presence of heat. Likewise, the RIM is not explosive and would not become explosive in the presence of heat.

- An SSE[39] does not create conditions that could carry RIM particles or dust off-site. The heat of an SSE is not high enough to ignite non-RIM wastes or chemical compounds or to cause them to explode.

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[38] This reaction has previously been called a "subsurface smoldering event" (SSE) or by some as a fire. The current understanding of the nature of the reaction, however, is that it is occurring within saturated landfill materials in the absence of oxygen, which indicates that it is not a result of fire or smoldering (i.e., combustion). Accordingly, current references are to a "subsurface reaction," or SSR, rather than using the prior SSE terminology. Unlike a fire, the SSR has not produced visible smoke or flames.

[39] As noted in the SSE Impact Study, subsurface heating events are described in the literature using many terms, including subsurface fire, smoldering fire, slow pyrolysis, glowing combustion, subsurface oxidation, and subsurface reaction. For purposes of the SSE Impact Study, a "subsurface heating event" was considered to include any and all of these differing heating events.

- An increase in subsurface temperatures may allow radon gas to more easily rise through the ground and reach the surface of the landfill than would otherwise occur, because heat reduces the amount of moisture in the buried solid waste (trash), thereby increasing the amount of air between the soil particles and thus limiting the ability of the buried solid waste to retain radon below-ground. Any radon gas that does make it to the surface would dissipate quickly in open air. This potential increase in the rate of release of radon gas at the surface of the landfill would be limited to the area of the SSE and would stop when the SSE ends.

- In the unlikely event that increased subsurface temperatures were to occur in West Lake Area 1 or 2, such an event would create no long-term additional risks to people or the environment.

- Any short-term risks would be associated with the temporary increase in radon gas coming from the surface of Areas 1 and 2 if no cap is installed, or if the cap called for by the 2008 ROD was not properly maintained.

- These short-term risks can be addressed by designing, building, and maintaining the landfill cap called for by the 2008 ROD, and by maintaining the land use restrictions already in place on the entire Site, which prevent certain land uses.

- There are no additional ARARs associated with an SSE.

As part of the IBAA, the projected increase in radon emissions if a heating event were to enter Area 1, or in the unlikely event that an independent heating event were to otherwise occur in Area 1, were estimated based on examination of three potential conditions associated with radon emissions under elevated temperatures and occurrence of a SSE in Area 1:

- Initial thermal expansion of landfill gas due to increased temperature as a hypothetical heating event approaches and enters into Area 1, resulting in exhalation (emission at the ground surface) of the incremental increase in the volume of landfill/soil gas due to expansion of the gas volume in response to an increase in subsurface temperature;

- Subsequent increase in radon emissions due to increased soil gas permeability resulting from vaporization of soil moisture in response to increased temperature; and

- Subsequent destruction (pyrolysis) of a portion of the waste mass and associated loss of pore space, resulting in further displacement and resultant emission of an additional portion of the landfill/soil gas.

Results of these calculations indicated that even if these conditions were to occur, the radon emission rate from Area 1 would still be less than the standard established by the radon NESHAP, and if such a release were to occur, risks at or beyond the fenceline would be below the acceptable risk levels established by EPA.

Additional evaluations performed in 2016 on behalf of Bridgeton Landfill, LLC and Rock Road Industries, Inc., further examined potential increases in radon emissions in the event that a heating event were to occur in the southern portion of Area 1, outside of a potential isolation barrier (Auxier and EMSI, 2016d) (the Supplemental Radon Flux Analysis). The Supplemental Radon Flux Analysis evaluated potential radionuclide emissions – primarily radon – if an SSR were to reach isolated RIM deposits on the south side of a hypothetical isolation barrier in the southern portion of Area 1. Specifically, evaluations were performed on potential radon-222 emissions from three sources: (1) Area 1 during a hypothetical, progressive SSR crossing the study area; (2) a postulated release of radon-222 gas by way of a hypothetical event, such as a cover surface crack that exposes a portion of deep RIM after the occurrence of an SSR; and (3) a hypothetical release of RIM-derived soil gas to the landfill gas collection and flare system. In each of these hypothetical situations, the performed calculations estimated the expected surface radon flux generated by diffusion from the RIM combined with advective flux produced by thermal and physical changes associated with the passage of the postulated SSR.

The Supplemental Radon Flux Analysis concluded that largest single contributor to radon emissions under the conditions assumed in the assessment is the area source[40] used to represent Area 1 during a theoretical SSR passing through the area, followed by radon emitted from the flare stack. The calculated flux emissions were compared to permissible radon flux levels for radium storage and disposal facilities set forth at 40 CFR § 61.192. The Supplemental Radon Flux Analysis concludes that the area weighted average radon flux in Area 1 is less than the radon flux standard of 20 pCi/m^2s.

The Supplemental Radon Flux Analysis also assessed potential risks to receptors beyond the Site fenceline under modeled conditions.[41] In particular, concentrations of radon-222 gas and its progeny were projected in air at four locations: the closest occupied structure, the closest boundary fence (along St. Charles Rock Road), and at the two closest communities (Spanish Village and the Terrisan Reste mobile home community). The highest combined radon concentration at the Area 1 fenceline from all sources – 0.013 pCi/L – was projected to occur at the fence line next to the Site office. This is less than the 0.5 pCi/L alternative radon air concentration limit published in 40 CFR § 192.02(b)(2).

Potential risks to one of three different receptor types were evaluated at each of these locations of interest: indoor workers at the Site office building, outdoor workers at the closest boundary fence, and residential receptors at the two closest communities. The highest theoretical risk identified in the Supplemental Radon Flux Analysis – 2×10^{-6} – was calculated to occur to EPA's default indoor worker inside the closest occupied structure. This theoretical risk is well within EPA's acceptable risk range of 1×10^{-4} to 1×10^{-6} for CERCLA sites. Risks to off-site

[40] The Supplemental Radon Flux Analysis defined the term "area source" as the size of the area affected by a heating event at any given point in time.

[41] Potential risks were calculated by entering calculated concentrations of radon progeny into EPA's Preliminary Remediation Goals for Radionuclides (PRG) calculator, which is a web-based tool developed by EPA pursuant to the Risk Assessment Guidance (RAGS) guidance.

residential communities were all projected to be below 1 x 10^{-7}, which is below EPA's acceptable risk range.

The potential for release of particulate matter containing radionuclides was also evaluated in a second report submitted on behalf of Bridgeton Landfill, LLC and Rock Road Industries, Inc., in 2016 (Auxier and EMSI, 2016e) (the Final Particulate Emission Analysis). The purpose of the Final Particulate Emission Analysis was to estimate hypothetical risks to potential receptors if particulates from deeply buried RIM on the south side of an assumed isolation barrier in Area 1 were to somehow be brought to the surface and become airborne. Few (if any) viable mechanisms could actually cause such an occurrence on a large scale; however, a review of non-routine practices or events was conducted to determine whether any could actually produce an event where particulates from deep RIM could be released. Based on this review, the Final Particulate Emission Analysis postulated that a theoretical subsurface drilling event in Area 1 south of a proposed isolation barrier brought a mixture of landfill waste and subsurface soil to the surface, where it was then deposited on the ground surface around the drilled hole. If this material were to be left unattended, dry particulates within it could become suspended via wind erosion and carried to off-site locations.[42]

Based on the calculated results, the Final Particulate Emission Analysis concluded that even with very conservative (worst-case) assumptions, the highest risk identified in the study – 2 x 10^{-6} – was calculated to occur to EPA's default indoor worker inside the closest occupied structure. This calculated risk is within EPA's acceptable risk range of 1 x 10^{-4} to 1 x 10^{-6} for CERCLA sites. Further, risks to off-site receptors at the closest boundary fence and at the two closest communities produced risks below 1 x 10^{-7}, far below EPA's acceptable risk range of 10^{-4} to 10^{-6}.

EPA recently asked that the evaluations of potential radon and fugitive dust emissions be updated to include same exposure factors as were used in the recently completed updated Baseline Risk Assessment (Auxier & Associates, 2016a). These evaluations are currently being performed and will be incorporated into the revised draft or final version of this FFS.

6.2.2.3.5 Effects of an Isolation Barrier

In 2013, Bridgeton Landfill, LLC began evaluation of potential engineering measures that might be implemented to isolate the RIM in Area 1 from a heating event should such an event either

[42] The conclusion that dry particulates could become airborne was based in part on several very conservative assumptions about drilling procedures and soil/waste conditions. In particular, the mixture was assumed to remain uncovered on the ground surface; it was assumed to be dry and friable, with the consistency of coal dust; all precipitation events were ignored; and all particulates produced were assumed to be respirable. These assumptions are in contrast to/not representative of conditions much more likely to occur in such a drilling event, namely: (1) much or all of the soil mixture would be covered or removed promptly in accordance with standard drilling procedures; (2) the mixture would be moist, not dry, when it was first brought to the surface; (3) precipitation would periodically wet the mixture, thereby reducing emissions and promoting the formation of a surface crust; and (4) a sizeable portion of the particulates produced would be too large to be entrained by the wind or ever become respirable.

migrate from the South Quarry portion of the Bridgeton Landfill or otherwise originate in the North Quarry portion of the Bridgeton Landfill. Extensive investigations (Feezor Engineering, Inc. et al., 2014) were performed as part of this evaluation. Contemporaneously, the USACE, on behalf of EPA, prepared an Isolation Barrier Alignment Alternatives Assessment (USACE, 2014). EPA subsequently requested that Bridgeton Landfill, LLC prepare the IBAA, which was completed in 2014 (EMSI et al., 2014). Agency comments (EPA, 2015d and MDNR, 2014) were received and responded to in 2015 (EMSI, 2015a). Evaluation of potential isolation barrier alignment alternatives was conducted by the USACE in 2015 (USACE, 2015). Additional evaluations were undertaken by Bridgeton Landfill, LLC in 2016 (Auxier and EMSI, 2016d and 2016e). In April 2016, EPA issued an Administrative Settlement Agreement and Order on Consent (ASAOC) requiring Bridgeton Landfill, LLC to install a heat extraction barrier (HEB) in the “neck” area between the South and North Quarry portions of the Bridgeton Landfill, to install additional temperature monitoring probes, and to develop and implement other plans relative to mitigation of a possible migration of the SSR in the South Quarry into the North Quarry portion of the Bridgeton Landfill, or the potential origination of a new SSR or SSE in the North Quarry portion of the Bridgeton Landfill. At the time this draft FFS was prepared, evaluation of potential alignments and technologies for implementation of an isolation barrier were still ongoing, and no specific alignment or technology (*e.g.*, physical or heat extraction barrier) has been chosen. In 2015, Bridgeton Landfill, LLC conducted technical evaluations of potential heat extraction technologies to halt any potential movement of the heating event in the South Quarry portion of the Bridgeton Landfill (Feezor Engineering, Inc., 2015 and MDNR, 2015). In 2016, EPA issued an Administrative Settlement Agreement and Order on Consent (ASAOC) to Bridgeton Landfill, LLC that required, among other things, installation of a heat extraction barrier (HEB) in the “neck” area between the North and South Quarry portions of the Bridgeton Landfill (EPA, 2016c). The HEB was installed in the summer of 2016 and began operating in October 2016.

EPA’s SOW for the RI Addendum and FFS (EPA, 2015b) requires an evaluation of the effects of an isolation barrier to be included in the FFS. As discussed in the previous subsection, no adverse impacts or unacceptable risks are expected to result if an SSR or SSE were to extend into Area 1. Therefore, regardless of the location or type of isolation barrier that may be installed, or even if no barrier is installed, no unacceptable risks are expected to occur. Installation of a heat extraction barrier consisting of various heat extraction points (regardless of location) would not have any impact on the protectiveness, long-term effectiveness, short-term effectiveness, implementability or cost of the ROD-selected remedy. Installation of a physical barrier, such as a vertical wall of inert material, would require excavation and regrading of the above-grade portion of the North Quarry part of the Bridgeton Landfill located over the southern portion of Area 1. If such a barrier were to be installed prior to implementation of the ROD-selected remedy, the design of the engineered cover included in the ROD-selected remedy would need to account for any changes in the surface grades, stormwater drainage system, and the presence of any above-grade features (*e.g.*, heat extraction points, temperature monitoring probes, or additional gas extraction wells) that may be installed in conjunction with a physical barrier. In contrast, if a physical barrier were installed after construction of the engineered cover included in the ROD-selected remedy, that portion of the engineered landfill cover that extended over the area of an isolation barrier and the associated revised landfill grades would need to be removed as part of construction of an isolation barrier.

6.2.2.3.6 Environmental Justice Considerations

EPA's SOW (EPA, 2015b) requires the FFS to include an acknowledgement of any environmental justice concerns to be included in both the short-term and long-term effectiveness sections of the alternatives analysis. Executive Order (E.O.) 12898, entitled "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," calls on each covered Federal agency to make achieving environmental justice part of its mission "by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations" (EPA, 2016d). EPA defines environmental justice (EJ) as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. EPA further defines the term *fair treatment* to mean that "no group of people should bear a disproportionate burden of environmental harms and risks, including those resulting from the negative environmental consequences of industrial, governmental, and commercial operations or programs and policies" (EPA, 2011). EPA defines meaningful involvement as, "1) potentially affected populations have an appropriate opportunity to participate in decisions about a proposed activity [i.e., rulemaking] that will affect their environment and/or health; 2) the population's contribution can influence [the EPA's] rulemaking decisions; 3) the concerns of all participants involved will be considered in the decision-making process; and 4) [the EPA will] seek out and facilitate the involvement of population's potentially affected by EPA's rulemaking process" (EPA, 2015e). EPA defines a potential EJ concern as "the actual or potential lack of fair treatment or meaningful involvement of minority populations, low-income populations, tribes, and indigenous peoples in the development, implementation and enforcement of environmental laws, regulations and policies" (EPA, 2015e).

E.O. 12898 identifies a number of population groups of concern in considering potential EJ implications of a regulatory action. These include: minority populations, low-income populations, and indigenous peoples. For purposes of E.O. 12898, the term "minority" means "individual(s) who are members of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic" (CEQ, 1997). A population is identified as minority in an area affected by the policy action if "either (a) the minority population of the affected area exceeds 50 percent or (b) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis" (CEQ, 1997). EPA has indicated that low-income populations may include families whose income is above the poverty threshold but still below the average household income for the United States (EPA, 2016d and 2015e). EPA Policy on Environmental Justice for Working with Federally Recognized Tribes and Indigenous Peoples (EPA, 2014c) defines "indigenous people" to include state-recognized tribes; indigenous and tribal community-based organizations; individual members of federally recognized tribes, including those living on a different reservation or living outside Indian country; individual members of state-recognized tribes; Native Hawaiians; Native Pacific Islanders; and individual Native Americans.

EPA's "Technical Guidance for Assessing Environmental Justice in Regulatory Analysis" (EPA, 2016d) (referred to as the EJ Technical Guidance) and EPA's Guidance on Considering Environmental Justice During the Development of Regulatory Actions (EPA, 2015e) (referred to as the EJ Process Guidance) were used to evaluate potential environmental justice concerns that may exist in the vicinity of the West Lake Landfill. The EJ Technical Guidance states that the analysis of potential EJ concerns for regulatory actions should address three questions:

- Are there potential EJ concerns associated with environmental stressors affected by the regulatory action for population groups of concern in the baseline?[43]

- Are there potential EJ concerns associated with environmental stressors affected by the regulatory action for population groups of concern for the regulatory option(s) under consideration?

- For the regulatory option(s) under consideration, are potential EJ concerns created or mitigated compared to the baseline?

Both the EJ Process Guidance and the EJ Technical Guidance recommend the use of a screening-level analysis to identify the extent to which a regulatory action may raise potential EJ concerns that need further evaluation, and what level of analysis is feasible and appropriate for that further evaluation. EPA's EJSCREEN: Environmental Justice Screening and Mapping Tool (EPA, 2015f) was used to perform a screening-level analysis to identify any potential environmental justice concerns that may exist in the vicinity of the Site. The EJ Technical Guidance indicates that when using EJSCREEN, the 80th percentile is a suggested starting point for the purpose of identifying geographic areas in the United States that may warrant further consideration, analysis, or outreach. That is, if any of the EJ Indexes for the areas under consideration are at or above the 80th percentile nationally, then further review may be appropriate (EPA, 2016d).

Areas 1 and 2 of the West Lake Landfill were identified on EJSCREEN, and a one-mile radius around these areas was created (Figure 6-1). EJSCREEN Indexes for the census blocks that intersected this one-mile radius were evaluated. The EJSCREEN Demographic Index, which is a combination of percent low-income and percent minority, was less than 80th percentile for all of the census blocks within the bounds of the one-mile radius (Figure 6-2). The individual EJSCREEN minority population (Figure 6-3), low income (Figure 6-4), and linguistically isolated (Figure 6-5) indexes were also below the 80th percentile; although the census block immediately to the east of Interstate 270, which is along the margin of the one-mile radius, was

[43] Per EPA's EJ Technical Guidance, this question asks whether there are discernible differences in impacts or risks to minority populations, low-income populations, or indigenous peoples that exist prior to or that may be created by the proposed regulatory action and that are extensive enough that they may merit Agency action. Differences in impacts or risks may include differential exposures, differential health and environmental outcomes, or other relevant effects. The subsequent analytic questions here are intended to prompt assessment of differences in anticipated impacts across population groups of concern for the baseline and proposed regulatory options, and to prompt the presentation of these results to decision makers to support their determinations regarding potentially actionable disproportionate impacts.

identified as a low-income population (Figure 6-4). The only EJSCREEN index that was greater than the 80th percentile for the area within the one-mile radius was the percentage of the population greater than 64 years of age, for which the EJSCREEN index was in the 95th percentile of the national rates (Figure 6-6). This indicates that a significant portion of the population living in the immediate area of the Site is elderly.

The EJSCREEN analyses did not identify any environmental justice concerns in the vicinity of the Site. Discussions with EPA Region 7 personnel on August 1, 2016 indicated that EPA had not identified any environmental justice concerns in the vicinity of the West Lake Landfill; however, EPA did indicate that interviews with the residents of the Terrisan Reste mobile home park suggested that more traditional methods of communication, such as U.S. mail, would be more appropriate than electronic methods for providing information to this group of residents.

Region 7 personnel did indicate that a few block groups[44] located within three miles of the Site were identified as being above the 80th percentile for low income. EPA Region 7 also indicated that it conducted visual inspections and community surveys in the area of the Site, and, based on this work, did identify the Terrisan Reste mobile home park, which is located approximately three-quarters of mile to the southeast of Area 1, as potentially being low income and potentially having a high proportion of elderly and disabled residents. Based on information obtained from its community survey, EPA indicated that the mobile home park residents faced communication challenges due to limited computer access. Consequently, communication by U.S. Postal Service mail is an important method for communication with these residents in order to ensure meaningful involvement.

6.2.2.4 Reduction of Toxicity, Mobility or Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy. Overall, the ROD-selected remedy is a containment remedy and therefore generally would not result in any reduction in the toxicity, mobility, or volume of the waste material through treatment.

As discussed in Section 4, radionuclides are naturally-occurring elements which cannot be fully neutralized or destroyed by treatment. Occurrences of radionuclides within Areas 1 and 2 are dispersed within soil material that is further dispersed throughout portions of the overall, heterogeneous matrix of municipal refuse, construction and demolition debris, and other non-impacted soil materials in Areas 1 and 2. Consequently, ex-situ treatment techniques are considered impracticable. In addition, the heterogeneous nature of the solid waste materials and the dispersed nature of the radionuclide occurrences within the overall solid waste matrix in portions of Areas 1 and 2 make in-situ treatment techniques impracticable. The ROD-selected

[44] A Census Block Group is a geographical unit used by the United States Census Bureau and is generally defined to contain between 600 and 3,000 people. It is the smallest geographical unit for which the Bureau publishes sample data.

remedy for the Buffer Zone/Crossroads Property also would not reduce toxicity, mobility, or volume through treatment because it consists of moving radiologically-impacted soil from the Buffer Zone/Crossroads Property to Area 1 or 2, where it would be consolidated with the RIM.

In the event that hazardous wastes are encountered during implementation of the remedy, such materials would be separated from the other solid wastes and subjected to waste profiling to determine the appropriate treatment and disposal requirements. Suspect material would initially be stored on-site while test results were obtained to verify the presence, if any, and type of hazardous wastes encountered. Storage would be conducted in accordance with RCRA and State hazardous waste regulation requirements for storage containers or units and limitations on the duration of storage (90 days if the amount of hazardous waste exceeds 2,200 lbs in a month or 270 days if the amount is less than 2,200 lbs a month).[45] Procedures to be used for testing, storage, management, treatment and disposal of any hazardous wastes or mixed wastes that could be encountered during implementation of the alternative would be documented as part of the RD activities.

To the extent that hazardous wastes or mixed wastes are encountered, they would be shipped off-site and would be treated at the disposal facility in accordance with the hazardous waste regulations (e.g., EPA's Land Disposal Restrictions (LDR) program and Universal Treatment Standards (UTS)) and in accordance with the permits and standard operating procedures of the receiving facility. Examples of treatment processes include stabilization of soil and micro- or macro-encapsulation of debris. To the extent that treatment of the hazardous waste or mixed waste would be required for off-site disposal, stabilization or encapsulation treatment would result in a reduction of the mobility of the hazardous waste or the radiologically-impacted components of the mixed waste. Toxicity and volume would not be reduced by these technologies but may be reduced by other technologies potentially applicable to hazardous wastes that do not contain RIM, if such wastes were encountered during implementation of the remedial action at the Site.

As the expected volume of waste material that would be disturbed during landfill regrading is relatively small, the amount of hazardous waste that may be encountered, if any, during implementation of the ROD-selected remedy is also expected to be relatively small. Therefore, it is anticipated that any hazardous waste that may be encountered during implementation of the ROD-selected remedy would be shipped to an off-site disposal facility by truck.

6.2.2.5 Short-Term Effectiveness

During the construction period, the ROD-selected remedy could pose radiation exposure and physical hazards for workers and result in additional local truck traffic. The ROD-selected remedy for the Buffer Zone/Crossroads Property would be effective over the short term and the

[45] These storage limitations assume that the off-site facility is located more than 200 miles from the Site. This distance is assumed based on the expectation that any identified hazardous waste would also be rad-contaminated and therefore shipped to one of the four off-site disposal facilities identified in Section 4.3.5.4.

relatively short duration required to remove the small amount of impacted soil should result in no significant adverse impacts.

The ROD-selected remedy would entail some excavation, handling, loading and transport of RIM within the Site associated with re-contouring to achieve slope requirements, and therefore would pose some short-term exposure risks to on-site workers. The number of truck trips required to import construction materials to the Site would also result in additional physical risks to the community and/or workers due to the potential for traffic accidents.

Potential short-term risks to the community and workers would be addressed through monitoring and dust control and other mitigative measures to assess and limit worker and community exposures during construction. Adherence to OSHA practices would be necessary to limit worker exposures and accidents.

6.2.2.5.1 Protectiveness of the Community During Remedial Actions

The projected carcinogenic risks that may be posed to off-site residents by this alternative would be less than 1×10^{-7}, which is substantially below EPA's accepted risk levels (Appendix H). No non-carcinogenic risks are expected to occur.

In order to further ensure that construction activities do not pose unacceptable risks, effective dust control measures would be implemented from the start of the project. An extensive perimeter environmental monitoring system has already been installed at the Site. Results of monitoring along the perimeter of Areas 1 and 2, combined with monitoring performed in the work zone during various investigative activities, have indicated that no significant airborne migration of radionuclides is occurring and that workers and the general public are not being exposed to radionuclides above background levels. Continued monitoring during construction would identify any potential for releases that could impact the area outside the work location.

The risk assessment (Appendix H) includes an estimate of the projected incidence of transportation accidents associated with each alternative. For the ROD-selected remedy, the projected incidence of transportation accidents associated with importing of materials for construction of the multi-layer landfill cover is 0.61, meaning that there would be a 61% probability of at least one transportation-related accident occurring during implementation of the remedy. To address this risk, traffic control for the incoming shipment of the materials would be implemented from the project start. All drivers would be cautioned about the normal congestion existing on St. Charles Rock Road. Routing of trucks, safety briefings, and adherence to traffic laws would reduce but not necessarily eliminate the potential for accidents. To the extent possible, shipments would be scheduled to avoid the highest traffic times.

Vehicle operations for importing the materials to be used to construct the multilayer landfill cover and during landfill regrading and cover construction are projected to emit 19,000 tons of carbon dioxide equivalent emissions to the atmosphere (Appendix I, Table I-2).

As Areas 1 and 2 are regraded during cap installation, the nuisance attraction to and congregation by birds at and above the affected areas could be problematic unless effectively controlled. Concerns include odor management, vector control, and the potential for increased bird strikes to aircraft approaching and departing from the Lambert-St. Louis International Airport. Excavation best management practices – including immediate re-deposition of cut material, limiting the area of excavation, and application of daily soil cover – are included in the ROD-selected remedy, and, if necessary, mitigation measures such as tarps, visual and auditory frightening devices, or wire or monofilament grids strung over exposed refuse to prevent bird access, could be implemented to minimize bird attraction to and congregation at and above the disturbed areas.

As Areas 1 and 2 are regraded during cap installation, stormwater controls would be implemented in accordance with Missouri Storm Water regulations 10 CSR 20-6.200.

6.2.2.5.2 Environmental Justice Concerns

As was previously discussed in Section 6.2.1.3.6, as part of the evaluation of long-term effectiveness, a screening-level analysis did not identify any environmental justice concerns. EPA did identify a need for implementation of more traditional (non-electronic) communication methods to inform and ensure meaningful involvement of residents in the Terrisan Reste mobile home community.

6.2.2.5.3 Protectiveness of Workers During Remedial Actions

The risk assessment (Appendix H) presents an evaluation of potential risks to Site workers that may occur for each alternative. These include risks from industrial accidents, exposure to carcinogenic substances, and projected radiation exposures. For the ROD-selected remedy, the projected incidence of industrial accidents is 2.76 over the life of the project (Appendix H). The projected carcinogenic risk to the maximally-exposed individual (field radiation technician) is estimated to be 9.2×10^{-5} and the projected radiation dose to a remediation worker is 187 millirems/year (mrem/yr) [Appendix H)].

A complete and comprehensive Health and Safety Program would form the core of worker protectiveness measures. The program would direct protective actions of all personnel on the Site. All workers at the Site would be trained to handle both radioactive materials (Rad Worker Training) and hazardous materials (HAZMAT Training). Protective clothing and equipment and constant monitoring for toxic hazards and radioactive emissions would be mandated. All workers on the project would be required to adhere to the project safety requirements, including any sub-contractors or vendors who are at the Site for an extended period of time.

6.2.2.5.4 Environmental Impacts

No measurable long-term impacts to plants or animals in surrounding ecosystems are expected from implementation of the ROD-selected remedy. A screening-level ecological assessment was performed as part of the original BRA (Auxier, 2000) and was updated as part of the updated BRA (Auxier, 2016a). The results of that assessment are presented in Section 7 of the BRA (Auxier, 2000) and Appendix B of the updated BRA (Auxier, 2016a). No wetlands are located within the on-site construction footprint of this alternative and no endangered species were identified.

The activities to be conducted during Site regrading and cover construction would affect wildlife and plant life on Areas 1 and 2 and possibly adjacent portions of the Site. This disruption would be temporary and would last for the period of active construction. Much of the habitat on Areas 1 and 2 was removed in 2016 in conjunction with construction of the non-combustible cover. Regrading of Areas 1 and 2 and construction of the engineered landfill cover included in the ROD-selected remedy would destroy the remaining portions of the habitats that currently exist on the surface of Areas 1 and 2, forcing wildlife to migrate to other areas. Vegetative cover would be placed on the Site as a part of the final cover, and the landfill would be allowed to return to an early-stage field ecosystem with periodic mowing and maintenance.

6.2.2.5.5 Ability to Monitor Effectiveness

Measurement of gamma radiation and radon flux through the newly constructed landfill cover would be conducted on Areas 1 and 2 after construction is complete. Regular monitoring of groundwater quality would be performed at appropriate locations around Areas 1 and 2. Measurements of subsurface occurrences of landfill gas and radon levels would be conducted along the property boundaries adjacent to Areas 1 and 2 to verify that off-site gas migration above regulatory thresholds does not occur.

6.2.2.5.6 Time Until Remedial Action Objectives Are Achieved

The RAO of (1) preventing direct contact with the landfill contents and exposure to external radiation would be met upon installation of an engineered landfill cover. The RAOs of: (2) minimizing infiltration and any resulting contaminant leaching to groundwater; (3) controlling surface water runoff and erosion and decreasing the potential for erosion and subsequent transport of RIM; and (4) controlling radon and landfill gas emissions from Areas 1 and 2 all would be met once construction of the new landfill cover over Areas 1 and 2 is completed. The RAO related to the Buffer Zone and Crossroads Property soil would be met upon removal of any remaining soil containing radionuclides above unrestricted levels from these areas.

Construction is estimated to require approximately 1.7 years after approval of the RD. Preparation of the RD should be completed within approximately one year of authorization to proceed with the RD. Therefore, the remedial action objectives should be achieved within approximately 2.7 years of authorization to begin (Appendix J).

6.2.2.6 Implementability

The design and construction of a landfill cover, with subsequent monitoring and maintenance as specified for the ROD-selected remedy, is not expected to pose any significant implementability challenges. Materials and services necessary for the regrading and construction of the final landfill covers over Areas 1 and 2 are readily available and the technologies have been proven through application at other landfills. Monitoring of the cover surfaces, landfill gas, groundwater, and surface water are proven methods for demonstrating the long-term effectiveness of landfill covers, and are easily implemented.

6.2.2.6.1 Ability to Construct and Operate the Technology

It is technically feasible to regrade existing materials and install a starter berm and/or place additional soil in order to achieve minimum and maximum slopes of 2% and 25% respectively. It is also technically feasible to construct an upgraded landfill cover over Areas 1 and 2. Regrading of existing landfills through placement of additional soil or regrading of existing materials is a common remedial action that has been implemented at many other CERCLA landfill sites as well as at RCRA corrective action sites.

Because of the configuration and location of Areas 1 and 2 within the overall existing larger Site footprint and the existing relatively steep side slopes on portions of the northern and eastern edges of Area 1 and the northern and western edges of Area 2, achieving the required maximum slope grades along the entire margin of Areas 1 and 2 cannot be achieved by placement of additional fill material alone. The toe of the landfill in the northern portion of Area 2 is located near or coincident with the property boundary/fence line, and therefore placement of additional soil or fill material is not an option to reduce the slope angle of the landfill berm in this area. Similar grading constraints exist for portions of the landfill in Area 1 due to the presence of the solid waste transfer station access road located along the northern toe of the landfill berm in Area 1, and the presence of the property/fence line along the eastern toe of the landfill. An existing drainage ditch located along the St. Charles Rock Road immediately outside of the fence line would also pose grading restraints around Area 1. For these areas, re-contouring the waste materials is a viable option to achieve the proper slope for construction of the cover. Re-contouring can be greatly reduced through use of a starter berm, as discussed elsewhere in this FFS report and in more detail in the prior SFS report (EMSI et al., 2011).

Bird nuisance mitigation measures such as best management practices (including, but not limited to, selective excavation, daily soil cover, and tarping of exposed wastes), visual and auditory frightening devices, and use of wire or monofilament grids strung over exposed refuse to prevent bird access, are demonstrated technologies that can be readily constructed and operated as part of the ROD-selected remedy.

Effective storm water controls can be readily implemented using conventional construction equipment, materials and best management practices.

6.2.2.6.2 Reliability of the Technology

Landfill cover systems that are designed and constructed consistent with State and Federal regulations and with post-closure care implemented in accordance with current regulatory guidance have been demonstrated to be reliable at: 1) minimizing percolation and infiltration of precipitation; 2) minimizing leachate generation; 3) minimizing impacts to groundwater quality; 4) minimizing impacts to surface water quality and quantity; 5) minimizing erosion of cover material; and 6) minimizing uncontrolled releases of landfill gas. In addition, existing security systems (*e.g.*, gates and fencing, signage, site surveillance, etc.) would be evaluated and enhanced, if necessary. These are reliable mechanisms to prevent unauthorized access to the Site.

Bird nuisance mitigation measures such as best management practices (including, but not limited to, selective excavation, daily soil cover, and tarps), visual and auditory frightening devices, and wire or monofilament grids strung over exposed refuse to prevent bird access, are demonstrated reliable technologies. However, while visual or auditory frightening devices can be effective in the short-term, birds tend to habituate to deterrents over time, causing the deterrent to lose effectiveness. Frequent relocation of predator birds and predator effigies and/or altering the timing of auditory activation may help, but long-term effectiveness is not assured. The FAA has stated that "[t]o date, no . . . [putrescible waste] facility has been able to demonstrate an ability to reduce and sustain hazardous wildlife [birds] to levels that existed before the putrescible-waste landfill operations began operating." (FAA, 2007).

Storm water controls are also well-established technologies that have been implemented and proven reliable at most landfill sites.

6.2.2.6.3 Ease of Undertaking Additional Remedial Actions, if Necessary

The only potential additional remedial actions that may need to be taken for the ROD-selected remedy would be maintenance activities to sustain the cover system, repair areas of differential settlement or erosion, or possible implementation of a contingent landfill gas control system. Regrading and contouring the existing waste materials to achieve final grades would require re-compaction of the regraded waste materials in order to minimize the potential for compaction or differential settlement over time that could affect the integrity of the landfill cover. Placement of additional fill material to achieve the final slope requirements and for construction of the landfill cover may result in differential compaction of the waste materials, depending upon the nature, age and amount of prior degradation of the waste materials. Runoff of stormwater can result in formation of erosional rills. Depressions caused by differential settlement of the wastes or erosional features can easily be (and commonly are) addressed at landfill sites through placement of additional soil material to fill such features.

In the event that monitoring of subsurface landfill gas and radon detects the presence of gas levels above regulatory thresholds along the perimeter of the Site, a landfill gas control system could be implemented as an additional remedial action. Implementation of a contingent landfill gas control system would entail drilling and installation of gas extraction wells, installation of conveyance piping, installation and operation of landfill gas extraction blowers and a landfill gas treatment (flare) system, and/or possible use of a carbon adsorption system to remove radon from the extracted gas stream. Installation of a contingent gas system can easily be performed as a future action. Any disruption to the final landfill cover resulting from the installation of a contingent gas extraction system would need to be repaired. Such activities are commonly and routinely undertaken at solid waste disposal sites.

Long-term monitoring and maintenance of the landfill covers at other Superfund sites and at non-Superfund site solid waste landfills is typically required to assess whether differential settlement or surface erosion of the cover has occurred over time. Long-term maintenance, including cover inspection and repair, would be part of this alternative. Cover repair, if necessary, would be straightforward, primarily entailing placement of additional fill, regrading, and re-vegetation of the repaired area.

Storm water management measures other than those using conventional earth-moving equipment, piping, pumps, liners, filtration and carbon adsorption water treatment equipment, rip-rap, and pond outlet structures are not anticipated.

6.2.2.6.4 Ability to Monitor Effectiveness of Remedy

One purpose of installing a landfill cover would be to prevent direct contact with the waste materials. The integrity of a landfill cover relative to protection from direct contact can easily be monitored through visual inspection to identify the presence of exposed waste or the existence of erosional features that could impact the landfill cover.

Another long-term goal of constructing new landfill covers over the surfaces of Areas 1 and 2 would be to minimize percolation and infiltration of precipitation with subsequent leachate generation and potential impacts to groundwater. Visual inspection of the cover integrity relative to the potential for erosion and infiltration impacts to the landfill cover can be easily performed. Groundwater monitoring to detect the presence of, or verify the absence of, impacts to groundwater is a standard technology that also can easily be performed at the Site.

Demonstrating the effectiveness of the cover systems would be accomplished by implementing the monitoring programs required by the ROD-selected remedy, including programs for the cover surface, landfill gas system, groundwater, and surface water (as previously described in Section 5.3.1). These types of monitoring programs are proven at demonstrating cover effectiveness and can be easily implemented.

6.2.2.6.5 Ability to Obtain Approvals from Other Agencies

No approvals by other agencies would be required to implement the ROD-selected remedy. The potential for increased bird strikes to aircraft approaching and departing the Lambert-St. Louis International Airport is a major concern of the Federal Aviation Administration (FAA) and the St. Louis Airport Authority (STLAA or Airport Authority). The effectiveness of best management practices and proposed bird nuisance mitigation measures would be of interest to the FAA and the Airport Authority.

6.2.2.6.6 Coordination with Other Agencies

Other than coordination with the STLAA regarding the bird hazard mitigation measures and effectiveness, coordination with other agencies would not be necessary to implement the ROD-selected remedy.

Although they would not be considered "agencies," coordination with the landfill owner and operator, the owners of the various parcels that comprise the West Lake Landfill property, and the asphalt batch plant tenant would be required during regrading and installation of an upgraded landfill cover under the ROD-selected remedy. Coordination would be necessary because:

- Access to operations conducted on other portions the Site would need to be maintained;
- Areas 1 and 2 are within a larger existing Site footprint, and use of areas on the West Lake Landfill property outside of Areas 1 and 2 might be necessary to stockpile cover materials or otherwise to facilitate cover construction; and
- For the time period during construction when trucks would be delivering rock, clay, and soil materials for cover construction, the flow of vehicles associated with remedy construction would need to be coordinated with the traffic patterns of vehicles associated with the on-site solid waste transfer station and asphalt plant.

The owners of all of the various parcels that comprise the West Lake Landfill are participating PRPs and given this, coordination with owners is expected to be feasible.

Coordination with other agencies including the Earth City Flood Control District and MSD and the Missouri Department of Transportation (MDOT), as well as the adjacent property owners and businesses (*i.e.*, Crossroads Property/AAA Trailer) would also be necessary to:

- Coordinate with the Earth City Flood Control District regarding the design of non-contact stormwater management and discharge facilities both during and after completion of construction;
- Coordinate with MSD regarding permitting and design of leachate/contact stormwater discharge during construction;
- Coordinate with MDOT for access to areas along St. Charles Rock Road (MO Route 180) and for any traffic control or ingress and egress additions along St. Charles Rock Road in the vicinity of the Site entrance; and
- Obtaining legal and physical access from Crossroad Properties, LLC and AAA Trailer for testing and, if necessary, remediation of the Crossroads Property and for implementation of remedial actions that may need to be performed along the property boundary (*e.g.* regrading, fencing, etc.).

6.2.2.6.7 Availability of Offsite Treatment, Storage and Disposal Services and Capacity

No off-site treatment, storage or disposal services are envisioned as part of the direct implementation of the ROD-selected remedy. Off-site treatment, storage and disposal may be required in the event that hazardous wastes or regulated asbestos-containing materials (RACM) are encountered during re-contouring Areas 1 and 2. Additionally, the four off-site disposal facilities identified for the "complete rad removal" and partial excavation alternatives are permitted to accept liquid, hazardous, and mixed wastes and asbestos, as well as to treat soil and/or debris that contain hazardous or mixed waste.

Offsite treatment and discharge of any leachate that may be encountered or stormwater that may contact waste materials during the landfill re-contouring activities could also be required. Off-site treatment and discharge of any leachate that may be encountered or stormwater that may contact RIM during the landfill excavation activities could also be required. Initial discussions with MSD indicated that they are willing to accept leachate and contact stormwater and initial discussions with the Earth City Flood Control District indicated a willingness to accept stormwater, subject to installation of additional stormwater detention/retention capacity.

6.2.2.6.8 Availability of Necessary Equipment and Specialists

Personnel, equipment, and materials are readily available to implement the cover systems, institutional controls, and monitoring components of this alternative. The implementability and potential cost of this alternative would be influenced by the availability and location of clean fill materials and/or off-site soil borrow sources at the time this alternative is implemented. Potential vendors of rock, clay and soil were contacted during the development of the FS (EMSI, 2006), during preparation of the Remedial Design Work Plan for the ROD-selected remedy (EMSI et al., 2008), and during preparation of the SFS (EMSI, et al., 2011). These vendors indicated that rock, clay and clean fill material were readily available from sources located near the Site at the time these inquiries were made. If these local sources of cover materials become exhausted prior to remedy implementation, cover materials would have to be obtained from suppliers at greater distances from the Site; however, all of the materials are expected to be available.

The necessary materials, equipment and personnel required for assessment and removal of radiologically-impacted soil that may be present at the Buffer Zone/Crossroads Property are also readily available.

6.2.2.6.9 Availability of Prospective Technologies

The ROD-selected remedy is based on proven, established, commonly used technologies. Use of prospective technologies is not anticipated to be part of the ROD-selected remedy.

6.2.2.7 Cost

Estimated capital, annual OM&M, and 30-year present worth costs for the ROD-selected remedy are included in Appendix K-3 and summarized on Table 6-1. Conceptual bottom and top of final cover grading plans and stormwater control features used as the basis for the ROD-selected remedy capital cost estimate are provided in Appendix M. The estimated costs to construct the ROD-selected remedy (i.e., design costs, capital costs, and costs for monitoring during the construction period) are $67 million. The estimated annual OM&M costs range from $167,000 to $326,000 per year depending upon the specific activities that occur each year (e.g., higher costs for years with additional environmental monitoring, years when landfill cover repairs may occur, and years when five year reviews are conducted). The cost estimates provided in this FFS are feasibility-level cost estimates; that is, they were developed to a level of accuracy such that the actual costs incurred to implement this alternative are anticipated to fall within a range bounded by 50% above and 30% below these estimates.

The present-worth costs of the ROD-selected remedy are projected to be $64 million over a 30-year period based on a discount rate of 7%. Based on the current OMB rate of 1.5%, the present worth costs would be $70 million. The total non-discounted costs for the ROD-selected remedy over 30 years are projected to be $73 million. Given the long life of the radionuclides present at OU-1, the costs for the ROD-selected remedy were also evaluated for 200- and 1,000-year periods (without consideration of any constraints on annual expenditures). The total non-discounted costs of the ROD-selected remedy are projected to be $102 million over a 200-year period. The total present-worth costs of the ROD-selected remedy are projected to be $64 million based on a 7% discount rate or $77 million based on a 1.5% discount rate, respectively, over a 200-year period. The total non-discounted and present worth costs of the ROD-selected remedy are projected to be $241 million over a 1,000-year period. The present worth costs over a 1,000-year period are projected to be $64 million based on a 7% discount rate or $78 million based on a 1.5% discount rate.

For purposes of demonstrating the extent to which shipping of mixed waste could influence costs, it was assumed that mixed waste would represent 0.5% of the total mass of the relocated volume for the ROD-selected remedy. The added costs for handling, sampling/analysis, shipping, treating, and disposing of mixed waste under the ROD-selected remedy are estimated to range from $240,000 to $450,000 depending upon the nature of the hazardous wastes (*i.e.,* metals or organics) that may be encountered. The range of costs primarily results from variations in the fees charged by the off-site disposal facilities and uncertainties associated with the nature of such wastes and the required method of treatment. If the volume of mixed waste is higher than the 0.5% of total mass assumption, the added costs would be higher as well.

6.2.3 "Complete Rad Removal" with Off-site Disposal Alternative

This section presents the detailed analysis of the "complete rad removal" alternative. As previously described in Section 5.4, this alternative consists of the following components:

- Removal of the asphalt plant and relocation of the Bridgeton Transfer Station, LLC building to provide access to RIM located adjacent to the building and construction of an overpass over the Site access road;

- Excavation and stockpiling of overburden from OU-1 Areas 1 and 2 in order to access the RIM;

- Excavation of RIM from OU-1 Areas 1 and 2 that contains radionuclides above levels that would allow for unrestricted use as defined by the UMTRCA standards in 40 CFR 192.12 as modified by EPA's 1997 and 1998 OSWER guidance (EPA, 1997a and 1998);

- Loading, transport, and disposal of the RIM at an off-site disposal facility;

- Survey and identification of the presence and extent of radiologically-impacted soil on the Buffer Zone and Crossroads Property;

- Excavation of any soil from the Buffer Zone and/or Crossroads Property that contains radionuclides at levels greater than those that would allow for unrestricted use and shipment of such soil to an off-site disposal facility;

- Regrading of the remaining solid waste materials within Areas 1 and 2 to meet the minimum (5%) and maximum (25%) slope criteria;

- Installation of a landfill cover meeting the Missouri closure and post-closure care requirements for sanitary landfills over Areas 1 and 2;

- Design, installation and maintenance of storm water runoff controls;

- Groundwater monitoring consistent with the requirements for sanitary landfills;

- Landfill gas monitoring and control, as necessary;

- Institutional controls to prevent land and resource uses that are inconsistent with a closed sanitary landfill site; and

- Long-term surveillance and maintenance of the landfill cover in Areas 1 and 2.

Under this alternative, an estimated 266,000 bank cubic yards (bcy) of RIM and impacted soils would be excavated for off-site disposal from Areas 1 and 2, and an additional approximately 2,900 bcy of impacted soil from the Buffer Zone/Crossroads Property would be excavated for off-site disposal under this alternative. However, the volume of material would increase upon excavation due to swelling, handling and loading for off-site transport. Applying an assumed swell factor of 1.5 and accounting for daily cover, it is estimated that approximately 444,000 loose cubic yards (lcy) would be transported off-site for disposal at a permitted disposal facility.

As indicated in Section 5.4.3, it is unknown whether extending a rail spur onto the Site would be feasible. If feasible, loading RIM material directly onto railcars on-site would reduce material handling steps and probably reduce transportation costs. Based on information provided by US Ecology for turnkey transportation and off-site disposal, transportation costs might be reduced as much as $35 per lcy of RIM if a rail spur of sufficient length could be extended onto the West Lake Landfill Site; however, this estimate does not take into account the costs of property acquisition, regulatory approval, or capital construction associated with an on-site rail spur, so the true cost reduction, if any, is unknown. Preparation of an engineering feasibility evaluation and a conceptual design to potentially extend a rail spur onto the Site is outside the scope of this FFS.

Therefore, based on discussions with US Ecology, for purposes of preparing a cost estimate for this alternative in this FFS it was assumed that excavated RIM would be loaded into 30-cubic-yard metal DOT IP intermodal (IM) containers, which would then be loaded onto and hauled by trucks to a truck-to-rail transloading operation at a rail spur location within a 10-mile radius of the West Lake Landfill Site, where the containers would be placed onto flatbed rail cars for shipment to one of the off-site disposal facilities described in Section 4.3.5.4.

For purposes of this FFS, it has been assumed that the RIM would be shipped for disposal at the US Ecology, Inc. facility in Grandview, Idaho. US Ecology provided the most complete information regarding transportation mechanisms and transportation and disposal costs. US Ecology has prior experience with transport and disposal of radioactive materials from SLAPS and other DOE/FUSRAP sites (Latty Avenue and Denver Radium Site Operable Unit 8).

Once all of the RIM above levels which would allow for unrestricted use has been removed from each area, the remaining solid waste materials in Areas 1 and 2 would be regraded to meet the final closure standards for sanitary landfills and a final sanitary landfill cover would be constructed over Areas 1 and 2. This cover would not include the additional hybrid components included in the ROD-selected remedy to address the UMTRCA requirements, because the RIM above unrestricted use levels would have been removed under this alternative.

However, because solid wastes would still be present in Areas 1 and 2, this alternative includes installation and maintenance of storm water runon and runoff controls, groundwater and landfill gas monitoring, and institutional controls, as described for the ROD-selected remedy. Environmental monitoring of groundwater quality would be performed to ensure that groundwater quality at the perimeter of the Site met UMTRCA and State groundwater standards or other ARARs. Monitoring of subsurface occurrences of landfill gas and, if necessary, implementation of contingent landfill gas extraction along the perimeter of Areas 1 and 2 would be performed to ensure that migration of landfill gas above regulatory thresholds does not occur beyond the Site perimeter.

Institutional controls would ensure that land and resource uses are consistent with permanent waste disposal.

6.2.3.1 Overall Protection of Human Health and the Environment

Conditions at the Site would be protective of human health and the environment after completion of construction of this alternative. This alternative would protect human health and the environment by limiting potential exposure to the Site contaminants through the removal and off-site disposal of RIM and implementation of engineering methods and land use controls to address the remaining solid wastes.

6.2.3.2 Compliance with ARARs

The "complete rad removal" alternative would comply with the ARARs discussed below.

6.2.3.2.1 UMTRCA

Removal of any soil containing radionuclides from the Buffer Zone and Crossroads Property would be done in a manner that meets the UMTRCA soil cleanup standards (40 CFR Part 192 Subpart B) as modified by the EPA guidance on the use of UMTRCA for cleanup at CERCLA sites (EPA, 1998 and 1997a). Although the UMTRCA standard is only intended to apply to land (which is defined to include any surface or subsurface land that is not part of a disposal site and is not covered by an occupiable building) and therefore is not considered to be an ARAR for Areas 1 and 2, removal of RIM from Areas 1 and 2 as specified by EPA (EPA, 2015b and 2010a) would also be conducted in a manner that achieved the UMTRCA standard as modified by the EPA guidance.

6.2.3.2.2 CERCLA Off-site Rule

Section 121(d)(3) of CERCLA (42 U.S.C. § 9621(d)(3)) applies to any CERCLA response action involving the off-site transfer of any hazardous substance, pollutant or contaminant (CERCLA wastes). These principles are stated in the Off-Site Rule (OSR) set forth in the NCP at 40 CFR § 300.440. The OSR requires that CERCLA wastes only be placed in a facility operating in compliance with RCRA or other applicable Federal or State requirements. The OSR prohibits the transfer of CERCLA wastes to a land disposal facility that is releasing contaminants into the environment, and requires that any releases from other waste management units at the disposal facility must be controlled.

The OSR establishes the criteria and procedures for determining whether facilities are acceptable for the receipt of CERCLA wastes from response actions authorized or funded under CERCLA. The OSR establishes both compliance and release criteria, and also establishes a process for determining whether facilities are acceptable based on those criteria. The OSR also establishes procedures for notification of unacceptability, reconsideration of unacceptability determinations, and re-evaluation of unacceptability determinations.

EPA verifies the acceptability of off-site treatment, storage, and disposal facilities (TSDFs) on a frequent basis. Consequently, before any off-site shipment occurs, a verification of current acceptability (VCA) must be obtained from EPA certifying that the proposed receiving facility is operating in compliance with the requirements of CERCLA Section 121(d)(3) and 40 CFR § 300.440. EPA (usually the EPA Regional Office) would determine the acceptability under this section of any facility selected for the treatment, storage, or disposal of CERCLA waste. EPA would determine if there are relevant releases or relevant violations at a facility prior to the facility's initial receipt of CERCLA waste. EPA typically makes such determinations every 60 days. The compliance status of an off-site disposal facility would need to be evaluated during RD and would need to be regularly evaluated and updated during remedy implementation.

6.2.3.2.3 Off-site Transportation Requirements

Transportation to an off-site disposal location would need to comply with both the substantive and administrative requirements of any regulations applicable to transportation of radiologically-contaminated materials. These would include U.S. Department of Transportation (DOT) regulations for transport of hazardous materials (49 CFR Parts 100 – 178), and specific regulations related to transport of radioactive materials (49 CFR Parts 171 – 180). These include regulations governing hazardous materials communications, emergency response information, training requirements and security plans (49 CFR Part 172) which address special provisions, preparation and retention of shipping papers, packaging and container marking, emergency response, security and planning. The regulations contain specific requirements associated with shipment of radioactive materials (*e.g.*, 49 CFR §§ 172.310, 172.436-440, and 172.556). Other regulations (49 CFR Part 173) describe requirements for shipment and packaging that are applicable to shippers and again include specific requirements for shipment of radioactive materials. Regulations set forth in 49 CFR Part 174 address shipment by rail and include special handling requirements for radioactive materials (49 CFR § 174.700). Required emergency response information is described in 49 CFR Subpart G (49 CFR § 173.602). The NRC, through a Memorandum of Understanding with DOT, also has promulgated regulations regarding transport of radioactive materials (10 CFR Part 71).

Requirements established by common carriers (including rail carriers) for transport of waste materials or radioactive wastes would also be applicable to this alternative. Because the specific carriers that might be used to transport the wastes under the "complete rad removal" alternative cannot be identified at this time, identification and evaluation of the carrier-specific requirements has not been performed.

Discussions with representatives of potential off-site disposal facilities indicate that most of the facilities would provide a turnkey service that includes transport of the RIM from the West Lake Site and subsequent treatment and disposal. As such, the disposal company would be responsible for arranging for transport, preparation of waste/shipping manifests, testing of RIM materials after they are loaded into transportation vehicles/containers, securing of vehicles/containers, unloading of vehicles/containers, safety and emergency response plans, and all other aspects associated with transport of RIM from the West Lake Site to an off-site disposal facility.

6.2.3.2.4 Waste Acceptance Criteria (WAC) for Off-site Disposal

WAC are established pursuant to the specific permit or license issued to each waste disposal facility, and consequently are different for each facility. Summaries of the WAC for each off-site disposal facility were presented in Section 3.2.3 of this FFS and would be complied with, as appropriate. Copies of the WAC provided by each of the facilities are contained in Appendix C. A comparison of RIM activity levels relative to the US Ecology WAC is presented on Table 6-2.

6.2.3.2.5 Missouri Solid Waste Rules for Sanitary Landfills

Regrading, cover and closure of the remaining solid waste at OU-1 Areas 1 and 2 after RIM removal would need to comply with the MDNR regulations described in Section 6.2.1.2.1 of this FFS. The only difference between the "complete rad removal" and the ROD-selected remedy would be that regrading Areas 1 and 2 after removal of the RIM under the "complete rad removal" alternative would need to meet a minimum slope angle of 5% instead of the 2% permitted for the ROD-selected remedy. The increased surface slope would be necessary to account for the increased risk of differential settlement resulting from the greater extent of excavation and material disturbance caused by the RIM removal including excavation, stockpiling, and relocation of relatively younger waste contained in the above-grade portion of the North Quarry part of the Bridgeton Landfill that overlies the southern portion of Area 1.

6.2.3.2.6 Safe Drinking Water Act

40 CFR Part 141 establishes primary drinking water regulations including maximum contaminant limits (MCLs) pursuant to section 1412 of the Public Health Service Act, as amended by the Safe Drinking Water Act (Public Law 93-523), and related regulations applicable to public water systems. These MCLs apply to public drinking water systems. Missouri regulations (10 CSR 60-4.010, et seq.) also establish MCLs for public drinking water systems. MCLs are considered relevant and appropriate to all potentially usable groundwater. As set forth in the NCP, non-zero maximum contaminant level goals (MCLGs) are also potentially relevant and appropriate to potentially usable groundwater. Regrading of the landfill surface and installation of an engineered landfill cover to promote runoff and minimize infiltration are included as part of this alternative. These measures should ensure groundwater quality that meets the MCLs and non-zero MCLGs.

6.2.3.2.7 NRC Standards for Protection Against Radiation

The NRC Standards for Protection Against Radiation (10 CFR Part 20) contain chemical-specific standards that address radiation protection. These regulations establish dose limits for individual members of the public and radiation workers, and define maximum permissible exposure limits for specific radionuclides in air and water at levels above background inside and outside of controlled areas. These requirements are considered applicable during implementation of any remedial action. Specifically, these regulations would require perimeter air monitoring during implementation of the "complete rad removal" alternative. In addition, Site health and safety plans would address worker protection consistent with these requirements.

6.2.3.2.8 Missouri Well Construction Code

MDNR has promulgated regulations pertaining to the location and construction of water wells. The Well Construction Code (10 CSR 23-3.010) prohibits the placement of a well within 300 feet of a landfill. These rules would provide protection against the placement of wells on or near the Site. The regulations on monitoring well construction (10 CSR 23-4) would apply to the construction of new or replacement monitoring wells. The "complete rad removal" alternative would meet these requirements through enforcement of the existing Institutional Controls[46] and adherence to the Well Construction Code requirements for installation of new monitoring wells or abandonment of existing monitoring wells.

6.2.3.2.9 Missouri Stormwater Regulations

The Missouri regulations governing stormwater management at construction sites are set out in 10 CSR 20-6.200 (Table 3-3). A disturbance of greater than one acre or the creation of a storm water point source during construction of the remedy would trigger these requirements. The "complete rad removal" alternative would meet these requirements through implementation of a SWPPP, use of BMPs during construction, installation and maintenance of an engineered landfill cover to prevent stormwater from contacting the waste materials, and construction and maintenance of stormwater diversion and control structures to control runon and runoff and reduce erosion potential as part of the design of the engineered landfill cover.

6.2.3.3 Long-Term Effectiveness and Permanence

Because the "complete rad removal" alternative is defined by EPA to result in removal of RIM containing radionuclides above unrestricted use levels from the Site, this alternative would provide permanent protection against exposures to radionuclides. This conclusion assumes there would be no long-term impacts to the environment in the vicinity of the off-site disposal facility or to any communities along the transport route from transport to and disposal of RIM at the off-site disposal facility.

RIM containing radionuclides at levels above those that would allow for unrestricted use would be removed from the Site under this alternative; however, other solid wastes would still remain at the Site, and it would still remain a landfill subject to the applicable requirements for closed solid waste landfills. Therefore, a new landfill cover would need to be installed over the remaining solid wastes after removal of the RIM above cleanup levels. Groundwater monitoring would need to be performed consistent with the applicable or relevant and appropriate requirements for a solid waste landfill. Institutional controls would also be required to ensure that future land uses at the Site would be compatible with the presence of a solid waste landfill and to prevent intrusion into the waste materials, disruption of the landfill cover, monitoring points, or other aspects of the solid waste landfill containment system.

6.2.3.3.1 Magnitude of residual risk

The calculated lifetime risks from radiological materials that would remain in Areas 1 and 2 after implementation of the "complete rad removal" alternative are as follows:

- Area 1: $<1 \times 10^{-7}$ for year 1 and $<1 \times 10^{-7}$ for year 1,000.

[46] In addition, the deed restrictions currently in place on Areas 1 and 2 and the Buffer Zone (and which are to be maintained in perpetuity) prohibit the placement of water wells for drinking water or agricultural purposes.

- Area 2: <1 x 10^{-7} for year 1 and <1 x 10^{-7} for year 1,000.

These calculated risks are attributable to gamma radiation and radon emissions from the radionuclide occurrences that would remain after implementation of the "complete rad removal" alternative. Any such residual materials would be present at levels which do not require further remediation. The calculated risk levels are below EPA's target risk range of 1 x 10^{-6} to 1 x 10^{-4} and the magnitude of the radiological carcinogenic risk from residual RIM in these two remediated areas is acceptable. These risks do not specifically include potential exposures from non-radiological landfill waste after construction is complete; however, those wastes would also be covered by a cap which would prevent exposures. Additional information regarding the risk assessment calculations is presented in Appendix H.

Additionally, the remaining landfill wastes, including any residual radionuclides below unrestricted use levels, would be capped with access to and future use of the capped waste disposal areas limited by Site access restrictions and institutional controls. Direct contact with residual RIM under the cap, or ingestion, inhalation, or dermal contact with such materials, is not expected to occur. These also are the primary exposure pathways for any non-radiological COPCs which may be present in the landfill wastes remaining in Areas 1 and 2 after removal of the RIM. Because no complete exposure pathway would exist for such materials after completion of the cap construction, the landfill waste materials would not be expected to produce non-carcinogenic effects or carcinogenic risks.

After soils containing radionuclide concentrations above the cleanup levels are removed from the Buffer Zone/Crossroads Property, residual risks posed by the remaining radionuclide-impacted soils on these properties, if any, are expected to be indistinguishable from variations in background levels.

6.2.3.3.2 Adequacy and reliability of controls

Although the "complete rad removal" alternative as defined by EPA (2015b and 2010a) is presumed to result in removal of RIM such that the remaining materials would allow for unrestricted use relative to the presence of radionuclides, there is uncertainty as to whether all of the RIM above cleanup levels could be removed. There are several areas where RIM is located at substantial depth. In addition, some of the RIM in OU-1 Area 1 is located adjacent to or beneath the above-grade portion of the North Quarry part of the Bridgeton Landfill and some of the RIM in OU-1 Area 2 is located very close to the adjacent Closed Demolition Landfill or the Inactive Sanitary Landfill, which are not known to contain radionuclides and are therefore part of OU-2. The proximity of these adjacent landfills greatly increases the level of difficulty and the amount of overburden material that would have to be moved to access and remove some of the RIM. These conditions would increase the potential for failure of the adjacent landfill units during implementation of the OU-2 remedy and the potential that all of the RIM above cleanup levels may not be able to be removed from Areas 1 and 2.

There are a very limited number of possible off-site facilities where the RIM could be disposed, and therefore there are uncertainties regarding land disposal. There also are uncertainties regarding the acceptability of the wastes at some of the facilities, further limiting the number of facilities that could accept the wastes. At this time, only four facilities have been identified that might be able to accept these wastes. See the discussion in Section 3.2.3 for a description of these facilities and their capabilities.

The engineered measures and institutional controls that would be implemented for Areas 1 and 2 under the "complete rad removal" alternative (landfill cover, groundwater and landfill gas monitoring, and institutional controls), are considered to be adequate and reliable. OM&M requirements for the "complete rad removal" alternative would be the same as those included in the ROD-selected remedy. No difficulties or uncertainties or potential need to replace significant components are envisioned for the long-term OM&M functions for the "complete rad removal" alternative.

Because the "complete rad removal" alternative entails removal of all RIM above the criteria that would allow for unrestricted use relative to radionuclide occurrences, the remedial actions included in this alternative are expected to be a final action for OU-1, and it is assumed that no components of the remedy would need to be replaced in the future. The landfill cap would need to be maintained but because it would be composed of natural materials (*e.g.*, soil) it should not need to be replaced. However, in the unlikely case that components of the remedy need replacement in the future, unacceptable risks are not expected to occur because the Site presents only slight risks under current conditions. Moreover, given that the components of the final covers at Areas 1 and 2 would be constructed from natural materials with properties that limit migration potential of any residual radionuclides below unrestricted levels or solid waste constituents, there is a high degree of confidence that the engineered controls would prevent or otherwise address potential problems.

6.2.3.3.3 Climate Changes and Potential Impacts of a Tornado

Because municipal solid waste would still remain in Areas 1 and 2, a new engineered landfill cover would be installed over these areas. Because radionuclides above unrestricted use levels would be removed from the Site under this alternative, the engineered landfill cover to be installed under this alternative would not include the 2-foot thick rock/rubble biointrusion layer. Instead, the engineered cover would consist of a standard landfill cover for a Subtitle D MSW landfill without a liner system, which would consist of a 2-foot-thick low-permeability layer and a 1-foot-thick vegetative layer. This engineered landfill cover would be classified as an in-situ containment system (EPA, 2014a).

Because of the general similarity between the engineered landfill cover to be installed over Areas 1 and 2 under the "complete rad removal" alternative with the landfill cover to be installed under the ROD-selected remedy, the analysis of the potential effects of climate change or impacts of a tornado are essentially the same for both alternatives. These effects were previously discussed in Section 6.2.1.3.3 for the ROD-selected remedy and therefore the overall evaluation of climate change effects and potential impacts from a tornado will not be repeated again here.

Similar to the ROD-selected remedy, the vegetative layer of the landfill cover to be installed under the "complete rad removal" alternative could be vulnerable to increased occurrences of extreme temperatures, sustained changes in average temperatures, decreased precipitation and increase in drought occurrences. Increased temperatures or decreased precipitation/drought could affect the viability of the vegetation (*e.g.*, grasses) on the surface of the landfill cover. Any changes to the overall health of the vegetative cover would be readily identifiable by visual inspection. Therefore, although the vegetative cover may be vulnerable to potential increased temperatures or drought conditions, the potential for impacts to the vegetative layer could be anticipated and readily identified in advance of any such occurrence.

The low permeability layer (CCL) could be damaged by periods of extended extreme temperatures or prolonged drought. Potential impacts could include the desiccation of the CCL, which could increase the CCL's permeability and therefore also increase the potential for precipitation infiltration. These potential impacts are not considered to be significant because the Site has existed for over 40 years with essentially flat (no grade) surfaces and minimal cover material, thereby maximizing precipitation infiltration. Even with this increased potential for infiltration of precipitation through Areas 1 and 2, the USGS (2014) concluded that that there is not a strong spatial association of monitoring wells surrounding or downgradient of RIM areas with elevated radium concentrations, as might be expected if RIM areas were releasing substantial quantities of radium to the groundwater. EPA has indicated that additional evaluations of groundwater will be conducted in the future as part of the OU-3 RI/FS. Therefore, even if desiccation of the low-permeability layer were to occur, the impacts to groundwater quality are not expected to be significant. More importantly, the vegetative layer would likely show significant signs of stress from increased temperatures/drought prior to the occurrence of any impacts to the underlying low-permeability layer and thereby provide advance notice of a potential impact to the CCL. Accordingly, although the low-permeability layer could potentially be vulnerable to effects of increased temperature or drought, the potential for any impacts could be anticipated and readily identified in advance of any such occurrence. For these reasons, potential degradation of the CCL due to extreme temperatures or drought is not expected to result in release of contamination.

Increased heavy precipitation events could result in erosion of the vegetation layer and, if left untended, could result in erosion of the underlying low permeability layer. Any erosion of the landfill cover would be readily identifiable by visual inspection. Given that the landfill cover under the "complete rad removal" alternative would not include the 2-foot thick rock layer in the base of the cover system, stormwater erosion under a severe storm event could potentially erode down through the entire landfill cover, resulting in temporary exposure of waste materials. Heavy precipitation events could impact the integrity or performance of stormwater drainage conveyance structures, including the erosion of drainage channels, damage to or bypassing of let-down and erosion control structures and features, or damage to stormwater detention structures. Heavy precipitation events could also temporarily restrict access to portions of the landfill cover, stormwater control structures, and environmental monitoring points, thereby causing delays in implementation of repairs (if any are needed). Therefore, the vegetation layer and stormwater controls are potentially vulnerable to impacts from heavy precipitation events. This could result in exposure of the waste material or release of contamination; however, because under the "complete rad removal" alternative it is presumed that all RIM above unrestricted use levels would be removed, such impacts would not result in release of radionuclides above risk-based levels. Furthermore, any impacts that occur could be readily addressed as part of normal maintenance and repair of the landfill cover, including localized regrading, repair and replacement of cover material in response to any damage that may occur.

The "complete rad removal" alternative is not anticipated to be impacted by flooding that may occur in the area of the Site. As previously discussed in Section 2.1.6, FEMA has determined that Areas 1 and 2 are located outside of the 500-year floodplain. In addition, the area to the north and west of Area 2 (*e.g.,* Crossroads Industrial Park and Earth City Industrial Park) that potentially could be subject to flooding by the Missouri River, are protected by the engineered levee and stormwater and flood control systems installed to protect the Earth City Industrial Park.

Similar to the ROD-selected remedy as discussed in Section 6.2.1.3.3, the "complete rad removal" alternative is not vulnerable to impacts from a tornado. Specifically, a tornado is not expected to damage the vegetative layer, and even if it did, such an impact would not be significant because it could be easily identified and, due to the design and thickness of the engineered cover, would not result in exposure of the underlying waste or release of contamination. A tornado could damage or destroy aboveground infrastructure such as signage, fencing or environmental monitoring equipment; however, such impacts are not expected to be significant because they would be readily identified and easily repaired or replaced. Therefore, the "complete rad removal" alternative is not considered to be vulnerable to potential impacts from a tornado.

Although the "complete rad removal" alternative is not considered to be vulnerable to climate change, implementation of adaptation measures could be considered during remedial design to provide a degree of adaptation for climate change. For example, regrading of the surface of Areas 1 and 2 to a 2% slope instead of a 5% slope could be considered to reduce the velocity of runoff across the surface of Areas 1 and 2 and thereby reduce erosion and soil loss potential under extreme precipitation events. Installation of runoff collection and diversion systems along the base of the above-grade portion of the North Quarry part of the Bridgeton Landfill adjacent to Area 1 and along the north sides of the Closed Demolition Landfill and the Inactive Sanitary Landfill adjacent to Area 2 could be installed in order to divert runoff from these areas around Areas 1 and 2 to reduce the potential for impacts from heavy precipitation events. Use of grass seed mixtures that are more tolerant of long-term changes in precipitation or temperature and/or soil addition to increase water storage capacity could be evaluated as part of the design. Similarly, inclusion of a geotextile at the base of the vegetative layer could be considered to minimize the potential for water or wind erosion extending down into the underlying low permeability layer. The design grades of the stormwater conveyance structures could be evaluated to provide a balance between the ability to quickly route stormwater away from Areas 1 and 2 while minimizing the stormwater velocity and the associated potential for erosion of the stormwater conveyance structures. Identification and evaluation of additional adaptation measures can be addressed as part of the design of the engineered landfill cover and stormwater controls to increase the overall resilience of these features to heavy precipitation events. Continuous re-evaluation of potential vulnerabilities, system resilience and possible adaptation measures would be included as part of the ongoing inspection and maintenance program.

6.2.3.3.4 Potential Impacts of a Subsurface Heating Event

Because it is presumed that all radionuclides above unrestricted use levels would be removed from the Site under the "complete rad removal" alternative, no radionuclide-related impacts would occur if an SSE or SSR were to occur in Areas 1 or 2. Odor emissions, ground settlement, and other impacts associated with a heating event could potentially still occur under the "complete rad removal" alternative. These would be addressed as part of OM&M activities including activities such as placement of additional soil to fill areas of subsidence, repair the landfill cover, and reduce odor emissions.

6.2.3.3.5 Effects of an Isolation Barrier

Because it is presumed that all of the radionuclides above unrestricted levels would be removed under the "complete rad removal" alternative, there would be no need for installation of an isolation barrier. If an isolation barrier were installed prior to implementation of a "complete rad removal" alternative, large portions of such a barrier would need to be removed and hence destroyed in order to gain access to RIM located in the subsurface in the vicinity of a barrier.

6.2.3.3.6 Environmental Justice Considerations

As was previously discussed in Section 6.2.1.3.6 as part of the evaluation of long-term effectiveness of the ROD-selected remedy, a screening level analysis did not identify any environmental justice concerns relative to the Site. EPA did identify a need for implementation of more traditional (non-electronic) communication methods to inform and ensure meaningful involvement of residents in the Terrisan Reste mobile home community.

6.2.3.4 Reduction of Toxicity, Mobility or Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy. The "complete rad removal" alternative is an off-site disposal action that does not include treatment as a primary component.

As discussed in Section 4, radionuclides are naturally-occurring elements which cannot be neutralized or destroyed by treatment. Occurrences of radionuclides within Areas 1 and 2 are dispersed within soil material that is further dispersed throughout portions of the overall, heterogeneous matrix of municipal refuse, construction and demolition debris, and other non-impacted soil materials in Areas 1 and 2. Consequently, ex-situ treatment techniques are considered impracticable. In addition, the heterogeneous nature of the solid waste materials and the dispersed nature of the radionuclide occurrences within the overall solid waste matrix in portions of Areas 1 and 2 make in-situ treatment techniques equally impracticable. The remedy for the Buffer Zone/Crossroads Property also would not reduce toxicity, mobility, or volume through treatment because it consists of removing radiologically-impacted soil from the Buffer Zone/Crossroads Property and shipping it off-site for disposal.

An on-site technology that may potentially be applicable to the "complete rad removal" alternative is physical separation of impacted soil from the solid wastes by using solids separation techniques such as hand-picking for large bulky items and various fixed, vibrating, or rotating screens, among others (see discussion in Section 4.3.5.2). Physical separation would not decrease the mobility or toxicity of the radiologically-impacted materials, but has the potential to separate existing RIM from non-radiologically-impacted materials. As previously discussed, any solids separation techniques would need to be pilot-tested at full-scale using materials from Areas 1 and 2 during remedial design to ascertain the potential effectiveness, implementability, and cost of this technology. Of particular interest in conducting pilot-testing with material from Areas 1 and 2 would be obtaining an estimate of the degree of RIM volume reduction that could be achieved, assessing the moisture content of the filled material, determining the fraction of soil that would be contained in or adhered to the segregated refuse, and determining the residual levels of radioactivity that would be present in the non-soil refuse after screening out the soil fraction. Assuming that solids separation could prove to be an effective and implementable technology (that is, it could effectively separate the radiologically-impacted soil from the other landfilled waste materials such that the other landfilled wastes would contain radionuclide activities below the levels that would allow for unrestricted use), it has the potential to reduce the volume of radiologically-impacted material that would need to be transported to an off-site disposal facility. However, little is known about the potential application of a soils separation technology to this situation, and it is possible that pilot-testing could demonstrate that physical separation would not be effective at separating RIM from non-radiologically-impacted materials, in which case, the non-radiologically-impacted materials would also need to be shipped off-site for disposal. At this stage of analysis, neither the estimated costs nor the estimated schedules in this FFS include any allowance for solids separation pilot-testing or implementation.

In the event that hazardous wastes are encountered during implementation of the remedy, such materials would be separated from the other solid wastes and subjected to waste profiling to determine the appropriate treatment and disposal requirements. To the extent that hazardous wastes or mixed wastes are encountered, they would be shipped off-site and would be treated at the disposal facility in accordance with the hazardous waste regulations (e.g., EPA's Land Disposal Restrictions (LDR) program and Universal Treatment Standards (UTS)) and in accordance with the permits and standard operating procedures of the receiving facility. After arriving at an off-site disposal facility and undergoing a waste receipt analysis, RCRA soil/debris and RCRA soil/debris with radionuclide material would be stabilized prior to placement in a disposal cell. Depending on its physical characteristics, RCRA debris and RCRA debris with radionuclide material would undergo either micro- or macro-encapsulation prior to placement in a disposal cell. To the extent that treatment of the hazardous waste or mixed waste would be required for off-site disposal, stabilization or encapsulation treatment would result in a reduction of the mobility of the hazardous waste and radiologically-impacted components of the mixed waste. Toxicity and volume would not be reduced by these technologies but may be reduced by other technologies potentially applicable to hazardous wastes that do not contain RIM, if such wastes were encountered during implementation of the remedial action at the Site.

For the “complete rad removal” alternative, any hazardous waste or mixed waste would be shipped to the off-site disposal facility either separately by truck or, depending upon the volume, possibly by rail in conjunction with shipment of the RIM. If the volume is small, the material may be placed in drums, metal boxes or other containers and shipped by truck, although if the volume is sufficient to fill an IM container, it may be shipped by rail. Shipment of mixed waste to an off-site disposal facility by rail would not be significantly different than shipment of RIM. Like the RIM, the mixed waste would be loaded into 30-cubic yard metal DOT intermodal containers and hauled by truck to a truck-to-rail transloading station. The IM containers would be placed on flatbed rail cars and transported via rail to one of the off-site disposal facilities described in Section 4.3.5.4. Either way, any material that is identified as hazardous would be handled and shipped as discrete material and not mixed with a larger volume of RIM. Both types of materials would be subjected to a radiation survey and classification in accordance with DOT requirements; however, the shipping documentation would be slightly different. While the RIM would be shipped under a bill of lading with appropriate placarding identifying the material as radioactive, the mixed waste would require use of a uniform hazardous waste manifest and specific placards and markings on the semi-trucks and rail cars identifying the material as hazardous waste in addition to being radioactive.

Beyond the shipping aspect, the hazardous component of any mixed waste would present additional issues with respect to waste segregation, sampling/analysis, and ultimate disposition at the off-site disposal facility. During excavation, any suspected hazardous or mixed waste would be segregated from the waste containing only overburden material or RIM, stockpiled in a separate area, sampled and analyzed for toxic characteristic leaching procedure (TCLP) parameters, and covered with a tarp or other cover material until analytical results were available. Sampling procedures and analytical methods would be addressed in a Remedial Action Sampling and Analysis Plan to be developed during the remedial design phase.

Based on analytical results, segregated materials would be assigned a waste profile of non-RCRA soil and debris, non-RCRA soil and debris with radionuclide material, RCRA soil, RCRA soil with radionuclide material, RCRA debris, or RCRA debris with radionuclide material. The non-RCRA soil and debris would be relocated with the overburden stockpile; the non-RCRA soil and debris with radionuclide material would be managed along with the RIM; and the RCRA soil, RCRA soil with radionuclide material, RCRA debris, and RCRA debris with radionuclide material would be packaged and shipped to the off-site disposal facility in containers separate from the RIM with appropriate marking/placarding under a unique manifest. In order to comply with the RCRA waste storage limitations, stockpiled RCRA soil, RCRA soil with radionuclide material, RCRA debris, and RCRA debris with radionuclide material would not be stored on-site beyond the RCRA specified maximum accumulation periods prior to shipment to the off-site disposal facility.

The four off-site disposal facilities identified and discussed in Section 4.3.5.4 are all permitted to accept RCRA wastes and mixed wastes (Section 3.2.3) subject to their WAC (Appendix C).

After arriving at the selected off-site disposal facility and undergoing a waste receipt analysis, RCRA waste/soil and RCRA waste/soil with radionuclide material would be stabilized prior to placement in a disposal cell. Depending on the physical characteristics of the debris, RCRA debris and RCRA debris with radionuclide material would undergo either micro- or macro-encapsulation prior to placement in a disposal cell.

6.2.3.5 Short-Term Effectiveness

The "complete rad removal" alternative poses significant potential short-term risks, as described below. During a public meeting held as part of the ROD-selected remedy process, EPA identified and discussed the following short-term risk issues for waste excavation: waste handling, sorting and stockpiling; water management; noise, odor and windblown trash; worker health and safety (PPE, gamma exposure, physical stress, physical hazards, workplace monitoring); contaminant migration/spreading (fugitive dust and airborne migration, fugitive dust control and water application, leachate generation, equipment decontamination water, and water from open excavations); and waste hauling and transportation/truck decontamination issues (transfer facilities, increased local traffic, waste handling on public roads, interstate transport by rail, DOT requirements, safety issues).

6.2.3.5.1 Protection of the Community During Remedial Actions

The projected carcinogenic risks that may be posed to off-site residents by this alternative are expected to be less than 1×10^{-7}, which is within EPA's acceptable risk range. No non-carcinogenic risks are expected to occur.

Unless a rail spur is extended onto the West Lake Landfill Site (the feasibility of which, as discussed in Section 5.4.3, is currently uncertain), significant additional local truck traffic would occur during the construction period for the "complete rad removal" alternative, in order to implement the transfer of the excavated RIM to a local off-site truck-to-rail transloading location. It is estimated that nearly 29,500 round trips of semi-trucks would be required to truck the excavated RIM from the Site to a rail spur location in the vicinity of the Site and from a rail spur transloading location near the off-site disposal facility to that facility. These additional truck trips would result in additional physical risk to the local communities and truck drivers due to potential traffic accidents. Transfer of RIM from the Site by truck to an off-site rail transloading facility, by rail to the general geographic area of the disposal facility, and off-loading and transfer by truck to the actual off-site disposal facility location would be required, all of which would result in the increased potential for release of RIM as a result of traffic or train accidents and the extensive amount of additional handling of the RIM required for this alternative.

The risk assessment (Appendix H) includes an estimate of the projected incidence of transportation accidents associated with each FFS alternative. For the "complete rad removal" alternative, the projected incidence of transportation accidents associated with removal of RIM, regrading of the landfill, and importing of materials for construction of the multi-layer landfill cover is 34.9, meaning that approximately 35 accidents are projected to occur if this option were implemented.

The excavated waste to be shipped off-site would be placed in sealed metal containers (sealed DOT Industrial Packaging [IP] intermodal [IM] containers) before leaving the Site, so there should not be any spillage or other release of RIM from the containers during transport unless a major vehicular accident occurs that results in significant damage to both the transport vehicle (truck trailer or railroad car) and the DOT IP container. Notwithstanding the implementation of appropriate protective measures, a potential does exist for loose debris that may contain RIM to adhere to the wheels, under-carriage, or sides of the transport vehicles. All vehicles leaving the Site would be subject to screening for potential radioactivity and cleaning as necessary to remove any debris that may contain radioactivity prior to leaving the Site. In the event that such material is not identified during screening or removed during cleaning, a potential exists for this material to be released along the route of transport from the Site to the off-site disposal facility. If such releases were to occur, members of the public that traverse the same roads or that trespass onto the railroad tracks could potentially be exposed to RIM that may be released. Such exposures are not expected to pose a significant risk due to the anticipated small amounts of material that potentially could be released, the distance between such materials and possible receptors, the limited duration of exposure, and the presence of shielding associated with vehicular use of the roads or limited trespass onto the rail lines (see Appendix H).

Disturbing the waste material during implementation of the “complete rad removal” alternative may expose the community to radioactive waste, methane and radon gas and other contaminants, and cause a release of undesirable odors. Excavation of existing waste materials would undoubtedly result in odor emissions during the period of time that existing wastes may be handled or exposed. Mitigation of odors through engineering means is limited.

The “complete rad removal” alternative would contribute significant carbon dioxide equivalent emissions as a result of ongoing vehicle operations associated with remedial work. In particular, approximately 83,000 tons of carbon dioxide equivalent emissions are projected to be emitted to the atmosphere as a result of landfill regrading work, construction of the landfill cover, the excavation, loading, and transport of the RIM to an off-site disposal facility, and the importation of materials used to construct the multilayer landfill cover (Appendix I, Table I-5).

Because RIM in Areas 1 and 2 would be excavated under this alternative, overburden containing putrescible wastes would be stockpiled and stored and RIM would be loaded into transport containers. During these activities, the nuisance attraction to and congregation by birds at and above the affected areas would be problematic unless effectively controlled. The FAA has stated that “[t]o date, no . . . [putrescible waste] facility has been able to demonstrate an ability to reduce and sustain hazardous wildlife [birds] to levels that existed before the putrescible-waste landfill operations began operating.” (FAA, 2007). The main concern would be the potential for increased bird strikes to aircraft approaching and departing from the Lambert-St. Louis International Airport. For the “complete rad removal” alternative, an enclosed waste staging and loading structure would be constructed to minimize the outdoor handling of waste and associated attraction of birds or other vectors. Additional mitigation measures (such as excavation best management practices, which include application of daily soil cover and/or tarping of exposed waste, visual and auditory frightening devices, or use of wire or monofilament grids positioned over exposed refuse to prevent bird access) could be implemented to attempt to minimize bird attraction to and congregation at and above the disturbed areas.

Excavation of waste materials from Areas 1 and 2 would require removal of the existing landfill cover and overburden from Areas 1 and 2 and portions of adjacent areas of OU-2. Excavation of overburden and RIM would create depressions in the landfill area during the period of time required to remove the RIM and regrade and cover the remaining landfill wastes. Precipitation that falls on the landfill while such depressions are open would potentially flow into and accumulate in the depressions. Any accumulation of precipitation[47] in depressions created during waste excavation could result in increased infiltration of precipitation runoff through the underlying waste materials, which could result in increased leaching of volatile organic compounds (VOCs) or other soluble contaminants from the waste materials.

Because Areas 1 and 2 would be excavated and RIM loaded into transport containers, storm water controls would be implemented in accordance with the Missouri Storm Water regulations 10 CSR 20-6.200 to protect the community. During construction, consideration would be given to minimizing the areas of excavation that would be open and the areas of exposed waste materials at any given time. Temporary diversion berms would also be constructed above the open excavation areas and any previously excavated (and temporarily covered) surfaces in order to divert precipitation runoff around the open excavation to prevent the runoff from contacting uncovered waste materials. Precipitation that would contact uncovered waste materials would flow into the low point of the excavation and be pumped out into temporary storage tanks using portable gas-driven pumps. Samples would be collected from the tanks and sent to a laboratory for analysis. The stored water would be directly discharged or treated and disposed appropriately based on the analytical results.

6.2.3.5.2 Environmental Justice Concerns

As was previously discussed in Section 6.2.1.5.1 as part of the evaluation of short-term impacts associated with the ROD-selected remedy, a screening level analysis did not identify any environmental justice concerns. EPA did identify a need for implementation of more traditional (non-electronic) communication methods to inform and ensure meaningful involvement of residents in the Terrisan Reste mobile home community.

6.2.3.5.3 Protection of Workers During Remedial Actions

The "complete rad removal" alternative would entail significant excavation, handling, loading and transport of RIM at the Site and therefore would pose both significantly increased radiological exposure risks as well as construction safety risks to on-site workers. The risk assessment (Appendix H) presents an evaluation of potential risks to Site workers that may occur

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[47] Accumulation could be significant during a heavy rainstorm insofar as the maximum historical 24-hour rainfall for the St. Louis area ranges from a low of 3.7 inches in November to a high of 8.8 inches in August (NOAA, 2011).

for each alternative. These include risks from industrial accidents, exposure to carcinogenic substances, and projected radiation exposures. For the “complete rad removal” alternative, the projected incidence of industrial accidents is 17.8 over the life of the project. The projected carcinogenic risk to the maximally exposed individual (radiation field technician) is 2.2 x 10^{-3}, and the projected radiation dose to a remediation worker is 405 mrem/yr (Appendix H).

Workers involved in the excavation activities may be subject to potential short-term risks associated with excavation of the waste materials, including exposure to contaminated waste; excavation/trenching instability; stormwater runoff entering areas where waste is exposed, resulting in the exposure to contact storm water; odor emissions; and other aesthetic issues (*e.g.*, windblown trash) arising from exposed waste. Worker exposures would be addressed through development and implementation of a site safety plan, use of personal protective equipment, and performance of personnel and environmental monitoring during implementation of remedial action. Workers would be protected during construction by adhering to OSHA practices; however, as this alternative entails extensive excavation, handling and transportation of RIM, OSHA work practices and personal protective equipment may not provide full protection against exposure to external gamma radiation.

Excavation would require construction workers and equipment that would initially disturb the overburden soil and underlying waste materials. Dust control measures would be required to limit worker exposure to fugitive dust during construction. As discussed in Section 6.2.2.4 above, the separation of radiologically-impacted soil from solid wastes and construction/ demolition debris may (if feasible) be a potential means of reducing the overall volume of material and resultant cost of off-site transport and disposal; however, this action would increase short-term exposures and risks to remediation workers because the screens or other equipment used to segregate large items and debris from the soil become fouled with plastic, wood, and other debris that potentially would need to be physically removed by workers. Such activities would require workers to be in close proximity to the RIM, thereby increasing their short-term exposure risks. The risk assessment conducted for this FFS does not account for such increased physical separation/segregation exposures to workers.

6.2.3.5.4 Environmental Impacts

No measurable long-term impacts to plants or animals in surrounding ecosystems are expected from this alternative. As noted in the original and updated BRA (Auxier & Associates, 2000 and 2016a), some of the ecosystems present at the Site are the result of existing institutional controls and other limitations on land use within or adjacent to OU-1 that have allowed field succession to take place. Much of the habitat on Areas 1 and 2 was removed in 2016 in conjunction with construction of the non-combustible cover. Excavation of RIM, regrading of Areas 1 and 2, and construction of the engineered landfill cover under the “complete rad removal” alternative would destroy the remaining portions of the habitats that currently exist on the surface of Areas 1 and 2, forcing wildlife to migrate to other areas. Vegetative cover would be placed on the Site as a part of the final cover, and the landfill would be allowed to return to an early-stage field ecosystem with periodic mowing and maintenance.

6.2.3.5.5 Ability to Monitor Effectiveness

Regular monitoring of groundwater quality would be performed at appropriate locations around Areas 1 and 2 to assess the effectiveness of this alternative.

6.2.3.5.6 Time Until Remedial Action Objectives Are Achieved

The RAO related to the Buffer Zone and Crossroads Property soil would be met upon removal of any remaining soil containing radionuclides above unrestricted levels from these areas. The RAOs related to Areas 1 and 2 would be met once the RIM excavation and construction of the new landfill cover over Areas 1 and 2 were completed. Excavation and off-site disposal of RIM makes achievement of these RAOs post-excavation more certain because the "complete rad removal" alternative is predicated on the assumption that all RIM above unrestricted use levels would be removed from the Site, thereby greatly reducing the RIM source term and the magnitude of potential exposures to radionuclides, potential future radon emissions, and potential leaching of radionuclide constituents in the unlikely event that the landfill cover or institutional controls were to fail.

Initiation of this alternative would require significant planning and permitting due to the limited number of off-site disposal facilities capable of taking RIM and the extensive logistics associated with identifying, handling, classifying and loading the materials for transport to the selected off-site facility. Preparation of the remedial design should be completed within approximately 15 months of authorization to proceed with the RD. RD could take significantly longer if full-scale pilot-testing of solids separation equipment were to be performed. The RAOs would be achieved upon completion of construction, which is estimated to be finished within approximately 12.1 years after approval of the RD. Therefore, the remedial action objectives should be achieved within 13.35 years of approval to proceed with the RD (Appendix J). This schedule estimate assumes that the buyout of the asphalt company lease and potential permitting for and subsequent relocation of the solid waste transfer station occurs during the remedial design phase; otherwise, the schedule would be longer.

The projected construction schedule and the cost estimate for the "complete rad removal" alternative are highly dependent on the waste material swell factor; that is, the amount the in-place waste volume expands as it is excavated, handled and loaded for transport to an off-site disposal facility. For purposes of this FFS, a swell factor of 1.5 has been assumed. A swell factor greater than 1.5 would result in an increase to the overall construction schedule and the estimated costs. The projected construction schedule and the cost estimate for the "complete rad removal" alternative also are highly dependent on the number of rail cars that could be loaded and shipped per day. The schedule and cost estimate developed in this FFS for this alternative are based on an assumption that a sufficient number of IM containers and rail cars can be made available, loaded, switched out and replaced every day. The schedule is also based on (1) a "fleet" (*e.g.*, approximately 20) of flat railcars being dedicated to the project that would be continuously cycled between the off-site disposal facility and the St. Louis area during the period of time required to transport RIM to the off-site disposal facility and (2) the RIM loading operation being performed in a relatively continuous manner with a constant volume of RIM being transport off-site per day. If the actual rate is less than the projected rates of RIM excavation used to develop the construction schedule or if the RIM loading and transport operation is not relatively continuous, the time required to complete construction and the costs for the "complete rad removal" alternative would increase.

6.2.3.6 Implementability

This alternative would involve excavation and off-site disposal of RIM in Areas 1 and 2, repair and restoration of the disturbed portions of the OU-2 landfill units adjacent to Areas 1 and 2, grading of the surfaces and installation of upgraded landfill covers over the excavated areas of Areas 1 and 2, long-term monitoring and maintenance of the covers, and long-term monitoring of landfill gas and groundwater and surface water quality.

Excavation of RIM would require removal of substantial amounts of overburden and material from the sidewalls of the excavations in order to maintain stability of the excavation areas. Overburden removal would entail removing and temporarily relocating a large amount of the above-grade portion of the North Quarry part of the Bridgeton Landfill in order to access the underlying RIM in OU-1 Area 1. The total amount of non-RIM waste required to be removed is estimated to be approximately 1,300,000 bcy, which, based on an expansion factor of 1.5, would result in the need to handle, stockpile and replace 1,950,000 lcy of waste. Management of such a large amount of exposed waste in both the excavation areas and the stockpiles (including management of stockpiles, stormwater runon and runoff, odor emissions, attraction to birds and other vectors, and litter control) would be a significant undertaking. The amount of space available for stockpiling the overburden material is limited, and therefore overburden material from Area 1 would need to be transported to Area 2 for temporary stockpiling while waiting for final placement and capping. Similarly, the total volume of RIM that would be excavated under this alternative is estimated to be 269,000 bcy, equivalent to approximately 400,000 lcy. Due to the double-handling (at a minimum) of the overburden material plus the RIM handling, it is anticipated that more than 4,700,000 lcy of waste would be handled under this alternative.

An additional complication arises from the proximity of the Bridgeton Transfer Station. In order to access the RIM in the southwest portion of Area 1, the solid waste transfer station would need to be relocated, as removal of waste material would extend up to and along the base of the transfer station such that the integrity of the transfer station building foundation and above-grade structure would be compromised. The only available space for relocation of the transfer station is the area currently occupied by Simpson Asphalt Company, which holds a long-term (99-year) lease on this area. This lease would have to be bought out and the asphalt company would need to be relocated before the transfer station could be relocated to this area. The estimated construction schedule (Appendix J) and costs (Appendix K-4) for this alternative are predicated on the solid waste transfer station being relocated prior the start of RIM excavation and transport.

It is anticipated that a new structure would be constructed to shelter the RIM staging and loading operations in order to minimize stormwater contact, odor emissions and bird attraction and to allow RIM loading for off-site disposal would occur on a relatively continuous basis. Such a structure would likely be constructed along the north side of the Site access road in the area that is currently being used to store new, reclaimed and surplus equipment and materials associated with ongoing operation and maintenance and closure activities for the Bridgeton Landfill. These materials would need to be relocated to another portion of the Site prior to construction of such a structure.

In order to minimize potential vehicle interactions between normal traffic to and from the re-located solid waste transfer station and the construction operations associated with this alternative, a temporary overpass would likely need to be constructed over the Site access road to allow for uninterrupted movement of construction traffic between Areas 1 and 2 and uninterrupted traffic of refuse trucks to/from the relocated solid waste transfer station. An overpass is considered the most efficient and safest means for transfer of overburden waste from Area 1 to stockpile locations in Area 2 and then back to Area 1. In addition, as discussed above, a single RIM staging and loading building would be constructed and operated as part of this alternative. RIM removed from Area 1 would need to be transferred over the Site access road to the RIM staging and loading building. Installation of an overpass would eliminate the potential for RIM material to be tracked across the Site access road and potentially tracked off-site. An overpass would also eliminate the need for traffic control and potential for accidents that would be associated with an intersection of the solid waste transfer station access road and the temporary construction traffic road between Area 1 and Area 2.

While excavation with subsequent off-site transportation and disposal have been implemented at other sites containing radioactively-impacted materials, materials from these other sites have not included significant amounts of landfill solid wastes and debris, and it is expected that these landfill wastes could complicate the implementation of any RIM removal. Significant technical and administrative implementability issues are also associated with excavating the RIM and loading it into IM containers for transportation if this alternative were to be implemented. These include the following:

- Reduced excavation production rates and increased volume of RIM ultimately subject to excavation and disposal resulting from application of daily cover over an extended excavation schedule;

- Ability to locate and obtain a lease to an off-site rail spur for use as a truck-to-rail transfer facility, or alternatively, the ability to construct an on-site rail spur and rail loading facility;

- Increased potential over an extended period of time for bird strikes to aircraft as a result of excavation of putrescible or organic solid waste overburden waste from the North Quarry portion of the Bridgeton Landfill and Areas 1 and 2 and excavation RIM contaminated waste from Areas 1 and 2, all of which are located within flight paths of Lambert–St. Louis International Airport;

- Ability to remove all of the RIM due to the close proximity of some of the deeper RIM in OU-1 Area 1 beneath and adjacent to the above-grade portion of North Quarry part of the

Bridgeton Landfill and in OU-1 Area 2 adjacent to other landfill units (*e.g.*, Closed Demolition Landfill and Inactive Sanitary Landfill); and

- Impacts to other Site operations and traffic on surrounding roads from additional truck traffic used to haul wastes to an off-site truck-to-rail transfer facility and to haul earthen materials to the Site for daily cover, stockpile covers, and construction of the final cover.

Design and construction of post-RIM-excavation landfill covers over Areas 1 and 2, with subsequent monitoring and maintenance, are not expected to pose any implementability challenges. Materials and services necessary for the regrading and construction of the final landfill covers over Areas 1 and 2 after RIM removal are available, and the technologies have been proven through application at other landfills.

The actions included for the Buffer Zone/Crossroads Property – that is, the testing and excavation of surface soil – are regularly and easily implementable.

Monitoring of the cover surfaces, landfill gas, groundwater, and surface water are proven methods for demonstrating the long-term effectiveness of the covers placed over Areas 1 and 2 and are easily implemented.

6.2.3.6.1 Ability to Construct and Operate the Technology

In general, excavation and off-site disposal are standard technologies. However, there are unique circumstances associated with excavation of RIM in Areas 1 and 2, located as Areas 1 and 2 are within an overall larger closed/inactive landfill site, which would complicate implementation of standard excavation technologies.

There are questions regarding the ability to remove all of the RIM from Area 1 and Area 2 due to the depth of some of the RIM and/or the proximity of OU-1 Areas 1 and 2 to the OU-2 landfill units such as the North Quarry portion of the Bridgeton Landfill, closed construction and demolition waste landfill (the C&D landfill) and the OU-2 inactive solid waste landfill. RIM is not present in these other landfill units, but it would be necessary to excavate into these OU-2 units in order to access some of the RIM in OU-1. Although sheet piling as a Site-wide replacement for excavation sidewall sloping was evaluated as part of the SFS and found not to save costs or time compared to sloping the sidewalls, small areas of sheet piling where the OU-1 RIM is closest to the adjacent OU-2 landfill units may prevent or minimize encroachment of excavation slopes into the OU-2 units and therefore prove economical for the “complete rad removal” alternative. Such targeted use of sheet piling could be further evaluated during remedial design.

Upon completion of removal of the RIM from OU-1, disturbed portions of the adjacent landfill units in OU-2 would need to be repaired and restored to a condition that meets or exceeds existing closure conditions prior to implementation of this alternative and subject to the requirements of any additional remedial actions required for either of these areas as part of implementation of the OU-2 remedy.

RIM excavation and placement in IM containers and hauling of the containers by truck for subsequent transfer to rail is also expected to present implementability concerns, challenges, and risks, specifically those associated with the following:

- Excavation and handling of contaminated materials;
- Safety risks associated with encountering methane gas during excavation;
- Management of fugitive dust and potential odors;
- Mitigation of bird hazards;
- Management and treatment of stormwater exposed to RIM during excavation; and
- Identifying, segregating, and disposing off-site of any hazardous wastes, polychlorinated biphenyls (PCBs) or RACM that may be encountered during RIM excavation.

If hazardous wastes, PCBs, or RACM are encountered during excavation of RIM, these materials would need to be segregated from the other waste materials, characterized, and transported to an off-site disposal facility in containers separate from the other RIM. Additional health and safety procedures would be required during excavation of these materials. These materials would require separate handling at the off-site disposal facility and could require treatment prior to disposal. Depending on the characteristics of any hazardous waste encountered during excavation, the hazardous waste could need to be transported to a different off-site facility for treatment and disposal in accordance with RCRA.

Directing and controlling the RIM excavation process using radiological scanning and sampling techniques would significantly impact overburden and RIM excavation production rates. Based on experience in excavation of radiologically-impacted waste at other sites, a reduction in efficiency is expected for overburden excavation and a greater reduction is expected for RIM excavation. Because thorium-230 is a primary radionuclide of concern with regard to a "complete rad removal" alternative, even greater reductions in efficiency and increased time may be required for RIM excavation. Thorium-230 cannot be detected using field survey instruments, and therefore excavation activities would have to rely on collection and laboratory analyses of samples for guidance. In order to minimize the potential impacts on the excavation schedule, it is assumed that an on-site laboratory would be set up and operated to provide quick analyses of samples to guide excavation activities and initial confirmation that all of the RIM had been removed. A percentage of such samples would also be sent to an off-site laboratory for verification of the on-site laboratory results. Samples obtained for final confirmation that all RIM has been removed from a particular area would also be subjected to off-site laboratory analyses and data validation. All of these activities would undoubtedly impact the rate of RIM excavation and the duration over which excavation areas need to remain open.

Daily soil cover and tarps would need to be placed over open excavation areas and stockpiled overburden to minimize dust, odor, and the attraction of birds and other wildlife. The proximity of Areas 1 and 2 to Lambert-St. Louis International Airport poses a potential risk to aviation operations. The St. Louis Airport Authority and the U.S. Department of Agriculture have identified as a problem the potential for increased bird activity in conjunction with waste excavation at the Site and the resultant increased risk of aviation bird strikes. Bird nuisance mitigation measures such as best management practices (including, but not limited to, daily soil cover and tarps over exposed overburden and wastes), visual and auditory frightening devices, and wire or monofilament grids strung over exposed refuse to prevent bird access, could be evaluated for use at Areas 1 and 2. The size of open excavations may limit the constructability of wire or monofilament grids. Careful evaluation of material properties would be necessary during remedial design to assure that the appropriate strength and elasticity of materials are considered, that the materials are available, and that grids can be reasonably constructed.

Effective storm water controls could be readily implemented using conventional construction equipment and materials. Temporary berms to direct stormwater away from open excavations would need to be constructed, and precipitation accumulation in depressions created by the excavation activities would need to be pumped out and managed. Direct precipitation or runoff that may contact waste material could become contaminated with soils or wastes containing thorium or radium. These elements would be entrained in colloidal material that would readily settle in low areas or in the tanks used to collect and store stormwater prior to treatment and discharge. At the end of excavation activities, accumulated sediment in any low areas or the tanks would also be removed and, depending upon the activity levels, either placed in Area 1 or 2 or transported to the off-site disposal facility.

Excavated RIM exposed to precipitation would be subject to the paint filter liquids test (PFLT) as necessary to determine if free liquids exist prior to being loaded for off-site disposal. If the excavated material to be hauled off-site does not pass the PFLT, a dewatering area would need to be staged and collected water treated and/or disposed, potentially through off-site disposal. The current estimated costs and schedules do not address any dewatering activities. Should such activities be necessary, a suitable area would have to be identified within the Site.

Truck hauling of IM containers of RIM to a truck-to-rail transloading facility and transferring the RIM to railcars is technically implementable. Loading RIM directly into railcars on-site if a rail spur could be extended onto the West Lake Landfill property is theoretically implementable; however, it is not known whether extension of a spur onto the property is actually feasible. If construction of an on-site rail spur were to be considered, an engineering study and development of a detailed design would be necessary to determine the feasibility and implementability. As previously discussed in Section 5.4.3 and as further discussed in Sections 6.2.3.6.5 and 6.2.3.6.6 below, construction of an on-site rail spur would also require coordination with a number of local and state regulatory authorities as well as private landowners.

An initial comparison of the US Ecology Grand View facility WAC to estimated activity levels in the OU-1 RIM under the “complete rad removal” alternative is presented on Table 6-2. Although a representative of the turnkey contractor would be on-site during RIM excavation to coordinate loading of containers, there is a potential that one or more shipping containers could contain activity levels that exceed the WAC and may have to be unloaded and re-distributed prior to shipment or, in the worst case, returned to the Site by the disposal facility and/or sent to a different disposal facility. These additional activities could result in additional worker exposures, additional time to complete the project, and potentially additional costs.

Regrading the landfills and placement of final cover is implementable and has been performed at other landfills, including CERCLA sites. Environmental monitoring is routinely performed at most sites and is not expected to present any feasibility challenges.

6.2.3.6.2 Reliability of the Technology

Excavation and off-site disposal of radioactively-impacted material generally is a reliable technology, and has been implemented at a number of FUSRAP sites. Notably, waste deemed “inaccessible” has generally been allowed to remain in place, including in the case of the St. Louis North County Sites, which were successfully remediated to conditions that pose no risk to human health and the environment under any future use scenarios. It should be noted, however, that none of these FUSRAP sites involved radiological materials commingled with municipal solid waste and disposed in a landfill setting. The reliability associated with disposal in an off-site facility would be dependent on the integrity of the liner and cover systems at the off-site facility being maintained, as well as the effectiveness of the various off-site facility monitoring programs.

Landfill cover systems such as those that would be implemented over Areas 1 and 2 after RIM removal, and which are designed and constructed consistent with State and Federal regulations and with post-closure care implemented in accordance with current regulatory guidance, have been demonstrated to be reliable at: (1) minimizing percolation and infiltration of precipitation; (2) minimizing leachate generation; (3) minimizing impacts to groundwater quality; (4) minimizing impacts to surface water quality and quantity; (5) minimizing erosion of cover material; and (6) minimizing uncontrolled releases of landfill gas. Landfill cover systems have been demonstrated to be reliable methods for isolating waste materials. Similarly, access restriction measures have been demonstrated to be reliable mechanisms to prevent unauthorized access to a site.

Bird nuisance mitigation measures such as best management practices (including, but not limited to daily soil cover and tarps over exposed RIM and waste), visual and auditory frightening devices, and wire or monofilament grids strung over exposed refuse to prevent bird access, are demonstrated reliable technologies under proper operating and excavating conditions. However, while visual or auditory frightening devices can be effective in the short-term, birds tend to habituate to deterrents over time, causing the deterrent to lose effectiveness. Frequent relocation of predator birds and predator effigies and/or altering the timing of auditory activation may help, but long-term effectiveness is not assured. In addition, the FAA has stated that “[t]o date, no . . . [putrescible waste] facility has been able to demonstrate an ability to reduce and sustain hazardous wildlife [birds] to levels that existed before the putrescible-waste landfill operations began operating.” (FAA, 2007).

Storm water controls are well-established technologies that are implemented at most landfill sites. For this alternative, gravity settling of suspended solids potentially containing radionuclides is a well-established and reliable technology.

6.2.3.6.3 Ease of Undertaking Additional Remedial Actions, if Necessary

It is possible that all of the RIM may not be removed during implementation of the "complete rad removal' alternative. In accordance with the Supplemental Standards provision of UMTRCA (40 CFR § 192.21), a decision could be made by EPA to leave some RIM at the Site. EPA could determine that RIM that is deeply buried beneath large volumes of waste or that is located adjacent to buildings (*e.g.*, adjacent to the solid waste transfer station) such that removal could impair/ undermine the integrity of those structures, would be better left at the Site. If this were to occur after completion of the "complete rad removal" alternative, regrading of the landfill, and construction of a new engineered landfill cover, performance of additional remedial action in the future to remove such materials would be very difficult and costly.

The only anticipated additional remedial actions that may need to be taken for the "complete rad removal" alternative would be maintenance activities needed to sustain the cover system, repair areas of differential settlement or address erosion, or possible implementation of a contingent landfill gas control system. Differential settlement or compaction of the underlying remaining waste materials after RIM excavation could necessitate placement of additional soil over all or portions of Areas 1 or 2 to maintain the required final grades. Long-term monitoring and maintenance of the landfill covers at other Superfund sites and at non-Superfund solid waste landfills is typically required to assess whether differential settlement or surface erosion of the cover has occurred over time. Long-term monitoring and maintenance including cover inspection and repair would be part of this alternative. Cover repair, if necessary, would involve placement of additional fill, regrading, and revegetation of the repaired area.

In the event that monitoring of subsurface landfill gas detects the presence of gas levels above regulatory thresholds along the perimeter of the landfill, a landfill gas control system could be implemented as an additional remedial action. Implementation of a contingent landfill gas control system would entail drilling and installation of gas extraction wells, installation of conveyance piping, installation and operation of landfill gas extraction blowers and a landfill gas treatment (flare) system. Installation of a contingent gas system could be performed as a future action. Any disruption to the final landfill cover resulting from the installation of a contingent gas extraction system would need to be repaired. Such activities are commonly and routinely undertaken at solid waste disposal sites.

Bird nuisance mitigation measures such as best management practices (including, but not limited to daily soil cover and tarps over exposed waste), visual and auditory frightening devices, and wire or monofilament grids strung over exposed refuse to prevent bird access, could be applied to additional excavated area in the event that additional waste volume is encountered.

Storm water management measures, other than those using conventional earth-moving equipment, piping, pumps, liners, filtration and carbon adsorption water treatment equipment, rip-rap, and pond outlet structures, are not anticipated to be necessary to support implementation of the "complete rad removal" alternative.

6.2.3.6.4 Ability to Monitor Effectiveness of Remedy

Demonstrating the effectiveness of the cover systems constructed over Areas 1 and 2 after RIM removal above unrestricted use levels would be accomplished by implementing monitoring programs for the cover surface, landfill gas system, groundwater and surface water programs as previously described in Section 5.4.4. These types of monitoring programs have been proven at demonstrating cover effectiveness and are easily implemented.

6.2.3.6.5 Ability to Obtain Approvals from Other Agencies

Implementation of the "complete rad removal" alternative would require approvals from other agencies, including the following:

- Approval from the FAA to conduct waste excavation activities within 10,000 feet of an active airport runway. FAA Advisory Circular AC 150/5200-33B, dated August 28, 2007, "Hazardous Wildlife Attractants On or Near Airports," recommends "against locating a MSWLF [municipal solid waste landfill] within the separation distances identified in Sections 1-2 through 1-4. The separation distances should be measured from the closest point of the airport's AOA [airport operations area] to the closest planned MSWLF cell." AC 150/5200-33B, p. 4. The separation distances referenced are 5,000 feet from the end of a runway for airports serving piston-powered (propeller) aircraft; 10,000 feet for airports serving turbine-powered (jet) aircraft; and 5 miles of protection from hazardous wildlife movement for approach, departure and circling airspace. The FAA strongly recommends against allowing a waste disposal operation within 10,000 feet of a jet aircraft runway if the material contains putrescible waste and so has the potential to attract wildlife that could threaten air traffic. The excavation of RIM material containing putrescible waste within 10,000 feet of the westernmost runway (11/29, formerly known as 12W/30W) at Lambert-St. Louis International Airport, as would occur during excavation of the RIM in Areas 1 and 2, is limited by the need to mitigate potential bird activity during excavation to address the requirements of the FAA Advisory Circular and to comply with the same prohibitions in the Missouri solid waste regulations. It may be necessary to work directly with the FAA and MDNR to identify specific bird mitigation measures during implementation.

- Approval of St. Louis Airport Authority (STLAA) relative to obtaining a release for the Negative Easement and Declaration of Restrictive Covenants Agreement (Appendix A-2). Excavation of RIM from Areas 1 and 2 poses a potential to increase the bird populations at the Site if mitigation procedures are not employed or prove ineffective. An increase in bird populations presents a greater potential for aircraft-bird strikes. The STLAA and USDA have identified this as a concern relative to construction and operation of a new on-site disposal cell that was included in the “complete rad removal” with on-site disposal alternative evaluated in the SFS. Based on the STLAA’s position stated in the STLAA’s September 20, 2010 letter to EPA (Appendix A-5), STLAA acceptance of RIM waste excavation would not be likely if bird activity were to increase. It may be necessary to work directly with the FAA and the STLAA to address these concerns, either by amending the FAA ROD, amending the Negative Easement, requiring specific bird mitigation measures during implementation, or making other changes to secure STLAA’s cooperation.

- Location of an off-site truck-to-rail loading facility. At a discussion held in September 2010, the STLAA indicated that they would not allow the use of the existing SLAPS truck-to-rail transloading facility for loading waste from the West Lake Landfill into railcars (see Appendix A-4). The SLAPS rail spur is reportedly owned by the U.S. Army Corps of Engineers and the land upon which the rail spur is built is owned by the City of St. Louis. It is not clear that the STLAA could prevent use of the SLAPS rail spur for loading and shipping via contractual means; however, as the STLAA is the owner of the property, their concurrence must be considered. Therefore, it appears unlikely that the rail spur at the airport would be available for implementation of a remedial action for West Lake Landfill. No other nearby off-site truck-to-rail loading facilities have been identified. Discussions with US Ecology have indicated that as part of the transportation and disposal activities, US Ecology would locate and lease an existing rail spur in the area or otherwise construct a rail spur somewhere in the area that could serve as a transloading facility.

- Approval for construction of on-site rail spur. If a rail spur were to be extended onto the West Lake Landfill Site, necessary permitting and approval to construct a rail spur across St. Charles Rock Road (Missouri Route 180) and associated rail crossing traffic control facilities would need to be obtained from the Missouri Department of Transportation, St. Louis County and/or the City of Bridgeton.

- Compliance with EPA’s Off-Site Rule (OSR). The EPA Region where the off-site disposal facility is located would need to be contacted every 60 days during the period of off-site waste shipments to obtain a compliance determination as to whether the disposal facility currently meets the criteria under the OSR to accept CERCLA waste. If, during RIM excavation, the contracted off-site disposal facility was to fall out of compliance for a period of time, excavation and transportation would either need to cease until the facility becomes compliant again, or RIM would need to be transported to another facility that is determined to be in compliance with the OSR. Besides schedule delays, temporary stoppage of construction would present significant technical implementability concerns regarding open excavation areas.

- Rocky Mountain Low Level Radioactive Waste Compact Consent. If RIM were to be disposed at the Clean Harbors Deer Trail, CO facility, an application would have to be submitted to and accepted by the Rocky Mountain Low Level Radioactive Waste

Compact. Disposal at the US Ecology Grand View, ID or Wayne, MI facilities, and Energy*Solutions* Clive, UT facility would not be subject to a Waste Compact consent.

6.2.3.6.6 Coordination with Other Agencies

Coordination with many entities would be necessary to implement the "complete rad removal" alternative (although not all of them are considered "agencies"). Coordination with the Site owner and operator and owners or occupants of the various parcels that comprise the West Lake Landfill Site would be necessary because of the following:

- Termination of the asphalt company lease and removal of the asphalt plant followed by relocation of the Bridgeton solid waste transfer facility and construction of an overpass between Areas 1 and 2 over the Site access road would need to occur prior to the start of RIM excavation;

- Access to operations conducted on other portions of the Site would need to be maintained.

- Areas 1 and 2 are within a larger existing Site footprint, and use of areas on the West Lake Landfill Site outside of Areas 1 and 2 might be necessary to stockpile cover materials or otherwise to facilitate cover construction.

- Implementation of this alternative would require excavation of portions of landfill units located outside of OU-1. Upon completion of removal of the RIM, disturbed portions of the adjacent landfill units would need to be repaired and restored, and regrading and installation of a replacement landfill cover over areas outside of OU-1 would need to be performed. Coordination would also be required relative to integration of the slopes and grading for adjacent landfill areas and routing and design of stormwater diversion and conveyance structures between OU-1 and other landfill areas.

- Use of other areas of the West Lake Landfill Site that may be necessary for stockpiling of overburden and staging or routing of trucks or rail cars used to haul the excavated RIM off-site.

- Implementation of any additional institutional controls or modifications of any of the existing institutional controls that EPA may require would need to be approved and accepted by the individual entities that own the various parcels that compose the Site.

For the duration of excavation, off-site transport, and import of cover materials, the flow of vehicles associated with remedy construction would need to be coordinated with the traffic patterns of vehicles associated with the current on-site solid waste transfer station and other Site tenants.

If a truck-to-rail transloading facility at an off-site rail spur location were to be used, a suitable location would need to be identified and a lease secured with the land/rail spur owner for the duration of the RIM loading and transport operations. As noted above, it does not appear that the existing SLAPS truck-to-rail transloading facility would be available, so costs for establishing a new facility would need to be considered[48].

If a rail spur were to be extended onto the West Lake Landfill Site:

- Land located across St. Charles Rock Road would either need to be purchased or long-term leases would be needed with landowners;
- State and local government, private landowner, facility occupant and community approval would need to be obtained in order to construction of a rail spur across private property located to the east of St. Charles Rock Road, across St. Charles Rock Road, and along the access roads which serve the existing solid waste transfer station and asphalt plant operations located at the Site;
- Appropriate safety measures for the crossing at St. Charles Rock Road would have to be installed, consistent with requirements of state and local governments;
- The long-term lease of the asphalt plant for land south of the solid waste transfer station, would need to be bought out or otherwise acquired; and
- Because of the high traffic volume on St. Charles Rock Road during the day, dropping off empty and picking up loaded railcars would likely be possible only during late nighttime and early morning hours.

Provision and switching of gondola railcars either at a truck-to-rail transloading facility spur or an on-site rail spur would need to be coordinated with the railroad company that would be hauling the railcars to the off-site disposal facility.

Future groundwater monitoring activities could require obtaining and maintaining access to off-site properties if off-site groundwater monitoring were required as part of the remedy.

The potential for increased bird strikes to aircraft approaching and departing the Lambert-St. Louis International Airport is a major concern of the FAA and St. Louis Airport Authority. The effectiveness of proposed bird nuisance mitigation measures would be of interest to the FAA and Airport Authority. Consequently, the FAA and Airport Authority would need to be involved in the remedial planning process.

Coordination with other agencies, including the Earth City Flood Control District, MSD and MDOT, as well as adjacent property owners and businesses (for example, the Crossroads Property/AAA Trailer) would also be necessary to:

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[48] The unit cost estimates provided by US Ecology for purposes of this FFS include costs to secure an off-site rail spur for a truck-to-rail transloading facility.

- Coordinate with the Earth City Flood Control District regarding the design of non-contact stormwater management and discharge facilities both during and after completion of construction;

- Coordinate with MSD regarding permitting and design of leachate/contact stormwater discharge during construction;

- Coordinate with MDOT for access to areas along St. Charles Rock Road and for any traffic control or ingress and egress additions along St. Charles Rock Road in the vicinity of the Site entrance; and

- Obtain legal and physical access from AAA Trailer for testing and, if necessary, remediation of the Crossroads Property and possibly for implementation of remedial actions that may need to be performed along the property boundary (e.g. regrading, fencing, etc. in Area 2).

As discussed at the beginning of this section (6.2.3.6), in order to access RIM in Area 1, the Bridgeton Transfer Station LLC building would need to be relocated. The only suitable area for relocation of the solid waste transfer station is the area currently under lease and occupied by Simpson Asphalt Company. The asphalt company lease would need to be bought out and their equipment removed from the Site before the transfer station could be relocated. Relocation of the transfer station would normally be subject to permitting by the City of Bridgeton and St. Louis County; however, because relocation of the transfer station would be performed as part of a Superfund remedial action and the transfer station would remain on-site, additional permitting is not anticipated to be required. However, it is likely that public meetings and hearings may be necessary, which would require coordination with the City of Bridgeton and St. Louis County and could impact the timing for the start of construction of a "complete rad removal" alternative.

6.2.3.6.7 Availability of Off-site Treatment, Storage and Disposal Services and Capacity

As discussed in Section 4.3.5.4., four off-site disposal facilities that could accept excavated RIM from the West Lake Landfill OU-1 have been identified. At least three of these facilities (located in Idaho, Utah and Colorado) have accepted radiologically-impacted soil from projects or sites in the United States, although none of them have previously accepted radiologically-impacted soil mixed with solid waste. All four of the identified facilities have available capacity to accept the estimated volume of RIM from the Site. The volumetric rate of acceptance for all facilities would be limited by the number of IM containers and railcars that could be provided and loaded at or near the Site, as well as the number that could be unloaded at or near the disposal facility. Off-site treatment, storage and disposal may be required in the event that hazardous wastes or regulated asbestos-containing materials (RACM) are encountered in the overburden or RIM excavated from Areas 1 and 2.

The identified off-site disposal facilities are also permitted to: (1) accept liquid wastes, should any stormwater that may accumulate in excavations during RIM excavation become contaminated and require disposal off-site; (2) accept mixed wastes, if mixed wastes are encountered during excavation; and (3) treat soil and/or debris that contains hazardous waste or mixed waste.

As discussed in Section 3.2.1, the CERCLA Off-Site Rule requires that waste materials removed from a CERCLA site only be placed in a facility operating in compliance with RCRA or other applicable Federal or State requirements. EPA makes such determinations every 60 days. The compliance status of an off-site disposal facility would need to be evaluated during remedial design and would need to be regularly evaluated and updated during remedy implementation.

Off-site treatment and discharge of any leachate that may be encountered or stormwater that may contact RIM during the landfill excavation activities could also be required. Initial discussions with MSD indicated that they are willing to accept leachate and contact stormwater and initial discussions with the Earth City Flood Control District indicated a willingness to accept stormwater, subject to installation of additional stormwater detention/retention capacity.

6.2.3.6.8 Availability of Necessary Equipment and Specialists

Materials, equipment and personnel required for excavation and transport of RIM to an off-site disposal facility are readily available. Trained health physics technicians and specialized equipment required to monitor personnel and environmental conditions, as well as to assist in directing the RIM excavation sequencing, are also available.

As discussed above, there are a limited number of disposal facilities that can accept these types of wastes, and most of these have stringent waste acceptance criteria which may limit the ability of some of the facilities to receive the wastes.

Availability of rail service, particularly the number of rail cars that can be made available and switched daily by the railroad, would also affect the production rate of RIM excavation and disposal and therefore the cost.

All of the materials, equipment and personnel needed to construct the covers over Areas 1 and 2 after RIM removal are readily available and the technologies have been generally proven through application at other landfills. The implementability and potential cost of the covers would be influenced by the availability and location of clean cover materials and/or off-site borrow sources at the time this alternative would be implemented. Potential vendors of rock, clay and soil were contacted during the development of the FS (EMSI, 2006) and during preparation of the Remedial Design Work Plan for the ROD-selected remedy (EMSI, 2008). Information obtained from the vendors at these times indicated that rock, clay and clean fill material were readily available from sources located near the Site. If these local sources of cover materials become exhausted prior to or during remedy implementation, cover materials would have to be obtained from suppliers at greater distances from the Site.

The necessary materials, equipment and personnel required for assessment and removal of RIM that may be present at the Buffer Zone/Crossroads Property to unrestricted use levels and to implement the institutional controls and monitoring components of this alternative are also readily available.

6.2.3.6.9 Availability of Prospective Technologies

The “complete rad removal” alternative is based on proven, established, and commonly used technologies. Use of prospective technologies is not currently envisioned to be part of this alternative.

6.2.3.7 Cost

Estimated capital, annual OM&M, and 30-year present worth costs for the “complete rad removal” alternative are included in Appendix K-4 and summarized on Table 6-1. Conceptual excavation, backfill, and bottom and top of final cover grading plans as well as stormwater control features used as the basis for the “complete rad removal” alternative capital cost estimate are provided in Appendix M. The estimated cost to conduct the “complete rad removal” remedy (i.e., design costs, capital costs, and costs for monitoring during the construction period) is $616,000,000 based in part on unit costs provided by US Ecology. These costs do not include costs to conduct full-scale pilot-testing of solids separation equipment, which is beyond the scope of the FFS. The estimated annual OM&M costs range from $167,000 to $326,000 per year depending upon the specific activities that occur each year (e.g., higher costs for years with additional environmental monitoring and years when landfill cover repairs may occur). The cost estimates provided in this FFS are feasibility-level cost estimates which were developed to a level of accuracy such that the actual costs incurred to implement this alternative are expected to fall within a range bounded by 50% above and 30% below these estimates.

The present-worth costs of the “complete rad removal” alternative are projected to be $420 million over a 30-year period based on a discount rate of 7%. Based on the current OMB rate of 1.5%, the present worth costs would be $566 million. The total non-discounted costs for the “complete rad removal” alternative over 30 years are projected to be $6190 million. Present-worth cost estimates were also calculated for 200-years and 1,000-years (Table 6-1), similar to what was done for the other alternatives.

Unit costs associated with transportation by rail and disposal of RCRA soil, RCRA soil with radionuclide material, RCRA debris, and RCRA debris with radionuclide material would have added treatment costs in order to meet the Land Disposal Restrictions (LDRs) and Universal Treatment Standards (UTS). Based on discussions with representatives of the disposal facilities during preparation of the SFS (EMSI et al., 2011), the additional costs for treatment at these facilities are estimated to range from $45 to $150 per ton for RCRA metals or $400 to $500 per ton for organics, depending on the type of treatment.

Since the amount of mixed waste that might be excavated along with the RIM is unknown, and because of the RCRA restrictions on waste accumulation amounts and timeframes and limited storage space on-site, it is unclear if volumes would support shipment by rail. As such, the mixed waste would likely be shipped to the off-site disposal facility directly via truck. For truck hauling to the off-site disposal facility, the interior of the semi-trailer would be lined with a disposable polyethylene slip liner and after the waste was loaded the trailer would be covered and the cover securely strapped down. The capacity of each truckload would be 22 tons or 17 cubic yards, depending on the weight of the material. Current trucking costs range from $4.70 to $5.10 per loaded mile. Road mileage from the West Lake Landfill to the US Ecology Wayne Disposal, Michigan; Clean Harbors Deer Trail, Colorado; Energy Solutions Clive, Utah; and US Ecology Grandview, Idaho facilities are 520, 720, 1,340, and 1,580 miles, respectively. Therefore, RCRA or mixed-waste truck transportation costs to an off-site facility could range from $145 to $470 per cubic yard or $110 to $370 per ton, depending on where the material is ultimately disposed.

For purposes of demonstrating how much shipping of mixed waste could influence costs, it was assumed that mixed waste would represent 0.5% of the sum of the volumes of overburden wastes and RIM for the "complete rad removal" with off-site disposal alternative. The added costs for handling, sampling/analysis, shipping, treating, and disposing of mixed waste for this alternative are estimated to range from $3 to $5.6 million. This cost range primarily results from variations in the fees charged by the off-site disposal facilities, as well as uncertainties associated with the nature of such wastes and the required method of treatment. If the volume of mixed waste is higher than the 0.5% of total mass assumption, the added costs would be higher.

6.2.4 Partial Excavation of Shallow RIM with Activities Above 52.9 pCi/g

This section presents the detailed analysis of a partial excavation alternative consisting of removal of RIM with combined radium and/or combined thorium activities greater than 52.9 pCi/g that is located within 16 feet of the 2005 topographic (ground) surface and subsequent regrading and capping of the remaining waste (hereafter referred to as the "52.9 Partial Excavation Alternative"). As previously described in Section 5.5, this alternative consists of the following components:

- Removal of the asphalt plant and relocation of the Bridgeton Transfer Station, LLC building to provide access to RIM located adjacent to the building and construction of an overpass over the Site access road;

- Excavation and stockpiling of overburden from OU-1 Areas 1 and 2 in order to access the RIM;

- Excavation of RIM from the OU-1 Areas 1 and 2 that contains combined radium or combined thorium activities greater than 52.9 pCi/g that is located within 16 feet of the 2005 topographic surface;

- Loading, transport, and disposal of the RIM and impacted soil at an off-site disposal facility;

- Survey and identification of the presence and extent of radiologically-impacted soil on the Buffer Zone and Crossroads Property;
- Excavation of any soil from the Buffer Zone and/or Crossroads Property that contains radionuclides at levels greater than those that would allow for unrestricted use and, depending upon activity levels, placement of such soil in Area 1 or 2 or alternatively transport of such soil that contains combined radium or combined thorium levels greater than 52.9 pCi/g to an off-site disposal facility;
- Regrading of the remaining solid waste materials within Areas 1 and 2 to meet the minimum (5%) and maximum (25%) slope criteria;
- Installation of a landfill cover meeting the Missouri closure and post-closure care requirements for sanitary landfills over Areas 1 and 2;
- Design, installation and maintenance of surface water runoff controls;
- Groundwater monitoring consistent with the requirements for sanitary landfills;
- Landfill gas and radon monitoring and control, as necessary;
- Institutional controls (currently in place) to prevent land and resource uses that are inconsistent with a closed sanitary landfill site containing radionuclides; and
- Long-term surveillance and maintenance of the landfill cover in Areas 1 and 2.

Under this alternative, an estimated 151,000 bcy of RIM would be excavated from Areas 1 and 2 for off-site disposal. The volume of material would increase upon excavation due to swelling, handling and loading for transport to an off-site disposal facility. Applying the swell factor of 1.5 and accounting for daily cover, it is estimated that approximately 249,000 lcy would be transported to and disposed off-site. Under this alternative an additional approximately 2,900 bcy of impacted soil would be excavated from the Buffer Zone/Crossroads Property and, depending upon activity levels, would either be placed in Area 1 or 2 or transported to the off-site disposal facility.

Once all of the material containing combined radium or combined thorium activities greater than 52.9 pCi/g that is located within 16 feet of the 2005 ground (topographic surface) has been removed from Areas 1 and 2, the remaining solid waste materials in Areas 1 and 2 would be regraded to meet the final closure standards for sanitary landfills and a final sanitary landfill cover would be constructed over Areas 1 and 2. Because waste containing radionuclides above unrestricted use standards would still remain in Areas 1 and 2, this cover would include the additional hybrid components included in the ROD-selected remedy to address the UMTRCA requirements.

This alternative also includes installation and maintenance of surface water runon and runoff controls, groundwater and landfill gas monitoring, and institutional controls for Areas 1 and 2 and the Buffer Zone. Environmental monitoring of groundwater quality would be performed to ensure that groundwater quality at the perimeter of the Site met State standards or other ARARs or risk-based levels. Monitoring of subsurface occurrences of landfill gas and radon and, if necessary, implementation of contingent landfill gas extraction would be performed to ensure that gas migration above regulatory thresholds does not occur beyond the perimeter of Areas 1 or 2. Landfill gas and groundwater monitoring as described in Sections 5.3.1.6 and 5.3.1.10, respectively, are also included as part of the 52.9 Partial Excavation Alternative.

Existing institutional controls would be maintained and enforced, and any additional controls or modifications to the existing controls that EPA determines are necessary would also be implemented. These institutional controls are necessary to ensure that residential uses do not occur at the Site, and that commercial and industrial uses or ancillary uses that could result in unacceptable risks do not occur on Areas 1 and 2 or the Buffer Zone. In addition to prohibiting land uses that could result in potential exposure to waste materials or contaminants at the Site, these institutional controls would also limit or prohibit land uses or activities that could disrupt the integrity, performance or longevity of the new landfill cover or other components of the remedy.

Long-term inspections and maintenance activities of the engineered components similar to those described for the ROD-selected remedy (Section 5.3.1.9) would also be required.

6.2.4.1 Overall Protection of Human Health and the Environment

The 52.9 Partial Excavation Alternative would protect human health and the environment through (1) removal and off-site disposal of a large portion (50% or more) of the RIM; and (2) engineered containment, long-term surveillance and maintenance, and institutional controls on land and resource use. The landfill cover would reduce potential risks from exposure to external gamma radiation or radon gas emissions, and eliminate potential risks associated with inhalation or ingestion of contaminated soils or other wastes, dermal contact with contaminated soils or other wastes, and wind dispersal of fugitive dust.

The presence of an engineered landfill cover would prevent users of the Site from exposure to external gamma radiation, primarily through shielding and increasing the distance to the radiation source (i.e., the cover materials would be of sufficient thickness and design to attenuate gamma radiation). For the types of clay soils used for infiltration protection in the construction of final covers, the depth of cover required for gamma radiation shielding is on the order of two feet (60 cm). The total thickness of the final cover for the 52.9 Partial Excavation Alternative would be a minimum of five feet (two feet of biointrusion rock/rubble, two feet of clay soil, and one foot of vegetative soil).

The cover materials would also be of sufficient thickness and design to retard or divert the vertical upward migration of radon. The landfill cover would act as a diffusion barrier, thereby allowing time for the decay of the relatively short-lived radon-222 gas (the half-life for radon-222 is 3.8 days) during migration through the pore spaces of the cover soil. Radon is continually produced from the radium source, but need only be detained in the cover materials for a few days to decay to its non-radiological progeny, thereby eliminating any significant radon emissions. The radon may also be intentionally vented or diverted to a landfill gas control system. Calculations presented in Appendix F indicate that a clay layer thickness of two feet, combined with a two-foot thick rock/rubble layer and a one-foot thick vegetative layer, would provide sufficient radon attenuation to meet the radon emissions ARAR of 20 pCi/m^2s. As discussed in Appendix F, these calculations were based on the increased levels of radium expected to be present at the Site after 1,000 years of in-growth of radium from decay of thorium.

The potential for direct contact with waste materials is eliminated by partial removal of RIM and by placing a barrier (multi-layer landfill cover including bio-intrusion layer) between the remaining RIM/waste materials and any potential receptors. There is no potential for the generation of fugitive dust from the waste material as long as the barrier remains in place.

The multi-layer cover would also be designed to minimize infiltration of surface water through the wastes, thereby reducing the potential for leaching of contaminants to the groundwater. This is typically accomplished by promoting surface drainage and using a hydraulic barrier (e.g., a compacted clay layer meeting the specified permeability requirements). These are all conventional functions for landfill cover technologies and are widely used by government and industry to address similar circumstances where contaminated materials must be encapsulated to protect against future potential contact. Long-term maintenance of the cover and monitoring of the groundwater would ensure that the 52.9 Partial Excavation Alternative functions as intended.

Environmental monitoring of groundwater quality would be performed to ensure that groundwater quality at the perimeter of the Site meets state standards or other ARARs. Monitoring of subsurface occurrences of landfill gas and radon and, if necessary, implementation of contingent landfill gas extraction along the perimeter of Areas 1 and 2 would be performed to ensure that gas migration above regulatory thresholds does not occur beyond the Site perimeter.

Institutional controls would ensure that land and resource uses are consistent with permanent waste disposal. The use restrictions would reflect the presence of radionuclides at the Site.

6.2.4.2 Compliance with ARARs

Insofar as the 52.9 Partial Excavation Alternative includes excavation and off-site disposal of a large portion of the RIM and regrading of the remaining solid wastes and installation of a new landfill cover over Areas 1 and 2, the Missouri solid waste rules for sanitary landfills would be relevant and appropriate to this alternative. Upon completion of RIM excavation, the remaining RIM and solid waste in Areas 1 and 2 would be regraded to achieve minimum 5% and maximum 25% slopes and an engineered cover consistent with the cover requirements for a solid waste landfill without a liner. Because all of the RIM above unrestricted use levels would not be removed from Areas 1 and 2, the UMTRCA standards would be relevant and appropriate for

Areas 1 and 2. Therefore, the landfill cover under this alternative would also include the 2-foot-thick rock biointrusion layer. Sections 6.2.2.2.1 and 6.2.2.2.2 contain full discussions of the MDNR solid waste regulations and the UMTRCA standards.

The 52.9 Partial Excavation Alternative would also need to comply with the applicable or relevant and appropriate requirements of NESHAPs, the Safe Drinking Water Act, Missouri Radiation Regulations for Protection Against Ionizing Radiation, the Missouri Well Construction Code, and the Missouri Storm Water Regulations. Sections 6.2.2.2.3 through 6.2.2.2.8 contain full discussions of these regulatory requirements. These requirements would be met or achieved using the same methods as previously described in Sections 6.2.3.2.3 through 6.2.3.2.8 with respect to the "complete rad removal" alternative.

6.2.4.3 Long-Term Effectiveness and Permanence

These criteria refer to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time. The 52.9 Partial Excavation Alternative would reduce risk through removal of a portion of the RIM and provide engineered containment in conjunction with long-term monitoring, maintenance, and land use control designed to be effective over the long term for the remaining RIM. Removal of a large portion of the RIM, combined with installation of an engineered landfill cover, would essentially eliminate the potential for gamma exposure, inhalation of radon gas or dust containing radionuclides or other constituents, dermal contact with impacted materials, and incidental ingestion of soil containing radionuclides or other chemicals and leaching of radionuclides or chemicals to the underlying groundwater. Maintaining the integrity of the engineered cover would protect the underlying RIM from erosion and intrusion. An UMTRCA-compliant cover would provide a reliable method to control exposure of the RIM to surface receptors and mitigate potential migration of the covered materials.

Long-term site management plans and institutional controls would be made as robust and durable as possible. Long-term groundwater monitoring would be effective in verifying that the remedy is performing as required and groundwater is protected. The landfill cover would also passively prevent potential contaminant migration and human exposures for an indefinite period in the unlikely event that institutional controls were compromised.

By moving the contamination from the Buffer Zone/Crossroads Property back on to Area 1 or 2 or, if the activity levels are high enough, shipping it to the off-site disposal facility in conjunction with shipping of the RIM with activity levels above 52.9 pCi/g, this alternative would provide long-term effectiveness and permanence relative to the Buffer Zone/Crossroads Property.

6.2.4.3.1 Magnitude of residual risk

The calculated lifetime risks following the exposure scenarios in the risk assessment after a portion of the RIM had been removed from Areas 1 and 2, an engineered landfill cover has been installed, and the remainder of this remedial alternative has been implemented (Appendix H) are as follows:

- Area 1: <1 x 10^{-7} for year 1 and <1 x 10^{-7} for year 1,000.
- Area 2: <1 x 10^{-7} for year 1 and <1 x 10^{-7} for year 1,000.

The calculated risk levels are below EPA's target risk range of 1 x 10^{-6} to 1 x 10^{-4}, and the magnitude of residual risk in Areas 1 and 2 is acceptable. These risk levels are attributable to gamma radiation and radon emissions from any radionuclide occurrences that would remain in Areas 1 and 2 after removal of RIM containing combined radium and/or combined thorium activities greater than 52.9 pCi/g, but take into consideration the installation of the new engineered cover and access restrictions and institutional controls. They do not specifically include potential exposures from non-radiological landfill wastes after construction is complete; however, those wastes would also be covered by caps which would prevent exposures. Additional information regarding the risk assessment calculations is presented in Appendix H.

Direct contact with the remaining RIM under the cap at Areas 1 and 2, and exposure by ingestion, inhalation, or dermal contact with such materials, is not expected to occur. These are the primary exposure pathways for any non-radiological COPCs which may be mixed with the RIM and landfill wastes that would remain in Areas 1 and 2 after partial excavation. Because no complete exposure pathway would exist for such materials after completion of the partial excavation and cap construction in Areas 1 and 2, the landfill waste materials would not be expected to produce non-carcinogenic effects or carcinogenic risks.

After soils containing radionuclide concentrations above unrestricted use levels are removed from the Buffer Zone/Crossroads Property, residual risks posed by the remaining radionuclide-impacted material on these properties, if any, should be indistinguishable from variations in background levels.

6.2.4.3.2 Adequacy and reliability of controls

The conceptual design of the engineered cover has been developed to provide protection against all potential exposure pathways. Cover construction is based on and relies upon the use of natural materials that would be expected to remain in place and meet performance criteria for at least 200 years, as required by the UMTRCA ARARs. Post-closure inspection and maintenance of the cover as required by the solid waste regulation ARARs, and as routinely performed at thousands of landfills across the country, also would ensure long-term reliability of the landfill cover.

The surfaces of Areas 1 and 2 are not currently graded to promote drainage of stormwater, but instead, are generally flat with several surface depressions which act to increase precipitation accumulation and infiltration through the waste mass. In addition, no engineered landfill cover exists over these areas. Even with these limitations, infiltration of precipitation has not resulted in discernible leaching of radionuclides or other chemicals to groundwater. Removal of a portion of the RIM, regrading Areas 1 and 2 to promote drainage, and installation of the engineered landfill cover included as part of the 52.9 Partial Excavation Alternative would significantly reduce infiltration of precipitation and potential for leaching, thereby providing further protection against potential impacts to groundwater.

Long-term OM&M would include routine cover and stormwater ditch inspection and service, if necessary, to mitigate erosion, and if such a system is necessary, OM&M of a landfill gas collection and treatment system. Long-term monitoring would also be implemented to assess compliance with environmental performance standards. The performance of these engineering controls would also be re-evaluated during statutory five-year reviews.

The current Covenants and Restrictions for Areas 1 and 2 would be adequate to protect human health. The permanence of these restrictions is assumed to be adequate for the foreseeable future, as both EPA and MDNR approval are required to remove or modify the restrictions. The adequacy of the restrictions would be continually evaluated during the statutory-required five-year reviews.

6.2.4.3.3 Climate Change and Potential Impacts of a Tornado

Because RIM and municipal solid waste would still remain in Areas 1 and 2 after implementation of the 52.9 Partial Excavation Alternative, a new engineered landfill cover would be installed over these areas. Because radionuclides above unrestricted use levels would remain in Areas 1 and 2, this engineered landfill cover would include the 2-foot-thick rock/rubble biointrusion layer along with the 2-foot-thick low-permeability and 1-foot thick vegetative layers as previously described for the ROD-selected remedy (Sections 5.3.1.4 and 6.2.2). This engineered landfill cover would be classified as in-situ containment system (EPA, 2014a).

Because the engineered landfill cover to be installed over Areas 1 and 2 under the 52.9 Partial Excavation Alternative is substantially similar to the landfill cover to be installed under the ROD-selected remedy, the analysis of the potential effects of climate change or impacts of a tornado are essentially the same for both alternatives. These effects were previously discussed in Section 6.2.2.3.3 for the ROD-selected remedy and therefore will not be repeated again here. The results of those evaluations (as discussed in Section 6.2.2.3.3) relevant to the landfill cover system for the 52.9 Partial Excavation Alternative are summarized below.

Similar to the ROD-selected remedy, the vegetative layer of the landfill cover to be installed under the 52.9 Partial Excavation Alternative could be vulnerable to increased occurrences of extreme temperatures, sustained changes in average temperatures, decreased precipitation and increase in drought occurrences. Increased temperatures or decreased precipitation/drought could affect the viability of the vegetation (*e.g.*, grasses) on the surface of the landfill cover. Any changes to the overall health of the vegetative cover would be readily identifiable by visual inspection. Therefore, although the vegetative cover may be vulnerable to potential increased temperatures or drought conditions, the potential for impacts to the vegetative layer could be anticipated and readily identified in advance of any such occurrence.

The low-permeability layer (CCL) could be damaged by periods of extended extreme temperatures or prolonged drought. Potential impacts could include desiccation of the CCL, with a resultant increase in permeability that in turn could lead to increased precipitation infiltration. Such impacts are not considered to be significant because the Site has existed for over 40 years with essentially flat (no grade) surfaces and minimal cover material, thereby maximizing precipitation infiltration without generation of currently identifiable impacts to underlying groundwater quality[49]. Therefore, even if desiccation of the low-permeability layer were to occur, the impacts to groundwater quality are not expected to be significant. More importantly, the vegetative layer would show significant signs of stress from increased temperatures/drought prior to the occurrence of any impacts to the underlying low permeability layer and thereby provide advance notice of a potential impact to the CCL. Therefore, although the low permeability layer could potentially be vulnerable to effects of increased temperature or drought, the potential for any impacts could be anticipated and readily identified in advance of any such occurrence and such impacts are not expected to result in release of contamination.

Increased heavy precipitation events could result in erosion of the vegetation layer, which, if left untended, could result in erosion of the underlying low-permeability layer. Any erosion of the landfill cover would be readily identifiable by visual inspection. Given the overall 5-foot thickness of the landfill cover and the inclusion of the 2-foot-thick rock layer in the base of the cover system, stormwater erosion, even under the most severe storm event, is not anticipated to result in erosion down through the entire landfill cover. Heavy precipitation events could impact the integrity or performance of stormwater drainage conveyance structures, including erosion of drainage channels, damage to or bypassing of let-down and erosion control structures and features, or damage to stormwater detention structures. Heavy precipitation events could also temporarily restrict access to portions of the landfill cover, stormwater control structures, and environmental monitoring points thereby causing delays in implementation of repairs if any are needed. Therefore, the vegetation layer and stormwater controls are potentially vulnerable to impacts from heavy precipitation events. However, due to the overall thickness and design of the landfill cover, any potential impacts are not expected to result in exposure of the waste material or release of contamination. Furthermore, any impacts that occur could be readily addressed as part of normal maintenance and repair of the landfill cover, including localized regarding, repair and replacement of cover material in response to any damage that may occur.

The 52.9 Partial Excavation Alternative is not anticipated to be impacted by flooding that may occur in the area of the Site. As previously discussed in Section 2.1.6, FEMA has determined that, with the exception of the easternmost portions of Areas 1 and 2, which do not contain waste materials, Areas 1 and 2 are located outside of the 500-year floodplain. In addition, the area to the north and west of Area 2 (*e.g.*, Crossroads Industrial Park and Earth City Industrial Park) that potentially could be subject to flooding by the Missouri River, are protected by the engineered

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[49] EPA has indicated that additional evaluations of groundwater will be conducted in the future as part of the OU-3 RI/FS.

levee and stormwater and flood control systems installed to protect the Earth City Industrial Park.

As previously discussed in Section 6.2.2.3.3 in connection with the ROD-selected remedy, an evaluation of potential impacts associated with a tornado was previously performed and submitted to EPA (EMSI, 2013f). Similar to the ROD-selected remedy, the 52.9 Partial Excavation Alternative is not vulnerable to impacts from a tornado. Specifically, a tornado is not expected to damage the vegetative layer and even if it did, such an impact is not considered to be significant because it could be easily identified and due to the design and thickness of the engineered cover, would not result in exposure of the underlying waste or release of contamination. A tornado could damage or destroy aboveground infrastructure such as signage, fencing or environmental monitoring equipment; however, such impacts are not expected to be significant because they would be readily identified and easily repaired or replaced. Therefore, the 52.9 Partial Excavation Alternative is not considered to be vulnerable to impacts from a tornado.

Although the 52.9 Partial Excavation Alternative is not considered to be vulnerable to climate change, implementation of adaptation measures could be considered during remedial design to provide a degree of adaptation for climate change. For example, regrading of the surface of Areas 1 and 2 to a 2% slope instead of a 5% slope could be considered to reduce the velocity of runoff across the surface of Areas and 1 and 2 and thereby reduce erosion and soil loss potential under extreme precipitation events. Installation of runoff collection and diversion systems along the base of the above-grade portion of the North Quarry part of the Bridgeton Landfill adjacent to Area 1 and along the north sides of the Closed Demolition Landfill and the Inactive Sanitary Landfill adjacent to Area 2 could be included in order to divert runoff from these areas around Areas 1 and 2 to reduce the potential for impacts from heavy precipitation events. Use of grass seed mixtures that are more tolerant of long-term changes in precipitation or temperature, and/or soil addition to increase water storage capacity, could be evaluated as part of the design. Similarly, inclusion of a geotextile at the base of the vegetative layer could be considered to minimize the potential for water or wind erosion extending down into the underlying low-permeability layer. The design grades of the stormwater conveyance structures could be evaluated to provide a balance between the ability to quickly route stormwater away from Areas 1 and 2 while minimizing the stormwater velocity and the associated potential for erosion of the stormwater conveyance structures. Identification and evaluation of additional adaptation measures can be addressed as part of the design of the engineered landfill cover and stormwater controls to increase the overall resilience of these features to heavy precipitation events. Continuous re-evaluation of potential vulnerabilities, system resilience, and possible adaptation measures would be included as part of the ongoing inspection and maintenance program.

6.2.4.3.4 Potential Impacts of a Subsurface Heating Event

Because radionuclides above unrestricted use levels would still remain at the Site under the 52.9 Partial Excavation Alternative, radionuclide-related impacts similar to those described in Section 6.2.2.3.4 for the ROD-selected remedy could potentially occur if an SSE or SSR were to occur in Areas 1 or 2. Specifically, a localized, temporary increase in radon emissions from the ground surface could occur. However, as discussed for the ROD-selected remedy, even if such an event were to occur, the radon emission rate would still be less than the standard established by the radon NESHAP. Additionally, if such a release were to occur, risks at or beyond the fence line are expected to be below the acceptable risk levels established by EPA.

6.2.4.3.5 Effects of an Isolation Barrier

As discussed in the previous subsection, no adverse impacts or unacceptable risks are expected to result if an SSR or SSE were to extend into Area 1. Therefore, regardless of the location or type of isolation barrier that may be installed, or even if no barrier is installed, no unacceptable risks are expected to occur. Installation of a heat extraction barrier consisting of various heat extraction points, regardless of location, would not have any impact on the protectiveness, long-term effectiveness, short-term effectiveness, implementability or cost of the 52.9 Partial Excavation Alternative. Installation of a physical barrier, such as a vertical wall of inert material, would require excavation and regrading of the above-grade portion of the North Quarry part of the Bridgeton Landfill wastes located over the southern portion of Area 1. If such a barrier were to be installed prior to implementation of the 52.9 Partial Excavation Alternative, portions of the barrier would need to be removed in conjunction with removal of RIM in the southwestern portion of Area 1. In addition, the design of the engineered cover included in this alternative would need to account for any changes in the surface grades, the stormwater drainage system, and the presence of any above-grade features (*e.g.,* heat extraction points, temperature monitoring probes, or additional gas extraction wells) that may be installed in conjunction with a barrier. In contrast, if a physical barrier were installed after RIM removal and construction of the engineered cover included in the 52.9 Partial Excavation Alternative, that portion of the engineered landfill cover that extended over the construction area of an isolation barrier and the associated revised landfill grades would need to be removed as part of construction of an isolation barrier. The potential alignment of a potential isolation barrier may also need to be revised to reflect the removal of some of the RIM from the southwestern portion of Area 1, assuming that the barrier is designed before the RIM removal and regrading occurs.

6.2.4.3.6 Environmental Justice Considerations

As was previously discussed in Section 6.2.2.3.6 as part of the evaluation of long-term effectiveness of the ROD-selected remedy, a screening-level analysis did not identify any environmental justice concerns relative to the Site. EPA did identify a need for implementation of more traditional (non-electronic) communication methods to inform and ensure meaningful involvement of residents in the Terrisan Reste mobile home community.

6.2.4.4 Reduction of Toxicity, Mobility or Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy. Although a portion of the RIM would be removed, the 52.9 Partial Excavation Alternative is overall a containment remedy and therefore generally would not reduce the toxicity, mobility, or volume of the waste material through treatment.

As discussed in Section 4, radionuclides are naturally-occurring elements which cannot be fully neutralized or destroyed by treatment. Occurrences of radionuclides within Areas 1 and 2 are dispersed within soil material that is further dispersed throughout portions of the overall, heterogeneous matrix of municipal refuse, construction and demolition debris, and other non-impacted soil materials in Areas 1 and 2. Consequently, ex-situ treatment techniques are considered impracticable. In addition, the heterogeneous nature of the solid waste materials and the dispersed nature of the radionuclide occurrences within the overall solid waste matrix in portions of Areas 1 and 2 make in-situ treatment techniques equally impracticable. The remedy for the Buffer Zone/Crossroads Property also would not reduce toxicity, mobility, or volume through treatment because it consists of moving radiologically-impacted soil from the Buffer Zone/Crossroads Property to Area 1 or 2, where it would either be shipped off-site for disposal or consolidated with the RIM in Areas 1 and 2.

An on-site technology that may potentially be applicable to this alternative is ex-situ physical separation of impacted soil from the solid wastes by using solids separation techniques such as hand picking for large bulky items and various fixed, vibrating, or rotating screens, among others (see prior discussion in Section 4.3.5.2). Physical separation would not decrease the mobility or toxicity of the radiologically-impacted materials, but has the potential to separate existing RIM from non-radiologically-impacted materials. As previously discussed, any solids separation techniques would need to be pilot-tested at full-scale using materials from Areas 1 and 2 during remedial design to ascertain the potential effectiveness, implementability, and cost of this technology. Of particular interest in conducting pilot-testing with material from Areas 1 and 2 would be obtaining an estimate of the degree of RIM volume reduction that could be achieved, assessing the moisture content of the filled material, determining the fraction of soil that would be contained in or adhered to the segregated refuse, and determining the residual levels of radioactivity that would be present in the non-soil refuse after screening out the soil fraction. Assuming that solids separation could prove to be an effective and implementable technology (that is, it could effectively separate the radiologically-impacted soil from the other landfilled waste materials such that the other landfilled wastes would contain radionuclide activities below the levels that would allow for unrestricted use), it has the potential to reduce the volume of radiologically-impacted material that would need to be transported to and disposed at an off-site disposal facility. However, little is known about the potential application of a soils separation technology to this situation, and it is possible that pilot-testing could demonstrate that physical separation would not be effective at separating RIM from non-radiologically-impacted materials, in which case the non-radiologically-impacted materials would need to also be shipped off-site for disposal. At this stage of analysis, neither the estimated costs nor the estimated schedules for this FFS include any allowance for solids separation pilot-testing or implementation.

In the event that hazardous wastes are encountered during implementation of the remedy, such materials would be separated from the other solid wastes and subjected to waste profiling to determine the appropriate treatment and disposal requirements. To the extent that hazardous wastes or mixed wastes are encountered, they would be shipped off-site and would be treated at the disposal facility in accordance with the hazardous waste regulations (e.g., EPA's LDR program and UTS) and in accordance with the permits and standard operating procedures of the receiving facility. After arriving at an off-site disposal facility and undergoing a waste receipt analysis, RCRA soil/debris and RCRA soil/debris with radionuclide material would be stabilized prior to placement in a disposal cell. Depending on its physical characteristics, RCRA debris and RCRA debris with radionuclide material would undergo either micro- or macro-encapsulation prior to placement in a disposal cell. To the extent that treatment of the hazardous waste or mixed waste would be required for off-site disposal, stabilization or encapsulation treatment would result in a reduction of the mobility of the hazardous waste and radiologically-impacted components of the mixed waste. Toxicity and volume would not be reduced by these technologies but may be reduced by other technologies potentially applicable to hazardous wastes that do not contain RIM, if such wastes were encountered during implementation of the remedial action at the Site.

Section 6.2.2.4 contains a full discussion of the procedures, protocols and concerns associated with the off-site shipment of hazardous wastes or mixed wastes.

6.2.4.5 Short-Term Effectiveness

This alternative poses significant potential short-term risks as described below. During a public meeting held as part of the ROD-selected remedy process, EPA identified and discussed the following short-term risk issues for waste excavation: waste handling, sorting and stockpiling; water management; noise, odor and windblown trash; worker health and safety (PPE, gamma exposure, physical stress, physical hazards, workplace monitoring); contaminant migration/spreading (fugitive dust and airborne migration, fugitive dust control and water application, leachate generation, equipment decontamination water, and water from open excavations); and waste hauling and transportation issues/truck decontamination (transfer facilities, increased local traffic, waste handling on public roads, interstate transport by rail, DOT requirements, safety issues).

6.2.4.5.1 Protection of the Community During Remedial Actions

The projected carcinogenic risks that may be posed to off-site residents by this alternative would be less than 1×10^{-7}. No non-carcinogenic risks are expected to occur.

The risk assessment (Appendix H) includes an estimate of the projected incidence of transportation accidents associated with each FFS alternative. For the 52.9 Partial Excavation Alternative, the projected incidence of transportation accidents associated with shipping of RIM for off-site disposal and importing of materials for construction of the multi-layer landfill cover is 10.6, meaning that approximately 11 transportation-related accidents are project to occur if this alternative were implemented. This risk is associated with transportation of excavated RIM from the Site to the rail transloading facility, hauling by rail, and transport of the RIM from the destination rail offloading facility to the disposal site, plus truck traffic associated with delivery of construction materials to be used for construction of the new engineered landfill cover on Areas 1 and 2.

Disturbing the waste material may expose the community to radioactive waste, methane and radon gas, dust and particulates and cause an undesirable release of odors. Excavation of existing waste materials would undoubtedly result in odor emissions during the period of time that existing wastes may be handled or exposed. Mitigation of odors through engineering means is limited.

The 52.9 Partial Excavation Alternative would contribute significant carbon dioxide equivalent emissions to the atmosphere as a result of vehicle operations associated with the remedial work. In particular, approximately 43,000 tons of carbon dioxide equivalent emissions are projected to be emitted to the atmosphere as a result of landfill regrading and cover construction in Areas 1 and 2, the excavation, loading, and transport of the RIM to an off-site disposal facility, and the importation of materials used to construct the multilayer landfill cover for Areas 1 and 2 (Appendix I, Table I-3).

Because RIM in Areas 1 and 2 would be excavated under this alternative, overburden would be stockpiled and stored, and RIM would be staged and loaded for off-site disposal. During these activities, the nuisance attraction to and congregation by birds at and above the affected areas could be problematic unless effectively controlled. The main concern would be the potential for increased bird strikes to aircraft approaching and departing from the Lambert-St. Louis International Airport. For the 52.9 Partial Excavation Alternative, an enclosed waste staging and loading structure would be constructed to minimize the outdoor handling of waste and associated attraction of birds or other vectors. Additional mitigation measures such as excavation best management practices, which include application of daily soil cover and/or placement of tarps over areas of exposed waste, visual and auditory frightening devices, or wire or monofilament grids positioned over exposed refuse to prevent bird access, could be implemented to minimize bird attraction to and congregation at and above the disturbed areas.

Excavation of waste materials from Areas 1 and 2 would require removal of the existing landfill cover and overburden from Areas 1 and 2 and portions of adjacent areas of OU-2. Excavation of overburden and RIM would create depressions in the landfill area during the period of time required to remove the RIM and regrade and cover the remaining landfill wastes. Precipitation that falls on the landfill while such depressions are open would potentially flow into and accumulate in the depressions. Any increased accumulation of precipitation[50] in depressions created during waste excavation could result in increased infiltration of precipitation runoff through the underlying waste materials, which could result in leaching of VOCs or other soluble contaminants from the waste materials.

Because Areas 1 and 2 would be excavated and RIM loaded into transport containers, storm water controls would be implemented in accordance with the Missouri Storm Water regulations

[50] Accumulation could be significant during a heavy rainstorm as the maximum historical 24-hour rainfall for the St. Louis area ranges from a low of 3.7 inches in November to a high of 8.8 inches in August (NOAA, 2011).

10 CSR 20-6.200 to protect the community. During construction, consideration would be given to minimizing the areas of excavation that would be open and exposed to waste materials at any given time. Temporary diversion berms using daily cover material would also be constructed above the open excavation areas on the previously excavated (and temporarily covered) surface of any excavation depressions in order to divert precipitation runoff around the open excavation to prevent the runoff from contacting uncovered waste materials. Precipitation that would contact uncovered waste materials would flow into the low point of the excavation and be pumped out into temporary storage tanks using portable gas-driven pumps. Samples from each tank would be collected and sent to a laboratory for analysis. The stored water would be directly discharged or treated and disposed appropriately based on the analytical results.

6.2.4.5.2 Environmental Justice Concerns

As was previously discussed in Section 6.2.2.5.1 as part of the evaluation of short-term impacts associated with the ROD-selected remedy, a screening-level analysis did not identify any environmental justice concerns. EPA did identify a need for implementation of more traditional (non-electronic) communication methods to inform and ensure meaningful involvement of residents in the Terrisan Reste mobile home community.

6.2.4.5.3 Protection of Workers During Remedial Actions

This alternative would entail significant excavation, handling, loading and transport of RIM at the Site and therefore would pose both significantly increased radiological exposure risks as well as construction safety risks to on-site workers.

Workers involved in the excavation activities would be subject to potential short-term risks. Possible short-term impacts associated with excavation and regrading of the RIM include the following potential risks: exposure of workers to contaminated waste; excavation/trenching instability; stormwater runoff entering areas where waste is exposed resulting in the exposure of workers to contact storm water; and odor emissions or other aesthetic issues arising from exposed waste. Worker exposures would be addressed through development and implementation of a Site safety plan, use of personal protective equipment, and performance of personnel and environmental monitoring during implementation of remedial action. Workers would be protected during construction by adhering to OSHA practices; however, as this alternative entails extensive excavation, handling and transportation of radiologically-impacted materials, OSHA work practices and personal protective equipment may not provide full protection against exposure to external gamma radiation.

The risk assessment (Appendix H) presents an evaluation of potential risks to Site workers that may occur for each alternative. These include risks from industrial accidents, exposure to carcinogenic substances, and projected radiation exposures. For the 52.9 Partial Excavation Alternative, the projected incidence of industrial accidents is 8.5 over the life of the project. The projected carcinogenic risk to the maximally exposed individual is 1.18×10^{-3} and the projected radiation dose to a remediation worker is 720 mrem/yr (Appendix H).

Excavation would require construction workers and equipment that would disturb the overburden soil and underlying waste materials. Dust control measures would be required to limit worker exposure to fugitive dust during construction.

6.2.4.5.4 Environmental Impacts

No measurable long-term impacts to plants or animals in surrounding ecosystems are expected from this alternative. As noted in the BRA (Auxier, 2000) and the updated BRA (Auxier, 2016a), some of the ecosystems present at the landfill are the result of existing institutional controls and other limitations on land use within or adjacent to OU-1 that have allowed field succession to take place. Much of the habitat on Areas 1 and 2 was removed in 2016 in conjunction with construction of the non-combustible cover. Excavation of RIM, regrading of Areas 1 and 2, and construction of the engineered landfill cover under the 52.9 Partial Excavation Alternative would destroy the remaining portions of the habitats that currently exist on the surface of Areas 1 and 2, forcing wildlife to migrate to other areas. Vegetative cover would be placed on the Site as a part of the final cover, and the landfill would be allowed to return to an early-stage field ecosystem with periodic mowing and maintenance.

6.2.4.5.5 Ability to Monitor Effectiveness

Measurement of gamma radiation and radon flux through the newly constructed landfill cover would be conducted on Areas 1 and 2 after construction is complete. Regular monitoring of groundwater quality would be performed at appropriate locations around Areas 1 and 2. Measurements of subsurface occurrences of landfill gas and radon levels would be conducted along the property boundaries adjacent to Areas 1 and 2 to verify that off-site gas migration above regulatory thresholds does not occur.

6.2.4.5.6 Time Until Remedial Action Objectives Are Achieved

The RAO of (1) preventing exposure to radionuclides or waste at concentrations above ARARs or risk levels would be met immediately upon completion of construction of a new engineered landfill cover. The RAOs of: (2) minimizing infiltration and any resulting contaminant leaching to groundwater; (3) controlling surface water runoff and erosion and decreasing the potential for erosion and subsequent transport of RIM; and (4) controlling radon and landfill gas emissions from Areas 1 and 2 would also be met once construction of the new landfill cover over Areas 1 and 2 is completed. The RAO related to the Buffer Zone and Crossroads Property soil would be met upon removal of any remaining soil containing radionuclides above unrestricted levels from these areas.

Initiation of this alternative would require significant planning and permitting due to the limited number of off-site disposal facilities capable of taking this material and the extensive logistics associated with identifying, handling, classifying and loading the materials for transport to the selected off-site facility. Preparation of the remedial design should be completed within approximately 15 months of authorization to proceed with the RD. RD could take significantly longer if full-scale pilot-testing of solids separation equipment were to be performed. The RAOs would be achieved upon completion of construction which is estimated to be finished within approximately 4.6 years after approval of the RD. Therefore, the remedial action objectives should be achieved within 5.9 years of approval to proceed with the RD (Appendix J). This schedule estimate assumes that the buyout of the asphalt company lease and relocation of the solid waste transfer station occurs during the remedial design phase; otherwise, the schedule would be longer.

The projected construction schedule and the cost estimate for the 52.9 Partial Excavation Alternative are highly dependent on the waste material swell factor; that is, the amount the in-place waste volume expands as it is excavated, handled and loaded for transport to an off-site disposal facility. For purposes of this FFS, a swell factor of 1.5 has been assumed. A swell factor greater than 1.5 would result in an increase to the overall construction schedule and the estimated costs. The projected construction schedule and the cost estimate for the 52.9 Partial Excavation Alternative also are highly dependent on the number of rail cars that could be loaded and shipped per day. The schedule and cost estimate developed in this FFS for this alternative are based on an assumption that a sufficient number of IM containers and rail cars can be made available, loaded, switched out and replaced every day. If the actual rate is less than the projected rates of RIM excavation used to develop the construction schedules, the time required to complete construction and consequently the costs for 52.9 Partial Excavation Alternative would increase.

6.2.4.6 Implementability

This alternative would involve excavation and off-site disposal of a portion of the RIM in Areas 1 and 2, repair and restoration of the disturbed portions of the OU-2 landfill units adjacent to Areas 1 and 2, grading of the surfaces and installation of upgraded landfill covers over the areas of Areas 1 and 2, long-term monitoring and maintenance of the covers, and long-term monitoring of landfill gas and groundwater and surface water quality.

Excavation of RIM would require removal of substantial amounts of overburden and material from the sidewalls of the excavations in order to maintain stability of the excavation areas. Overburden removal would entail removing and temporarily relocating part of the above-grade portion of the North Quarry part of the Bridgeton Landfill in order to access the underlying RIM in Area 1 of OU-1. The total amount of non-RIM waste required to be removed under this alternative is estimated to be approximately 350,000 bcy, which, based on an expansion factor of 1.5, would result in the need to handle, stockpile and replace 525,000 lcy of waste. Management of exposed waste in both the excavation areas and the stockpiles – including management of stockpiles, stormwater runon and runoff, odor emissions, attraction to birds and other vectors, and litter control – would be a significant undertaking. The amount of space available for stockpiling the overburden material is limited, and therefore overburden material from Area 1 would likely need to be transported to Area 2 for temporary stockpiling while waiting for final placement and capping. Similarly, the total volume of RIM that would be excavated under this alternative is estimated to be 151,000 bcy, equivalent to 226,000 lcy. Due to the double-handling (at a minimum) of the overburden material plus the RIM handling, it is anticipated that more than 1,100,000 lcy of waste would be handled under this alternative.

An additional complication arises from the proximity of the Bridgeton Transfer Station. In order to access the RIM in the southwest portion of Area 1, the solid waste transfer station would need to be relocated, as removal of waste material would extend up to and along the base of the solid waste transfer station such that the integrity of the solid waste transfer station building foundation and above-grade structure would be compromised. The only available space for relocation of the transfer station is the area currently occupied by Simpson Asphalt Company, which holds a long-term (99-year) lease on this area. This lease would have to be bought out and the asphalt company would need to be relocated before the transfer station could be relocated to this area.

It is anticipated that a new structure would be constructed to shelter the RIM staging and loading operations in order to minimize stormwater contact, odor emissions and bird attraction. It is anticipated that such a structure would be constructed along the north side of the Site access road in the area that is currently being used to store new, reclaimed and surplus equipment and materials associated with ongoing operation and maintenance and closure activities for the Bridgeton Landfill. These materials would need to be relocated to another portion of the Site prior to construction of such a structure.

In order to minimize potential vehicle interactions between normal traffic to and from the solid waste transfer station and the construction operations associated with this alternative, a temporary overpass would likely need to be constructed over the Site access road to allow for uninterrupted movement of construction traffic between Areas 1 and 2. An overpass is considered the most efficient and safest means for transfer of overburden waste from Area 1 to stockpile locations in Area 2 and then back to Area 1. In addition, as discussed above, a single RIM staging and loading building would be constructed and operated as part of this alternative. RIM removed from Area 1 would need to be transferred over the Site access road. Installation of an overpass would eliminate the potential for RIM to be tracked across the Site access road and potentially tracked off-site.

While excavation with subsequent off-site transportation and disposal have been implemented at other sites containing radioactively-impacted materials, materials from these other sites have not included significant amounts of landfill solid wastes. Significant technical and administrative implementability issues are associated with excavating the RIM and loading it into IM containers for transportation if this alternative were to be implemented. These include the following:

- Reduced excavation production rates and increased volume of RIM subject to excavation resulting from application of daily cover over an extended excavation schedule;
- Ability to locate and obtain a lease to an off-site rail spur for use as a truck-to-rail transfer facility, or alternatively the ability to construct an on-site rail spur and rail loading facility;
- Increased potential for bird strikes to aircraft as a result of excavation of putrescible or organic solid waste overburden waste from the North Quarry portion of the Bridgeton

Landfill and Areas 1 and 2 and excavation of RIM-contaminated waste from Areas 1 and 2, all of which are located within flight paths of Lambert–St. Louis International Airport;

- Impacts to other Site operations and traffic on surrounding roads from additional truck traffic used to haul wastes to an off-site truck-to-rail transfer facility and to haul earthen materials to the Site for daily cover, stockpile covers, and construction of the final cover.

Design and construction of post-RIM-excavation landfill covers over Areas 1 and 2, with subsequent monitoring and maintenance, are not expected to pose any implementability challenges. Materials and services necessary for the regrading and construction of the final landfill covers over Areas 1 and 2 after RIM removal are available and the technologies have been proven through application at other landfills. Design and construction of landfill covers over Areas 1 and 2 after RIM removal are not expected to pose any significant implementability challenges.

The actions included for the Buffer Zone/Crossroads Property – that is, testing and excavation of surface soil – are regularly and easily implementable.

Monitoring of the cover surfaces, landfill gas, groundwater, and surface water are proven methods for demonstrating the long-term effectiveness of the engineered landfill cover that would be placed over Areas 1 and 2 and are easily implemented.

6.2.4.6.1 Ability to Construct and Operate the Technology

In general, excavation and off-site disposal are standard technologies. However, there are unique circumstances associated with excavation of RIM in Areas 1 and 2, located as they are within an overall larger closed/inactive landfill site, which would complicate implementation of standard excavation technologies.

RIM excavation and placement in IM containers and hauling of the containers by truck for subsequent transfer to rail is also expected to present implementability concerns, challenges, and risks, specifically those associated with the following:

- Excavation and handling of contaminated materials;
- Safety risks associated with encountering methane gas during excavation;
- Management of fugitive dust and potential odors;
- Mitigation of bird hazards;
- Management and treatment of stormwater exposed to RIM during excavation; and
- Identifying, segregating, and disposing off-site any hazardous wastes, PCBs or RACM that may be encountered during RIM excavation.

If hazardous wastes, PCBs, or RACM are encountered during excavation of RIM, these materials would need to be segregated from the other waste materials, characterized, and transported to an off-site disposal facility in containers separate from the other RIM. Additional health and safety procedures would be required during excavation of these materials. These materials would require separate handling at the off-site disposal facility and could require treatment prior to disposal. Depending on the characteristics of any hazardous waste encountered during excavation, the hazardous waste could need to be transported to a different off-site facility for treatment and disposal in accordance with RCRA.

Directing and controlling the RIM excavation process using radiological scanning and sampling techniques would significantly impact overburden and RIM excavation production rates. Based on experience in excavation of radiologically-impacted waste at other sites, a reduction in efficiency is expected for overburden excavation and a greater reduction is expected for RIM excavation. Because thorium-230 is a primary radionuclide of concern relative to any excavation alternative that may be considered for the Site, even greater reductions in efficiency and increased time may be required for RIM excavation. Thorium-230 cannot be detected using field survey instruments, and therefore excavation guidance would have to rely on collection and laboratory analyses of samples. In order to minimize the potential impacts on the excavation schedule, it is assumed that an on-site laboratory would be set up and operated to provide quick analyses of samples to guide excavation activities and initial confirmation that all RIM had been removed. A percentage of such samples would also be sent to an off-site laboratory for verification of the on-site laboratory results. Samples obtained for final confirmation that all RIM has been removed from a particular area would also be subjected to off-site laboratory analyses and data validation. All of these activities would undoubtedly impact the rate of RIM excavation and the duration over which excavation areas need to remain open.

Daily soil cover and tarps would need to be placed over open excavation areas and stockpiled overburden to minimize dust, odor, and the attraction of birds and other wildlife. The proximity of Areas 1 and 2 to Lambert-St. Louis International Airport poses a potential risk to aviation operations. The St. Louis Airport Authority and the U.S. Department of Agriculture have identified as a problem the potential for increased bird activity in conjunction with waste excavation at the Site and the resultant increased risk of bird strikes to aircraft. Bird nuisance mitigation measures such as best management practices (including, but not limited to, daily soil cover and tarps over exposed overburden and wastes), visual and auditory frightening devices, and wire or monofilament grids strung over exposed refuse to prevent bird access, could be evaluated for use at Areas 1 and 2. The size of open excavations may limit the constructability of wire or monofilament grids. Careful evaluation of material properties would be necessary during remedial design to assure that the appropriate strength and elasticity of materials are considered, that the materials are available, and that grids can be reasonably constructed.

Effective storm water controls could be readily implemented using conventional construction equipment and materials. Temporary berms to direct stormwater away from open excavations would need to be constructed, and precipitation accumulation in depressions created by the excavation activities would need to be pumped out and managed. Direct precipitation or runoff that may contact waste material could become contaminated with soils or wastes containing thorium or radium. These elements would be entrained in colloidal material that would readily settle in low areas or in the tanks used to collect and store stormwater prior to treatment and discharge. At the end of excavation activities, after all RIM above cleanup levels would have been removed, accumulated sediment in any low areas or the tanks would also be removed and, depending upon activity levels, either placed in Area 1 or 2 or transported to the off-site disposal facility.

Excavated RIM exposed to precipitation would be subject to the paint filter liquids test (PFLT) as necessary to determine if free liquids exist prior to being loaded for off-site disposal. If the excavated material to be hauled off-site does not pass the PFLT, a dewatering area would need to be staged and collected water treated and/or disposed, potentially through off-site disposal. The current costs and schedules do not address any dewatering activities. Should such activities be necessary, a suitable area would have to be identified within the Site.

Truck hauling of IM containers of RIM to a truck-to-rail transloading facility and transferring the RIM to railcars is technically implementable. Loading RIM directly into railcars on-site if a rail spur could be extended onto the West Lake Landfill property is theoretically implementable; however, it is not known whether extension of a spur onto the property is actually feasible. If construction of an on-site rail spur were to be considered, an engineering study and development of a detailed design would be necessary to determine the feasibility and implementability. As discussed in detail in Sections 6.2.3.6.5 and 6.2.3.6.6 above, construction of an on-site rail spur would also require coordination with a number of local and state regulatory authorities as well as private landowners.

An initial comparison of the US Ecology Grand View facility WAC to estimated activity levels in the OU-1 RIM under the 52.9 Partial Excavation Alternative is presented on Table 6-3. Although a representative of the turnkey contractor would be on site during RIM excavation to coordinate loading of containers, there is a potential that one or more shipping containers could contain activity levels that exceed the WAC and may have to be unloaded and re-distributed prior to shipment or, in the worst case, returned to the Site by the disposal facility and/or sent to a different disposal facility. These additional activities could result in additional worker exposures, additional time to complete the project, and potentially additional costs.

Regrading the remaining landfills and placement of final cover is implementable and has been performed at other landfills, including CERCLA sites. Environmental monitoring is routinely performed at most sites and is not expected to present any feasibility challenges.

6.2.4.6.2 Reliability of the Technology

Excavation and off-site disposal of radioactively-impacted material has been performed at number of FUSRAP facilities and is a reliable technology. It should be noted, however, that none of these FUSRAP sites involved radiological materials commingled with municipal solid waste and disposed in a landfill setting. The reliability associated with disposal in an off-site facility would be dependent on the integrity of the liner and cover systems at the off-site facility being maintained, as well as the effectiveness of the various off-site facility monitoring programs.

Landfill cover systems such as those that would be implemented over Areas 1 and 2 after partial removal of RIM, and which are designed and constructed consistent with State and Federal regulations and with post-closure care implemented in accordance with current regulatory guidance, have been demonstrated to be reliable at: (1) minimizing percolation and infiltration of precipitation; (2) minimizing leachate generation; (3) minimizing impacts to groundwater quality; (4) minimizing impacts to surface water quality and quantity; (5) minimizing erosion of cover material; and (6) minimizing uncontrolled releases of landfill gas. Landfill cover systems have been demonstrated to be reliable methods for isolating waste materials. Similarly, access restriction measures have been demonstrated to be reliable mechanisms to prevent unauthorized access to a site.

Bird nuisance mitigation measures such as best management practices (including, but not limited to daily soil cover and tarps over exposed RIM and waste), visual and auditory frightening devices, and wire or monofilament grids strung over exposed refuse to prevent bird access, are demonstrated reliable technologies under proper operating and excavating conditions. However, while visual or auditory frightening devices can be effective in the short-term, birds tend to habituate to deterrents over time, causing the deterrent to lose effectiveness. Frequent relocation of predator birds and predator effigies and/or altering the timing of auditory activation may help, but long-term effectiveness is not assured. In addition, the FAA has stated that “[t]o date, no . . . [putrescible waste] facility has been able to demonstrate an ability to reduce and sustain hazardous wildlife [birds] to levels that existed before the putrescible-waste landfill operations began operating.” (FAA, 2007).

Stormwater controls are well-established technologies that are implemented at most landfill sites. For this alternative, gravity settling of suspended solids potentially containing radionuclides is a well-established and reliable technology.

6.2.4.6.3 Ease of Undertaking Additional Remedial Actions, if Necessary

Because all of the RIM would not be removed during implementation of this partial excavation alternative, it is possible that EPA could later require removal of additional RIM. If such a decision were to occur after construction completion of this alternative, performance of any such additional remedial action in the future would be very difficult and costly. Such actions would require removal of the newly constructed engineered landfill cover and re-excavation of materials previously removed and replaced as part of this partial excavation alternative.

Other than the possibility of additional excavation in the future, the only potential additional remedial actions that may need to be taken for the 52.9 Partial Excavation Alternative would be maintenance activities to sustain the cover system, repair areas of differential settlement or erosion, or possible implementation of a contingent landfill gas control system. Regrading and contouring the existing waste materials to achieve final grades would require re-compaction of the regraded waste materials in order to minimize the potential for compaction or differential settlement over time that could affect the integrity of the landfill cover. Placement of additional fill material to achieve the final slope requirements and for construction of the landfill cover may result in differential compaction of the waste materials, depending upon the nature, age and amount of prior degradation of the waste materials. Runoff of stormwater can result in formation of erosional rills. Depressions caused by differential settlement of the wastes or erosional features can easily be (and commonly are) addressed at landfill sites through placement of additional soil material to fill such features.

In the event that monitoring of subsurface landfill gas and radon detects the presence of gas levels above regulatory thresholds along the perimeter of the Site, a landfill gas control system could be implemented as an additional remedial action. Implementation of a contingent landfill gas control system would entail drilling and installation of gas extraction wells, installation of conveyance piping, installation and operation of landfill gas extraction blowers and a landfill gas treatment (flare) system, and/or possible use of a carbon adsorption system to remove radon from the extracted gas stream. Installation of a contingent gas system could be performed as a future action. Any disruption to the final landfill cover resulting from the installation of a contingent gas extraction system would need to be repaired. Such activities are commonly and routinely undertaken at solid waste disposal sites.

Long-term monitoring and maintenance of the landfill covers at other Superfund sites and at non-Superfund solid waste landfills is typically required to assess whether differential settlement or surface erosion of the cover has occurred over time. Long-term maintenance, including cover inspection and repair, would be part of this alternative. Cover repair, if necessary, would be straightforward, primarily entailing placement of additional fill, regrading, and revegetation of the repaired area.

Bird nuisance mitigation measures such as best management practices (including, but not limited to, selective excavation, daily soil cover, and tarps), visual and auditory frightening devices, and wire or monofilament grids strung over exposed refuse to prevent bird access, are demonstrated to be readily implementable at landfill sites.

Storm water management measures other than those using conventional earth-moving equipment, piping, pumps, liners, filtration and carbon adsorption water treatment equipment, rip-rap, and pond outlet structures are not anticipated.

6.2.4.6.4   Ability to Monitor Effectiveness of Remedy

Demonstrating the effectiveness of the cover systems constructed over Areas 1 and 2 after partial excavation of RIM would be accomplished by implementing monitoring programs for the cover surface, landfill gas system, groundwater and surface water programs, as previously described in Section 5.4.4. These types of monitoring programs have been proven at demonstrating cover effectiveness and are easily implemented.

6.2.4.6.5 Ability to Obtain Approvals from Other Agencies

Implementation of the 52.9 Partial Excavation Alternative would require approvals from other agencies, including the following:

- Approval from the FAA to conduct waste excavation activities within 10,000 feet of an active airport runway. FAA Advisory Circular AC 150/5200-33B, dated August 28, 2007, "Hazardous Wildlife Attractants On or Near Airports," recommends "against locating a MSWLF [municipal solid waste landfill] within the separation distances identified in Sections 1-2 through 1-4. The separation distances should be measured from the closest point of the airport's AOA [airport operations area] to the closest planned MSWLF cell." AC 150/5200-33B, p. 4. The separation distances referenced are 5,000 feet from the end of a runway for airports serving piston-powered (propeller) aircraft; 10,000 feet for airports serving turbine-powered (jet) aircraft; and 5 miles of protection from hazardous wildlife movement for approach, departure and circling airspace. The FAA strongly recommends against allowing a waste disposal operation within 10,000 feet of a jet aircraft runway if the material contains putrescible waste and so has the potential to attract wildlife that could threaten air traffic. The excavation of RIM containing putrescible waste within 10,000 feet of the westernmost runway (11/29, formerly known as 12W/30W) at Lambert-St. Louis International Airport, as would occur during excavation of the RIM in Areas 1 and 2, is limited by the need to mitigate potential bird activity during excavation to address the requirements of the FAA Advisory Circular and to comply with the same prohibitions in the Missouri solid waste regulations. It may be necessary to work directly with the FAA and MDNR to identify specific bird mitigation measures during implementation.

- Approval of St. Louis Airport Authority (STLAA) relative to obtaining a release for the Negative Easement and Declaration of Restrictive Covenants Agreement. Excavation of RIM from Areas 1 and 2 poses a potential to increase the bird populations at the Site if mitigation procedures are not employed or prove ineffective. An increase in bird populations presents a greater potential for aircraft-bird strikes. The STLAA and USDA have identified this as a concern relative to construction and operation of a new on-site disposal cell that was included in the "complete rad removal" with on-site disposal alternative evaluated in the SFS. Based on the STLAA's position stated in the STLAA's September 20, 2010 letter to EPA, STLAA acceptance of RIM waste excavation would not be likely if bird activity were to increase. It may be necessary to work directly with the FAA and the STLAA to address these concerns, either by amending the FAA ROD, amending the Negative Easement, requiring specific bird mitigation measures during implementation, or making other changes to secure STLAA's cooperation.

- Location of an off-site truck-to-rail loading facility. At the discussion held in September 2010, the STLAA indicated that they would not allow the use of the existing SLAPS truck-to-rail transloading facility for loading waste from the West Lake Landfill into railcars (Appendix A-4). The SLAPS rail spur is reportedly owned by the U.S. Army Corps of Engineers and the land upon which the rail spur is built is owned by the City of

St. Louis. It is not clear that the STLAA could prevent use of the SLAPS rail spur for loading and shipping via contractual means; however, as the STLAA is the owner of the property, their concurrence must be considered. Therefore, it appears unlikely that the SLAPS rail spur would be available for implementation of a remedial action for West Lake Landfill. No other nearby off-site truck-to-rail loading facilities have been identified. Discussions with US Ecology have indicated that as part of the transportation and disposal activities, US Ecology would locate and lease an existing rail spur in the area or otherwise construct a rail spur somewhere in the area that could serve as a transloading facility.

- Compliance with EPA's OSR. The EPA Region where the off-site disposal facility is located would need to be contacted every 60 days during the period of off-site waste shipments to obtain a compliance determination as to whether the disposal facility currently meets the criteria under the OSR to accept CERCLA waste. If, during RIM excavation, the contracted off-site disposal facility was to be out of compliance for a period of time, excavation and transportation would need to cease until the facility becomes compliant or RIM would need to be transported to another facility that is determined to be in compliance with the OSR. Besides schedule delays, temporary stoppage of construction would present significant technical implementability concerns regarding open excavation areas.

- Rocky Mountain Low Level Radioactive Waste Compact Consent. If RIM were to be disposed at the Clean Harbors Deer Trail, CO facility, an application would have to be submitted to and accepted by the Rocky Mountain Low Level Radioactive Waste Compact. Disposal at the US Ecology Grand View, ID, US Ecology Wayne, MI, and Energy*Solutions* Clive, UT facilities would not be subject to a Waste Compact consent.

6.2.4.6.6 Coordination with Other Agencies

Although not all would be considered "agencies," coordination with many entities would be necessary to implement the 52.9 Partial Excavation Alternative. Coordination with the landfill owner and operator and owners or occupants of the various parcels that comprise the West Lake Landfill Site would be necessary because of the following:

- Termination of the asphalt company lease and removal of the asphalt plant followed by relocation of the Bridgeton solid waste transfer facility and construction of an overpass between Areas 1 and 2 over the Site access road would need to occur prior to the start of RIM excavation;

- Access to operations conducted on other portions the Site would need to be maintained.

- Areas 1 and 2 are within a larger existing Site footprint, and use of areas on the Site outside of Areas 1 and 2 might be necessary to stockpile cover materials or otherwise to facilitate cover construction.

- Implementation of this alternative would require excavation of portions of landfill units located outside of OU-1. Upon completion of removal of the RIM, disturbed portions of the adjacent landfill units would need to be repaired and restored, and regrading and installation of a replacement landfill cover over areas outside of OU-1 would need to be performed. Coordination would also be required relative to integration of the slopes and grading for adjacent landfill areas and routing and design of stormwater diversion and conveyance structures between OU-1 and other landfill areas.

- Use of other areas of the West Lake Landfill Site that may be necessary for stockpiling of overburden and staging or routing of trucks or rail cars used to haul the excavated RIM off-site.

- Implementation of any additional institutional controls or modifications to existing institutional controls that EPA may require would need to be approved and accepted by the individual entities that own the various parcels that compose the Site.

For the duration of excavation, off-site transport, and import of cover materials, the flow of vehicles associated with remedy construction would need to be coordinated with the traffic patterns of vehicles associated with the current on-site solid waste transfer station and other Site tenants.

If a truck-to-rail transloading facility at an off-site rail spur location were to be used, a suitable location would need to be identified and a lease secured with the land/rail spur owner for the duration of the RIM loading and transport operations. As noted above, it does not appear that the existing SLAPS truck-to-rail transloading facility would be available, so costs for establishing a new facility would need to be considered[51].

If a rail spur were to be extended onto the West Lake Landfill Site:

- Land located across St. Charles Rock Road would either need to be purchased or long-term leases would be needed with landowners;

- State and local government, private landowner, facility occupant and community approval would need to be obtained in order to construct a rail spur across private property located to the east of St. Charles Rock Road, across St. Charles Rock Road, and along the access roads which serve the existing solid waste transfer station and asphalt plant operations located at the Site;

- Appropriate safety measures for the crossing at St. Charles Rock Road would have to be installed, consistent with requirements of state and local governments;

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[51] The unit cost estimates provided by US Ecology for purposes of this FFS include costs to secure an off-site rail spur for a truck-to-rail transloading facility.

- The long-term lease of the asphalt plant for land south of the solid waste transfer station, would need to be bought out or otherwise acquired; and

- Because of the high traffic volume on St. Charles Rock Road during the day, dropping off empty and picking-up loaded railcars would likely be possible only during late nighttime and early morning hours.

Provision of and switching of gondola railcars either at a truck-to-rail transloading facility spur or an on-site rail spur would need to be coordinated with the railroad company that would be hauling the railcars to the off-site disposal facility.

Future groundwater monitoring activities could require obtaining and maintaining access to off-site properties if off-site groundwater monitoring were required as part of the remedy.

The potential for increased bird strikes to aircraft approaching and departing the Lambert-St. Louis International Airport is a major concern of the FAA and St. Louis Airport Authority. The effectiveness of proposed bird nuisance mitigation measures would be of interest to the FAA and STLAA. Consequently, the FAA and STLAA would need to be involved in the remedial planning process.

Coordination with other agencies, including the Earth City Flood Control District, MSD and MDOT, as well as the adjacent property owners and businesses (for example, the Crossroads Property/AAA Trailer) would also be necessary to:

- Coordinate with the Earth City Flood Control District regarding the design of non-contact stormwater management and discharge facilities both during and after completion of construction;

- Coordinate with MSD regarding permitting and design of leachate/contact stormwater discharge during construction;

- Coordinate with MDOT for access to areas along St. Charles Rock Road and for any traffic control or ingress and egress additions along St. Charles Rock Road in the vicinity of the Site entrance; and

- Obtain legal and physical access from AAA Trailer for testing and if necessary remediation of the Crossroads Property and possibly for implementation of remedial actions that may need to be performed along the property boundary (e.g., regrading, fencing, etc. in Area 2).

As discussed at the beginning of this section (6.2.3.6), in order to access RIM in Area 1, the solid waste transfer station facility would need to be relocated. The only suitable area for relocation of the transfer station is currently under lease and occupied by Simpson Asphalt Company. The asphalt company lease would need to be bought out and their equipment removed from the Site before the transfer station could be relocated. Relocation of the transfer station would normally be subject to permitting by the City of Bridgeton and St. Louis County; however, because relocation of the transfer station would be performed as part of a Superfund remedial action and the transfer station would remain on-site, additional permitting is not anticipated to be required. However, it is likely that public meetings and hearings may be necessary, which would require coordination with the City of Bridgeton and St. Louis County and could impact the timing for the start of construction of a 52.9 Partial Excavation Alternative.

6.2.4.6.7 Availability of Off-site Treatment, Storage and Disposal Services and Capacity

As discussed in Section 4.3.5.4, four off-site disposal facilities that could accept excavated RIM from the West Lake Landfill OU-1 have been identified. At least three of these facilities (located in Idaho, Utah and Colorado) have accepted radiologically-impacted soil from projects or sites in the United States, although none of them have previously accepted radiologically-impacted soil mixed with solid waste. All four of the identified facilities have available capacity to accept the estimated volume of RIM from the Site. The volumetric rate of acceptance for all facilities would be limited by the number of IM containers and railcars that could be provided and loaded at or near the Site, as well as the number that could be unloaded at or near the disposal facility. Off-site treatment, storage and disposal may be required in the event that hazardous wastes or RACM are encountered in the overburden or RIM excavated from Areas 1 and 2.

The identified facilities are also permitted to: (1) accept liquid wastes, should any stormwater that may accumulate in excavations during RIM excavation become contaminated and require disposal off-site; (2) accept mixed wastes if mixed wastes are encountered during excavation; and (3) treat soil and/or debris that contains hazardous waste or mixed waste.

As discussed in Section 3.2.1, the CERCLA OSR requires that waste materials removed from a CERCLA site be placed only in a facility operating in compliance with RCRA or other applicable Federal or State requirements. EPA makes such determinations every 60 days. The compliance status of an off-site disposal facility would need to be evaluated during remedial design and would need to be regularly evaluated and updated during remedy implementation.

Offsite treatment and discharge of any leachate that may be encountered or stormwater that may contact waste materials during the landfill re-contouring activities could also be required. Off-site treatment and discharge of any leachate that may be encountered or stormwater that may contact RIM during the landfill excavation activities could also be required. Initial discussions with MSD indicated that they are willing to accept leachate and contact stormwater and initial discussions with the Earth City Flood Control District indicated a willingness to accept stormwater, subject to installation of additional stormwater detention/retention capacity.

6.2.4.6.8 Availability of Necessary Equipment and Specialists

Materials, equipment and personnel required for excavation and transport of RIM to an off-site disposal facility are readily available. Trained health physics technicians and specialized equipment required to monitor personnel and environmental conditions, as well as to assist in directing the RIM excavation sequencing, are also available.

As discussed above, there are a limited number of disposal facilities that can accept these types of wastes, and most of these have stringent waste acceptance criteria which may limit the ability of some of the facilities to receive the wastes.

Availability of rail service, particularly the number of rail cars that can be made available and switched daily by the railroad, would also affect the production rate of RIM excavation and disposal and therefore the cost.

All of the materials, equipment and personnel necessary to remove the designated portion of the RIM and to regrade and construct the engineered landfill cover over Areas 1 and 2 after the designated portion of the RIM (*i.e.*, greater than 52.9 pCi/g) has been removed are readily available and the technologies have been generally proven through application at other landfills. The implementability and potential cost of the covers would be influenced by the availability and location of clean cover materials and/or off-site borrow sources at the time this alternative would be implemented. Potential vendors of rock, clay and soil were contacted during the development of the FS (EMSI, 2006) and during preparation of the Remedial Design Work Plan for the ROD-selected remedy (EMSI, 2008) regarding availability, and the availability of some of the materials was verified in conjunction with construction of the NCC. Information obtained from the vendors at these times indicated that rock, clay and clean cover material were readily available from sources located near the Site. If these local sources of cover materials become exhausted prior to or during remedy implementation, cover materials would have to be obtained from suppliers at greater distances from the Site.

The necessary materials, equipment and personnel required for assessment and removal of RIM that may be present at the Buffer Zone/Crossroads Property above unrestricted use levels and to implement the institutional controls and monitoring components of this alternative are also readily available.

6.2.4.6.9 Availability of Prospective Technologies

The 52.9 Partial Excavation Alternative is based on proven, established, and commonly used technologies. Use of prospective technologies is not currently envisioned to be part of this alternative.

6.2.4.7 Cost

Estimated capital, annual OM&M, and 30-year present worth costs for the 52.9 Partial Excavation Alternative are included in Appendix K-5 and summarized on Table 6-1. Conceptual excavation, backfill, and bottom and top of final cover grading plans as well as stormwater control features used as the basis for the 52.9 Partial Excavation Alternative capital cost estimate are provided in Appendix M. The estimated cost to conduct the 52.9 Partial Excavation Alternative (i.e., design costs, capital costs, and costs for monitoring during the construction period) is $313,000,000 based in part on unit costs provided by US Ecology. These costs do not include costs to conduct full-scale pilot-testing of solids separation equipment. The estimated annual OM&M costs range from $159,000 to $326,000 per year depending upon the specific activities that occur each year (e.g., higher costs for years with additional environmental monitoring and years when landfill cover repairs and five year reviews may occur). The cost estimates provided in this FFS are feasibility-level cost estimates which were developed to a level of accuracy such that the actual costs incurred to implement this alternative are expected to fall within a range bounded by 50% above and 30% below these estimates.

The present-worth costs of the 52.9 Partial Excavation Alternative are projected to be $265 million over a 30-year period based on a discount rate of 7%. Based on the current OMB rate of 1.5%, the present worth costs would be $305 million. The total non-discounted costs for the 52.9 Partial Excavation Alternative over 30 years are projected to be $318 million.

Given the long life of the radionuclides present at OU-1, the costs for the 52.9 Partial Excavation Alternative were also evaluated for 200- and 1,000-year periods (without consideration of any constraints on annual expenditures). The total non-discounted costs of the 52.9 Partial Excavation Alternative are projected to be $348 million over a 200-year period. The total present-worth costs of the 52.9 Partial Excavation Alternative are projected to be $265 million based on a 7% discount rate or $312 million based on a 1.5% discount rate, respectively, over a 200-year period. The total non-discounted costs of the 52.9 Partial Excavation Alternative are projected to be $487 million over a 1,000-year period. The present-worth costs over a 1,000-year period are projected to be $265 million based on a 7% discount rate or $312 million based on a 1.5% discount rate.

Unit costs associated with transportation by rail and disposal of RCRA soil, RCRA soil with radionuclide material, RCRA debris, and RCRA debris with radionuclide material would have added treatment costs in order to meet the LDRs and UTS. Based on discussions with representatives of the disposal facilities during preparation of the SFS (EMSI et al., 2011), the additional costs for treatment at their facilities are estimated to range from $45 to $150 per ton for RCRA metals or $400 to $500 per ton for organics, depending on the type of treatment.

Since the amount of mixed waste, if any, that might be excavated along with the RIM is unknown, and because of the RCRA restrictions on waste accumulation amounts and timeframes and limited storage space on-site, it is unclear if volumes would support shipment by rail. As such, the mixed waste would likely be shipped to the off-site disposal facility directly via truck. For truck hauling to the off-site disposal facility, the interior of the semi-trailer would be lined with a disposable polyethylene slip liner and, after the waste was loaded the trailer, would be covered and the cover securely strapped down. The capacity of each truckload would be 22 tons or 17 cubic yards, depending on the weight of the material. Current trucking costs range from $4.70 to $5.10 per loaded mile. Road mileage from the West Lake Landfill to the US Ecology Wayne Disposal, Michigan, Clean Harbors Deer Trail, Colorado; Energy Solutions Clive, Utah; and US Ecology Grandview, Idaho facilities are 520, 720, 1,340, and 1,580 miles, respectively. Therefore, RCRA or mixed-waste truck transportation costs to an off-site facility could range from $145 to $470 per cubic yard or $110 to $370 per ton, depending on where the material is ultimately disposed.

For purposes of demonstrating how much shipping of mixed waste could influence costs, it was assumed that mixed waste would represent 0.5% of the sum of the volumes of overburden wastes and RIM for the 52.9 Partial Excavation Alternative. The added costs for handling, sampling/analysis, shipping, treating, and disposing of mixed waste for this alternative are estimated to range from $950,000 to $1.8 million. The range of costs primarily results from variations in the fees charged by the off-site disposal facilities and uncertainties associated with the nature of such wastes and the required method of treatment. If the volume of mixed waste is higher than the 0.5% of total mass assumption, the added costs would be higher.

6.2.5 Partial Excavation of RIM with Activities Above 1,000 pCi/g

This section presents the detailed analysis of a partial excavation alternative consisting of removal of RIM with combined radium and/or combined thorium activities greater than 1,000 pCi/g and subsequent regrading and capping of the remaining waste (hereafter referred to as the "1,000 Partial Excavation Alternative"). As previously described in Section 5.6, this alternative consists of the following components:

- Removal of the asphalt plant and relocation of the Bridgeton Transfer Station, LLC building to provide access to RIM located adjacent to the building and construction of an overpass over the Site access road;
- Excavation and stockpiling of overburden from OU-1 Areas 1 and 2 in order to access the RIM;
- Excavation of RIM from the OU-1 Areas 1 and 2 that contains combined radium or combined thorium activities greater than 1,000 pCi/g;
- Loading, transport, and disposal of the RIM at an off-site disposal facility;
- Survey and identification of the presence and extent or radiologically-impacted soil on the Buffer Zone and Crossroads Property;
- Excavation of any soil from the Buffer Zone and/or Crossroads Property that contains radionuclides at levels greater than those that would allow for unrestricted use and placement of such soil in Area 1 or 2;
- Regrading of the remaining solid waste materials within Areas 1 and 2 to meet the minimum (5%) and maximum (25%) slope criteria;
- Installation of a landfill cover meeting the Missouri closure and post-closure care requirements for sanitary landfills over Areas 1 and 2;

- Design, installation and maintenance of surface water runoff controls;
- Groundwater monitoring consistent with the requirements for sanitary landfills;
- Landfill gas and radon monitoring and control, as necessary;
- Institutional controls to prevent land and resource uses that are inconsistent with a closed sanitary landfill site containing radionuclides; and
- Long-term surveillance and maintenance of the landfill cover in Areas 1 and 2.

Under this alternative, an estimated 38,200 bcy of RIM would be excavated from Areas 1 and 2 for off-site disposal. The volume of material would increase upon excavation due to swelling, handling and loading for transport to an off-site disposal facility. Applying the swell factor of 1.5 and accounting for daily cover, it is estimated that approximately 63,100 lcy would be transported to and disposed off-site. An additional approximately 2,900 bcy of impacted soil would be excavated from the Buffer Zone/Crossroads Property and placed in either Area 1 or 2 under this alternative.

Once all of the material containing combined radium or combined thorium activities greater than 1,000 pCi/g has been removed from Areas 1 and 2, the remaining solid waste materials in Areas 1 and 2 would be regraded to meet the final closure standards for sanitary landfills and a final sanitary landfill cover would be constructed over Areas 1 and 2. Because waste containing radionuclides above unrestricted use standards would still remain in Areas 1 and 2, this cover would include the additional hybrid components included in the ROD-selected remedy to address the UMTRCA requirements.

This alternative also includes installation and maintenance of surface water runon and runoff controls, groundwater and landfill gas monitoring, and institutional controls for Areas 1 and 2 and the Buffer Zone. Environmental monitoring of groundwater quality would be performed to ensure that groundwater quality at the perimeter of the Site met State standards or other ARARs. Monitoring of subsurface occurrences of landfill gas and radon and, if necessary, implementation of contingent landfill gas extraction would be performed to ensure that gas migration above regulatory thresholds does not occur beyond the perimeter of Areas 1 or 2. Landfill gas and groundwater monitoring as described in Sections 5.3.1.6 and 5.3.1.10, respectively, are also included as part of the 1,000 Partial Excavation Alternative.

Existing institutional controls would be maintained and enforced as previously described in Section 5.3.2.1 for the ROD-selected remedy to ensure that land and resource uses are consistent with permanent waste disposal. These institutional controls are necessary to ensure that residential uses do not occur at the landfill and that commercial and industrial uses or ancillary uses that could result in unacceptable risks do not occur on Areas 1 and 2 or the Buffer Zone. In addition to prohibiting land uses that could result in potential exposure to waste materials or contaminants at the Site, these institutional controls would also limit or prohibit land uses or activities that could disrupt the integrity, performance or longevity of the new landfill cover or other components of the remedy. Any modifications to the existing institutional controls or any additional controls that EPA may determine are necessary would be implemented as part of remedial design.

Long-term inspections and maintenance activities of the engineered components, similar to that described for the ROD-selected remedy (Section 5.3.1.9) and enforcement of the institutional controls (Section 5.3.2.1) would also be required.

6.2.5.1 Overall Protection of Human Health and the Environment

The 1,000 Partial Excavation Alternative would protect human health and the environment through (1) removal and off-site disposal of RIM above industrial use risk-based levels which also possess the highest activity levels found at the Site, and (2) engineered containment, long-term surveillance and maintenance, and institutional controls on land and resource use. The landfill cover would reduce potential risks from exposure to external gamma radiation or radon gas emissions and eliminate potential risks associated with inhalation or ingestion of contaminated soils or other wastes, dermal contact with contaminated soils or other wastes, and wind dispersal of fugitive dust.

The presence of an engineered landfill cover would prevent users of the Site from exposure to external gamma radiation primarily through shielding and increasing the distance to the radiation source (i.e., the cover materials would be of sufficient thickness and design to attenuate gamma radiation). For the types of clay soils used for infiltration protection in the construction of final covers, the depth of cover required for gamma radiation shielding is on the order of two feet (60 cm). The total thickness of the final cover for the 1,000 Partial Excavation Alternative would be a minimum of five feet (two feet of biointrusion rock/rubble, two feet of clay soil, and one foot of vegetative soil).

The cover materials would also be of sufficient thickness and design to retard or divert the vertical upward migration of radon. The landfill cover acts as a diffusion barrier, allowing time for the decay of the relatively short-lived radon-222 gas (the half-life for radon-222 is 3.8 days) during migration through the pore spaces of the cover soil. Radon is continually produced from the radium source, but need only be detained in the cover materials for a few days to decay to its non-radiological progeny, thereby eliminating any significant radon emissions. The radon may also be intentionally vented or diverted to a landfill gas control system. Calculations presented in Appendix F indicate that a clay layer thickness of two feet, combined with a two-foot-thick rock/rubble layer and a one-foot-thick vegetative layer, would provide sufficient radon attenuation to meet the radon emissions ARAR of 20 pCi/m^2s. As discussed in Appendix F, these calculations were based on the increased levels of radium expected to be present at the Site after 1,000 years of in-growth of radium from decay of thorium.

The potential for direct contact with waste materials is eliminated by partial removal of RIM and by placing a barrier (multi-layer landfill cover including bio-intrusion layer) between the remaining RIM/waste materials and any potential receptors. Likewise, there is no potential for the generation of fugitive dust from the waste material as long as the barrier remains in place.

The multi-layer cover would also be designed to minimize infiltration of surface water through the wastes, thereby reducing the potential for leaching of contaminants to the groundwater. This is typically accomplished by promoting surface drainage and using a hydraulic barrier (e.g., a compacted clay layer meeting the specified permeability requirements). These are all conventional functions for landfill cover technologies and are widely used by government and industry to address similar circumstances where contaminated materials must be encapsulated to protect against future potential contact. Long-term maintenance of the cover and monitoring of the groundwater would ensure that the 1,000 Partial Excavation Alternative functions as intended.

Environmental monitoring of groundwater quality would be performed to ensure that groundwater quality at the perimeter of the Site meets state standards or other ARARs. Monitoring of subsurface occurrences of landfill gas and radon and, if necessary, implementation of contingent landfill gas extraction along the perimeter of Areas 1 and 2, would be performed to ensure that gas migration above regulatory thresholds does not occur beyond the Site perimeter.

Institutional controls would ensure that land and resource uses are consistent with permanent waste disposal. The use restrictions would reflect the presence of radionuclides at the Site.

6.2.5.2 Compliance with ARARs

Insofar as the 1,000 Partial Excavation Alternative includes excavation and off-site disposal of a large portion of the RIM, regrading of the remaining solid wastes, and installation of a new landfill cover over Areas 1 and 2, the Missouri solid waste rules for sanitary landfills would be relevant and appropriate to this alternative. Upon completion of RIM excavation, the remaining RIM and solid waste in Areas 1 and 2 would be regraded to achieve minimum 5% and maximum 25% slopes, and an engineered cover consistent with the cover requirements for a solid waste landfill without a liner would be installed. These actions would result in this alternative meeting the MDNR solid waste rules. Because some RIM above unrestricted use levels would remain in Areas 1 and 2, the UMTRCA standards for gamma and radon emissions in 40 CFR 192.02 are potentially relevant and appropriate for Areas 1 and 2. Therefore, the landfill cover under this alternative would also include the 2-foot thick rock biointrusion layer and the cover would be designed to meet the radiation exposure and radon emission requirements of UMTRCA. Sections 6.2.2.2.1 and 6.2.2.2.2 contain full discussions of the MDNR solid waste regulations and the UMTRCA standards. The design of the landfill cover would meet these requirements.

The 1,000 Partial Excavation Alternative would also need to comply with the applicable or relevant and appropriate requirements of NESHAPs, the Safe Drinking Water Act, the NRC Standards for Protection Against Radiation, the Missouri Well Construction Code, the Missouri Storm Water Regulations, and the Clean Water Act (for stormwater runoff). These requirements would be met or achieved using the same methods as previously described in Sections 6.2.3.2.3 through 6.2.3.2.8 with respect to the "complete rad removal" alternative.

6.2.5.3 Long-Term Effectiveness and Permanence

These criteria refer to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time. The 1,000 Partial Excavation Alternative would reduce risk through removal of a portion of the RIM and provide engineered containment in conjunction with long-term monitoring, maintenance, and land use control designed to be effective over the long term for the remaining RIM. Removal of a portion of the RIM, combined with installation of an engineered landfill cover, would essentially eliminate the potential for gamma exposure, inhalation of radon gas or dust containing radionuclides or other constituents, dermal contact with impacted materials, and incidental ingestion of soil containing radionuclides or other chemicals and leaching of radionuclides or chemicals to the underlying groundwater. Maintaining the integrity of the engineered cover would protect the underlying RIM from erosion and intrusion. An UMTRCA-compliant cover would provide a reliable method to control exposure of the RIM to surface receptors and mitigate potential migration of the covered materials.

Long-term site management plans and institutional controls would be made as robust and durable as possible. Long-term groundwater monitoring would be effective in verifying a remedy is performing as required and groundwater is protected. The landfill cover would also passively prevent potential contaminant migration and human exposures for an indefinite period in the unlikely event of a loss of institutional controls.

By moving the contamination from the Buffer Zone/Crossroads Property to either Areas 1 or 2, the remedy would provide long-term effectiveness and permanence relative to the Buffer Zone/Crossroads Property.

6.2.5.3.1 Magnitude of residual risk

The calculated lifetime risks following the exposure scenarios in the risk assessment after removal from Areas 1 and 2 of RIM with combined radium and/or combined thorium activities greater than 1,000 pCi/g, an engineered landfill cover has been installed, and the remainder of this remedial alternative has been implemented (Appendix H) are as follows:

- Area 1: <1 x 10^{-7} for year 1 and <1 x 10^{-7} for year 1,000.
- Area 2: <1 x 10^{-7} for year 1 and <1 x 10^{-7} for year 1,000.

These calculated risk levels are below EPA's target risk range of 1 x 10^{-6} to 1 x 10^{-4}, and the magnitude of residual risk in Areas 1 and 2 is acceptable. These calculated risk levels are attributable to gamma radiation and radon emissions from any radionuclide occurrences that would remain in Areas 1 and 2 after removal of RIM containing combined radium and/or combined thorium activities greater than 1,000 pCi/g and the new engineered cover had been installed, and are also reflective of access restrictions and institutional controls. They do not specifically include potential exposures from non-radiological landfill wastes after construction is complete; however, those wastes would also be covered by caps which would prevent exposures. Additional information regarding the risk assessment calculations is presented in Appendix H.

Direct contact with the remaining RIM under the cap at Areas 1 and 2, and exposure by ingestion, inhalation, or dermal contact with such materials, is not expected to occur. These are the primary exposure pathways for any non-radiological COPCs which may be mixed with the RIM and landfill wastes that would remain in Areas 1 and 2 after partial excavation. Because no complete exposure pathway would exist for such materials after completion of the partial excavation and cap construction in Areas 1 and 2, the landfill waste materials would not be expected to produce non-carcinogenic effects or carcinogenic risks.

After soils containing radionuclide concentrations above unrestricted use levels are removed from the Buffer Zone/Crossroads Property, residual risks posed by the remaining radionuclide-impacted soil on these properties, if any, should be indistinguishable from variations in background levels.

6.2.5.3.2 Adequacy and reliability of controls

The conceptual design of the engineered cover has been developed to provide protection against all potential exposure pathways. Cover construction is based on and relies upon the use of natural materials that would be expected to remain in place and meet performance criteria for at least 200 years, as required by the UMTRCA ARARs. Post-closure inspection and maintenance of the cover – as required by the solid waste regulation ARARs, and as routinely performed at thousands of landfills across the country – also would ensure long-term reliability of the landfill cover.

The surfaces of Areas 1 and 2 are not currently graded to promote drainage of stormwater, but instead are generally flat with several surface depressions which act to increase precipitation accumulation and infiltration through the waste mass. In addition, no engineered landfill cover exists over these areas. Even with these limitations, infiltration of precipitation has not resulted in discernible leaching of radionuclides or other chemicals to groundwater. Removal of a portion of the RIM, regrading Areas 1 and 2 to promote drainage, and installation of the engineered landfill cover included as part of the 1,000 Partial Excavation Alternative would significantly reduce infiltration of precipitation and potential for leaching, thereby providing further protection against potential impacts to groundwater.

Long-term OM&M would include routine cover and stormwater ditch inspection and service to mitigate erosion, and OM&M of a landfill gas collection and treatment system if such a system is needed. Long-term monitoring would also be implemented to assess compliance with environmental performance standards. The performance of these engineering controls would also be re-evaluated during statutory five-year reviews.

The current Covenants and Restrictions for Areas 1 and 2 would be adequate to provide protection to human health. The permanence of these restrictions is assumed to be adequate for the foreseeable future, as both EPA and MDNR approval are required to remove or modify the restrictions. The adequacy of the restrictions would be continually evaluated during the statutorily-required five-year reviews.

6.2.5.3.3 Climate Changes and Potential Impacts of a Tornado

Because RIM and municipal solid waste would still remain in Areas 1 and 2 after the 1,000 Partial Excavation Alternative is implemented, a new engineered landfill cover would be installed over these areas. Because radionuclides above unrestricted use levels would remain in Areas 1 and 2, the engineered landfill cover that would be installed under this alternative would include the 2-foot-thick rock/rubble biointrusion layer along with the 2-foot-thick low permeability and 1-foot-thick vegetative layers as previously described for the ROD-selected remedy (Sections 5.3.1.4 and 6.2.2). This engineered landfill cover would be classified as an in-situ containment system (EPA, 2014a).

Because of the similarity between the engineered landfill cover to be installed over Areas 1 and 2 under the 1,000 Partial Excavation Alternative with the landfill cover to be installed under the ROD-selected remedy, the analysis of the potential effects of climate change or impacts of a tornado are essentially the same for both alternatives. These effects were previously discussed in Section 6.2.2.3.3 for the ROD-selected remedy and therefore will not be fully repeated here. The results of those evaluations (as discussed in Section 6.2.2.3.3) with regard to the landfill cover system for the 1,000 Partial Excavation Alternative are summarized below.

Similar to the ROD-selected remedy, the vegetative layer of the landfill cover to be installed under the 1,000 Partial Excavation Alternative could be vulnerable to increased occurrences of extreme temperatures, sustained changes in average temperatures, decreased precipitation and increase in drought occurrences. Increased temperatures or decreased precipitation/drought could affect the viability of the vegetation (*e.g.,* grasses) on the surface of the landfill cover. Any changes to the overall health and voracity of the vegetative cover would be readily identifiable by visual inspection. Therefore, although the vegetative cover may be vulnerable to potential increased temperatures or drought conditions, the potential for impacts to the vegetative layer could be anticipated and readily identified in advance of any such occurrence.

The low-permeability layer (CCL) could be damaged by periods of extended extreme temperatures or prolonged drought. Potential impacts could include desiccation of the CCL, with a resultant increase in permeability that could lead to increased precipitation infiltration. Such impacts are not considered to be significant because Areas 1 and 2 have existed for over 40 years with essentially flat (no grade) surfaces and minimal cover material, thereby maximizing precipitation infiltration without generation of currently identifiable impacts to underlying groundwater quality[52]. Therefore, even if desiccation of the low-permeability layer were to occur, the impacts to groundwater quality are not expected to be significant. More importantly, the vegetative layer would show significant signs of stress from increased temperatures/drought prior to the occurrence of any impacts to the underlying low permeability layer and thereby provide advance notice of a potential impact to the CCL. Therefore, although the low-permeability layer could potentially be vulnerable to effects of increased temperature or drought, the potential for any impacts could be anticipated and readily identified in advance of any such occurrence, and therefore are not expected to result in release of contamination.

Increased heavy precipitation events could result in erosion of the vegetation layer and, if left untended, could result in erosion of the underlying low-permeability layer. Any erosion of the landfill cover would be readily identifiable by visual inspection. Given the overall 5-foot thickness of the landfill cover and the inclusion of the 2-foot-thick rock layer in the base of the cover system, stormwater erosion, even under the most severe storm event, is not anticipated to result in erosion down through the entire landfill cover. Heavy precipitation events could impact the integrity or performance of stormwater drainage conveyance structures, including erosion of drainage channels, damage to or bypassing of let-down and erosion control structures, and features, or damage to stormwater detention structures. Heavy precipitation events could also temporarily restrict access to portions of the landfill cover, stormwater control structures, and environmental monitoring points, thereby causing delays in implementation of repairs if any are needed. Therefore, the vegetation layer and stormwater controls are potentially vulnerable to impacts from heavy precipitation events. However, due to the overall thickness and design of the landfill cover, any potential impacts are not expected to result in exposure of the waste material or release of contamination. Furthermore, any impacts that occur could be readily addressed as part of normal maintenance and repair of the landfill cover, including localized regrading, repair and replacement of cover material in response to any damage that may occur.

The 1,000 Partial Excavation Alternative is not anticipated to be impacted by flooding that may occur in the area of the Site. As previously discussed in Section 2.1.6, FEMA has determined that with the exception of the easternmost portions of Areas 1 and 2, which do not contain waste materials, Areas 1 and 2 are located outside of the 500-year floodplain. In addition, the areas to the north and west of Area 2 (*e.g.*, Crossroads Industrial Park and Earth City Industrial Park) that potentially could be subject to flooding by the Missouri River are protected by the engineered levee and stormwater and flood control systems installed to protect the Earth City Industrial Park.

As previously discussed in Section 6.2.2.3.3 relative to the ROD-selected remedy, an evaluation of potential impacts associated with a tornado was previously performed and submitted to EPA (EMSI, 2013f). Similar to the ROD-selected remedy, the 1,000 Partial Excavation Alternative is not vulnerable to impacts from a tornado. Specifically, a tornado is not expected to damage the vegetative layer and even if it did, such an impact is not considered to be significant because it could be easily identified and, due to the design and thickness of the engineered cover, would not

[52] EPA has indicated that additional evaluations of groundwater will be conducted in the future as part of the OU-3 RI/FS.

result in exposure of the underlying waste or release of contamination. A tornado could damage or destroy aboveground infrastructure such as signage, fencing or environmental monitoring equipment; however, such impacts are not expected to be significant because they would be readily identified and easily repaired or replaced. Therefore, the 1,000 Partial Excavation Alternative is not considered to be vulnerable to impacts from a tornado.

Although the 1,000 Partial Excavation Alternative is not considered to be vulnerable to climate change, implementation of adaptation measures could be considered during remedial design to provide a degree of adaptation for climate change. For example, regrading of the surface of Areas 1 and 2 to a 2% slope instead of a 5% slope could be considered to reduce the velocity of runoff across the surface of Areas and 1 and 2 and thereby reduce erosion and soil loss potential under extreme precipitation events. Installation of a runoff collection and diversion system along the base of the above-grade portion of the North Quarry part of the Bridgeton Landfill adjacent to Area 1 and along the north sides of the Closed Demolition Landfill and the Inactive Sanitary Landfill adjacent to Area 2 could be included to divert runoff from these areas around Areas 1 and 2 to reduce the potential for impacts from heavy precipitation events. Use of grass seed mixtures that are more tolerant of long-term changes in precipitation or temperature and/or soil addition to increase water storage capacity could be evaluated as part of the design. Similarly, inclusion of a geotextile at the base of the vegetative layer could be considered to minimize the potential for water or wind erosion extending down into the underlying low permeability layer. The design grades of the stormwater conveyance structures could be evaluated to provide a balance between the ability to quickly route stormwater away from Areas 1 and 2 while minimizing the stormwater velocity and the associated potential for erosion of the stormwater conveyance structures. Identification and evaluation of additional adaptation measures can be addressed as part of the design of the engineered landfill cover and stormwater controls to increase the overall resilience of these features to heavy precipitation events. Continuous re-evaluation of potential vulnerabilities, system resilience, and possible adaptation measures should be included as part of the ongoing inspection and maintenance program.

6.2.5.3.4 Potential Impacts of a Subsurface Heating Event

Because radionuclides above unrestricted use levels would still remain at the Site under the 1,000 Partial Excavation Alternative, radionuclide-related impacts similar to those described in Section 6.2.2.3.4 for the ROD-selected remedy could potentially occur if an SSE or SSR were to occur in Areas 1 or 2. Specifically, a localized, temporary increase in radon emissions from the ground surface could occur. However, as discussed for the ROD-selected remedy, even if such an event were to occur, the radon emission rate would still be less than the standard established by the radon NESHAP. Additionally, if such a release were to occur, risks at or beyond the fence line are expected to be below the acceptable risk levels established by EPA.

6.2.5.3.5 Effects of an Isolation Barrier

As discussed in the previous subsection, no adverse impacts or unacceptable risks are expected to result if an SSR or SSE were to extend into in Area 1. Therefore, regardless of the location or type of isolation barrier that may be installed, or even if no barrier is installed, no unacceptable risks are expected to occur. Installation of a heat extraction barrier consisting of various heat extraction points would not have any impact on the protectiveness, long-term effectiveness, short-term effectiveness, implementability or cost of the 1,000 Partial Excavation Alternative, regardless of barrier location. Installation of a physical barrier, such as a vertical wall of inert material, would require excavation and regrading of the above-grade portion of the North Quarry part of the Bridgeton Landfill wastes located over the southern portion of Area 1. If such a barrier were to be installed prior to implementation of the 1,000 Partial Excavation Alternative, portions of the barrier would need to be removed in conjunction with removal of RIM in the southwestern portion of Area 1. In addition, the design of the engineered cover included in this alternative would need to account for any changes in the surface grades, stormwater drainage system and the presence of any above-grade features (*e.g.,* heat extraction points, temperature monitoring probes, or additional gas extraction wells) that may be installed in conjunction with a barrier. In contrast, if a physical barrier were installed after RIM removal and construction of the engineered cover included in the 1,000 Partial Excavation Alternative, that portion of the engineered landfill cover that extended over the area of an isolation barrier and the associated revised landfill grades would need to be removed as part of the construction of an isolation barrier. The alignment of a potential isolation barrier may also need to be revised to reflect the removal of some of the RIM from the southwestern portion of Area 1 assuming that it is designed before the RIM removal and regrading occurs.

6.2.5.3.6 Environmental Justice Considerations

As was previously discussed in Section 6.2.2.3.6 as part of the evaluation of long-term effectiveness of the ROD-selected remedy, a screening-level analysis did not identify any environmental justice concerns relative to the Site. EPA did identify a need for implementation of more traditional (non-electronic) communication methods to inform and ensure meaningful involvement of residents in the Terrisan Reste mobile home community.

6.2.5.4 Reduction of Toxicity, Mobility or Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy. Although a portion of the RIM would be removed, the 1,000 Partial Excavation Alternative is overall a containment remedy and therefore generally would not reduce the toxicity, mobility, or volume of the waste material through treatment.

As discussed in Section 4, radionuclides are naturally-occurring elements which cannot be neutralized or destroyed by treatment. Occurrences of radionuclides within Areas 1 and 2 are dispersed within soil material that is further dispersed throughout portions of the overall, heterogeneous matrix of municipal refuse, construction and demolition debris, and other non-impacted soil materials in Areas 1 and 2. Consequently, ex-situ treatment techniques are considered impracticable. In addition, the heterogeneous nature of the solid waste materials and the dispersed nature of the radionuclide occurrences within the overall solid waste matrix in portions of areas 1 and 2 make in-situ treatment techniques equally impracticable. The remedy for the Buffer Zone/Crossroads Property also would not reduce toxicity, mobility, or volume through treatment because it consists of moving radiologically-impacted soil from the Buffer Zone/Crossroads Property to Area 1 or 2, where it would either be shipped off-site for disposal or consolidated with the RIM in Areas 1 and 2.

An on-site technology that may potentially be applicable to this alternative is ex-situ physical separation of impacted soil from the solid wastes by using solids separation techniques such as hand picking for large bulky items and various fixed, vibrating, or rotating screens, among others (see prior discussion in Section 4.3.5.2). Physical separation would not decrease the mobility or toxicity of the radiologically-impacted materials, but has the potential to separate existing RIM from non-radiologically-impacted materials. As previously discussed, any solids separation techniques would need to be pilot-tested at full-scale using materials from Areas 1 and 2 during remedial design to ascertain the potential effectiveness, implementability, and cost of this technology. Of particular interest in conducting pilot-testing with material from Areas 1 and 2 would be obtaining an estimate of the degree of RIM volume reduction that could be achieved, assessing the moisture content of the filled material, determining the fraction of soil that would be contained in or adhered to the segregated refuse, and determining the residual levels of radioactivity that would be present in the non-soil refuse after screening out the soil fraction. Assuming that solids separation could prove to be an effective and implementable technology (that is, it could effectively separate the radiologically-impacted soil from the other landfilled waste materials such that the other landfilled wastes would contain radionuclide activities below the levels that would allow for unrestricted use), it has the potential to reduce the volume of radiologically-impacted material that would need to be transported to and disposed at an off-site disposal facility. However, little is known about the potential application of a soils separation technology to this situation, and it is possible that pilot-testing could demonstrate that physical separation would not be effective at separating RIM from non-radiologically-impacted materials, in which case the non-radiologically-impacted materials would need to also be shipped off-site for disposal. At this stage of analysis, neither the estimated costs nor the estimated schedules for this FFS include any allowance for solids separation pilot-testing or implementation.

In the event that hazardous wastes are encountered during implementation of the remedy, such materials would be separated from the other solid wastes and subjected to waste profiling to determine the appropriate treatment and disposal requirements. To the extent that hazardous wastes or mixed wastes are encountered, they would be shipped off-site and would be treated at the disposal facility in accordance with the hazardous waste regulations (*e.g.*, EPA's LDR program and UTS) and in accordance with the permits and standard operating procedures of the receiving facility. After arriving at an off-site disposal facility and undergoing a waste receipt analysis, RCRA soil/debris and RCRA soil/debris with radionuclide material would be stabilized prior to placement in a disposal cell. Depending on its physical characteristics, RCRA debris and RCRA debris with radionuclide material would undergo either micro- or macro-encapsulation prior to placement in a disposal cell. To the extent that treatment of the hazardous waste or mixed waste would be required for off-site disposal, stabilization or encapsulation treatment would result in a reduction of the mobility of the hazardous waste and radiologically-impacted components of the mixed waste. Toxicity and volume would not be reduced by these technologies, but may be reduced by other technologies potentially applicable to hazardous wastes that do not contain RIM, if such wastes were encountered during implementation of the remedial action at the Site.

Section 6.2.3.4 contains a full discussion of the procedures, protocols and concerns associated with the off-site shipment of hazardous wastes or mixed wastes.

6.2.5.5 Short-Term Effectiveness

This alternative poses significant potential short-term risks, as described below. During a public meeting held as part of the ROD-selected remedy process, EPA identified and discussed the following short-term risk issues for waste excavation: waste handling, sorting and stockpiling; water management; noise, odor and windblown trash; worker health and safety (PPE, gamma exposure, physical stress, physical hazards, workplace monitoring); contaminant migration/spreading (fugitive dust and airborne migration, fugitive dust control and water application, leachate generation, equipment decontamination water, and water from open excavations); and waste hauling and transportation issues/truck decontamination (transfer facilities, increased local traffic, waste handling on public roads, interstate transport by rail, DOT requirements, safety issues).

6.2.5.5.1 Protection of the Community During Remedial Actions

The projected carcinogenic risks that may be posed to off-site residents by this alternative would be less than 1×10^{-7} (see Appendix H). No non-carcinogenic risks are expected to occur.

The risk assessment (Appendix H) includes an estimate of the projected incidence of transportation accidents associated with each FFS alternative. For the 1,000 Partial Excavation Alternative, the projected incidence of transportation accidents associated with shipping of RIM for off-site disposal and importing of materials for construction of the multi-layer landfill cover is 16.6, meaning that approximately 17 transportation-related accidents are projected to occur if this alternative were implemented. The risk of an increased number of transportation-related accidents is associated with the transport of excavated RIM from the Site, and in particular: (1) transport from the Site to the rail transloading facility; (2) hauling by rail of the RIM to the disposal site; (3) transport of the RIM from the destination rail offloading facility to the disposal site; and (4) truck traffic associated with delivery of construction materials to be used for construction of the new engineered landfill cover on Areas 1 and 2.

Disturbing the waste material may expose the community to radioactive waste, methane and radon gas, dust and particulates. Excavation of existing waste materials would also undoubtedly result in undesirable odor emissions during the period of time that existing wastes may be handled or exposed. Mitigation of odors through engineering means is limited.

The 1,000 Partial Excavation Alternative would contribute significant carbon dioxide equivalent emissions to the atmosphere as a result of ongoing, vehicle operations associated with remedial work. In particular, approximately 53,000 tons of carbon dioxide equivalent emissions are projected to be emitted to the atmosphere as a result of the excavation, loading, and transport of the RIM to an off-site disposal facility, landfill regrading and cover construction work in Areas 1 and 2, and the importation of materials used to construct the multilayer landfill cover for Areas 1 and 2 (Appendix I, Table I-4).

Because RIM in Areas 1 and 2 would be excavated under this alternative, overburden would be stockpiled and stored, and RIM would be staged and loaded for off-site disposal. During these activities, the nuisance attraction to and congregation by birds at and above the affected areas could be problematic unless effectively controlled. The main concern would be the potential for increased bird strikes to aircraft approaching and departing from the Lambert-St. Louis International Airport. For the 1,000 Partial Excavation Alternative, an enclosed waste staging and loading structure would be constructed to minimize the outdoor handling of waste and associated attraction of birds or other vectors. Additional mitigation measures such as excavation best management practices, which include application of daily soil cover and/or placement of tarps over areas of exposed waste, visual and auditory frightening devices, or wire or monofilament grids positioned over exposed refuse to prevent bird access, could be implemented to minimize bird attraction to and congregation at and above the disturbed areas.

Excavation of waste materials from Areas 1 and 2 would require removal of the existing landfill cover and overburden from Areas 1 and 2 and portions of adjacent areas of OU-2. Excavation of overburden and RIM would create depressions in the landfill area during the period of time required to remove the RIM and regrade and cover the remaining landfill wastes. Precipitation that falls on the Site while such depressions are open would potentially flow into and accumulate in the depressions. Any accumulation of precipitation in depressions created during waste excavation could result in increased infiltration of precipitation runoff through the underlying waste materials, which could result in increased leaching of VOCs or other soluble contaminants from the waste materials. Such leaching potentially could contaminate the underlying groundwater if not adequately controlled.

Because Areas 1 and 2 would be excavated and RIM loaded into transport containers, stormwater controls would be implemented in accordance with the Missouri Storm Water regulations 10 CSR 20-6.200 to protect the community. During construction, consideration would be given to minimizing the areas of excavation that would be open and exposed to waste materials at any given time. Temporary diversion berms using daily cover material would also be constructed above the open excavation areas on the previously excavated (and temporarily covered) surface of any excavation depressions in order to divert precipitation runoff around the open excavation to prevent the runoff from contacting uncovered waste materials. Precipitation that contacts uncovered waste materials would flow into the low point of the excavation and be pumped out into temporary storage tanks using portable gas-driven pumps. Samples from each tank would be collected and sent to a laboratory for analysis. The stored water would be either directly discharged or treated and disposed appropriately based on the analytical results.

6.2.5.5.2 Environmental Justice Concerns

As was previously discussed in Section 6.2.2.5.1 as part of the evaluation of short-term impacts associated with the ROD-selected remedy, a screening-level analysis did not identify any environmental justice concerns. EPA did identify a need for implementation of more traditional (non-electronic) communication methods to inform and ensure meaningful involvement of residents in the Terrisan Reste mobile home community.

6.2.5.5.3 Protection of Workers During Remedial Actions

The 1,000 Partial Excavation Alternative would entail significant excavation, handling, loading and transport of RIM at the Site and therefore would pose both significantly increased radiological exposure risks as well as construction safety risks to on-site workers.

Workers involved in excavation and regrading of the RIM would be subject to potential short-term risks, including: exposure of workers to contaminated waste; excavation/trenching instability; stormwater runoff entering areas where waste is exposed, resulting in the exposure of workers to contact stormwater; and odor emissions or other aesthetic issues arising from exposed waste. Worker exposures would be addressed through development and implementation of a site safety plan, use of personal protective equipment, and performance of personnel and environmental monitoring during implementation of remedial action. Workers would be protected during construction by adhering to OSHA practices; however, as this alternative entails extensive excavation, handling and transportation of radiologically-impacted materials, OSHA work practices and personal protective equipment may not provide full protection against exposure to external gamma radiation.

The risk assessment (Appendix H) presents an evaluation of potential risks to Site workers that may occur for each alternative. These include risks from industrial accidents, exposure to carcinogenic substances, and projected radiation exposures. For the 1,000 Partial Excavation Alternative, the projected incidence of industrial accidents is 11.7 over the life of the project. The projected carcinogenic risk to the reasonably maximally exposed individual, a radiation technician, is 2.37×10^{-3}, which exceeds EPA's generally accepted risk range of 10^{-4} to 10^{-6}. The projected radiation dose to a remediation worker is 867 mrem/yr (Appendix H).

Excavation would necessarily entail disturbance of the overburden soil and underlying waste materials by construction workers and equipment. Dust control measures would be required in order to limit worker exposure to fugitive dust during construction.

6.2.5.5.4 Environmental Impacts

No measurable long-term impacts to plants or animals in surrounding ecosystems are expected from the 1,000 Partial Excavation Alternative. As noted in the BRA (Auxier, 2000) and the updated BRA (Auxier, 2016a), some of the ecosystems present at the Site are the result of existing institutional controls and other limitations on land use within or adjacent to OU-1 that have allowed field succession to take place. Much of the habitat on Areas 1 and 2 was removed in 2016 in conjunction with construction of the non-combustible cover. Excavation of RIM, regrading of Areas 1 and 2, and construction of the engineered landfill cover under the 1,000 Partial Excavation Alternative would destroy the remaining portions of the habitats that currently exist on the surface of Areas 1 and 2, forcing wildlife to migrate to other areas. Vegetative cover would be placed on the Site as a part of the final cover, and the Site would be allowed to return to an early-stage field ecosystem with periodic mowing and maintenance.

6.2.5.5.5 Ability to Monitor Effectiveness

Measurement of gamma radiation and radon flux through the newly constructed landfill cover would be conducted on Areas 1 and 2 after construction is complete. Regular monitoring of groundwater quality would be performed at appropriate locations around Areas 1 and 2. Measurements of subsurface occurrences of landfill gas and radon levels would be conducted along the property boundaries adjacent to Areas 1 and 2 to verify that off-site gas migration above regulatory thresholds does not occur.

6.2.5.5.6 Time Until Remedial Action Objectives are Achieved

The RAO of (1) preventing exposure to radionuclides or waste at concentrations above ARARs or risk levels would be met immediately upon construction of a new engineered landfill cover. The RAOs of: (2) minimizing infiltration and any resulting contaminant leaching to groundwater; (3) controlling surface water runoff and erosion and decreasing the potential for erosion and subsequent transport of RIM; and (4) controlling radon and landfill gas emissions from Areas 1 and 2 would also be met once construction of the new landfill cover over Areas 1 and 2 is completed. The RAO related to the Buffer Zone and Crossroads Property soil would be met upon removal of any remaining soil containing radionuclides above unrestricted levels from these areas.

Initiation of this alternative would require significant planning and permitting due to the limited number of off-site disposal facilities capable of taking this material and the extensive logistics associated with identifying, handling, classifying and loading the materials for transport to the selected off-site facility. Preparation of the remedial design should be completed within approximately 15 months of authorization to proceed with the RD. RD could take significantly longer if full-scale pilot-testing of solids separation equipment were to be performed. The RAOs would be achieved upon completion of construction, which is estimated to be finished within approximately 7.7 years after approval of the RD. Therefore, the remedial action objectives should be achieved within 9 years of approval to proceed with the RD (Appendix J). This schedule estimate assumes that the buyout of the asphalt company lease and relocation of the solid waste transfer station occurs during the remedial design phase; otherwise, the schedule would be longer.

The projected construction schedule and the cost estimate for the 1,000 Partial Excavation Alternative are highly dependent on the waste material swell factor; that is, the amount the in-place waste volume expands as it is excavated, handled and loaded for transport to an off-site disposal facility. For purposes of this FFS, a swell factor of 1.5 has been assumed. A swell factor greater than 1.5 would result in an increase to the overall construction schedule and the estimated costs. The projected construction schedule and the cost estimate for the 1,000 Partial Excavation Alternative also are highly dependent on the number of rail cars that could be loaded and shipped per day. The schedule and cost estimate developed in this FFS for this alternative are based on an assumption that a sufficient number of IM containers and rail cars can be made available, loaded, switched out and replaced every day. If the actual rate is less than the projected rates of RIM excavation used to develop the construction schedule, the time required to complete construction and consequently the costs for the 1,000 Partial Excavation Alternative would increase.

6.2.5.6 Implementability

The 1,000 Partial Excavation Alternative would involve excavation and off-site disposal of a portion of the RIM in Areas 1 and 2, repair and restoration of the disturbed portions of the OU-2 landfill units adjacent to Areas 1 and 2, surface grading and installation of upgraded landfill covers over the areas of Areas 1 and 2, long-term monitoring and maintenance of the covers, and long-term monitoring of landfill gas and groundwater and surface water quality.

Excavation of RIM would require removal of substantial amounts of overburden and material from the sidewalls of the excavations in order to maintain stability of the excavation areas. Overburden removal would entail removing and temporarily relocating part of the above-grade portion of the North Quarry part of the Bridgeton Landfill in order to access the underlying RIM in Area 1 of OU-1. The total amount of non-RIM waste required to be removed under this alternative is estimated to be 787,000 bcy, which – based on an expansion factor of 1.5 – would result in the need to handle, stockpile and replace approximately 1,200,000 lcy of waste. Management of exposed waste in both the excavation areas and the stockpiles, including management of stockpiles, stormwater runon and runoff, odor emissions, attraction to birds and other vectors, and litter control, would be a significant undertaking. The amount of space available for stockpiling the overburden material is limited, and therefore overburden material from Area 1 would likely need to be transported to Area 2 while waiting for final placement and capping. Similarly, the total volume of RIM that would be excavated under this alternative is estimated to be 38,200 bcy, which is equivalent to 57,300 lcy. Accounting for the excavation and handling of overburden, side slope cut material, and RIM, a total of approximately 3.4 million cubic yards of waste would be handled under this alternative.

An additional complication arises from the proximity of the Bridgeton Transfer Station. In order to access the RIM in the southwest portion of Area 1, the solid waste transfer station would need to be relocated, as removal of waste material would extend up to and along the base of the transfer station such that the integrity of the transfer station building foundation and above-grade structure would be compromised. The only available space for relocation of the solid waste transfer station is the area currently occupied by Simpson Asphalt Company, which holds a long-term (99-year) lease on this area. This lease would have to be bought out and the asphalt company would need to be relocated before the solid waste transfer station could be relocated to this area.

It is anticipated that a new structure would be constructed to shelter the RIM staging and loading operations in order to minimize stormwater contact, odor emissions and bird attraction. It is anticipated that such a structure would be constructed along the north side of the Site access road in the area that is currently being used to store new, reclaimed and surplus equipment and materials associated with ongoing operation and maintenance and closure activities for the Bridgeton Landfill. These materials would need to be relocated to another portion of the Site prior to construction of such a structure.

In order to minimize potential vehicle interactions between normal traffic to and from the solid waste transfer station and the construction operations associated with this alternative, a temporary overpass would likely need to be constructed over the Site access road to allow for uninterrupted movement of construction traffic between Areas 1 and 2. An overpass is considered the most efficient and safest means for transfer of overburden waste from Area 1 to stockpile locations in Area 2 and then back to Area 1. In addition, as discussed above, a single RIM staging and loading building would be constructed and operated as part of this alternative. RIM removed from Area 1 would need to be transferred over the Site access road. Installation of an overpass would eliminate the potential for RIM to be tracked across the Site access road and potentially tracked off-site.

While excavation with subsequent off-site transportation and disposal have been implemented at other sites containing radioactively-impacted materials, materials from these other sites have not included significant amounts of landfill solid wastes. Significant technical and administrative implementability issues are associated with excavating the RIM and loading it into IM containers for transportation if this alternative was to be implemented. These include the following:

- Reduced excavation production rates and increased volume of RIM subject to excavation resulting from application of daily cover over an extended excavation schedule;

- Ability to locate and obtain a lease to an off-site rail spur for use as a truck-to-rail transfer facility, or alternatively the ability to construct an on-site rail spur and rail loading facility;

- Increased potential for bird strikes to aircraft as a result of excavation of putrescible or organic solid waste overburden waste from the North Quarry portion of the Bridgeton Landfill and Areas 1 and 2 and excavation of RIM contaminated waste from Areas 1 and 2, all of which are located within flight paths of Lambert–St. Louis International Airport; and

- Impacts to other Site operations and traffic on surrounding roads from additional truck traffic used to haul wastes to an off-site truck-to-rail transfer facility and to haul earthen materials to the Site for daily cover, stockpile covers, and construction of the final cover.

Design and construction of post-RIM-excavation landfill covers over Areas 1 and 2, with subsequent monitoring and maintenance, are not expected to pose any implementability challenges. Materials and services necessary for the regrading and construction of the final landfill covers over Areas 1 and 2 after RIM removal are available and the technologies have been proven through application at other landfills. Design and construction of landfill covers post RIM removal over Areas 1 and 2 are not expected to pose any significant implementability challenges.

The actions included for the Buffer Zone/Crossroads Property – that is, testing and excavation of surface soil – are regularly and easily implementable.

Monitoring of the cover surfaces, landfill gas, groundwater, and surface water are proven methods for demonstrating the long-term effectiveness of the engineered landfill cover that would be placed over Areas 1 and 2 and are easily implemented.

6.2.5.6.1 Ability to Construct and Operate the Technology

In general, excavation and off-site disposal are standard technologies. However, there are unique circumstances associated with excavation of RIM in Areas 1 and 2, located as they are within an overall larger closed/inactive landfill site, which would complicate implementation of standard excavation technologies.

RIM excavation and placement in IM containers and hauling of the containers by truck for subsequent transfer to rail is also expected to present implementability concerns, challenges, and risks, specifically those associated with the following:

- Excavation and handling of contaminated materials;
- Safety risks associated with encountering methane gas during excavation;
- Management of fugitive dust and potential odors;
- Mitigation of bird hazards;
- Management and treatment of stormwater exposed to RIM during excavation; and
- Identifying, segregating, and disposing off-site any hazardous wastes, PCBs or RACM that may be encountered during RIM excavation.

If hazardous wastes, PCBs, or RACM are encountered during excavation of RIM, these materials would need to be segregated from the other waste materials, characterized, and transported to an off-site disposal facility in containers separate from the other RIM. Additional health and safety procedures would be required during excavation of these materials. These materials would require separate handling at the off-site disposal facility and could require treatment prior to disposal. Depending on the characteristics of any hazardous waste encountered during excavation, the hazardous waste could need to be transported to a different off-site facility for treatment and disposal in accordance with RCRA.

Directing and controlling the RIM excavation process using radiological scanning and sampling techniques would significantly impact overburden and RIM excavation production rates. Based on experience in excavation of radiologically-impacted waste at other sites, a reduction in efficiency is expected for overburden excavation and a greater reduction is expected for RIM excavation. Because thorium-230 is a primary radionuclide of concern relative to any excavation alternative that may be considered for the Site, even greater reductions in efficiency and increased time may be required for RIM excavation. Thorium-230 cannot be detected using field survey instruments, and therefore excavation guidance would have to rely on collection and laboratory analyses of samples. In order to minimize the potential impacts on the excavation schedule, it is assumed that an on-site laboratory would be set up and operated to provide quick analyses of samples to guide excavation activities and initial confirmation that all RIM had been removed. A percentage of such samples would also be sent to an off-site laboratory for verification of the on-site laboratory results. Samples obtained for final confirmation that RIM has been removed from a particular area would also be subjected to off-site laboratory analyses and data validation. All of these activities would undoubtedly impact the rate of RIM excavation and the duration over which excavation areas need to remain open.

Daily soil cover and tarps would need to be placed over open excavation areas and stockpiled overburden to minimize dust, odor, and the attraction of birds and other wildlife. The proximity of Areas 1 and 2 to Lambert-St. Louis International Airport poses a potential risk to aviation operations. The St. Louis Airport Authority and the U.S. Department of Agriculture have identified as a problem the potential for increased bird activity in conjunction with waste excavation at the Site and the resultant increased risk of aviation bird strikes. Bird nuisance mitigation measures such as best management practices (including, but not limited to, daily soil cover and tarps over exposed overburden and wastes), visual and auditory frightening devices, and wire or monofilament grids strung over exposed refuse to prevent bird access, could be evaluated for use at Areas 1 and 2. The size of open excavations may limit the constructability of wire or monofilament grids. Careful evaluation of material properties would be necessary during remedial design to assure that the appropriate strength and elasticity of materials are considered, that the materials are available, and that grids can be reasonably constructed.

Effective stormwater controls could be readily implemented using conventional construction equipment and materials. Temporary berms to direct stormwater away from open excavations would need to be constructed and precipitation accumulation in depressions created by the excavation activities would need to be pumped out and managed. Direct precipitation or runoff that may contact waste material could become contaminated with soils or wastes containing thorium or radium. These elements would be entrained in colloidal material that would readily settle in low areas or in the tanks used to collect and store stormwater prior to treatment and discharge. At the end of excavation activities, after all RIM above cleanup levels would have been removed, accumulated sediment in any low areas or the tanks would also be removed and, depending upon activity levels, either placed in Area 1 or 2 or transported to the off-site disposal facility.

Excavated RIM exposed to precipitation would be subject to the PFLT as necessary to determine if free liquids exist prior to being loaded for off-site disposal. If the excavated material to be hauled off-site does not pass the PFLT, a dewatering area would need to be staged and collected water treated and/or disposed, potentially through off-site disposal. The current costs and schedules do not address any dewatering activities. Should such activities be necessary, a suitable area would have to be identified within the Site.

Truck hauling of IM containers of RIM to a truck-to-rail transloading facility and transferring the RIM to railcars is technically implementable. Loading RIM directly into railcars on-site if a rail spur could be extended onto the West Lake Landfill Site is theoretically implementable; however, it is not known whether extension of a spur onto the property is actually feasible. If construction of an on-site rail spur were to be considered, an engineering study and development of a detailed design would be necessary to determine the feasibility and implementability. As discussed in detail in Sections 6.2.3.6.5 and 6.2.3.6.6 above, construction of an on-site rail spur would also require coordination with a number of local and state regulatory authorities as well as private landowners.

An initial comparison of the US Ecology Grand View facility WAC to estimated activity levels in the OU-1 RIM under the 1,000 Partial Excavation Alternative is presented on Table 6-4. Although a representative of the turnkey contractor would be on-site during RIM excavation to coordinate loading of containers, there is a potential that one or more shipping containers could contain activity levels that exceed the WAC and may have to be unloaded and re-distributed prior to shipment or, in the worst case, returned to the Site by the disposal facility and/or sent to a different disposal facility. These additional activities could result in additional worker exposures, additional time to complete the project, and potentially additional costs.

Regrading the landfill surface and placement of final cover is implementable and has been performed at other landfills, including CERCLA sites. Environmental monitoring is routinely performed at most sites and is not expected to present any feasibility challenges.

6.2.5.6.2 Reliability of the Technology

Excavation and off-site disposal of radioactively-impacted material has been performed at FUSRAP facilities and is generally a reliable technology. It should be noted, however, that none of these FUSRAP sites involved radiological materials commingled with municipal solid waste and disposed in a landfill setting. The reliability associated with disposal in an off-site facility would be dependent on the integrity of the liner and cover systems at the off-site facility being maintained, as well as the effectiveness of the various off-site facility monitoring programs.

Landfill cover systems such as those that would be implemented over Areas 1 and 2 after partial removal of RIM, and which are designed and constructed consistent with State and Federal regulations and with post-closure care implemented in accordance with current regulatory guidance, have been demonstrated to be reliable at: (1) minimizing percolation and infiltration of precipitation; (2) minimizing leachate generation; (3) minimizing impacts to groundwater quality; (4) minimizing impacts to surface water quality and quantity; (5) minimizing erosion of cover material; and (6) minimizing uncontrolled releases of landfill gas. Landfill cover systems have been demonstrated to be reliable methods for isolating waste materials. Similarly, access restriction measures have been demonstrated to be reliable mechanisms to prevent unauthorized access to a site.

Bird nuisance mitigation measures such as best management practices (including, but not limited to daily soil cover and tarps over exposed RIM and waste), visual and auditory frightening devices, and wire or monofilament grids strung over exposed refuse to prevent bird access, are demonstrated reliable technologies under proper operating and excavating conditions. While visual or auditory frightening devices can be effective in the short-term, birds tend to habituate to deterrents over time, causing the deterrent to lose effectiveness. Frequent relocation of predator birds and predator effigies and/or altering the timing of auditory activation may help, but long-term effectiveness in not assured. In addition, the FAA has stated that "[t]o date, no . . . [putrescible waste] facility has been able to demonstrate an ability to reduce and sustain hazardous wildlife [birds] to levels that existed before the putrescible-waste landfill operations began operating." (FAA, 2007).

Stormwater controls are well-established technologies that are implemented at most landfill sites. For this alternative, gravity settling of suspended solids potentially containing radionuclides is a well-established and reliable technology.

6.2.5.6.3 Ease of Undertaking Additional Remedial Actions, if Necessary

Because all of the RIM would not be removed during implementation of this partial excavation alternative, it is possible that EPA could later require removal of additional RIM. If such a decision were to occur after construction completion of this alternative, performance of any such additional remedial action in the future would be very difficult and costly. Such actions would require removal of the newly constructed engineered landfill cover and re-excavation of materials previously removed and replaced as part of this partial excavation alternative.

The only other potential additional remedial actions that may need to be taken for the 1,000 Partial Excavation Alternative would be maintenance activities to sustain the cover system, repair areas of differential settlement or erosion, or possible implementation of a contingent landfill gas control system. Regrading and contouring the existing waste materials to achieve final grades would require re-compaction of the regraded waste materials in order to minimize the potential for compaction or differential settlement over time that could affect the integrity of the landfill cover. Placement of additional fill material to achieve the final slope requirements and for construction of the landfill cover may result in differential compaction of the waste materials dependent upon the nature, age and amount of prior degradation of the waste materials. Runoff of stormwater can result in formation of erosional rills. Depressions caused by differential settlement of the wastes or erosional features can easily be (and commonly are) addressed at landfill sites through placement of additional soil material to fill such features.

In the event that monitoring of subsurface landfill gas and radon detects the presence of gas levels above regulatory thresholds along the perimeter of the landfill, a landfill gas control system could be implemented as an additional remedial action. Implementation of a contingent landfill gas control system would entail drilling and installation of gas extraction wells, installation of conveyance piping, installation and operation of landfill gas extraction blowers and a landfill gas treatment (flare) system, and/or possible use of a carbon adsorption system to remove radon from the extracted gas stream. Installation of a contingent gas system can easily be performed as a future action. Any disruption to the final landfill cover resulting from the installation of a contingent gas extraction system would need to be repaired. Such activities are commonly and routinely undertaken at solid waste disposal sites.

Long-term monitoring and maintenance of the landfill covers at other Superfund sites and at non-Superfund site solid waste landfills is typically required to assess whether differential settlement or surface erosion of the cover has occurred over time. Long-term maintenance, including cover inspection and repair, would be part of this alternative. Cover repair, if necessary, would be straightforward, primarily entailing placement of additional fill, regrading, and revegetation of the repaired area.

Bird nuisance mitigation measures such as best management practices (including, but not limited to, selective excavation, daily soil cover, and tarps), visual and auditory frightening devices, and wire or monofilament grids strung over exposed refuse to prevent bird access, are demonstrated to be readily implementable at landfill sites.

Storm water management measures other than those using conventional earth-moving equipment, piping, pumps, liners, filtration and carbon adsorption water treatment equipment, rip-rap, and pond outlet structures are not anticipated.

6.2.5.6.4 Ability to Monitor Effectiveness of Remedy

Demonstrating the effectiveness of the cover systems constructed over Areas 1 and 2 after partial excavation of RIM would be accomplished by implementing monitoring programs for the cover surface, landfill gas system, groundwater and surface water programs as previously described in Section 5.4.4. These types of monitoring programs are easily implemented and have been proven to be successful at demonstrating cover effectiveness in landfill settings.

6.2.5.6.5 Ability to Obtain Approvals from Other Agencies

Implementation of the 1,000 Partial Excavation Alternative would require approvals from other agencies, including the following:

- Approval from the FAA to conduct waste excavation activities within 10,000 feet of an active airport runway. FAA Advisory Circular AC 150/5200-33B, dated August 28, 2007, "Hazardous Wildlife Attractants On or Near Airports," recommends "against locating a MSWLF [municipal solid waste landfill] within the separation distances identified in Sections 1-2 through 1-4. The separation distances should be measured from the closest point of the airport's AOA [airport operations area] to the closest planned MSWLF cell." AC 150/5200-33B, p. 4. The separation distances referenced are 5,000 feet from the end of a runway for airports serving piston-powered (propeller) aircraft; 10,000 feet for airports serving turbine-powered (jet) aircraft; and 5 miles of protection from hazardous wildlife movement for approach, departure and circling airspace. The FAA strongly recommends against allowing a waste disposal operation within 10,000 feet of a jet aircraft runway if the material contains putrescible waste and so has the potential to attract wildlife that could threaten air traffic. The excavation of RIM material containing putrescible waste within 10,000 feet of the westernmost runway (11/29, formerly known as 12W/30W) at Lambert-St. Louis International Airport, as would occur during excavation of the RIM in Areas 1 and 2, is limited by the need to mitigate potential bird activity during excavation to address the requirements of the FAA Advisory Circular and to comply with the same prohibitions in the Missouri solid waste regulations. It may be necessary to work directly with the FAA and MDNR to identify specific bird mitigation measures during implementation.

- Approval of St. Louis Airport Authority with regard to obtaining a release for the Negative Easement and Declaration of Restrictive Covenants Agreement. Excavation of RIM from Areas 1 and 2 poses a potential to increase the bird populations at the Site if mitigation procedures are not employed or prove ineffective. An increase in bird populations presents a greater potential for aircraft bird strikes. It may be necessary to work directly with the FAA and the Airport Authority to address these concerns, either by amending the FAA ROD, amending the Negative Easement, requiring specific bird mitigation measures during implementation, or making other changes to secure STLAA's cooperation.

- Location of an off-site truck-to-rail loading facility. At the discussion held in September 2010, the STLAA indicated that they would not allow the use of the existing SLAPS truck-to-rail transloading facility for loading waste from the West Lake Landfill into railcars. The SLAPS rail spur is reportedly owned by the U.S. Army Corps of Engineers and the land upon which the rail spur is built is owned by the City of St. Louis. It is not clear that the STLAA could prevent use of the SLAPS rail spur for loading and shipping via contractual means; however, as the STLAA is the owner of the property, their concurrence must be considered. No other nearby off-site truck-to-rail loading facilities have been identified.

- Compliance with EPA's Off-Site Rule. The EPA Region where the off-site disposal facility is located would need to be contacted every 60 days during the period of off-site waste shipments to obtain a compliance determination as to whether the disposal facility currently meets the criteria under the OSR to accept CERCLA waste. If during RIM excavation the contracted off-site disposal facility were to be out of compliance for a period of time, excavation and transportation would need to cease until the facility becomes compliant or RIM would need to be transported to another facility that is determined to be in compliance with the OSR. Besides schedule delays, temporary stoppage of construction would present significant technical implementability concerns regarding open excavation areas.

- Rocky Mountain Low Level Radioactive Waste Compact Consent. If RIM were to be disposed at the Clean Harbors Deer Trail, CO facility, an application would have to be submitted to and accepted by the Rocky Mountain Low Level Radioactive Waste Compact. Disposal at the US Ecology Grand View, ID, US Ecology Wayne, MI, and Energy*Solutions* Clive, UT facilities would not be subject to a Waste Compact consent.

6.2.5.6.6 Coordination with Other Agencies

Although not all would be considered "agencies," coordination with many entities would be necessary to implement the 1,000 Partial Excavation Alternative. Coordination with the landfill owner and operator and owners or occupants of the various parcels that comprise the West Lake Landfill Site would be necessary because of the following:

- Termination of the asphalt company lease and removal of the asphalt plant followed by relocation of the Bridgeton solid waste transfer facility and construction of an overpass between Areas 1 and 2 over the Site access road would need to occur prior to the start of RIM excavation;

- Access to operations conducted on other portions the Site would need to be maintained.

- Areas 1 and 2 are within a larger existing landfill footprint and use of areas on the West Lake Landfill Site outside of Areas 1 and 2 might be necessary to stockpile cover materials or otherwise to facilitate cover construction.

- Implementation of this alternative would require excavation of portions of landfill units located outside of OU-1. Upon completion of removal of the RIM, disturbed portions of the adjacent landfill units would need to be repaired and restored, and regrading and installation of a replacement landfill cover over areas outside of OU-1 would need to be performed. Coordination would also be required relative to integration of the slopes and grading for adjacent landfill areas and routing and design of stormwater diversion and conveyance structures between OU-1 and other landfill areas.

- Use of other areas of the West Lake Landfill Site that may be necessary for stockpiling of overburden and staging or routing of trucks or rail cars used to haul the excavated RIM off-site.

For the duration of excavation, off-site transport, and import of cover materials, the flow of vehicles associated with remedy construction would need to be coordinated with the traffic patterns of vehicles associated with the current on-site solid waste transfer station and other Site tenants.

If a truck-to-rail transloading facility at an off-site rail spur location were to be used, a suitable location would need to be identified and a lease secured with the land/rail spur owner for the duration of the RIM loading and transport operations. As noted above, it does not appear that the existing SLAPS truck-to-rail transloading facility would be available, so costs for establishing a new facility would need to be considered[53].

If a rail spur were to be extended onto the West Lake Landfill Site:

- Land located across St. Charles Rock Road would either need to be purchased or long-term leases would be needed with landowners;

- State and local government, private landowner, facility occupant and community approval to construct a rail spur across private property located to the east of St. Charles Rock Road, across St. Charles Rock Road, and along the access roads which serve the existing solid waste transfer station and asphalt plant operations located at the Site would need to be obtained;

- Appropriate safety measures for the crossing at St. Charles Rock Road would have to be installed, consistent with requirements of state and local governments;

- The long-term lease of the asphalt plant for land south of the solid waste transfer station, would need to be bought out or otherwise acquired; and

- Because of the high traffic volume on St. Charles Rock Road during the day, dropping off empty and picking up loaded railcars would likely be possible only during late nighttime and early morning hours.

Provision of and switching of gondola railcars either at a truck-to-rail transloading facility spur or an on-site rail spur would need to be coordinated with the railroad company that would be hauling the railcars to the off-site disposal facility.

Future groundwater monitoring activities could require obtaining and maintaining access to off-site properties if off-site groundwater monitoring were required as part of the remedy.

The potential for increased bird strikes to aircraft approaching and departing the Lambert-St. Louis International Airport is a major concern of the FAA and St. Louis Airport Authority. The effectiveness of proposed bird nuisance mitigation measures would be of interest to the FAA and Airport Authority. Consequently, the FAA and Airport Authority would need to be involved in the remedial planning process.

Coordination with other agencies including the Earth City Flood Control District, MSD and MDOT, as well as the adjacent property owners and businesses (for example, the Crossroads Property/AAA Trailer) would also be necessary to:

[53] The unit cost estimates provided by US Ecology for purposes of this FFS include costs to secure an off-site rail spur for a truck-to-rail transloading facility.

- Coordinate with the Earth City Flood Control District regarding the design of non-contact stormwater management and discharge facilities both during and after completion of construction;

- Coordinate with MSD regarding permitting and design of leachate/contact stormwater discharge during construction;

- Coordinate with MDOT for access to areas along St. Charles Rock Road and for any traffic control or ingress and egress additions along St. Charles Rock Road in the vicinity of the Site entrance; and

- Obtain legal and physical access from AAA Trailer for testing and, if necessary, remediation of the Crossroads Property and possibly for implementation of remedial actions that may need to be performed along the property boundary (e.g., regrading, fencing, etc. in Area 2).

As discussed at the beginning of this section (6.2.3.6), in order to access RIM in Area 1, the Bridgeton Transfer Station would need to be relocated. The only suitable area for relocation of the solid waste transfer station is the area currently under lease and occupied by Simpson Asphalt Company. The asphalt company lease would need to be bought out and their equipment removed from the Site before the transfer station could be relocated. Relocation of the transfer station would normally be subject to permitting by the City of Bridgeton and St. Louis County; however, because relocation of the transfer station would be performed as part of a Superfund remedial action and the transfer station would remain on-site, additional permitting is not anticipated to be required. However, it is likely that public meetings and hearings may be necessary, which would require coordination with the City of Bridgeton and St. Louis County and could impact the timing for the start of construction of a 1,000 Partial Excavation Alternative.

6.2.5.6.7 Availability of Off-site Treatment, Storage and Disposal Services and Capacity

As discussed in Section 4.3.5.4., four off-site disposal facilities that could accept excavated RIM from the West Lake Landfill OU-1 have been identified. At least three of these facilities (located in Idaho, Utah and Colorado) have accepted radiologically-impacted soil from projects or sites in the United States, although none of them have previously accepted radiologically-impacted materials mixed with solid waste. All four of the identified facilities have available capacity to accept the estimated volume of RIM from the Site. The volumetric rate of acceptance for all facilities would be limited by the number of IM containers and railcars that could be provided and loaded at or near the Site, as well as the number that could be unloaded at or near the disposal facility. Off-site treatment, storage and disposal may be required in the event that hazardous wastes or regulated asbestos-containing materials (RACM) are encountered in the overburden or RIM excavated from Areas 1 and 2.

The identified facilities are also permitted to: (1) accept liquid wastes, should any stormwater that may accumulate in excavations during RIM excavation become contaminated and require disposal off-site; (2) accept mixed wastes if mixed wastes are encountered during excavation; and (3) treat soil and/or debris that contains hazardous waste or mixed waste.

As discussed in Section 3.2.1, the CERCLA OSR requires that waste materials removed from a CERCLA site only be placed in a facility operating in compliance with RCRA or other applicable Federal or State requirements. EPA makes such determinations every 60 days. The compliance status of an off-site disposal facility would need to be evaluated during remedial design and would need to be regularly evaluated and updated during remedy implementation.

Offsite treatment and discharge of any leachate that may be encountered or stormwater that may contact waste materials during the landfill re-contouring activities could also be required. Off-site treatment and discharge of any leachate that may be encountered or stormwater that may contact RIM during the landfill excavation activities could also be required. Initial discussions with MSD indicated that they are willing to accept leachate and contact stormwater and initial discussions with the Earth City Flood Control District indicated a willingness to accept stormwater, subject to installation of additional stormwater detention/retention capacity.

6.2.5.6.8 Availability of Necessary Equipment and Specialists

Materials, equipment and personnel required for excavation and transport of RIM to an off-site disposal facility are readily available. Trained health physics technicians and specialized equipment required to monitor personnel and environmental conditions, as well as to assist in directing the RIM excavation sequencing, are also available.

As discussed above, there are a limited number of disposal facilities that can accept these types of wastes, and most of these have stringent waste acceptance criteria which may limit the ability of some of the facilities to receive the wastes.

Availability of rail service, particularly the number of rail cars that can be made available and switched daily by the railroad, would also affect the production rate of RIM excavation and disposal and therefore the cost.

All of the materials, equipment and personnel to remove the designated portion of the RIM and to construct the engineered landfill cover over Areas 1 and 2 are readily available, and the technologies have been generally proven through application at other landfills. The implementability and potential cost of the covers would be influenced by the availability and location of clean cover materials and/or off-site borrow sources at the time this alternative would be implemented. Potential vendors of rock, clay and soil were contacted during the development of the FS (EMSI, 2006) and during preparation of the Remedial Design Work Plan for the ROD-selected remedy (EMSI, 2008). Information obtained from the vendors at these times indicated that rock, clay and clean cover material were readily available from sources located near the Site. If these local sources of cover materials become exhausted prior to and during remedy implementation, cover materials would have to be obtained from suppliers at greater distances from the Site.

The necessary materials, equipment and personnel required for assessment and removal of RIM that may be present at the Buffer Zone/Crossroads Property above unrestricted use levels and to implement the institutional controls and monitoring components of this alternative are also readily available.

6.2.5.6.9 Availability of Prospective Technologies

The 1,000 Partial Excavation Alternative is based on proven, established, and commonly used technologies. Use of prospective technologies is not currently envisioned to be part of this alternative.

6.2.5.7 Cost

Estimated capital, annual OM&M, and 30-year present worth costs for the 1,000 Partial Excavation Alternative are included in Appendix K-6 and summarized on Table 6-1. Conceptual excavation, backfill, and bottom and top of final cover grading plans as well as stormwater control features used as the basis for the 1,000 Partial Excavation Alternative capital cost estimate are provided in Appendix M. The estimated cost to conduct the 1,000 Partial Excavation Alternative (i.e., design costs, capital costs, and costs for monitoring during the construction period) is $361,000,000 based in part on unit costs provided by US Ecology. These costs do not include costs to conduct full-scale pilot-testing of solids separation equipment. The estimated annual OM&M costs range from $167,000 to $326,000 per year depending upon the specific activities that occur each year (e.g., higher costs for years with additional environmental monitoring and years when landfill cover repairs and five year reviews may occur). The cost estimates provided in this FFS are feasibility-level cost estimates which were developed to a level of accuracy such that the actual costs incurred to implement this alternative are expected to fall within a range bounded by 50% above and 30% below these estimates.

The present-worth costs of a 1,000 Partial Excavation Alternative are projected to be $275 million over a 30-year period based on a discount rate of 7%. Based on the current OMB rate of 1.5%, the present worth costs would be $342 million. The total non-discounted costs for the 1,000 Partial Excavation Alternative over 30 years are projected to be $365 million.

Given the long life of the radionuclides present at OU-1, the costs for the 1,000 Partial Excavation Alternative were also evaluated for 200 and 1,000 year periods (without consideration of any constraints on annual expenditures). The total non-discounted costs of the 1,000 Partial Excavation Alternative are projected to be $395 million over a 200-year period. The total present-worth costs of the 1,000 Partial Excavation Alternative are projected to be $276 million based on a 7% discount rate or $349 million based on a 1.5% discount rate, respectively, over a 200-year period. The total non-discounted costs of the 1,000 Partial Excavation Alternative are projected to be $534 million over a 1,000-year period. The present-worth costs over a 1,000-year period are projected to be $276 million based on a 7% discount rate or $350 million based on a 1.5% discount rate.

Unit costs associated with transportation by rail and disposal of RCRA soil, RCRA soil with radionuclide material, RCRA debris, and RCRA debris with radionuclide material would have added treatment costs in order to meet the LDRs and UTS. Based on discussions with representatives of the disposal facilities during preparation of the SFS (EMSI et al., 2011), the additional costs for treatment at their facilities are estimated to range from $45 to $150 per ton for RCRA metals or $400 to $500 per ton for organics, depending on the type of treatment.

Since the amount of mixed waste that might be excavated along with the RIM is unknown, and because of the RCRA restrictions on waste accumulation amounts and timeframes and limited storage space on-site, it is unclear if volumes would support shipment by rail. As such, the mixed waste would likely be shipped to the off-site disposal facility directly via truck. For truck hauling to the off-site disposal facility, the interior of the semi-trailer would be lined with a disposable polyethylene slip liner and after the waste was loaded the trailer would be covered and the cover securely strapped down. The capacity of each truckload would be 22 tons or 17 cubic yards, depending on the weight of the material. Current trucking costs range from $4.70 to $5.10 per loaded mile. Road mileage from the West Lake Landfill to the US Ecology Wayne Disposal, MI, Clean Harbors Deer Trail, Colorado; Energy Solutions Clive, Utah; and US Ecology Grandview, Idaho facilities are 520, 720, 1,340, and 1,580 miles, respectively. Therefore, RCRA or mixed-waste truck transportation costs to an off-site facility could range from $145 to $470 per cubic yard or $110 to $370 per ton, depending on where the material is ultimately disposed.

For purposes of demonstrating how much shipping of mixed waste could influence costs, it was assumed that mixed waste would represent 0.5% of the sum of the volumes of overburden wastes and RIM for the 1,000 Partial Excavation Alternative. The added costs for handling, sampling/analysis, shipping, treating, and disposing of mixed waste for this alternative are estimated to range from $1.6 to $3 million. The range of costs primarily results from variations in the fees charged by the off-site disposal facilities and uncertainties associated with the nature of such wastes and the required method of treatment. If the volume of mixed waste is higher than the 0.5% of total mass assumption, the added costs would be higher.

7 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section presents a comparative analysis of the No Action alternative, the ROD-selected remedy, the "complete rad removal," and the partial excavation alternatives evaluated in Section 6. The relative performance of each alternative, including advantages and disadvantages, is compared to the performance of the other alternatives for each of the threshold (subsection 7.1) and primary balancing (subsection 7.2) criteria prescribed in the NCP, as previously discussed in Section 6 and summarized below.

Threshold Criteria:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs

Primary Balancing Criteria:

- Long-Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, or Volume through Treatment
- Short-Term Effectiveness
- Implementability
- Cost

As discussed in Section 6, the NCP "modifying criteria" (state acceptance and community acceptance) will be evaluated by EPA as part of any decision process that may be undertaken by EPA after completion of the FFS. Therefore, a comparison of alternatives using the modifying criteria is beyond the scope of this FFS, and is not undertaken here.

The comparative analysis identifies the general similarities and differences between the alternatives, the relative advantages and disadvantages of each alternative, and trade-offs among the alternatives in terms of the NCP criteria. The purpose of the comparative analysis is to provide information for a balanced remedy selection. The results of this comparative analysis are discussed below and summarized on Table 7-1.

7.1 Threshold Criteria

Two of the nine criteria specified in the NCP relate directly to statutory findings that must ultimately be made in the ROD. These two criteria are (1) overall protection of human health and the environment, and (2) compliance with ARARs. They are classified as threshold criteria, as each alternative must meet both of these two criteria.

7.1.1 Overall Protection of Human Health and the Environment

This criterion addresses how risks would be eliminated, reduced, or controlled by each remedial alternative to provide short- and long-term protection of human health and the environment from unacceptable risks posed by contaminants present at the Site.

Based on the results of the updated BRA evaluations (Auxier, 2016a), conditions associated with OU-1 do not currently pose an unacceptable risk to on-site workers or the off-site community as long as the existing institutional controls are maintained, monitored and enforced and Areas 1 and 2 are monitored and maintained. These analyses indicated that the potential risks posed to a future groundskeeper working in Areas 1 and 2 could be above the generally accepted risk range used by EPA. Therefore, the No Action alternative would not be adequately protective of human health. The potential for future leaching to groundwater or erosion and transport of waste or radionuclides by stormwater indicates that the No Action alternative would not be protective of the environment.

All of the other alternatives are expected to be protective of human health and the environment through the use of engineered containment, long-term surveillance and maintenance, and institutional controls on land and resource use. Installation of a new multi-layer landfill cover under the ROD-selected remedy and two partial excavation alternatives, and excavation of RIM under the "complete rad removal" and partial excavation alternatives, would all serve to reduce potential risks from exposure to external gamma radiation or radon gas emissions from the RIM in Areas 1 and 2. Installation of a new multi-layer landfill cover over Areas 1 and 2 is included as part of all of the remedial alternatives. This cover would eliminate potential risks associated with inhalation or ingestion of contaminated soils or wastes, dermal contact with contaminated soils or wastes, and wind dispersal of fugitive dust. Installation of a cover over Areas 1 and 2 also would greatly reduce the potential for infiltration of precipitation and thus the potential for leaching of contaminants from wastes into groundwater.

Long-term maintenance of the cover under each remedial alternative, as well as monitoring of the groundwater and subsurface occurrences of landfill gas and radon, would ensure that each remedial action functions as intended and remains protective. The institutional controls included as part of each remedial alternative would ensure that land and resource uses are consistent with permanent waste disposal. These use restrictions address the presence of radionuclides and chemical constituents within the waste mass under the ROD-selected remedy and partial excavation alternatives, as well as the presence of chemical constituents under the "complete rad removal" alternative.

7.1.2 Compliance with ARARs

An alternative must comply with ARARs in order to be selected as a remedy, unless a waiver is obtained for any particular ARAR. ARARs that may be potentially applicable or relevant and appropriate to the remedial alternatives are summarized on Tables 3-1, 3-2, and 3-3.

7.1.2.1 Chemical-Specific ARARs

As discussed in Section 6.2.1.2, the No Action alternative is expected to meet some but not all of the potentially applicable chemical-specific ARARs. All of the other remedial alternatives will meet the chemical-specific ARARs. These include the UMTRCA and NESHAP standards for radon emissions; the UMTRCA standards for cleanup of contaminated land (Buffer Zone and Crossroad Property), as modified by the EPA OSWER Directives regarding use of these standards at Superfund sites; Nuclear Regulatory Commission (NRC) radiation protection standards; the maximum concentrations for groundwater protection under the UMTRCA standards; and the Missouri maximum contaminant levels (MCLs).

7.1.2.2 Location-Specific ARARs

All of the alternatives (including the No Action alternative) would meet the location-specific ARARs found in the Missouri solid waste regulations standards for landfills located within the 100-year floodplain or within 10,000 feet of an airport runway. As discussed in Section 2.1.6, evaluations of the floodplain by FEMA indicate that with the exception of the easternmost portions of Areas 1 and 2 (which do not contain waste materials), Areas 1 and 2 are located outside of the 500-year floodplain.

The Missouri Solid Waste Management regulations require owners or operators of sanitary landfills located within 10,000 feet of an airport runway end used by turbojet aircraft to demonstrate to MDNR that the landfill is designed and operated such that it does not pose a bird hazard to aircraft. Portions of the Site are located within 10,000 feet of the end of the westernmost runway at Lambert-St. Louis International Airport; however, none of the alternatives evaluated in this FFS entail construction of new disposal cells or new solid waste disposal activities. Waste excavation under the complete and partial excavation alternatives and waste regrading activities under all of the remedial alternatives (except for No Action Alternative) would need to be performed in a manner that minimizes attractions for birds. Specifically, an avian management plan that incorporates the various techniques described in Section 4.3.6.2 of this FFS would need to be developed and approved by EPA and MDNR. Such a plan would also be of interest to the FAA and the Airport Authority. The FAA has stated, "[t]o date, no [landfill] facility has been able to demonstrate an ability to reduce and sustain hazardous wildlife to levels that existed before the putrescible-waste landfill began operating." (FAA Advisory Circular 150/5200-33B at page 16, August 2007).

7.1.2.3 Action-Specific ARARs

Because there are no active engineering measures or waste handling, treatment, or disposal activities associated with the No Action alternative, there are no action-specific ARARs for the No Action alternative. All of the other remedial alternatives would meet the requirements of the action-specific ARARs. In particular, all of the remedial alternatives would meet the Missouri closure and post-closure standards of the solid waste regulations, the NRC radiation protection standards, and the noise protection standards during implementation of a remedial action and closure of Areas 1 and 2.

Design of the final cover for Areas 1 and 2 under the ROD-selected remedy and the partial excavation alternatives would meet the design standards for landfill covers established by the Missouri solid waste management regulations and the substantive relevant and appropriate requirements of the UMTRCA regulations. Although design of the final cover for these alternatives would primarily be based on the design standards of the solid waste regulations, additional components would be included to address the presence of radionuclides and the requirements of the UMTRCA regulations. Specifically, the design of the final cover would need to be thick enough to shield against gamma radiation and attenuate radon emissions under both current and future conditions (including projected ingrowth of radium from thorium decay over time). A rock layer within the landfill cover would be included to address the longevity criteria of the UMTRCA standards. Under the “complete rad removal” alternative, all of the material containing radium and/or thorium levels above those that would allow for unrestricted use is assumed to have been removed; therefore, the design of the final cover system for this alternative is based solely on the design standards of the solid waste regulations.

The off-site disposal component of the partial excavation and the “complete rad removal” alternatives would also need to be designed and implemented to meet the requirements of the CERCLA Off-Site Rule, DOT and NRC requirements for transport of radioactive materials/wastes, and the waste acceptance criteria (WAC) of any off-site disposal facility.

7.2 Primary Balancing Criteria

The five NCP primary balancing criteria are: (1) long-term effectiveness and permanence; (2) reduction of toxicity, mobility and volume through treatment; (3) short-term effectiveness; (4) implementability; and (5) cost. Primary balancing criteria are used to weigh effectiveness and cost tradeoffs among alternatives. The primary balancing criteria represent the main technical criteria upon which the alternatives evaluation is based, and provide the primary basis for differentiation among the various alternatives.

Since the No Action Alternative does not meet the threshold criteria it is not included in the evaluation of the primary balancing criteria. Therefore, the discussion of the primary balancing criteria only considers the other four alternatives (*i.e.*, ROD-selected remedy, “complete rad removal’”, and the 52.9 and 1,000 partial excavation alternatives).

7.2.1 Long-Term Effectiveness and Permanence

This criterion addresses the risks that may remain at a site after the remedial action objectives have been met. The primary focus of this evaluation is the extent and effectiveness of the controls that may be required to manage the risk posed by the wastes that remain at the site.

Although conditions associated with OU-1 currently do not pose an unacceptable risk to on-site workers or the off-site community, the BRA analyses indicated that the potential risks posed to a future groundskeeper working in Areas 1 and 2 could pose a risk above the generally accepted risk range used by EPA in CERCLA actions (Auxier, 2016a) if no remedial action is taken at the Site. None of the remedial alternatives pose significant radiological or chemical exposure-related risks to on-site workers or the general public. The long-term risks associated with each of the alternatives are essentially the same, and the residual cancer risks posed to a potential future groundskeeper at the Site under all four remedial alternatives are below EPA's target risk range of 1×10^{-6} to 1×10^{-4}. Projected radiation doses after 1,000 years of radium ingrowth for all four remedial alternatives are far below the limit of 100 mrem per year established by NRC for the general public. The estimated long-term risks associated with each alternative are listed on Table 7-1. Detailed information regarding the estimated potential long-term risks and estimated radiation doses relative to a future on-site groundskeeper associated with each remedial alternative is provided as part of the assessment of risks included as Appendix H.

All of the remedial alternatives result in some amount of waste materials remaining on-site, thereby necessitating installation, maintenance and monitoring of engineered containment structures and institutional controls. Engineering measures are the primary method that would be used to control waste materials that remain on-site. The primary engineering measures included in the ROD-selected remedy and the partial excavation alternatives are the construction, inspection and maintenance of multilayer engineered landfill cover systems over Areas 1 and 2 that are designed to reduce potential exposures to gamma radiation and reduce radon emissions, including increased levels of gamma radiation and radon emissions occurring after 1,000 years of radioactive decay of thorium. The "complete rad removal" and partial excavation alternatives include excavation and off-site disposal of at least a portion of the RIM. In addition, the partial excavation alternatives include construction, inspection and maintenance of multilayer engineered landfill cover systems over Areas 1 and 2 designed to reduce potential exposures to gamma radiation and reduce radon emissions, including increased levels of gamma radiation and radon emissions occurring after 1,000 years of radioactive decay. The "complete rad removal" alternative entails removal and off-site disposal of all RIM containing radionuclides at levels above those that would allow for unrestricted use. Therefore, this alternative would not need to address potential gamma exposures or radon emissions and would not include the rock/rubble layer that would be part of the landfill cover system included under the ROD-selected remedy and the partial excavation alternatives.

Although the RIM and other wastes have been present in Areas 1 and 2 for many decades without grading to promote runoff or an engineered landfill cover to minimize infiltration and leachate production, the USGS (2014) concluded that that there is not a strong spatial association of monitoring wells surrounding or downgradient of RIM areas with elevated radium concentrations, as might be expected if RIM areas were releasing substantial quantities of radium to the groundwater. EPA has indicated that additional evaluations of groundwater will be conducted in the future as part of the OU-3 RI/FS. All of the remedial alternatives rely on the construction, inspection and maintenance of multilayer covers to prevent or reduce the potential for infiltration of precipitation and resultant leaching to groundwater. The "complete rad removal" alternative (as well as the partial excavation alternatives) includes removal of at least some of the RIM from the Site, thus providing a corresponding additional level of effectiveness and permanence relative to potential leaching of radionuclides to groundwater.

The performance and effectiveness of the engineered measures for each of the remedial alternatives is primarily based on the durability of natural earthen materials used to construct these measures. Natural earthen materials such as clay and rock are extremely durable and, with minimal maintenance and repair over time, are expected to remain effective for decades or centuries. The design of the cover systems for the ROD-selected remedy and the partial excavation alternatives has been determined to be effective at limiting exposures to projected gamma radiation and radon levels after 1,000 years of radioactive decay using only the performance of those natural earthen components. The potential effects of erosion of the landfill cover by precipitation, disruption of the landfill cover by possible intrusion by woody vegetation, or potential human actions that could affect the cover system would necessitate regular and ongoing inspections and maintenance (O&M) to ensure that the cover system continues to remain effective over time.

The engineering measures implemented under each remedial alternative would be augmented and supported by maintenance of the existing institutional controls at the Site and implementation of additional institutional controls, as necessary. Institutional controls would limit future uses of the land and resources at the Site so as to eliminate or restrict potential exposure to the wastes or contaminated media and to reduce the potential for future land uses to impact or reduce the effectiveness of the engineered measures. Areas 1 and 2 currently are solid waste disposal units and would remain as such under all of the remedial alternatives. Institutional controls would be necessary to restrict future land uses that could interfere with the landfill closure at Areas 1 and 2 for all alternatives, regardless of the presence of RIM.

7.2.1.1 Climate Change Considerations

Potential effects of climate change were evaluated in Section 6 for each of the alternatives; pertinent considerations are briefly discussed below.

The vegetative layer included in the landfill covers for all of the alternatives could be vulnerable to increased occurrences of extreme temperatures, sustained changes in average temperatures, decreased precipitation, and an increase in drought occurrences. Increased temperatures or decreased precipitation/drought could affect the viability of the vegetation (*e.g.*, grasses) on the surface of the landfill cover. Any changes to the overall health and voracity of the vegetative cover would be readily identifiable by visual inspection. Therefore, although the vegetative cover may be vulnerable to potentially increased temperatures or drought conditions, the potential for impacts to the vegetative layer could be anticipated and readily identified in advance of any such occurrence.

The low permeability layer included as part of the landfill cover for all of the remedial alternatives could be damaged by periods of extended extreme temperatures or prolonged drought. Potential impacts could include drying out of the low-permeability materials (CCL or

GCL) with a resultant increase in permeability, which could lead to increased infiltration of precipitation. Such potential impacts are not considered to be significant because the landfill has existed for over 40 years with minimal cover material and essentially flat (no grade) surfaces with low spots that collect and pond water, thereby maximizing precipitation infiltration. Even with this increased potential for infiltration of precipitation through Areas 1 and 2, the USGS (2014) concluded that that there is not a strong spatial association of monitoring wells surrounding or downgradient of RIM areas with elevated radium concentrations, as might be expected if RIM areas were releasing substantial quantities of radium to the groundwater. However, EPA has indicated that additional evaluations of groundwater will be conducted in the future as part of the OU-3 RI/FS. Drying of the low-permeability layer could also result in an increase in radon emissions for all of the alternatives except for the “complete rad removal” alternative; however, even without significant cover material, the radon emissions from the surfaces of Areas 1 and 2 are far below the UMTRCA and NESHAP standards (see Section 2.3.1 of this FFS and Section 7.1.1.1 of the RI Addendum) and are projected to remain below these standards in the future (Appendix F). Therefore, even if drying of the low-permeability layer was to occur, the impacts to groundwater quality or radon emissions are not expected to be significant. More importantly, the vegetative layer would show significant signs of stress from increased temperatures/drought prior to the occurrence of any impacts to the underlying low-permeability layer, thereby providing advance notice of a potential impact to the CCL/GCL. Therefore, the potential for any impacts could be anticipated and readily identified in advance of any such occurrence and such impacts are not expected to result in release of contamination

Increased heavy precipitation events could result in erosion of the vegetation layer and, if left untended, could result in erosion of the underlying low-permeability layer. Any erosion of the landfill cover would be readily identifiable by visual inspection. Given the overall 5-foot thickness of the landfill cover and the inclusion of the 2-foot-thick rock layer in the base of the cover system for the ROD-selected remedy and the two partial excavation alternatives, stormwater erosion, even under the most severe storm events, is not anticipated to result in erosion down through the entire landfill cover. Since the landfill cover under the “complete rad removal” alternative would not include that 2-foot-thick rock layer in the base of the cover system, stormwater erosion under a severe storm event could potentially erode down through the entire landfill cover, resulting in temporary exposure of non-radiological waste materials.

Heavy precipitation events could also impact the integrity or performance of stormwater drainage conveyance structures, including erosion of drainage channels, damage to or bypassing of let-down and erosion control structures and features, or damage to stormwater detention structures. Heavy precipitation events could also temporarily restrict access to portions of the landfill cover, stormwater control structures, and environmental monitoring points, thereby causing delays in implementation of repairs (if any are needed). The vegetation layer and stormwater controls are therefore potentially vulnerable to impacts from heavy precipitation events; however, due to the overall thickness and design of the landfill cover, any potential impacts are not expect to result in exposure of the waste material or release of contamination. Further, any impacts that occur could be readily addressed as part of normal maintenance and repair of the landfill cover, including localized regrading, repair and replacement of cover material, and repair or implementation of stormwater controls in response to any damage that may occur.

None of the alternatives are expected to be impacted by flooding that may occur in the area of the Site. As previously discussed in Section 2.1.6, recent updates to the flood insurance rate map (FIRM) by FEMA indicate that, with the exception of the easternmost portions of Areas 1 and 2 (which do not contain waste materials), Areas 1 and 2 are located outside of the 500-year floodplain. In addition, the area to the north and west of Area 2 (*e.g.,* Crossroads Industrial Park and Earth City Industrial Park) that potentially could be subject to flooding by the Missouri River is protected by the engineered levee and stormwater and flood control systems installed to protect the Earth City Industrial Park. Further, the conceptual design for the ROD-selected remedy includes construction of a perimeter (starter) berm along the toe of the entire northern boundary of Area 2, which would result in placement of approximately 25 feet of rock and soil between any possible floodwaters and the landfilled waste. This perimeter berm may be further protected from flooding by placement of rip-rap along the base of the berm. Therefore, although increased occurrences of flooding in the area of the Site may be a potential impact of climate change, the ROD-selected remedy and the other alternatives are not expected to be vulnerable to flooding.

An evaluation of the potential impacts of a tornado was included as part of the evaluation of the long-term effectiveness of each of the alternatives in Section 6 and concluded that none of the alternatives are vulnerable to such impacts. Specifically, a tornado is not expected to damage the vegetative layer, and even if it did, such an impact is not considered to be significant because it could be easily identified and, due to the design and thickness of the engineered cover, would not result in exposure of the underlying waste or release of contamination. A tornado could damage or destroy above-ground infrastructure such as signage, fencing or environmental monitoring equipment; however, such impacts are not considered to be significant because they would be readily identified and easily repaired or replaced. Therefore, none of the alternatives are considered to be vulnerable to impacts from a tornado.

Although the remedial alternatives are not considered to be vulnerable to effects of climate change, implementation of adaptive measures (discussed in Section 6) could be considered during remedial design to minimize any potential impacts from future climate change. For example, consideration could be given to reducing the final grades of the landfill surface under the complete and partial excavation alternatives from 5% to 2% to reduce the potential for erosion of the cover soil.

7.2.1.2 Subsurface Heating Event and Thermal Isolation Barrier

At EPA's request, a qualitative evaluation of the conditions and processes known to be associated with subsurface heating events at landfills was previously completed by the Respondents (EMSI, 2014e). This evaluation reached the following conclusions:

- The RIM disposed of in West Lake Areas 1 and 2 would not become more or less radioactive in the presence of heat. Likewise, the RIM is not explosive and would not become explosive in the presence of heat.

- A subsurface heating event does not create conditions that could carry RIM particles or dust off the Site. The heat generated by such an event is not high enough to ignite non-RIM wastes or chemical compounds or to cause them to explode.

- An increase in subsurface temperatures may allow radon gas to more easily rise through the ground and reach the surface of the landfill than would otherwise occur, because heat would reduce the amount of moisture in the buried solid waste (trash), thereby increasing the amount of air between the soil particles and thus reducing the ability of the buried solid waste to retain radon below ground. Any radon gas that does make it to the surface would dissipate quickly in open air. This potential increase in the rate of release of radon gas at the surface of the landfill would be limited to the area of increased temperature and would quickly reach an equilibrium at a lower rate reflective of the rate of radon emanation.

- In the unlikely event that an increased subsurface temperature were to occur in West Lake Area 1 or 2, it would not result in any additional long-term risks to people or the environment.

- Any short-term risks associated with increased subsurface temperatures would result from the temporary increase in radon gas coming from the surface of Areas 1 and 2 if no cover is installed, or if the cover was not properly maintained.

- These short-term risks can be addressed by designing, constructing, and maintaining the landfill cover required under all of the remedial alternatives and by the Missouri landfill closure regulations, and by maintaining the land use restrictions already in place on the entire Site that prevent certain land uses.

Based on the foregoing conclusions, the only potential impact that may occur as a result of a subsurface heating event would be a temporary, localized increase in radon emissions. Because it is expected that all of the RIM above unrestricted levels would be removed under the "complete rad removal" alternative, any potential short-term increase in radon emissions as a result of a heating event would only be associated with the two partial excavation alternatives and the ROD-selected remedy.

Quantitative evaluations of the potential magnitude of an increase in radon emissions were performed on behalf of the Respondents in 2014 (EMSI et al., 2014e). Quantitative evaluations of potential increases in radon emissions were performed as part of evaluations of a potential thermal isolation barrier on behalf of Bridgeton Landfill, LLC and Rock Road Industries in 2014, 2015 and 2016 (EMSI et al., 2014, EMSI, 2015f, and Auxier and EMSI, 2016d). Three potential conditions associated with radon emissions under elevated temperatures and occurrence of a heating event in Area 1 were examined:

- Initial thermal expansion of landfill gas due to increased temperature as a hypothetical heating event approaches and enters into Area 1, resulting in exhalation (emission at the ground surface) of the incremental increase in the volume of landfill/soil gas due to expansion of the gas volume in response to an increase in subsurface temperature;

- Subsequent increase in radon emissions due to increased soil gas permeability resulting from vaporization of soil moisture in response to increased temperature; and

- Subsequent destruction (pyrolysis) of a portion of the waste mass and associated loss of pore space resulting in further displacement and resultant emission of an additional portion of the landfill/soil gas.

Results of these calculations indicated that even if these conditions were to occur, the radon emission rate from Area 1 would still be less than the standard established by the radon NESHAP, and if such a release were to occur, risks at or beyond the fence line would be below the acceptable risk levels established by EPA.

The potential for a hypothetical release of particulate matter containing radionuclides was also evaluated on behalf of Bridgeton Landfill, LLC and Rock Road Industries in 2016 (Auxier and EMSI, 2016e). This evaluation concluded that even with very conservative (worst-case) assumptions, the projected air concentrations at the closest occupied structure, the closest boundary fence, and at the two closest communities produced risks on the order of 10^{-8}, far below EPA's acceptable risk range of 10^{-4} to 10^{-6}.

7.2.1.3 Environmental Justice Considerations

As discussed in Section 6.2.2.3.6, a screening-level analysis did not identify any environmental justice concerns relative to the Site. EPA did identify a need for implementation of more traditional (non-electronic) communication methods to inform and ensure meaningful involvement of residents in the Terrisan Reste mobile home community.

7.2.2 Reduction of Toxicity, Mobility or Volume through Treatment

This criterion addresses the statutory preference to select remedial actions that employ treatment technologies which permanently and significantly reduce toxicity, mobility, or volume of hazardous substances as their principal element.

None of the alternatives include treatment technologies that would reduce the toxicity, mobility, or volume of the waste material through treatment. Treatment technologies are generally not applicable to solid waste landfills due to the overall large volume and heterogeneity of the wastes, which make treatment impracticable (EPA, 1991b and 1993b). For the RIM interspersed within portions of the solid waste in Areas 1 and 2, the radionuclides are naturally-occurring elements which cannot be fully neutralized or destroyed by treatment. Occurrences of radionuclides are dispersed within soil material that is further dispersed throughout portions of the overall heterogeneous matrix of municipal refuse, construction and demolition debris, and other non-impacted landfill materials within portions of Areas 1 and 2. Consequently, ex-situ treatment techniques are considered impracticable. In addition, the heterogeneous nature of the solid waste materials and the dispersed nature of the radionuclide occurrences within the overall solid waste matrix in portions of Areas 1 and 2 make in-situ treatment techniques equally impracticable.

Accordingly, under all of the alternatives, no treatment processes would be employed on-site or at an off-site disposal facility for soil or debris containing only RIM. Therefore, there would not be any reduction in toxicity, mobility, or volume through treatment for RIM under any alternative.

The potential exists to reduce the volume of materials handled as RIM (but not the overall total volume of waste materials in Areas 1 and 2) through use of ex-situ physical separation processes to separate impacted soil from solid wastes such as hand-picking of large, bulky items, shredding and physical sorting with various fixed, vibrating, or rotating screens. For example, revolving cylindrical Trommel sieve screens have been used in conjunction with landfill mining and reclamation (LFMR) projects to separate materials by size, with the soil fraction passing through the screen. While not a "treatment" process, this physical separation process could potentially be employed to reduce the volume of excavated RIM that would be transported to an off-site disposal facility under the "complete rad removal" or the partial excavation alternatives. Because such processes have not been applied to a solid waste matrix that contains radiologically-impacted materials, no data exist regarding the potential effectiveness, implementability or cost of such technologies in this context. Therefore, though the potential exists as part of the "complete rad removal" or partial excavation alternatives to reduce the volume of RIM (but not the overall volume of waste materials at the Site), the potential viability of any physical separation technology cannot be determined based on existing information. Full-scale pilot-testing of such a physical separation process during remedial design, using excavated materials from Area 1 and/or Area 2, would be necessary in order to evaluate the reduction in volume of RIM, as well as the effectiveness, implementability, and cost of the technology. Additional evaluation would be necessary to assess the potential for increased short-term risk to workers and off-site receptors due to additional materials handling associated with pilot-testing, or full-scale operation of any physical separation process.

To the extent that hazardous wastes or mixed wastes are encountered under any of the alternatives, such wastes would be shipped off-site and would be treated at the disposal facility in accordance with the hazardous waste regulations (e.g., EPA's LDR program and UTS) and in accordance with the permits and standard operating procedures of the receiving facility. Examples of treatment processes for hazardous wastes or mixed wastes include solidification/stabilization of soil and micro- or macro-encapsulation of debris. To the extent that treatment of any hazardous waste or mixed waste would be required for off-site disposal, stabilization or encapsulation treatment would result in a reduction of the mobility of the hazardous constituents or the radiological components of the waste. Toxicity and volume would not be reduced by these technologies but may be reduced by other technologies potentially applicable to hazardous wastes that do not contain RIM, if such wastes were encountered during implementation of remedial action at the Site.

7.2.3 Short-Term Effectiveness

This criterion addresses the effects that would occur during construction and implementation of the alternatives prior to achievement of the Site RAOs. Factors considered in the evaluation of this criterion include protection of the community during the remedial action, protection of workers, environmental impacts, and the time until the RAOs are met. Environmental justice considerations that may occur during implementation of the alternatives are also discussed in this section. Severity of impacts among the excavation and disposal alternatives corresponds to the duration and extent (volume, area) of the remedial action. Because the "complete rad removal" alternative is of significantly longer duration and requires contact with a substantially greater volume of the RIM than the partial excavation alternatives, it has significantly greater short-term impacts.

7.2.3.1 Protection of the Community

None of the remedial alternatives pose significant radiological or chemical exposure-related risks to the general public during remedy implementation. Potential exposures to area residents that may occur during construction of each and all of the alternatives were projected to pose total radiocarcinogenic and chemocarcinogenic risks that are less than 10^{-7}, which is below EPA's target risk range of 10^{-4} to 10^{-6}. Projected non-carcinogenic hazard indices for all of the alternatives were projected to be less than 0.0001, far below a hazard index of 1.0 used by EPA to identify unacceptable toxic effects.

The greatest potential risks to the community are associated with the off-site disposal components of the "complete rad removal" and partial excavation alternatives, with the "complete rad removal" alternative posing the greatest risk. These risks arise largely from the much greater number of truck trips associated with off-site disposal, resulting in greater traffic congestion on St. Charles Rock Road and other nearby highways, as well as the associated potential for traffic accidents and fatalities, greater greenhouse gas emissions, and greater noise impacts. The projected incidence of transportation-related accidents (Table 7-1) is 34.9 for the "complete rad removal" alternative, compared to 16.6 for the 1,000 pCi/g partial excavation alternative, 10.6 for the 52.9 pCi/g partial excavation alternative, and 0.61 for the ROD-selected remedy, respectively[54]. The off-site disposal components of the complete and partial excavation

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[54] If it were feasible to extend a rail spur onto to the West Lake Landfill Site such that RIM could be directly loaded into rail cars for transport to an off-site disposal facility, the projected incidence of traffic accidents for the "complete rad removal" or partial excavation alternatives may be reduced; however, even if the trains were only

alternatives pose the potential for an off-site release resulting from potential vehicle accidents or other losses of vehicle or container integrity during material handling and transfer activities and transport to an off-site disposal facility. Projected carbon dioxide equivalent (greenhouse gas) emissions are also substantially greater for the "complete rad removal" alternative, at 83,000 tons of carbon dioxide equivalent emissions, compared to 43,000 tons and 53,000 tons for the 52.9 and 1,000 partial excavation alternatives, respectively, and 19,000 tons for the ROD-selected remedy (Table 7-1).

In contrast to the ROD-selected remedy, which only includes regrading of existing landfill surfaces, the "complete rad removal" and partial excavation alternatives require excavation of large portions of Areas 1 and 2. Excavation of RIM from Areas 1 and 2 would require removal of (1) the existing landfill cover; (2) non-RIM overburden over Areas 1 and 2; (3) RIM above cleanup levels in Areas 1 and 2; and (4) portions of adjacent areas of landfill at OU-2. The "complete rad removal" and 1,000 pCi/g partial excavation alternatives also would require removal, temporary relocation and subsequent replacement of a large amount of the above-ground portion of the North Quarry part of the Bridgeton Landfill that overlies the southwestern portion of Area 1. Excavation, handling, stockpiling and replacement of overburden is likely to result in generation of significant amounts of odor. The total amount of waste material to be relocated as part of the regrading process under the ROD-selected remedy is estimated to be approximately 130,000 bank cubic yards (bcy). In contrast, the total volume of waste that would need to be excavated under the "complete rad removal" alternative is estimated to be nearly 1,600,000 bcy, much of which would be associated with younger, and therefore more putrescible, wastes contained in the above-grade portion of the North Quarry part of the Bridgeton Landfill. Similarly, the 1,000 pCi/g partial excavation alternative would require removal of approximately 820,000 bcy of waste, while the 52.9 pCi/g partial excavation alternative would require removal of approximately 500,000 bcy. Both of these partial excavation alternatives also require removal of significant portions of North Quarry waste. Because this waste was placed in the 2003 to 2004 timeframe, it is likely to be less decomposed (putrescible). Putrescible waste poses a greater potential to attract birds and emit odors than that posed by the older waste materials in Areas 1 and 2.

The above volume estimates do not account for the additional handling associated with temporary stockpiling or subsequent replacement of the overburden material, and therefore the actual volumes of waste being handled under the three excavation alternatives would be significantly greater than the amounts listed above.

Excavation of overburden and RIM would also create depressions in the landfill areas during the period of time required to remove the RIM and re-grade and cover the remaining landfill wastes. Precipitation that falls on the landfill while such depressions are open would potentially flow into and accumulate in the depressions. Any accumulation of precipitation[55] in depressions created

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transferred at night, an at-grade rail crossing would still represent a significant safety issue for traffic on St. Charles Rock Road.

[55] Accumulation could be significant during a heavy rainstorm, as the maximum historical 24-hour rainfall for the St. Louis area ranges from a low of 3.7 inches in November to a high of 8.8 inches in August (NOAA, 2011).

during waste excavation could result in infiltration of precipitation runoff through the underlying waste materials, which in turn could result in leaching of VOCs or other soluble contaminants from the waste materials.

During construction, consideration would be given to minimizing the area of excavation that would be open and exposed to waste materials at any given time, though the ability to accomplish this for the "complete rad removal" and partial excavation alternatives may be limited. Application of daily soil cover or placement of tarps over areas of exposed waste at the end of each work day would be employed to reduce the potential for odor generation and infiltration of precipitation. Stormwater best management practices, including temporary diversion berms, would also be constructed above the open excavation areas to divert precipitation runoff and attempt to prevent the runoff from contacting uncovered waste materials. Precipitation that would contact uncovered waste materials would flow into the low point of the excavation and be pumped out of the excavation into temporary storage tanks using portable gas-driven pumps. Samples from each tank would be collected and sent to a laboratory for analysis. The stored water would be directly discharged on-site or treated and disposed off-site based on the analytical results.

7.2.3.2 Environmental Justice Considerations During Remedy Implementation

As discussed in Section 6.2.1.5.1, a screening level analysis did not identify any environmental justice concerns. EPA did identify a need for implementation of more traditional (non-electronic) communication methods to inform and ensure meaningful involvement of residents in the Terrisan Reste mobile home community.

7.2.3.3 Worker Protection

All of the remedial alternatives pose potentially increased cancer risks to workers involved with the remedy implementation, although the risks associated with the "compete rad removal" and partial excavation alternatives are higher than those associated with the ROD-selected remedy (Table 7-1). Workers involved with remedy implementation are assumed to be exposed to gamma radiation owing to their proximity to RIM. Carcinogenic risks to the reasonably maximally-exposed individual, determined to be a radiation technician, were projected to range from a high of 2.4×10^{-3} for the 1,000 partial excavation alternative to a low of 9.2×10^{-5} for the ROD-selected remedy (see Table 7-1 and Appendix H). The total effective dose equivalent (TEDE) to remediation workers are projected to be approximately 867 mrem/year for the 1,000 partial excavation alternative, 720 mrem/per year for the 52.9 partial excavation alternative, 405 mrem per year for the "complete rad removal" alternative, and 187 mrem/year for the ROD-selected remedy; however, the TEDEs associated with all of the alternatives are projected to be less than the OSHA and NRC standards of 5,000 mrem/year. Remediation workers would also be exposed to non-carcinogenic risks from exposure to chemicals within the waste materials. All of the alternatives are projected to result in hazard indices greater than 1.0 for worker exposures to chemical (non-radiological) constituents.

Potential risks to on-site workers are also associated with the projected incidence of industrial accidents, which were estimated to range from a high of 17.8 for the "complete rad removal" alternative to a low of 2.8 for the ROD-selected remedy (Table 7-1).

For all of the alternatives, workers would be instructed and trained in safe work practices, work practices at hazardous waste sites, work practices in extreme temperatures, vehicle and pedestrian safety, use and care of personal protective equipment and monitoring devices, and other measures to reduce worker exposures and the potential for accidents. Risks and doses to workers from exposure to RIM can be controlled by limiting exposure durations.

7.2.3.4 Environmental Impacts

No measurable long-term impacts to plants or animals in surrounding ecosystems are expected to occur from any of the alternatives. No wetlands are located within the on-site construction footprint of the alternatives and no endangered species were identified in the Site area. Excavating and re-grading Areas 1 and 2 and constructing new landfill covers over these areas would affect the wildlife and plant life on those portions of the landfill. Disturbance of the landfill surface would occur under all of the remedial alternatives and would destroy those portions of the habitats that currently exist on the surface of Areas 1 and 2, forcing wildlife to migrate to other areas. This disruption would be temporary and would last for the period of active construction[56]. Vegetative cover would be placed on the Site and the landfill would be allowed to return to an early-stage field ecosystem with periodic mowing and maintenance.

As discussed in the prior section, excavation of overburden and RIM could result in creation of depressions which could accumulate stormwater. Accumulation of stormwater in these depressions would increase infiltration and potential leaching and transport of chemicals or radionuclides, which could result in impacts to the underlying groundwater quality. Such impacts are expected to only be temporary because once regrading is completed, no further stormwater accumulation and infiltration would be expected to occur.

7.2.3.5 Time to Achieve Remedial Action Objectives (RAOs)

The RAOs would be achieved upon completion of construction, which is estimated to be finished within the following timeframes after notice to proceed with remedial design is issued (see also Table 7-1 and Appendix J). The ROD-selected remedy would achieve the RAOs in the shortest amount of time, while the "complete excavation alternative" would take the longest time to achieve RAOs.

- Approximately 2.7 years for the ROD-selected remedy,

[56] It should be noted that much of the vegetative cover was recently removed from Areas 1 and 2 as part of construction of the Non-Combustible Cover.

- Approximately 5.9 years for the 52.9 pCi/g partial excavation alternative, and
- Approximately 9 years for the 1,000 pCi/g partial excavation alternative, and
- Approximately 13.4 years for the “complete rad removal” alternative.

These estimated durations assume that remedial design for each alternative can be completed and approved within one year to 15 months of remedy approval and authorization to begin the RD phase, and that construction of the remedy is not fiscally constrained.

The short-term effectiveness of the alternatives would be assessed by monitoring performed during, at the completion of, and after construction. Monitoring performed during construction would include perimeter and work space air monitoring, as well as worker health and safety monitoring. Construction quality control monitoring would be performed as part of all of the remedial alternatives to document that remedy construction was completed in accordance with the design specifications.

For the “complete rad removal” and partial excavation alternatives, measurements, sampling and laboratory analyses would be performed to guide the excavation activities and verify that the RIM above the respective cleanup levels was removed. Because thorium-230 is a primary radionuclide of concern relative to the “complete rad removal” and partial excavation alternatives, significant reductions in efficiency and increased time may be required for RIM excavation, as compared with the ROD-selected remedy. Thorium-230 cannot be detected using field survey instruments, so excavation would have to be guided by collection and laboratory analyses of samples. In order to minimize the potential impacts on the excavation schedule, it is assumed that an on-site laboratory would be set up and operated to provide quick analyses of samples to guide excavation activities and initial confirmation that RIM to the specified cleanup level had been removed. A percentage of such samples would also be sent to an off-site laboratory for verification of the on-site laboratory results. Samples obtained for final confirmation that RIM has been removed from a particular area would also be subjected to off-site laboratory analyses. All of these activities would undoubtedly impact the rate of RIM excavation and the duration over which excavation areas need to remain open.

For the ROD-selected remedy and the partial excavation alternatives, measurements of gamma radiation levels and radon flux would be made on and around Areas 1 and 2 after construction is complete to provide for final quantification of the cover effectiveness.

All of the alternatives include long-term groundwater and landfill gas monitoring along the perimeter of Areas 1 and 2 and, if necessary, at off-site locations.

Because RIM and solid wastes would remain in Areas 1 and 2 under the ROD-selected remedy and the partial excavation alternatives, and solid wastes would remain in these areas under all of the alternatives, engineering measures and institutional controls intended to address the presence of solid wastes would be required for all of the alternatives. Engineering measures and institutional controls to address the presence of RIM would also be required for the ROD-selected remedy and partial excavation alternatives; however, these are the same types of measures that would be used to address the solid waste materials remaining in Areas 1 and 2 under the “complete rad removal” alternative, with certain enhancements to address the presence of RIM.

Unlike the ROD-selected remedy, the estimated schedules for construction of the “complete rad removal” and partial excavation alternatives are highly dependent upon the amount of expansion (the swell factor) the waste materials experience during excavation, handling and loading for shipment. Based on experience at the Mound Site, the Tulalip Landfill and other landfill waste excavation projects (see section 6.1.7.2), it is likely that the actual volume expansion swell factor could be greater than what has been assumed in this FFS, and unlikely that it would be less. To the extent that the swell factor is greater than what has been assumed during preparation of this FFS, the schedules for completion of construction – and consequently, the costs and risks associated with the “complete rad removal” and partial excavation alternatives – would increase. The swell factor does not apply to the ROD-selected remedy and therefore would not increase the costs and risks associated with that remedial alternative.

The projected construction schedule and the cost estimate for the “complete rad removal” and partial excavation alternatives are also highly dependent on the number of containers that could be loaded with RIM and shipped off-site per day. The schedules and cost estimates developed in this FFS for these alternatives are based on an assumption that a sufficient number of IM containers and rail cars can be made available, loaded, switched out and replaced every day. If the actual rate is less than the projected rates of RIM excavation used to develop the construction schedules, the time required to complete construction – and consequently, the costs and risks for the “complete rad removal” or partial excavation alternatives – would increase.

Similarly, the schedule, costs and risks for the “complete rad removal” and partial excavation alternatives are sensitive to the rates at which soil and RIM can be relocated on-site. These rates are a function of the capacity of the internal roads and road intersections, as well as the demands of the on-site truck traffic generated by the existing transfer station and asphalt plant operations. Since these estimates were based on an optimal number of trucks, it is possible that the number of off-road haul truck trips assumed for purposes of preparing this FFS may not be achievable; similarly, it is unlikely that the number assumed could be greater. Consequently, the actual duration required for construction of the “complete rad removal” and partial excavation alternatives could be greater than that assumed in this FFS, resulting in increased time to complete, costs and risks.

7.2.4 Implementability

This criterion addresses the technical and administrative implementability of each alternative and the availability of the various services and materials required to implement each alternative.

Installation of upgraded landfill covers to promote runoff and minimize infiltration, excavation and off-site disposal of waste materials, and implementation of institutional controls are all technically feasible, reliable, and established technologies that have been implemented and proven at other CERCLA landfill sites. Monitoring of landfill cover surfaces, landfill gas, radon, groundwater, and surface water are proven methods for demonstrating the long-term effectiveness of a covered landfill and are easily implemented.

All of the alternatives include re-grading and contouring the existing overburden and waste materials in Areas 1 and 2 in order to achieve final grades. Re-compaction of the re-graded materials will be required to minimize the potential for differential settlement over time that could affect the integrity of the landfill cover. Placement of additional fill material to achieve the final slope requirements and for construction of the landfill covers over Areas 1 and 2 may result in compaction of the existing waste materials, depending upon the nature, age, and amount of prior degradation of the materials. Long-term maintenance, including inspection and repair, is typically required to address the potential for differential settlement or surface erosion of the landfill cover over time and is anticipated to be part of all alternatives. The level of effort for inspection and repair of the cover surfaces over Areas 1 and 2 would be the same for all alternatives.

Monitoring of the Area 1 and 2 landfill cover surfaces, perimeter landfill gas monitoring, and groundwater and surface water quality monitoring, would be required for all of the alternatives in order to demonstrate the effectiveness of the remedy. Future groundwater monitoring activities could require acquisition and maintenance of access to off-site properties if off-site groundwater monitoring was required as part of the remedy. All of the monitoring activities are implementable.

The proximity of the landfill mass to the property boundaries and adjacent properties constrains the potential methods that can be utilized to re-grade Areas 1 and 2. Specifically, the lack of space along the margins of Areas 1 and 2 dictates that re-grading of these areas to achieve the desired slopes cannot be completed by placement of additional fill material alone. Relocation of a limited amount of existing waste materials would be necessary in some areas, and grading and contouring of existing waste would be required in other areas. Even so, the amount of waste relocation that may need to be performed for the ROD-selected remedy is still anticipated to be considerably less than the amount of overburden excavation and waste movement that would be required for the “complete rad removal” or partial excavation alternatives, as these alternatives entail removal and stockpiling of substantial amounts of overburden, removal of substantial amounts of RIM, and replacement of the overburden material.

Uncertainty exists concerning the ability to remove all of the RIM under the “complete rad removal” and partial excavation alternatives due to the depth of the RIM in some areas and the proximity of some of the RIM to other (OU-2) solid waste management units, including the North Quarry portion of the Bridgeton Landfill, closed construction and demolition waste landfill, and the inactive sanitary waste landfill.

Excavation of RIM would also present significant implementability concerns associated with the excavation and handling of contaminated materials, including:

- management of fugitive dust and potential odors;
- mitigation of bird hazards;
- management and treatment of stormwater exposed to RIM or other waste during excavation;
- management of RIM that fails the paint filter liquids test; and
- the identification, segregation, and disposal off-site of any hazardous wastes or regulated asbestos containing materials that may be encountered during RIM excavation.

These factors are discussed further in Section 6.

In addition, under the “complete rad removal” and partial excavation alternatives, directing and controlling the RIM excavation process using radiological scanning, sampling and laboratory analytical techniques would greatly impact (i.e., decrease) overburden and RIM excavation rates.

Implementability concerns specific to the off-site transport and disposal components of the “complete rad removal” and partial excavation alternatives include the considerations listed below. The ROD-selected remedy would not pose such implementability concerns because it does not involve the excavation and off-site disposal of waste.

- If a truck-to-rail transloading facility at an off-site rail spur location were to be used, a suitable location would have to be identified and a lease secured with the land/rail spur owner.

- If a rail spur were to be extended onto the West Lake Landfill property: (1) land located across St. Charles Rock Road would either need to be purchased or long-term leases would be needed with landowners, (2) it would be necessary to obtain state and local government, private landowner, facility occupant and community approval to construct a rail spur across private property located to the east of St. Charles Rock Road, across St. Charles Rock Road, and along the Site access roads which serve the existing solid waste transfer station and asphalt plant operations, and (3) the long-term lease of the asphalt plant would likely need to be renegotiated or otherwise acquired.

- Switching of railcars either at a truck-to-rail transloading facility spur or an on-site rail spur would need to be coordinated with the railroad company that would be hauling the rail cars to the off-site disposal facility. The capacity to switch rail cars could affect the rate at which RIM could be excavated and removed from the Site.

- If a rail spur could be extended onto the West Lake Landfill property, dropping off empty and picking up loaded railcars would likely be possible only during late nighttime due to the high traffic volume on St. Charles Rock Road during the day. The rail spur crossing at St. Charles Rock Road would need to meet appropriate state and local safety requirements.

- The EPA Region where the off-site disposal facility is located would need to be contacted every 60 days to obtain a compliance determination as to whether the disposal facility currently meets the criteria under the CERCLA Off-Site Rule. If, during RIM excavation, the contracted off-site disposal facility was found not to be in compliance for a period of time, excavation and transportation would need to cease until the facility became compliant, or RIM would need to be transported to another facility that EPA determined to be in compliance with all permit and regulatory requirements. Besides schedule delays, temporary stoppage of construction would present significant technical implementability concerns regarding open excavation areas.[57]

- If RIM were to be disposed at the Clean Harbors Deer Trail, CO facility, an application would have to be submitted to and accepted by the Rocky Mountain Low Level Radioactive Waste Compact.

Management and discharge of any leachate that may be collected or generated during implementation of any of the remedial actions would require coordination with the Metropolitan Sewer District (MSD) with respect to acceptance and conditions for discharge of leachate to the sewer system. Design for and discharge of stormwater will require coordination with the Earth City Flood Control District. Removal of soil containing radionuclides above unrestricted use levels that may still remain on the Crossroads Property, will require coordination with Crossroad Properties, LLC and AAA Trailer. A traffic control plan for and possibly improvements to the Site ingress and egress from St. Charles Rock Road may need to be developed and coordinated with the City of Bridgeton and/or the Missouri Department of Transportation

Because Areas 1 and 2 exist within a larger Site with other landfill areas, the following activities impact one or more of the alternatives and would require coordination with the Site owner and operator:

- Regrading of Areas 1 and 2, installation of an upgraded landfill cover, and design of stormwater management structures under any of the remedial alternatives would need to be integrated with the grading, landfill covers, and stormwater controls that currently exist or that may be constructed on the adjacent OU-2 landfill units;

- Use of Site areas outside of Areas 1 and 2 to stockpile cover materials in order to facilitate cover construction under all four remedial alternatives would need to be integrated with ongoing Site operations and/or implementation of remedial actions for OU-2;

- The flow of vehicles associated with remedy construction would need to be coordinated with the flow of vehicles associated with the on-site solid waste transfer station and asphalt plant operations;

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[57] For example, if such an event of non-compliance were to occur and could not be resolved quickly, excavation at the Site might be required to halt temporarily, and existing excavations may need to be backfilled in order to minimize potential RIM exposures.

- Excavation of RIM under the "complete rad removal" and partial excavation alternatives would need to be coordinated with remedial actions to be performed for OU-2;

- Truck hauling of RIM off-site to a truck-to-rail transloading facility for the off-site disposal alternatives would need to be coordinated with vehicle activity associated with the existing Site operations;

- If a rail spur could be extended onto the Site for the off-site disposal alternatives, loading of railcars with RIM and switching of railcars would need to be coordinated with the Site owners and existing operations at the Site; and

- Truck delivery of rock, clay, and soil materials for cover construction over Areas 1 and 2 under all four remedial alternatives would need to be coordinated with vehicle traffic associated with the existing Site activities.

Specialized personnel, equipment, and materials are expected to be readily available to implement the cover systems, institutional controls, and monitoring components of the remedial alternatives. The implementability and potential costs for all of the remedial alternatives will be influenced by the availability and location of clean fill materials and/or off-site soil borrow sources at the time the selected alternative is implemented. Potential vendors of rock, clay and soil were contacted during the development of the FS and during preparation of the Remedial Design Work Plan for the ROD-selected remedy. These vendors indicated that rock, clay, and soil material were readily available from sources close to the Site. However, if these local sources become exhausted prior to or during remedy implementation, cover materials would have to be obtained from suppliers at greater distances from the Site.

Materials, equipment and personnel required for excavation of RIM and transport of RIM to an off-site disposal facility are readily available. Only a limited number of off-site disposal facilities exist that can accept excavated RIM from the West Lake Landfill. All of the facilities currently are anticipated to have sufficient available capacity to accept the estimated volumes of RIM from the Site; however, there is no assurance that sufficient capacity at one or more of these facilities would be available in the future to serve the "complete rad removal" or one of the partial excavation alternatives if such an alternative were to be selected by EPA. At this time, it is difficult to evaluate which disposal facilities that can currently accept wastes from the West Lake Landfill may be available in the future, or what their respective future capacities or waste acceptance criteria may be. The volumetric rate of acceptance for all off-site disposal facilities would also be a function of the availability of IM containers and the number of railcars that could be loaded at or near the Site, as well as the number of railcars that could be unloaded at or near the disposal facility. If a "complete rad removal" or partial excavation alternative were to be selected, the facilities identified in Section 3.2.3 and as further detailed in Appendix C are also permitted to (1) accept liquid wastes, should any stormwater accumulated in excavations during RIM excavation become contaminated and require disposal off-site, (2) accept mixed wastes, if mixed wastes are encountered during excavation, and (3) treat soil and/or debris that contains hazardous or mixed waste.

7.2.5 Cost

The final primary balancing criterion is cost. Table 6-1 presents a summary of the anticipated costs associated with each alternative. The highest costs are associated with the "complete rad removal" alternative, followed by the 1,000 pCi/g partial excavation alternative and the 52.9 pCi/g partial excavation alternative, with the lowest costs associated with the ROD-selected remedy as the second lowest (see listing below). Detailed information regarding the cost estimates for each alternative is presented in Appendix K.

- The ROD-selected remedy would result in the lowest overall estimated capital (design, construction and environmental monitoring during construction) costs of all of the remedial alternatives at $67 million, with estimated annual OM&M costs ranging from $167,000 to $326,000.

- Capital costs for construction of the 52.9 pCi/g partial excavation alternative are estimated to be $313 million with estimated annual operations, maintenance and monitoring costs of $167,000 to $326,000.

- Capital costs for construction of the 1,000 pCi/g partial excavation alternative are projected to be $361 million with estimated annual operations, maintenance and monitoring costs of $167,000 to $326,000.

- Implementation of the "complete rad removal" with off-site disposal alternative would result in incurrence of the highest total estimated capital cost at $616 million, with estimated annual operations, maintenance and monitoring costs of $167,000 to $326,000.

The cost estimates summarized above and provided elsewhere in this FFS are feasibility-level cost estimates; that is, they were developed to a level of accuracy such that the actual costs incurred to implement the alternatives are anticipated to be within a range bounded by 50% above and 30% below these estimates.

The ranges in values for the annual OM&M costs cited above result from variations in the specific activities that occur each year (*e.g.*, higher costs for years with additional environmental monitoring, years when landfill cover repairs may occur, and years when five-year reviews are conducted).

Based on a 7% discount rate, the 30-year present worth costs of the alternatives are estimated to be:

- $63 million for the ROD-selected remedy,

- $265 million for the 52.9 pCi/g partial excavation alternative,

- $275 million for the 1,000 pCi/g partial excavation alternative, and
- $421 million for the "complete rad removal" alternative.

Based on the Office of Management and Budget's current value (2016 value issued in December 2015) of 1.5% for the 30-year discount rate, the 30-year present worth costs of the alternatives are estimated to be:

- $70 million for the ROD-selected remedy,
- $305 million for the 52.9 pCi/g partial excavation alternative,
- $342 million for the 1,000 pCi/g partial excavation alternative, and
- $567 million for the "complete rad removal" alternative.

Finally, the total non-discounted costs over the same 30-year period are estimated to be:

- $72 million for the ROD-selected remedy,
- $318 million for the 52.9 pCi/g partial excavation alternative,
- $365 million for the 1,000 pCi/g partial excavation alternative, and
- $620 million for the "complete rad removal" alternative.

As discussed in Section 6.1.7.2, variable scope contingency factors were developed and applied to each of the major construction activities including excavation (55%), off-site disposal (15%), and landfill cover construction (10%). Scope contingency addresses unknown costs due to scope changes that may occur during RD and represents project risks associated with an incomplete design, because design concepts are not typically developed enough during preparation of an FS to identify all project components or quantities. This type of contingency represents costs unforeseeable at the time the FFS and conceptual design cost estimate were prepared, both of which are likely to become better known as the RD phase progresses.

The greatest source of uncertainty is associated with RIM excavation, and results from uncertainties associated with (1) the volume, configuration and composition of the RIM; (2) the volume and configuration of the overburden material; (3) excavation rates; (4) the material swell factors; (5) available areas for stockpiling overburden; (6) the nature and degree of nuisance factors (*e.g.*, odors, weather, stormwater management, bird control, etc.); and (7) the associated management techniques, and changes or additions to the construction and management procedures that may be requested or required by the regulatory agencies or other parties, among other factors. Among the alternatives, the greater the amount of RIM excavated, the greater the degree of uncertainty. Due to the limited number of off-site disposal facilities that could accept the waste materials, the greatest degree of uncertainty with the capital costs is associated with the off-site disposal component of the “complete rad removal” and partial excavation alternatives. There also are uncertainties regarding the specification and cost of the rock that would be used for the bio-intrusion layer included in the ROD-selected remedy and the partial excavation alternatives, as well as the source and unit costs for acquisition and delivery of the clay and soil to be used to construct the low permeability and vegetative layers of the final landfill covers over Areas 1 and 2 that are included in all of the remedial alternatives.

A 20% bid contingency was also included in the capital costs for all of the remedial alternatives to address unknowns that might occur after a construction contract is awarded. The ROD-selected remedy is not expected to have the potential for significant cost growth after construction begins because it is a demonstrated technology with fewer uncertainties in cost-determining factors. In contrast, the “complete rad removal” and partial excavation alternatives have the potential for significant cost growth due to the unknowns associated with excavation of the RIM, including, among other factors: (1) the configuration and volume of the RIM; (2) the swell resulting from RIM excavation; (3) the amount of overburden; (4) potential occurrences of hazardous wastes or RACM; and (5) actual production rates of excavation and disposal activities, especially under different weather conditions.

As an example, at OU-1 of the Mound CERCLA site in Miamisburg, OH, the remediation of landfilled contaminated soil/debris that contained radionuclides cost significantly more than anticipated. Review of available documents (ARC, 2009 and ARC, 2010) and discussions with regulatory agency representatives for this project indicate that one reason for the significant increase in costs was “variations with respect to waste location and waste type from those modeled by the project team in the original Remedial Action Work Plan were encountered during excavation” (ARC, 2009). Specific factors that resulted in the increased costs included:

- Uncertainty regarding the locations, extents, depths, configurations, volumes, types, and characteristics of the waste deposits;
- No data, or only limited characterization data, for the waste materials prior to initiation of the removal action;
- The presence of unanticipated and undocumented waste materials and waste types, including (but not limited to) mercury, PCBs, previously unidentified VOCs, Pu-239, and Am-241;
- The presence of a substantial amount of both mixed radioactive and hazardous wastes/debris and hazardous waste/debris, with both the hazardous wastes/debris and the mixed wastes requiring off-site incineration and chemical oxidation;
- The necessity of transporting materials to four different off-site disposal or waste processing facilities (rather than only one facility, as was anticipated during project planning) because of the variability in types of wastes encountered;

- The impacts of weather (heat, cold, rain, lightning) on implementability, employee productivity rates, equipment operation, and progress of the excavation activities;
- Excessive water ponding in trenches and limited operations during backfilling activities caused by severe precipitation; and
- Delayed and complicated backfill and soil cover compaction due to excessive precipitation and frozen soil.

Excavation of waste materials from OU-1 Areas 1 and 2 is likely to encounter many of the same complications encountered at the Mound OU-1 Landfill Area. In addition to the cost overrun issues listed above, experience with waste excavation at other landfill sites indicates that the following additional factors could also contribute to increased costs for the "complete rad removal" or partial excavation alternatives:

- Unanticipated variations in the volume-weight relationships for the wastes that could result in variability in costs charged on either a volumetric or weight-based unit price;
- Increased fuel and resultant transportation costs over time;
- Loss of the availability of one or more of the currently available off-site disposal facilities in the future;
- Potential increases in the off-site transportation and disposal pricing over time;
- Potential for encountering leachate containing hazardous substances that may require treatment;
- Potential for stormwater accumulation in depressions created by waste excavation and resultant potential for generation of contaminated stormwater requiring treatment; and
- Decreased availability and/or increased pricing for local fill material required to regrade Areas 1 and 2 to 5% slopes upon completion of the waste excavation activities.

The nature of the activities and the longer duration required for implementation of the "complete rad removal" and, to a lesser extent, partial excavation alternatives, significantly increases the potential for occurrence of cost increases over time.

7.3 Modifying Criteria

The two NCP modifying criteria are: (1) state acceptance; and (2) community acceptance. Comparison of the alternatives with respect to modifying criteria will be performed by EPA as part of the FFS review and decision process.

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TABLES

Table 2-1: Summary of Occurrences of Radiologically-Impacted Material (RIM) in Area 1

Boring	Northing	Easting	Ground Surface Elevation (ft amsl)	Maximum Gamma Value (cpm)	Depth to Maximum Gamma (ft)	Elevation of Maximum Gamma (ft amsl)	RIM Present ?	Depth to Top of RIM Interval (ft)	Elevation Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval					
													Downhole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium
NRC (1981)																		
PVC-24-MH	1069234.280	516312.810	469.570	BKGD			No						-	NA	NA	NA	NA	NA
PVC-25-MH	1069345.420	516406.580	467.650	72,000	9	458.7	Yes	7	460.7	11	456.7	4.0	X	NA	NA	-	-	-
PVC-26-MH	1069464.450	516376.130	465.220	86,000	5	460.2	Yes	3	462.2	10	455.2	7.0	X	NA	NA	-	-	-
PVC-27-MH	1069460.560	516510.300	469.140	BKGD			No						-	NA	NA	NA	NA	NA
PVC-28-MH	1069255.020	516488.890	473.110	132,000	14	459.1	Yes	12	461.1	17	456.1	5.0	X	NA	NA	-	-	-
PVC-36-MH	1069217.890	516193.840	466.800	15,780	7.8	459.0	Yes	6	460.8	9.5	457.3	3.5	X	NA	NA	-	-	-
PVC-37-MH	1069146.480	516421.570	473.430	BKGD			No						-	NA	NA	NA	NA	NA
PVC-38-MH	1069315.550	516580.410	470.520	1,298,000	10	460.5	Yes	0	470.5	15	455.5	15.0	X	NA	NA	-	-	-
PVC-41-MH	1069213.330	516701.180	474.060	BKGD			No						-	NA	NA	NA	NA	NA
NRC-29	1069125.900	516607.450	473.460	2,000	9	464.46	No						-	NA	NA	NA	NA	NA
McLaren/Hart RI (1995)																		
WL-101-MH	1069549.550	516317.210	456.500	BKGD			No						-	NA	NA	-	-	-
WL-102-MH	1069260.460	515974.050	462.800	60,000	3.25	459.6	Yes	0	462.8	6	456.8	6.0	X	NA	NA	-	-	-
WL-103-MH	1069407.360	516737.060	450.900	BKGD			Yes	9	441.9	11	439.9	2.0	-	NA	NA	-	X	-
WL-104-MH	1069575.470	516602.770	449.800	BKGD			No						-	NA	NA	-	-	-
WL-105A-MH	1069136.260	515871.620	467.200	180,000	9	458.2	Yes	5.5	461.7	12	455.2	6.5	X	NA	NA	X	X	-
WL-105B-MH	1069148.420	515889.500	466.000	263,000	6.5	459.5	Yes	5.5	460.5	10.5	455.5	5.0	X	NA	NA	-	-	-
WL-105C-MH	1069155.840	515901.030	465.700	386,000	3.5	462.2	Yes	2	463.7	5	460.7	3.0	X	NA	NA	-	-	-
WL-106A-MH	1069317.250	516061.920	462.800	25,000	4	458.8	Yes	0	462.8	6	456.8	6.0	-	NA	NA	X	X	X
WL-106-MH	1069301.640	516082.180	465.400	25,000	4	461.4	Yes	1	464.4	5.5	459.9	4.5	X	NA	NA	-	-	-
WL-107-MH	1068909.520	516254.310	486.000	BKGD			No						-	NA	NA	-	-	-
WL-108-MH	1069144.210	516379.680	456.500	BKGD			No						-	NA	NA	-	-	-
WL-109A-MH	1068932.920	516509.670	485.500	BKGD			No						-	NA	NA	-	-	-
WL-109B-MH	1068947.160	516523.170	484.500	BKGD			No						-	NA	NA	-	-	-
WL-109C-MH	1068961.120	516528.430	483.900	BKGD			No						-	NA	NA	-	-	-
WL-109D-MH	1068947.380	516504.970	485.600	BKGD			No						-	NA	NA	-	-	-
WL-110-MH	1068852.431	516664.579	484.410	BKGD			No						-	NA	NA	-	-	-
WL-111-MH	1069187.350	516583.610	474.500	BKGD			No						-	NA	NA	-	-	-
WL-112-MH	1069379.450	516628.220	467.600	10,000	5.5	462.1	Yes	4	463.6	7	460.6	3.0	X	NA	NA	-	X	-
WL-113-MH	1069483.190	516469.950	467.000	14,000	3.75	463.3	Yes	3	464.0	5	462.0	2.0	X	NA	NA	-	-	-
WL-114-MH	1069391.530	516338.570	468.300	14,000	5	463.3	Yes	0	468.3	6	462.3	6.0	X	NA	NA	X	X	X
WL-115-MH	1069298.980	516395.130	468.900	BKGD			No						-	NA	NA	-	-	-
WL-116-MH	1069083.490	516160.600	474.300	BKGD			No						-	NA	NA	-	-	-
WL-117-MH	1069237.400	516221.330	467.600	16,000	6.5	461.1	Yes	3	464.6	11	456.6	8.0	X	NA	NA	-	X	-
WL-118-MH	1069411.090	516304.950	465.800	12,000	0	465.8	Yes	0	465.8	7	458.8	7.0	X	NA	NA	X	X	-
WL-119-MH	1069031.140	516289.260	477.400	BKGD			No						-	NA	NA	-	-	-
WL-120-MH	1069053.640	516846.570	474.700	BKGD			No						-	NA	NA	-	-	-
WL-121-MH	1068762.531	516241.324	523.210	BKGD			No						-	NA	NA	-	-	-
WL-122-MH	1068774.622	516110.181	507.192	BKGD			No						-	NA	NA	-	-	-
WL-123-MH	1068792.759	515934.652	480.135	BKGD			No						-	NA	NA	-	-	-
WL-124-MH	1069050.704	515857.983	470.484	BKGD			No						-	NA	NA	-	-	-
Phase 1A (2013)/Phase 1B (2014)																		
GCPT 1-1	1068826.649	515829.017	471.003	6,258	1.1	469.9	No						-	NA	NA	NA	NA	NA
GCPT 1-1A	1068820.373	515835.155	470.952	7,464	32.5	438.5	No						-	NA	NA	NA	NA	NA
GCPT 1-2	1068777.662	515870.573	471.709	67,878	24.4	447.3	Yes	23.5	448.2	25.2	446.5	1.7	X	NA	NA	NA	NA	NA
GCPT 2-1	1068905.795	515882.108	472.776	5,610	3.3	469.5	No						-	NA	NA	NA	NA	NA
GCPT 2-2	1068879.341	515916.514	474.933	6,294	1.5	473.4	No						-	NA	NA	NA	NA	NA

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Boring	Northing	Easting	Ground Surface Elevation (ft amsl)	Maximum Gamma Value (cpm)	Depth to Maximum Gamma (ft)	Elevation of Maximum Gamma (ft amsl)	RIM Present ?	Depth to Top of RIM Interval (ft)	Elevation Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval					
													Downhole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium
GCPT 2-2A	1068874.348	515928.265	475.273	5,766	1.5	473.8	No						-	NA	NA	NA	NA	NA
GCPT 2-3	1068819.102	515941.573	476.607	BKGD			No						-	NA	NA	NA	NA	NA
GCPT 2-3A	1068819.102	515941.573	476.607	34,722	35.6	441.0	Yes	35	441.6	36.8	439.8	1.8	X	NA	NA	NA	NA	NA
GCPT 2-2B	1068874.348	515928.265	475.273	96,000	34	441.3	Yes	33.2	442.1	34.7	440.6	1.5	X	NA	NA	NA	NA	NA
GCPT 2-2C	1068878.507	515931.137	475.300	18,906	32.5	442.8	Yes	31.8	443.5	32.7	442.6	0.9	X	NA	NA	NA	NA	NA
GCPT 2-4	1068863.196	515948.689	476.643	10,320	29.4	447.2	No						-	NA	NA	NA	NA	NA
GCPT 3-1	1068944.022	515949.289	474.936	5,724	4.4	470.5	No						-	NA	NA	NA	NA	NA
GCPT 3-1A	1068944.022	515949.289	474.936	78,810	27.7	447.2	Yes	27	447.9	28.5	446.4	1.5	X	NA	NA	NA	NA	NA
GCPT 3-2	1068866.409	516005.995	479.012	6,186	1	478.0	No						-	NA	NA	NA	NA	NA
GCPT 4-1	1068941.601	516007.654	474.382	488,196	28.9	445.5	Yes	27.5	446.9	31	443.4	3.5	X	NA	NA	NA	NA	NA
GCPT 4-2	1068880.888	516037.985	479.036	40,644	34	445.0	Yes	33.5	445.5	34.5	444.5	1.0	X	NA	NA	NA	NA	NA
GCPT 5-1	1069052.620	516101.781	473.644	126,738	25.1	448.5	Yes	23.2	450.4	25.8	447.8	2.6	X	NA	NA	NA	NA	NA
GCPT 5-2	1069012.133	516040.892	473.341	114,684	26.2	447.1	Yes	25.2	448.1	27	446.3	1.8	X	NA	NA	NA	NA	NA
GCPT 5-3	1068985.452	516093.331	474.679	631,662	29.4	445.3	Yes	25.5	449.2	33	441.7	7.5	X	NA	NA	NA	NA	NA
GCPT 5-4	1068925.017	516116.619	478.216	5,310	1.3	476.9	No						-	NA	NA	NA	NA	NA
GCPT 5-4A	1068931.178	516116.457	477.965	8,820	11.8	466.2	No						-	NA	NA	NA	NA	NA
GCPT 5-5	1068953.892	516113.219	476.700	450,360	32.2	444.5	Yes	30.1	446.6	34.4	442.3	4.3	X	NA	NA	NA	NA	NA
GCPT 5-6	1068998.386	516126.377	474.700	405,864	27.4	447.3	Yes	25.5	449.2	29	445.7	3.5	X	NA	NA	NA	NA	NA
GCPT 6-2	1069108.868	516196.534	472.997	6,258	13.3	459.7	No						-	NA	NA	NA	NA	NA
GCPT 6-3	1069036.469	516180.777	474.043	103,218	27.9	446.1	Yes	27.2	446.8	28.8	445.2	1.6	X	NA	NA	NA	NA	NA
GCPT 6-4	1068976.421	516208.637	482.702	4,434	3.1	479.6	No						-	NA	NA	NA	NA	NA
GCPT 6-5	1068969.612	516218.253	482.621	6,108	3.3	479.3	No						-	NA	NA	NA	NA	NA
GCPT 6-6	1069012.482	516193.425	475.200	191,856	28.1	447.1	Yes	26	449.2	29	446.2	3.0	X	NA	NA	NA	NA	NA
GCPT 7-1	1069155.521	516310.797	470.865	6,204	7.9	463.0	No						-	NA	NA	NA	NA	NA
GCPT 7-2	1069085.747	516269.321	472.588	6,012	4.9	467.7	No						-	NA	NA	NA	NA	NA
GCPT 7-3	1069013.045	516308.254	479.220	12,558	40	439.2	No						-	NA	NA	NA	NA	NA
GCPT 8-1	1069039.242	516366.519	479.726	19,854	29	450.7	Yes	27.5	452.2	30	449.7	2.5	X	NA	NA	NA	NA	NA
GCPT 9-1	1069152.039	516357.317	470.278	8,280	6.2	464.1	No						-	NA	NA	NA	NA	NA
GCPT 9-2	1069098.604	516379.609	472.123	5,826	16.9	455.2	No						-	NA	NA	NA	NA	NA
GCPT 9-3	1069055.624	516401.053	479.625	3,642	1.8	477.8	No						-	NA	NA	NA	NA	NA
GCPT 9-3A	1069049.417	516404.583	479.231	6,228	15.3	463.9	No						-	NA	NA	NA	NA	NA
GCTP 9-4	1069113.505	516407.046	471.412	5,622	2.1	469.3	No						-	NA	NA	NA	NA	NA
GCPT 10-1	1069190.539	516433.004	471.077	6,828	1.6	469.5	No						-	NA	NA	NA	NA	NA
GCPT 10-2	1069140.593	516449.840	472.326	6,486	7.5	464.8	No						-	NA	NA	NA	NA	NA
GCPT 10-3	1069074.641	516465.592	485.347	4,074	1.6	483.7	No						-	NA	NA	NA	NA	NA
GCPT 10-3A	1069075.419	516462.854	485.373	4,890	3.4	482.0	No						-	NA	NA	NA	NA	NA
GCPT 10-4	1069060.422	516474.665	483.551	BKGD			No						-	NA	NA	NA	NA	NA
GCPT 10-4A	1069061.187	516477.897	483.556	6,642	14.9	468.7	No						-	NA	NA	NA	NA	NA
GCPT 11-1	1069222.929	516503.558	479.814	9,210	0.2	479.6	No						-	NA	NA	NA	NA	NA
GCPT 11-2	1069167.995	516518.208	474.796	7,614	15.4	459.4	No						-	NA	NA	NA	NA	NA
GCPT 11-3	1069137.542	516551.085	476.620	6,858	6.1	470.5	No						-	NA	NA	NA	NA	NA
GCPT 11-4	1069072.777	516565.515	482.682	9,792	45.9	436.8	No						-	NA	NA	NA	NA	NA
GCPT 12-1	1069249.275	516567.619	479.376	308,106	24.1	455.3	Yes	22	457.4	24.9	454.5	2.9	X	NA	NA	NA	NA	NA
GCPT 12-2	1069198.102	516592.800	476.014	6,546	1.3	474.7	No						-	NA	NA	NA	NA	NA
GCPT 12-3	1069163.456	516608.867	475.910	7,476	4.1	471.8	No						-	NA	NA	NA	NA	NA
GCPT 12-4	1069124.740	516619.657	476.420	7,374	38.5	437.9	No						-	NA	NA	NA	NA	NA
GCPT 12-5	1069091.157	516638.742	478.450	6,432	7.5	471.0	No						-	NA	NA	NA	NA	NA
GCPT 12-6	1069031.297	516650.636	478.965	6,378	23.1	455.9	No						-	NA	NA	NA	NA	NA

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													Downhole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium
GCPT 13-1	1069279.353	516642.002	470.898	28,302	15.4	455.5	Yes	15	455.9	16.3	454.6	1.3	X	NA	NA	NA	NA	NA
GCPT 13-2	1069258.075	516646.324	471.546	2,490	0.8	470.7	No						-	NA	NA	NA	NA	NA
GCPT 13-2A	1069256.406	516650.406	471.769	3,162	1.6	470.2	No						-	NA	NA	NA	NA	NA
GCPT 13-3	1069242.473	516658.268	472.195	2,520	1.3	470.9	No						-	NA	NA	NA	NA	NA
GCPT 13-4	1069194.628	516676.493	474.034	BKGD			No						-	NA	NA	NA	NA	NA
GCPT 13-4S	1069195.799	516675.988	474.100	6,120	36.6	437.5	No						-	NA	NA	NA	NA	NA
GCPT 13-5	1069148.378	516695.025	475.365	1,872	0.3	475.1	No						-	NA	NA	NA	NA	NA
GCPT 13-5S	1069148.524	516697.133	475.500	5,682	11.5	464.0	No						-	NA	NA	NA	NA	NA
GCPT 13-6	1069094.279	516722.059	475.910	5,802	3.4	472.5	No						-	NA	NA	NA	NA	NA
GCPT 13-6S	1069094.328	516722.082	476.000	6,552	23.8	452.2	No						-	NA	NA	NA	NA	NA
GCPT 13-7	1069028.275	516764.522	474.263	5,964	1.6	472.7	No						-	NA	NA	NA	NA	NA
GCPT 13-7S	1069028.451	516763.208	474.200	6,366	20.8	453.4	No						-	NA	NA	NA	NA	NA
GCPT 14-1	1069289.841	516676.946	474.151	29,640	18.9	455.3	Yes	18.3	455.9	19.6	454.6	1.3	X	NA	NA	NA	NA	NA
GCPT 14-2	1069248.776	516702.985	474.471	3,600	1.1	473.4	No						-	NA	NA	NA	NA	NA
GCPT 14-3	1069218.180	516720.735	473.680	BKGD			No						-	NA	NA	NA	NA	NA
GCPT 14-3S	1069218.942	516719.904	473.700	6,708	36.6	437.1	No						-	NA	NA	NA	NA	NA
GCPT 14-4	1069177.042	516745.043	474.597	BKGD			No						-	NA	NA	NA	NA	NA
GCPT 14-5	1069125.940	516777.935	473.330	5,772	1.6	471.7	No						-	NA	NA	NA	NA	NA
GCPT 14-5S	1069125.781	516777.333	473.300	5,880	15.4	457.9	No						-	NA	NA	NA	NA	NA
GCPT 14-6	1069077.338	516811.126	472.680	6,654	7.4	465.3	No						-	NA	NA	NA	NA	NA
GCPT 14-6S	1069077.339	516809.484	472.800	6,330	14.9	457.9	No						-	NA	NA	NA	NA	NA
GCPT 14-7	1069029.001	516850.785	473.149	1,338	0.2	472.9	No						-	NA	NA	NA	NA	NA
GCPT 15-1	1069362.505	516757.424	453.830	11,940	20.3	433.5	No						-	NA	NA	NA	NA	NA
GCPT 15-2	1069277.200	516767.371	477.333	3,222	1.6	475.7	No						-	NA	NA	NA	NA	NA
GCPT 15-3	1069247.590	516788.341	473.986	9,828	30.5	443.5	No						-	NA	NA	NA	NA	NA
GCPT 15-4	1069209.876	516811.939	473.090	8,400	29.4	443.7	No						-	NA	NA	NA	NA	NA
GCPT 15-5	1069166.487	516848.251	469.170	7,098	57.7	411.5	No						-	NA	NA	NA	NA	NA
GCPT 15-6	1069125.130	516878.774	468.775	7,098	2.6	466.2	No						-	NA	NA	NA	NA	NA
GCPT 15-7	1069083.743	516906.231	472.113	6,444	2.5	469.6	No						-	NA	NA	NA	NA	NA
GCPT 15-8	1069045.994	516931.453	473.775	8,724	2.3	471.5	No						-	NA	NA	NA	NA	NA
GCPT 16-1	1069393.686	516784.741	451.150	9,228	7.2	444.0	No						-	NA	NA	NA	NA	NA
GCPT 16-2	1069364.966	516787.054	453.091	6,948	1.8	451.3	No						-	NA	NA	NA	NA	NA
GCPT 16-3	1069262.220	516837.666	471.257	6,744	2.3	469.0	No						-	NA	NA	NA	NA	NA
GCPT 16-4	1069234.210	516866.371	472.459	7,446	3	469.5	No						-	NA	NA	NA	NA	NA
GCPT 16-5	1069196.904	516903.898	474.011	6,864	4.8	469.2	No						-	NA	NA	NA	NA	NA
GCPT 16-6	1069158.015	516935.268	476.777	6,600	13.6	463.2	No						-	NA	NA	NA	NA	NA
GCPT 16-7	1069114.104	516970.890	479.817	6,414	2.6	477.2	No						-	NA	NA	NA	NA	NA
GCPT 16-8	1069073.911	517002.539	481.927	6,648	20.7	461.2	No						-	NA	NA	NA	NA	NA
Phase 1C (2014)																		
GCPT 1C-1	1068771.644	515837.945	463.703	5,256	3	460.7	No						-	NA	NA	NA	NA	NA
GCPT 1C-1A	1068766.648	515841.442	463.588	5,988	3.1	460.5	No						-	NA	NA	NA	NA	NA
GCPT 1C-2	1068737.758	515904.377	472.318	BKGD			No						-	NA	NA	NA	NA	NA
GCPT 1C-2R	1068733.913	515907.223	472.500	31,290	30.3	442.2	Yes	29.6	442.9	32	440.5	2.4	X	NA	NA	NA	NA	NA
GCPT 1C-3	1068778.999	515991.398	486.422	6,576	22	464.4	No						-	NA	NA	NA	NA	NA
GCPT 1C-4	1068832.903	516068.813	486.098	1,851	27.7		No						-	NA	NA	NA	NA	NA
GPCT 1C-4R	1068835.119	516070.919	486.000	22,638	43.8	442.2	Yes	43.4	442.6	44	442.0	0.6	X	NA	NA	NA	NA	NA
GCPT 1C-5	1068986.634	516413.538	478.999	BKGD			No						-	NA	NA	NA	NA	NA
GCPT 1C-5A	1068986.634	516413.538	478.999	6,516	15.1	463.9	No						-	NA	NA	NA	NA	NA

Table 2-1: Summary of Occurrences of Radiologically-Impacted Material (RIM) in Area 1

Boring	Northing	Easting	Ground Surface Elevation (ft amsl)	Maximum Gamma Value (cpm)	Depth to Maximum Gamma (ft)	Elevation of Maximum Gamma (ft amsl)	RIM Present ?	Depth to Top of RIM Interval (ft)	Elevation Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval					
													Downhole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium
GCPT 1C-6	1068691.769	515934.812	468.800	84,810	22.1	446.7	Yes	21.4	447.4	23.2	445.6	1.8	X	NA	NA	NA	NA	NA
GCPT 1C-6T	1068685.948	515938.701	468.900	90,390	22.8	446.1	Yes	22	446.9	24	444.9	2.0	X	NA	NA	NA	NA	NA
GCPT 1C-6T1	1068684.148	515939.610	468.900	171,774	23.5	445.4	Yes	22.5	446.4	23.6	445.3	1.1	X	NA	NA	NA	NA	NA
GCPT 1C-7	1068646.890	515958.200	468.599	6,978	4.3	464.3	No						-	NA	NA	NA	NA	NA
GCPT 1C-8	1068728.323	516014.864	491.227	6,144	3	488.2	No						-	NA	NA	NA	NA	NA
GCPT 1C-9	1068746.456	516049.886	495.235	6,360	10.4	484.8	No						-	NA	NA	NA	NA	NA
GCPT 1C-10	1068797.838	516095.938	496.493	6,276	11.8	484.7	No						-	NA	NA	NA	NA	NA
GCPT 1C-11	1068838.882	516151.875	496.895	6,516	3	493.9	No						-	NA	NA	NA	NA	NA
GCPT 1C-12	1068865.907	516200.860	500.100	57,414	56.3	443.8	Yes	55.7	444.4	57	443.1	1.3	X	NA	NA	NA	NA	NA
GCPT 1C-13	1068982.241	516321.892	480.072	6,438	34.1	446.0	No						-	NA	NA	NA	NA	NA
GCPT-108	1069142.077	516388.988	470.448	6,408	2	468.4	No						-	NA	NA	NA	NA	NA
GCPT-111A	1069183.707	516592.402	475.656	9,564	25.9	449.8	No						-	NA	NA	NA	NA	NA
GCPT-119	1069021.032	516294.161	478.577	14,616	45.6	433.0	No						-	NA	NA	NA	NA	NA
GCPT-28A	1069253.583	516490.663	480.478	82,512	24.9	455.6	Yes	24.2	456.3	25.6	454.9	1.4	X	NA	NA	NA	NA	NA
GCPT-36	1069217.918	516193.669	464.969	19,470	8.5	456.5	Yes	7.8	457.2	8.8	456.2	1.0	X	NA	NA	NA	NA	NA
GCPT-25	1069345.436	516405.360	465.274	74,880	8.4	456.9	Yes	7.3	458.0	9.8	455.5	2.5	X	NA	NA	NA	NA	NA
PVC-25R	1069345.436	516405.360	465.300	74,562	9.5	455.8	Yes	8.3	457.0	10.9	454.4	2.6	X	NA	NA	NA	NA	NA
1-2	1068783.142	515878.536	472.600	4,271	33	439.6	No						-	-	NA	-	-	-
2-2	1068876.813	515926.163	475.200	4,354	32	443.2	No						-	-	NA	-	-	-
5-3	1068986.832	516093.839	474.400	336,937	29.5	444.9	Yes	26	448.4	34	440.4	8.0	X	X	NA	X	X	X
5-3	1068986.832	516093.839	474.400	44,163	51.5	422.9	Yes	49	425.4	53?	421.4?	4?	X	-	NA	-	-	-
8-1	1069041.228	516368.555	479.800	4,821	28	451.8	No						-	-	NA	-	-	-
12-5	1069087.130	516641.299	478.900	3,864	14	464.9	No						-	-	NA	-	-	-
13-3	1069232.054	516662.275	472.600	3,607	16.5	456.1	No						-	-	NA	-	-	-
13-6	1069093.452	516723.784	475.900	3,902	24.5	451.4	No						-	-	NA	-	-	-
14-2	1069250.965	516701.546	474.600	4,008	27.5	447.1	No						-	-	NA	-	-	-
14-4	1069179.619	516743.234	474.400	3,888	9	465.4	No						-	-	NA	-	-	-
14-5	1069122.899	516777.908	472.900	3,454	13.5	459.4	No						-	-	NA	-	-	-
14-7	1069027.735	516848.642	473.300	3,637	31.5	441.8	No						-	-	NA	-	-	-
15-2	1069281.151	516768.917	476.500	5,184	26	450.5	Yes	22	454.5	27	449.5	5.0	-	-	NA	-	X	-
16-3	1069267.110	516837.299	470.700	4,118	20	450.7	No						-	-	NA	-	-	-
16-6	1069155.378	516938.746	477.100	3,841	14	463.1	No						-	-	NA	-	-	-
1C-6	1068688.971	515936.009	469.200	53,732	22.5	446.7	Yes	20	449.2	27	442.2	7.0	X	-	NA	X	X	-
WL-119	1069017.400	516296.369	479.200	7,941	32.5	446.7	Yes	31.5	447.7	33	446.2	1.5	X	-	NA	-	-	-
1-2-Geoprobe	1068779.843	515869.22	472.859	NA			No						NA	NA	NA	-	-	-
2-2-Geoprobe	1068870.734	515929.287	475.250	NA			Yes	30	445.250	34	441.250	4.0	NA	NA	NA	X	X	-
2-3-Geoprobe	1068815.973	515943.908	476.459	NA			Yes	33	443.459	38	438.459	5.0	NA	NA	NA	X	X	-
8-1B-Geoprobe	1069041.054	516363.853	479.703	NA			No						NA	NA	NA	-	-	-
1C-12-Geoprobe	1068867.887	516204.389	500.064	NA			No						NA	NA	NA	-	-	-
1C-12B-Geoprobe	1068863.729	516197.682	499.723	NA			Yes	54	445.723	56	443.723	2.0	NA	NA	NA	-	X	-
1C-12C-Geoprobe	1068862.939	516203.039	500.161	NA			Yes	53	447.161	58	442.161	5.0	NA	NA	NA	X	X	-
1C-2RA-Geoprobe	1068730.068	515908.919	472.398	NA			No						NA	NA	NA	-	-	-
1C-4R-Geoprobe	1068835.529	516073.369	486.107	NA			No						NA	NA	NA	-	-	-
1C-4RB-Geoprobe	1068837.644	516076.741	485.970	NA			No						NA	NA	NA	-	-	-
1C-6T1-Geoprobe	1068681.573	515937.074	468.930	NA			No						NA	NA	NA	-	-	-
WL-119-Geoprobe	1069018.294	516291.964	478.594	NA			No						NA	NA	NA	-	-	-
WL-119B-Geoprobe	1069013.907	516287.796	479.244	NA			No						NA	NA	NA	-	-	-

Table 2-1: Summary of Occurrences of Radiologically-Impacted Material (RIM) in Area 1

Boring	Northing	Easting	Ground Surface Elevation (ft amsl)	Maximum Gamma Value (cpm)	Depth to Maximum Gamma (ft)	Elevation of Maximum Gamma (ft amsl)	RIM Present ?	Depth to Top of RIM Interval (ft)	Elevation Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval					
													Downhole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium
WL-119C-Geoprobe	1069012.752	516291.905	479.148	NA			No						NA	NA	NA	-	-	-
Phase 1D (2015)																		
1D-1	1069085.157	515745.035	462.487	6,288	8.9	453.6	No						-	NA	NA	NA	NA	NA
1D-2	1068999.089	515778.193	468.382	5,142	5.9	462.5	No						-	NA	NA	NA	NA	NA
1D-3	1068972.272	515874.232	472.064	390,720	27.4	444.7	Yes	25.5	446.6	29.5	442.6	4.0	X	NA	NA	NA	NA	NA
1D-4	1068794.546	516092.056	496.410	14,154	55.8	440.6	No						-	NA	NA	NA	NA	NA
1D-5	1068649.773	516043.497	487.632	143,724	55.1	432.5	Yes	54.1	433.5	56.2	431.4	2.1	X	NA	NA	NA	NA	NA
1D-6	1068727.516	516153.004	512.509	6,834	3.9	508.6	No						-	NA	NA	NA	NA	NA
1D-7	1068647.213	516155.853	512.790	775,560	82.8	430.0	Yes	80.2	432.6	85.5	427.3	5.3	X	NA	NA	NA	NA	NA
1D-8	1068818.180	516243.565	517.157	44,028	75.3	441.9	Yes	74.7	442.5	75.6	441.6	0.9	X	NA	NA	NA	NA	NA
1D-8A	1068820.740	516250.571	517.322	6,318	2.6	514.7	No						-	NA	NA	NA	NA	NA
1D-9	1068667.863	516221.690	518.577	13,236	58.6	460.0	No						-	NA	NA	NA	NA	NA
1D-9A	1068662.945	516220.860	518.595	14,508	56.8	461.8	No						-	NA	NA	NA	NA	NA
1D-10	1068897.481	516306.812	503.702	7,554	38.9	464.8	No						-	NA	NA	NA	NA	NA
1D-11	1068732.965	516319.191	522.966	5,970	1.8	521.2	No						-	NA	NA	NA	NA	NA
1D-11A	1068728.093	516324.559	522.829	6,648	1.6	521.2	No						-	NA	NA	NA	NA	NA
1D-12	1068878.274	516446.247	505.566	6,054	29.4	476.2	No						-	NA	NA	NA	NA	NA
1D-13	1068807.791	516405.192	520.176	7,980	36.4	483.8	No						-	NA	NA	NA	NA	NA
1D-13A	1068807.910	516397.463	520.165	5,934	2.1	518.1	No						-	NA	NA	NA	NA	NA
1D-13B	1068807.560	516392.053	520.392	5,964	7.1	513.3	No						-	NA	NA	NA	NA	NA
1D-13C	1068808.169	516414.237	519.931	6,432	2.5	517.4	No						-	NA	NA	NA	NA	NA
1D-14	1068737.296	516389.489	522.027	5,952	2.5	519.5	No						-	NA	NA	NA	NA	NA
1D-15	1068600.173	516194.976	516.672	16,194	89.6	427.1	Yes	89.4	427.3	89.7	427.0	0.3	X	NA	NA	NA	NA	NA
1D-16	1068604.580	516049.511	484.823	68,700	46.9	437.9	Yes	46	438.8	48	436.8	2.0	X	NA	NA	NA	NA	NA
1D-16A	1068611.344	516048.677	485.168	17,712	49.9	435.3	Yes	49.7	435.5	49.9	435.3	0.2	X	NA	NA	NA	NA	NA
1D-17	1068872.427	515830.991	472.494	4,938	4.1	468.4	No						-	NA	NA	NA	NA	NA
1D-17A	1068870.009	515836.352	472.546	5,496	17.7	454.8	No						-	NA	NA	NA	NA	NA
1D-18	1068551.103	516059.874	480.990	7,224	10.2	470.8	No						-	NA	NA	NA	NA	NA
1D-18A	1068545.369	516060.390	480.524	6,984	41.3	439.2	No						-	NA	NA	NA	NA	NA
1D-1S	1069074.230	515747.359	462.568	3,382	6.5	456.1	No						-	-	-	-	-	-
1D-2S	1068990.154	515784.257	468.561	4,001	19.5	449.1	No						-	-	-	-	-	-
1D-3S	1068968.601	515882.929	472.250	204,471	27	445.3	Yes	23	449.3	31	441.3	8.0	X	X	X	X	X	-
1D-4S	1068804.861	516101.296	496.422	4,349	12.5	483.9	No						-	-	-	-	-	-
1D-5S	1068657.730	516040.319	487.751	12,059	53	434.8	Yes	51	436.8	56	431.8	5.0	X	X	X	X	X	-
1D-6S	1068732.994	516160.954	512.707	3,749	11	501.7	No						-	-	-	-	-	-
1D-7S	1068653.591	516157.910	513.346	1,503,082	82.5	430.8	Yes	76	437.3	93	420.3	17.0	X	X	X	X	X	-
1D-8S	1068810.599	516238.029	516.742	6,869	73	443.7	Yes	72	444.7	74	442.7	2.0	X	-	-	-	-	-
1D-9S	1068678.246	516223.760	518.893	16,313	71.5	447.4	Yes	70	448.9	72.5	446.4	2.5	X	-	-	-	-	-
1D-9S	1068678.246	516223.760	518.893	1,174,844	87.5	431.4	Yes	82	436.9	96	422.9	14.0	X	X	X	X	X	-
1D-10S	1068898.786	516318.538	503.074	3,942	37.5	465.6	No						-	-	-	-	-	-
1D-11S	1068739.042	516311.220	522.303	16,554	84	438.3	Yes	82	440.3	86	436.3	4.0	X	X	X	X	X	-
1D-12S	1068880.804	516434.947	505.890	4,173	29.5	476.4	No						-	-	-	-	-	-
1D-13S	1068786.080	516399.333	520.512	4,304	42	478.5	No						-	-	-	-	-	-
1D-14S	1068730.267	516381.884	522.532	4,010	43.5	479.0	No						-	-	-	-	-	-
1D-15S	1068611.681	516196.257	516.098	20,523	85	431.1	Yes	83.5	432.6	86	430.1	2.5	X	X	X	X	X	-
1D-16S	1068620.165	516047.598	485.581	11,886	50	435.6	Yes	49.5	436.1	51.5	434.1	2.0	X	X	X	X	X	-
1D-17S	1068865.421	515846.051	472.920	3,650	16	456.9	No						-	-	-	-	-	-
1D-18S	1068573.847	516056.126	482.022	4,480	48.5	433.5	No						-	-	-	-	-	-

Table 2-1: Summary of Occurrences of Radiologically-Impacted Material (RIM) in Area 1

Boring	Northing	Easting	Ground Surface Elevation (ft amsl)	Maximum Gamma Value (cpm)	Depth to Maximum Gamma (ft)	Elevation of Maximum Gamma (ft amsl)	RIM Present ?	Depth to Top of RIM Interval (ft)	Elevation Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval: Downhole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium
1D-19S	1068620.714	516259.114	521.112	3,437	44	477.1	No						-	-	-	-	-	-
1D-20S	1068540.263	516226.617	517.696	1,576	2.5	515.2	No						-	-	-	-	-	-
Area 1 - Additional Characterization (2015)																		
AC-1a	1069120.740	516017.324	466.725	824,868	10.5	456.2	Yes	4.5	462.2	22	444.7	17.5	X	X	X	X	X	X
AC-1b	1069120.740	516017.324	466.725	3,686	29.0	437.7	Yes	29	437.7	32	434.7	3.0	-	X	X	X	X	-
AC-1c	1069120.740	516017.324	466.725	20,364	38.5	428.2	Yes	35	431.7	41	425.7	6.0	X	-	-	-	-	-
AC-2Ba	1069151.417	515831.894	466.165	7,931	4.5	461.7	Yes	2	464.2	6.5	459.7	4.5	X	-	-	-	-	-
AC-2Bb	1069151.417	515831.894	466.165	15,570	10.0	456.2	Yes	9.5	456.7	13.5	452.7	4.0	X	X	X	X	X	-
AC-3a	1069183.583	516040.675	466.425	906,839	4.0	462.4	Yes	0	466.4	19	447.4	19.0	X	X	X	X	X	X
AC-3b	1069183.583	516040.675	466.425	46,921	38.5	427.9	Yes	32.5	433.9	39.5	426.9	7.0	X	-	-	-	-	-
AC-4B	1069555.665	516492.941	464.661	5,114	5.0	459.7	No						-	-	-	-	-	-
AC-5	1069483.755	516657.795	451.372	4,656	12.5	438.9	No						-	-	-	-	-	-
AC-6	1069420.320	516222.713	464.254	4,857	26.0	438.3	No						-	-	-	-	-	-
AC-7	1069315.677	516025.425	461.529	24,727	2.5	459.0	Yes	0.5	461.0	5	456.5	4.5	X	-	-	-	-	-
Cotter (2015)																		
WL-102-CT	1069271.265	515974.528	461.697	4,379	3.0	458.7	No						-	-	X	-	-	-
WL-106A-CT	1069300.779	516090.264	463.803	27,546	4.5	459.3	Yes	2	461.8	12	451.8	10.0	X	X	X	X	X	-
WL-114-CT	1069381.076	516352.442	467.381	5,669	5.0	462.4	Yes	2	465.4	6	461.4	4.0	-	X	-	-	-	-

amsl = above mean sea level cpm = counts per minute

Notes: NA - Data were not collected or are otherwise not available.

X - Data support the presence of RIM in the indicated interval

'- Data do not indicate the presence of RIM at this location/interval

Table 2-2: Summary of Occurrences of Radiologically-Impacted Material (RIM) in Area 2

Boring	Northing	Easting	Ground Surface Elevation (ft amsl)	Maximum Gamma Value (cpm)	Depth to Maximum Gamma (ft)	Elevation of Maximum Gamma (ft amsl)	RIM Present ?	Depth to Top of RIM Interval (ft)	Elevation Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval: Downhole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium
NRC (1981)																		
PVC-4	1070516.46	514691.78	469.91	1,290,000	1	468.91	Yes	0	469.91	5.5	464.41	5.5	X	NA	NA	X	NA	X
PVC-4	1070516.46	514691.78	469.91	14,000	11.5	458.41	Yes	11	458.91	13	456.91	2	X	NA	NA	-	NA	NA
PVC-5	1070548.99	514548.01	464.99	15,000	5.5	459.49	Yes	1	463.99	7	457.99	6	X	NA	NA	-	NA	NA
PVC-5	1070548.99	514548.01	464.99	14,000	11.5	453.49	Yes	9.5	455.49	14.5	450.49	5	X	NA	NA	-	NA	NA
PVC-6	1070626.94	514760.76	466.08	367,000	11	455.08	Yes	0	466.08	16	450.08	16	X	NA	NA	X	NA	-
PVC-6	1070626.94	514760.76	466.08	23,000	20.5	445.58	Yes	19	447.08	22.5	443.58	3.5	X	NA	NA	NA	NA	NA
PVC-7	1070484.08	514749.72	470.99	1,386,000	2	468.99	Yes	0	470.99	7	463.99	7	X	NA	NA	NA	NA	NA
PVC-7	1070484.08	514749.72	470.99	22,000	19.5	451.49	Yes	17	453.99	22	448.99	5	X	NA	NA	NA	NA	NA
PVC-8	1070343.56	514871.72	471.41	24,000	0.5	470.91	Yes	0	471.41	1.5	469.91	1.5	X	NA	NA	-	NA	NA
PVC-9	1070386.31	515127.48	470.92	22,000	5	465.92	Yes	1	469.92	6.5	464.42	5.5	X	NA	NA	X	NA	-
PVC-10	1069916.35	514518.86	473.75	752,000	3	470.75	Yes	0	473.75	7	466.75	7	X	NA	NA	X	NA	NA
PVC-10	1069916.35	514518.86	473.75	152,000	9.5	464.25	Yes	7	466.75	13	460.75	6	X	NA	NA	X	NA	X
PVC-11B	1069844.18	514456.61	475.87	2,144,000	3	472.87	Yes	0	475.87	10.5	465.37	10.5	X	NA	NA	X	NA	X
PVC-12	1070528.68	515176.76	468.32	58,000	2.5	465.82	Yes	0.5	467.82	5.5	462.82	5	X	NA	NA	NA	NA	NA
PVC-13	1070515.37	514386.08	464.45	6,000	No peak	None	No	None	None	None	None	None	-	NA	NA	NA	NA	NA
PVC-18	1070300.94	514677.19	470.72	6,000	No peak	None	No	None	None	None	None	None	-	NA	NA	-	NA	NA
PVC-19	1070599.18	514961.49	469.55	332,000	8	461.55	Yes	6	463.55	10.5	459.05	4.5	X	NA	NA	X	NA	-
PVC-20	1070750.51	514806.92	466.65	127,000	1.5	465.15	Yes	0	466.65	4	462.65	4	X	NA	NA	X	NA	NA
PVC-33	1070857.78	514810.78	466.31	10,000	2.5	463.81	Yes	1.5	464.81	3.5	462.81	2	X	NA	NA	NA	NA	NA
PVC-34	1070742.95	514647.99	463.31	22,000	1	462.31	Yes	0	463.31	3	460.31	3	X	NA	NA	NA	NA	NA
PVC-35	1070722.28	515029.87	467.11	745,000	4	463.11	Yes	0.5	466.61	8	459.11	7.5	X	NA	NA	NA	NA	NA
PVC-39	1070540.52	515388.6	466.67	14,000	2.5	464.17	Yes	1.5	465.17	4	462.67	2.5	X	NA	NA	NA	NA	NA
PVC-40	1070639.64	515256.1	467.09	120,000	2.5	464.59	Yes	0.5	466.59	5	462.09	4.5	X	NA	NA	NA	NA	NA
PVC-40	1070639.64	515256.1	467.09	46,000	7	460.09	Yes	6	461.09	9	458.09	3	X	NA	NA	NA	NA	NA
NRC-2	1069760.3	514524.439	482.25	11,000	16	466.25	Yes	15	467.25	18	464.25	3	X	NA	NA	NA	NA	NA
NRC-3	1070125.45	514647.91	476	> 50,000	0	476	Yes	0	476	3	473	3	X	NA	NA	NA	NA	NA
NRC-16	1069680.96	514630.204	485.5	> 50,000	11	474.5	Yes	0	485.5	19 +	< 466.5	19 +	X	NA	NA	NA	NA	NA
NRC-17	1069551.8	514684.924	487.5	3,000	20	467.5	Yes	20	467.5	21	466.5	1	X	NA	NA	NA	NA	NA
NRC-21	1069806.61	514696.505	474	14,000	0	474	Yes	0	474	2	472	2	X	NA	NA	NA	NA	NA
NRC-21	1069806.61	514696.505	474	> 50,000	6	468	Yes	5	469	12	462	7	X	NA	NA	NA	NA	NA
NRC-21	1069806.61	514696.505	474	10,000	15	459	Yes	14	460	16	458	2	X	NA	NA	NA	NA	NA
NRC-22	1069582.39	514524.142	486.5	13,000	1	485.5	Yes	0	486.5	2	484.5	2	X	NA	NA	NA	NA	NA
NRC-22	1069582.39	514524.142	486.5	9,000	15	471.5	Yes	8	478.5	17	469.5	9	X	NA	NA	NA	NA	NA
NRC-22	1069582.39	514524.142	486.5	> 50,000	23	463.5	Yes	18	468.5	25 +	< 461.5	7 +	X	NA	NA	NA	NA	NA
NRC-30	1069518.48	514458.816	482.25	1,200	15	467.25	No	None	None	None	None	None	-	NA	NA	NA	NA	NA
NRC-31	1069476.62	514588.473	491	1,500	4	487	No	None	None	None	None	None	-	NA	NA	NA	NA	NA
NRC-32	1069898.79	514796.564	473	> 50,000	1	472	Yes	0	473	2	471	2	X	NA	NA	NA	NA	NA
McLaren/Hart RI (1995)																		
WL-207	1070743.05	514299.87	444.5	6,000	No peak	None	No	None	None	None	None	None	-	NA	NA	-	-	-
WL-208	1070141.19	514752.42	474.8	12,000	No peak	None	Yes	0	474.8	10	464.8	10	-	NA	NA	-	X	-
WL-209	1070492.55	514686.34	467.4	744,000	0	467.4	Yes	0	467.4	11	456.4	11	X	NA	NA	X	X	X
WL-209	1070492.55	514686.34	467.4	6,000	No peak	None	Yes	24	443.4	26	441.4	2	-	NA	NA	-	X	-
WL-210	1069775.15	514811.55	477.8	509,000	0	477.8	Yes	0	477.8	16.5	461.3	16.5	X	NA	NA	X	X	X
WL-210	1069775.15	514811.55	477.8	88,000	47.5	430.3	Yes	39	438.8	49.5	428.3	10.5	X	NA	NA	-	X	-
WL-211	1070046.08	514684.07	475.3	330,000	0.75	474.55	Yes	0	475.3	13	462.3	13	X	NA	NA	X	X	-
WL-212	1070025.86	514973.26	472.9	6,000	No peak	None	Yes	8	464.9	12	460.9	4	-	NA	NA	-	X	-
WL-213	1070223.38	514947.61	472.3	6,000	No peak	None	Yes	0	472.3	6	466.3	6	-	NA	NA	-	X	-
WL-214	1070206.86	515241.19	468.5	6,000	No peak	None	Yes	4	464.5	6	462.5	2	-	NA	NA	-	X	-
WL-214	1070206.86	515241.19	468.5	6,000	No peak	None	Yes	24	444.5	26	442.5	2	-	NA	NA	-	X	-
WL-215	1070432.01	515259.72	470	Not logged	NA	NA	No	NA	NA	NA	NA	NA	NA	NA	NA	-	-	-
WL-216A	1069836.29	514936.08	477.4	24,000	3.5	473.9	Yes	0	477.4	10	467.4	10	X	NA	NA	X	X	-
WL-216B	1069827.87	514931.35	477.5	6,000	No peak	None	No	None	None	None	None	None	-	NA	NA	-	-	-
WL-216C	1069819.16	514925.06	477.6	48,000	3.5	474.1	Yes	0	477.6	8	469.6	8	X	NA	NA	NA	NA	NA
WL-217	1069961.3	515082.21	474.7	6,000	No peak	None	Yes	9	465.7	11	463.7	2	-	NA	NA	-	X	-
WL-218	1069462.69	514839.09	489.7	6,000	No peak	None	No	None	None	None	None	None	-	NA	NA	-	-	-
WL-219	1069142.47	514545.63	496.7	6,000	No peak	None	No	None	None	None	None	None	-	NA	NA	-	-	-
WL-220	1069258.11	514733.38	503.9	6,000	No peak	None	No	None	None	None	None	None	-	NA	NA	-	-	-
WL-221	1070567.35	514459.37	462.3	6,000	No peak	None	No	None	None	None	None	None	-	NA	NA	-	-	-
WL-222	1070799.38	514618.74	457.8	6,000	No peak	None	Yes	0	457.8	7	450.8	7	-	NA	NA	-	X	-

Table 2-2: Summary of Occurrences of Radiologically-Impacted Material (RIM) in Area 2

Boring	Northing	Easting	Ground Surface Elevation (ft amsl)	Maximum Gamma Value (cpm)	Depth to Maximum Gamma (ft)	Elevation of Maximum Gamma (ft amsl)	RIM Present ?	Depth to Top of RIM Interval (ft)	Elevation Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval					
													Downhole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium
WL-223	1070745.71	514734.14	462.2	15,000	4	458.2	Yes	1	461.2	7.5	454.7	6.5	X	NA	NA	-	X	-
WL-224	1070485.74	515601.73	468.4	6,000	No peak	None	No	None	None	None	None	None	-	NA	NA	-	-	-
WL-225	1070576.93	515632.66	468.2	6,000	No peak	None	No	None	None	None	None	None	-	NA	NA	-	-	-
WL-226	1070536.03	514992.1	467.5	370,000	10.5	457	Yes	0	467.5	22	445.5	22	X	NA	NA	-	X	-
WL-227	1070685.99	515258.39	462	8,000	No peak	None	Yes	4	458	6	456	2	-	NA	NA	-	X	-
WL-228	1071044.35	514724.16	441.6	6,000	No peak	None	No	None	None	None	None	None	-	NA	NA	-	-	-
WL-229	1069329.26	514268.59	448.5	6,000	No peak	None	No	None	None	None	None	None	-	NA	NA	-	-	-
WL-230	1070716.09	515139.66	463.3	10,000	1.5	461.8	Yes	0	463.3	6	457.3	6	X	NA	NA	-	X	-
WL-231	1070850.73	515007.27	464.8	29,000	5.5	459.3	Yes	3	461.8	11	453.8	8	X	NA	NA	-	X	-
WL-233	1069542.4	514609.19	489.2	90,000	22	467.2	Yes	17	472.2	31	458.2	14	X	NA	NA	-	X	-
WL-234	1069757.62	514428.12	480	1,104,000	7	473	Yes	0	480	21	459	21	X	NA	NA	X	X	X
WL-235	1069615.23	514418.87	481.1	6,000	No peak	None	Yes	0	481.1	1	480.1	1	-	NA	NA	-	X	-
WL-235	1069615.23	514418.87	481.1	20,000	22.5	458.6	Yes	20.5	460.6	24.5	456.6	4	X	NA	NA	-	-	-
WL-236	1069399.29	514384.13	484.3	6,000	No peak	None	No	None	None	None	None	None	-	NA	NA	-	-	-
WL-237	1070069.42	515161.88	473.9	6,000	No peak	None	No	None	None	None	None	None	-	NA	NA	NA	NA	NA
WL-238	1070705.96	514916.28	466.2	130,000	6	460.2	Yes	1	465.2	10.5	455.7	9.5	X	NA	NA	NA	NA	NA
WL-239	1070921.77	514829.72	458.9	6,000	No peak	None	No	None	None	None	None	None	-	NA	NA	-	-	-
WL-240	1070320.97	515315.69	468.5	6,000	No peak	None	No	None	None	None	None	None	-	NA	NA	NA	NA	NA
WL-241	1070319.84	515100.73	469.6	46,000	5.5	464.1	Yes	1	468.6	9.5	460.1	8.5	X	NA	NA	X	X	-
WL-242	1070836.39	515098.99	NA	Not logged	NA	NA	Yes	0	NA	3	NA	3	NA	NA	NA	-	X	-
WL-243	1070860.46	515113.42	NA	Not logged	NA	NA	Yes	0	NA	2	NA	2	NA	NA	NA	-	X	-
WL-244	1070946.92	515215.29	NA	Not logged	NA	NA	Yes	0	NA	1	NA	1	NA	NA	NA	-	X	-
WL-245	1070976.4	515093.24	NA	Not logged	NA	NA	No	None	None	None	None	None	NA	NA	NA	-	-	-
WL-246	1071018.3	515193.17	NA	Not logged	NA	NA	No	None	None	None	None	None	NA	NA	NA	-	-	-
Area 2 - Additional Characterization (2015)																		
AC-8	1069429.27	514606.086	490.616	3,917	51	439.616	No	None	None	None	None	None	-	-	-	-	-	-
AC-9	1069593.07	514302.64	469.194	3,785	31	438.194	No	None	None	None	None	None	-	-	-	-	-	-
AC-10	1070422.82	514642.616	467.676	3,423	3	464.676	Yes	11	456.676	14	453.676	3	-	-	-	-	X	-
AC-11	1070423.22	514437.378	462.965	3,413	2	460.965	No	NA	NA	NA	NA	NA	-	-	-	-	-	-
AC-12	1070680.1	514526.364	459.587	3,577	2.5	457.087	Yes	1	458.587	5	454.587	4	X	X	-	-	X	-
AC-13	1070614.43	514865.994	468.089	500,239	18	450.089	Yes	14	454.089	24	444.089	10	X	X	X	X	X	-
AC-14	1070798.35	515338.175	457.834	3,847	22	435.834	No	None	None	None	None	None	-	-	-	-	-	-
AC-15	1070703.03	515525.938	457.237	3,803	11.5	445.737	No	None	None	None	None	None	-	-	-	-	-	-
AC-16	1070482.01	515440.258	468.212	443,815	18	450.212	Yes	10	458.212	30	438.212	20	X	X	X	X	X	X
AC-17	1070259.66	515183.215	471.311	3,519	9	462.311	No	None	None	None	None	None	-	-	-	-	-	-
AC-18	1070438.51	514922.137	469.529	259,236	2	467.529	Yes	0	469.529	15	454.529	15	X	X	X	X	X	X
AC-19	1069959.2	514772.616	477.185	214,732	2.5	474.685	Yes	0	477.185	14	463.185	14	X	X	X	X	X	X
AC-20	1069664.02	514960.169	488.976	402,171	21.5	467.476	Yes	19	469.976	29	459.976	10	X	X	X	X	X	X
AC-21	1069642.25	514760.309	477.569	272,024	10.5	467.069	Yes	8	469.569	33	444.569	25	X	X	X	X	X	X
AC-21A	1069646.97	514754.423	477.393	338,865	12	465.393	Yes	6	471.393	17	460.393	11	X	X	X	X	X	X
AC-22	1069738.46	514617.507	483.275	45,675	18	465.275	Yes	16	467.275	20	463.275	4	X	X	X	X	X	-
AC-23	1069568.41	514618.063	486.548	200,376	22	464.548	Yes	17	469.548	29	457.548	12	X	X	X	X	X	X
AC-24	1069783.77	514810.651	477.384	470,901	2	475.384	Yes	0	477.384	17	460.384	17	X	X	X	X	X	X
AC-24	1069783.77	514810.651	477.384	40,193	44.5	432.884	Yes	42.5	434.884	46	431.384	3.5	X	-	-	NA	NA	NA
AC-25	1069622.81	514420.771	479.445	19,802	21	458.445	Yes	20	459.445	22.5	456.945	2.5	X	-	-	NA	NA	NA
AC-26A	1069548.81	515122.279	473.186	15,245	3.5	469.686	Yes	2.5	470.686	6	467.186	3.5	X	X	X	X	X	-
AC-26A	1069548.81	515122.279	473.186	4,134	36	437.186	Yes	36	437.186	39	434.186	3	-	-	-	-	X	-
Cotter (2015)																		
WL-209-CT	1070488.51	514687.354	467.546	488,730	1.5	466.046	Yes	0	467.546	12	455.546	12	X	X	X	X	X	X
WL-234-CT	1069762.44	514435.675	480.017	894,913	9	471.017	Yes	1	479.017	22	458.017	21	X	X	X	X	X	X

Notes: NA - Data were not collected or are otherwise not available.
X - Data support the presence of RIM in the indicated interval
- Data do not indicate the presence of RIM at this location/interval

Table 2-3: Area 1 Combined Radium, Thorium, and Uranium Results (RI Borings, Phases 1C and 1D, A1 Additional Borings, and Cotter Borings)

DRAFT

Sample Designation	Upper Sample Depth (feet)	Lower Sample Depth (feet)	Units	Radium-226 Result	Final Q	CSU[1]	CV	MDA	Radium-228 Result	Final Q	CSU[1]	CV	MDA	Combined Radium 226 + 228		Combined Radium relative to 7.9 pCi/g Unrestricted Use Criteria	Thorium-230 Result	Final Q	CSU[1]	CV	MDA	Thorium-232 Result	Final Q	CSU[1]	CV	MDA	Combined Thorium 230 + 232		Combined Thorium relative to 7.9 pCi/g Unrestricted Use Criteria	Uranium-234 Result	Final Q	CSU[1]	CV	MDA	Uranium-235 Result	Final Q	CSU[1]	CV	MDA	Uranium-238 Result	Final Q	CSU[1]	CV	MDA	Combined Uranium 234 + 235 + 238		Combined Uranium relative to 54.4 pCi/g Unrestricted Use Criteria
McLaren/Hart RI Data																																															
WL-101	5	5	pCi/g	1.04		0.22		0.33	0.95	U			0.95	1.52	*	Less than Criteria	2.18		0.57		0.07	0.89				0.07	3.07		Less than Criteria	1.54		0.44		0.13	0.72	U			0.72	0.88		0.31		0.11	2.78	*	Less than Criteria
WL-101	20	20	pCi/g	0.91		0.19		0.35	1.08	U			1.08	1.45	*	Less than Criteria	1.63		0.57		0.23	1.45		0.53		0.19	3.08		Less than Criteria	1.47		0.46		0.17	0.54	U			0.54	1.63		0.49		0.13	3.37	*	Less than Criteria
WL-102	5	5	pCi/g	1.17		0.22		0.26	0.99	U			0.99	1.67	*	Less than Criteria	4.18		1.02		0.23	0.90		0.38		0.14	5.08		Less than Criteria	1.06		0.37		0.11	0.49	U			0.49	0.88		0.33		0.12	2.19	*	Less than Criteria
WL-102	15	15	pCi/g	0.98		0.23		0.35	1.07	U			1.07	1.52	*	Less than Criteria	1.68		0.58		0.3	1.64		0.56		0.2	3.32		Less than Criteria	1.24		0.41		0.11	0.83	U			0.83	1.34		0.43		0.10	3.00	*	Less than Criteria
WL-103	5	5	pCi/g	1.17		0.26		0.34	1.19	U			1.19	1.77	*	Less than Criteria	1.42		0.51		0.22	0.78		0.36		0.17	2.20		Less than Criteria	1.95		0.55		0.20	0.73	U			0.73	1.60		0.48		0.16	3.92	*	Less than Criteria
WL-103	10	10	pCi/g	0.81		0.34		0.53	1.26	U			1.26	1.44	*	Less than Criteria	7.52		1.65		0.16	0.77				0.09	8.29		Exceeds Criteria	1.41		0.39		0.19	1.41	U			1.41	1.12		0.34		0.14	3.24	*	Less than Criteria
WL-104	5	5	pCi/g	0.78		0.18		0.30	0.84	U			0.84	1.20	*	Less than Criteria	3.08		0.85		0.21	0.94		0.41		0.19	4.02		Less than Criteria	1.19		0.37		0.15	0.55	U			0.55	0.70		0.27		0.14	2.17	*	Less than Criteria
WL-104	20	20	pCi/g	0.39		0.19		0.34	0.92	U			0.92	0.85	*	Less than Criteria	1.26		0.47		0.21	0.77		0.35		0.14	2.03		Less than Criteria	0.52		0.19		0.10	0.56	U			0.56	0.32		0.14		0.11	1.12	*	Less than Criteria
WL-105	10	10	pCi/g	40.8		2.1		0.6	1.59	U			1.59	41.6	*	Exceeds Criteria	522		95		0.09	4.34		2.62		1.36	526		Exceeds Criteria	6.64		1.23		0.16	3.95		0.73		1.97	6.94		1.28		0.14	17.53		Less than Criteria
WL-105	30	30	pCi/g	0.99		0.23		0.34	1.18	U			1.18	1.58	*	Less than Criteria	1.59		0.56		0.31	1.04		0.42		0.15	2.63		Less than Criteria	1.16		0.36		0.10	0.73	U			0.73	1.10		0.34		0.08	2.63	*	Less than Criteria
WL-106	0	0	pCi/g	906		37		2	5.86	U			5.86	909	*	Exceeds Criteria	9,700		1,800		11.8	35.2				11.2	9,735		Exceeds Criteria	105		22		3	75.5		8.5		8.7	105		22		2	286		Exceeds Criteria
WL-106	5	5	pCi/g	18.8		1.3		0.4	1.42				1.07	20.2		Exceeds Criteria	731		135		0.21	3.22				0.2	734		Exceeds Criteria	11.5		4.8		4.0	2.10		0.43		1.12	6.69		3.5		2.73	20.3		Less than Criteria
WL-106 DUP (F)	5	5	pCi/g	128		6		1.0	2.69	U			2.69	129	*	Exceeds Criteria	766		142		0.14	4.71				0.12	771		Exceeds Criteria	31.5	U	17.1		35.3	12.1		1.7		3.4	26.4		10.1		17.2	54.3	*	Exceeds Criteria
WL-106	25	25	pCi/g	1.26		0.25		0.4	1.18	U			1.18	1.85	*	Less than Criteria	2.38		0.55		0.14	0.56				0.09	2.94		Less than Criteria	2.7		0.53		0.06	0.78	U			0.78	2.89		0.56		0.06	6.0	*	Less than Criteria
WL-106 DUP (F)	25	25	pCi/g	2.92		0.35		0.31	1.16	U			1.16	3.50	*	Less than Criteria	6.49		1.37		0.12	0.47				0.09	6.96		Less than Criteria	1.9		0.42		0.18	1.14	U			1.14	2.08		0.45		0.17	4.6	*	Less than Criteria
WL-107	5	5	pCi/g	0.80		0.21		0.29	0.91		0.38		0.68	1.71		Less than Criteria	0.89		0.34		0.13	0.89		0.34		0.09	1.78		Less than Criteria	1.30		0.43		0.11	0.58	U			0.58	0.89		0.34		0.11	2.48	*	Less than Criteria
WL-107	51	51	pCi/g	0.71		0.21		0.36	0.98	U			0.98	1.20	*	Less than Criteria	0.56		0.27		0.15	0.14		0.12		0.09	0.70		Less than Criteria	0.54		0.24		0.08	0.63	U			0.63	0.33		0.18		0.08	1.19	*	Less than Criteria
WL-107 DUP (L)	51	51	pCi/g	0.42		0.2		0.38	1.11	U			1.11	0.98	*	Less than Criteria	0.67		0.33		0.23	0.22		0.17		0.13	0.89		Less than Criteria	0.34		0.19		0.08	0.63	U			0.63	0.59		0.25		0.08	1.25	*	Less than Criteria
WL-108	5	5	pCi/g	0.95		0.25		0.37	1.34	U			1.34	1.62	*	Less than Criteria	1.21		0.42		0.16	0.79		0.32		0.12	2.00		Less than Criteria	0.74		0.31		0.10	0.67	U			0.67	1.05		0.38		0.12	2.13	*	Less than Criteria
WL-109	5	5	pCi/g	0.90		0.21		0.31	1.18		0.4		0.62	2.08		Less than Criteria	0.67		0.3		0.13	0.21		0.16		0.11	0.88		Less than Criteria	0.66		0.25		0.08	0.61	U			0.61	0.66		0.24		0.07	1.63	*	Less than Criteria
WL-109	50	50	pCi/g	0.95		0.21		0.30	1.36		0.48		0.71	2.31		Less than Criteria	1.1		0.36		0.2	0.58		0.25		0.21	1.7		Less than Criteria	0.57		0.27		0.11	0.77	U			0.77	0.99		0.38		0.12	1.95	*	Less than Criteria
WL-109 DUP (L)	50	50	pCi/g	1.36		0.37		0.56	1.51	U			1.51	2.12	*	Less than Criteria	2.43		0.71		0.26	1.13				0.12	3.56		Less than Criteria	0.83		0.32		0.11	1.28	U			1.28	1.13		0.39		0.12	2.60	*	Less than Criteria
WL-110	5	5	pCi/g	0.87		0.25		0.40	1.27	U			1.27	1.51	*	Less than Criteria	0.66		0.35		0.23	0.37		0.25		0.16	1.03		Less than Criteria	1.25		0.41		0.09	0.84	U			0.84	0.87		0.33		0.09	2.54	*	Less than Criteria
WL-110	50	50	pCi/g	1.01		0.21		0.31	1.02	U			1.02	1.52	*	Less than Criteria	0.87		0.29		0.12	0.87		0.28		0.08	1.74		Less than Criteria	1.17		0.4		0.20	0.74	U			0.74	1.14		0.39		0.23	2.68	*	Less than Criteria
WL-111	0	0	pCi/g	0.91		0.22		0.33	1.05	U			1.05	1.44	*	Less than Criteria	2.12		0.72		0.29	0.68		0.36		0.20	2.80		Less than Criteria	1.70		0.63		0.25	0.70	U			0.70	1.04		0.46		0.18	3.09	*	Less than Criteria
WL-111	5	5	pCi/g	0.61		0.21		0.42	1.02	U			1.02	1.12	*	Less than Criteria	2.76		0.90		0.77	0.38	U	0.39		0.70	2.95	*	Less than Criteria	3.37		1.08		0.97	0.70	U			0.70	1.16		0.65		0.90	4.88	*	Less than Criteria
WL-111 DUP (L)	5	5	pCi/g	0.91		0.23		0.41	1.36	U			1.36	1.59	*	Less than Criteria																															
WL-111	51	51	pCi/g	0.48		0.18		0.33	1.10	U			1.10	1.03	*	Less than Criteria	2.47		1.26		0.79	0.41	U	0.49		0.58	2.68	*	Less than Criteria	0.75		0.47		0.58	0.64	U			0.64	0.33	U	0.32		0.48	1.24	*	Less than Criteria
WL-111 DUP (L)	51	51	pCi/g	0.51		0.22		0.35	1.01	U			1.01	1.02	*	Less than Criteria																															
WL-112	0	0	pCi/g	1.32		0.24		0.41	1.18	U			1.18	1.91	*	Less than Criteria	2.67		0.76		0.25	0.84		0.34		0.19	3.51		Less than Criteria	1.45		0.48		0.13	0.85	U			0.85	1.22		0.43		0.12	3.10	*	Less than Criteria
WL-112	5	5	pCi/g	4.66		0.46		0.42	1.20	U			1.20	5.26	*	Less than Criteria	84.4		15.8		1.9	0.66	U	0.81		1.56	84.7	*	Exceeds Criteria	2.92		1.46		0.89	0.99	U			0.99	3.44		1.58		0.42	6.86	*	Less than Criteria
WL-112	42	42	pCi/g	0.76		0.20		0.34	1.31		0.44		0.58	2.07		Less than Criteria	0.92		0.44		0.42	0.68		0.37		0.3	1.60		Less than Criteria	1.74		1.15		1.06	0.56	U			0.56	1.62		1.09		0.88	3.64	*	Less than Criteria
WL-113	5	5	pCi/g	0.97		0.08		0.06	1.06		0.14		0.13	2.03		Less than Criteria	0.33		0.15		0.11	0.19		0.11		0.08	0.52		Less than Criteria	1.40		0.59		0.32	0.23	U			0.23	1.25		0.54		0.26	2.77	*	Less than Criteria
WL-113 DUP (F)	5	5	pCi/g	1.06		0.08		0.06	0.98		0.13		0.13	2.04		Less than Criteria	0.58		0.23		0.15	0.15		0.11		0.08	0.73		Less than Criteria	0.76		0.34		0.16	0.17	U			0.17	0.62		0.30		0.08	1.47	*	Less than Criteria
WL-113	10	10	pCi/g	1.53		0.15		0.12	0.98		0.22		0.24	2.51		Less than Criteria	2.21		0.52		0.13	0.08		0.07		0.08	2.29		Less than Criteria	1.20		0.48		0.22	0.42	U			0.42	1.06		0.44		0.09	2.47	*	Less than Criteria
WL-114	0	0	pCi/g	109		5		0.9	2.50	U			2.50	110	*	Exceeds Criteria	7,850		1,470		0.92	18.1		4.6		0.78	7,868		Exceeds Criteria	154		40		1.0	17.6		2.1		3.0	147		38		0.9	319		Exceeds Criteria
WL-114	5	5	pCi/g	2.59		0.17		0.06	0.39		0.12		0.16	2.98		Less than Criteria	23.2		4.9		0.4	0.25	U	0.22		0.26	23.3	*	Exceeds Criteria	3.43		1.35		0.63	0.32		0.06		0.27	3.54		1.38		0.51	7.29		Less than Criteria
WL-114 DUP (L)	5	5	pCi/g	2.54		0.14		0.07	0.46		0.12		0.15	3.00		Less than Criteria																															
WL-114	15	15	pCi/g	0.98		0.08		0.07	1.04		0.15		0.14	2.02		Less than Criteria	1.08		0.46		0.28	0.14	U	0.16		0.2	1.15	*	Less than Criteria	1.29		0.74		0.56	0.24	U			0.24	1.60		0.82		0.23	3.01	*	Less than Criteria
WL-114 DUP (L)	15	15	pCi/g	0.97		0.08		0.07	1.08		0.17		0.15	2.05		Less than Criteria																															
WL-115	5	5	pCi/g	1.00		0.08		0.06	0.93		0.13		0.12	1.93		Less than Criteria	0.84		0.29		0.18	0.21		0.13		0.11	1.05		Less than Criteria	1.30		0.52		0.29	0.15	U			0.15	1.22		0.49		0.21	2.60	*	Less than Criteria
WL-115	40	40	pCi/g	0.58		0.05		0.05	0.69		0.1		0.10	1.27		Less than Criteria	0.29		0.16		0.12	0.27		0.15		0.09	0.56		Less than Criteria	0.35		0.21		0.16	0.13	U			0.13	0.33		0.20		0.11	0.75	*	Less than Criteria
WL-116	0	0	pCi/g	0.94		0.21		0.33	1.19	U			1.19	1.54	*	Less than Criteria	1.94		0.69		0.52	0.52		0.34		0.46	2.46		Less than Criteria	1.04		0.38		0.20	1.02	U			1.02	0.88		0.34		0.15	2.43	*	Less than Criteria
WL-116	5	5	pCi/g	1.11		0.08		0.06	0.94		0.13		0.14	2.05		Less than Criteria	0.51		0.21		0.13	0.25		0.14		0.04	0.76		Less than Criteria	1.15		0.49		0.36	0.17	U			0.17	1.18		0.50		0.41	2.42	*	Less than Criteria
WL-116 DUP (F)	5	5	pCi/g	1.18		0.13		0.13	1.0		0.2		0.28	2.2		Less than Criteria	0.35		0.17		0.11	0.21		0.13		0.07	0.56		Less than Criteria	0.64		0.39		0.28	0.44	U			0.44	1.03		0.51		0.20	1.89	*	Less than Criteria
WL-116	10	10	pCi/g	1.00		0.07		0.05	0.76		0.11		0.11	1.76		Less than Criteria	0.36		0.2		0.21	0.33		0.18		0.13	0.69		Less than Criteria	1.14		0.37		0.17	0.13	U			0.13	1.32		0.41		0.05	2.53	*	Less than Criteria
WL-117	10	10	pCi/g	3.15		0.19		0.07	0.64		0.14		0.16	3.79		Less than Criteria	36.58		7.4		0.13	1		0.35		0.12	38		Exceeds Criteria	1.72		0.61		0.25	0.30		0.06		0.27	2.90		0.86		0.16	4.92		Less than Criteria
WL-117	25	25	pCi/g	0.62		0.06		0.05	0.64		0.12		0.12	1.26		Less than Criteria	0.7		0.28		0.15	0.2		0.14		0.12	0.9		Less than Criteria	0.56		0.31		0.17	0.20	U			0.20	0.56		0.31		0.10	1.22	*	Less than Criteria
WL-118	5	5	pCi/g	18.4		1		0.3	0.73	U			0.73	18.8	*	Exceeds Criteria	425		87		2.5	10.3		3.5		2.22	435		Exceeds Criteria	15.6		3.6		0.2	2.40		0.37		1.41	17.8		4.1		0.2	35.8		Less than Criteria
WL-118	10	10	pCi/g	1.31		0.1		0.05	0.49		0.09		0.14	1.80		Less than Criteria	7.19		1.88		0.2	0.35		0.23		0.2	7.54		Less than Criteria	1.18		0.48		0.18	0.18		0.03		0.15	1.14		0.47		0.17	2.50		Less than Criteria
WL-119	5	5	pCi/g	0.89		0.07		0.06	0.73		0.12		0.12	1.62		Less than Criteria	0.6		0.28		0.22	0.26		0.17		0.13	0.9		Less than Criteria	0.51		0.29		0.21	0.15	U			0.15	0.72		0.35		0.17	1.31	*	Less than Criteria
WL-119	50	50	pCi/g	0.46		0.05		0.04	0.41		0.09		0.10	0.87		Less than Criteria	0.67		0.35		0.41	0.32	U	0.26		0.41	0.83	*	Less than Criteria	0.85		0.53		0.50	0.12	U			0.12	0.34	U	0.36		0.58	1.08	*	Less than Criteria
WL-119 DUP (L)	50	50	pCi/g	0.48		0.05		0.06	0.44		0.1		0.12	0.92		Less than Criteria																															
WL-119 DUP (F)	50	50	pCi/g	0.45		0.05		0.06	0.50		0.10		0.12	0.95		Less than Criteria	0.22		0.13		0.11	0.1		0.08		0.09	0.3		Less than Criteria	0.57		0.29		0.19	0.13	U			0.13	0.36		0.23		0.25	1.00	*	Less than Criteria
WL-120	5	5	pCi/g	1.00		0.09		0.07	1.08		0.15		0.16	2.08		Less than Criteria	0.48		0.18		0.12	0.14		0.09		0.09	0.62		Less than Criteria	1.15		0.43		0.26	0.24	U			0.24	0.95		0.38		0.18	2.22	*	Less than Criteria
WL-120	50	50	pCi/g	0.92		0.1		0.11	0.91		0.21		0.22	1.83		Less than Criteria	0.32		0.19		0.15	0.23		0.16		0.13	0.55		Less than Criteria	0.46		0.23		0.14	0.37	U			0.37	0.52		0.25		0.12	1.17	*	Less than Criteria
WL-120 DUP (F)	50	50	pCi/g	1.07		0.09		0.09	1.04		0.18		0.17	2.11		Less than Criteria	0.38		0.19		0.21	0.25		0.15		0.15	0.63		Less than Criteria	0.98		0.47		0.35	0.25	U			0.25	0.92		0.46		0.38	2.03	*	Less than Criteria
WL-121	0	0	pCi/g	7.28	U			7.28	2.14	U			2.14	Non-detect	*	Non-detect	1.57		0.36		0.1	0.87		0.23		0.09	2.44		Less than Criteria	0.78		0.24		0.13						0.94		0.27		0.17	1.72		Less than Criteria
WL-122	0	0	pCi/g	5.44	U			5.44	1.69	U			1.69	Non-detect	*	Non-detect	1.93		0.43		0.12	1.02		0.26		0.1	2.95		Less than Criteria	0.94		0.26		0.1						0.87		0.25		0.09	1.81		Less than Criteria
WL-123	0	0	pCi/g	5.98	U			5.98	1.82	U			1.82	Non-detect	*	Non-detect	1.45		0.34		0.07	1.06		0.27		0.05	2.51		Less than Criteria	2.94		0.65		0.07						2.33		0.54		0.12	5.27		Less than Criteria
WL-124	0	0	pCi/g	5.22	U			5.22	1.79	U			1.79	Non-detect	*	Non-detect	2.16		0.49		0.07	1.16		0.3		0.07	3.32		Less than Criteria	1.5		0.34		0.06						1.02		0.26		0.06	2.5		Less than Criteria
Phase 1C data (and Cotter samples from Core of Phase 1C borings)																																															
FEEBRI14-5.012-013	12	13	pCi/g	1.24		0.22	0.14	0.29	1.22		0.28	0.23	0.48	2.46		Less than Criteria	1.66		0.48	0.01	0.08	1.19		0.36	0.10	0.10	2.86		Less than Criteria	0.805		0.227	0.013	0.054	0.123		0.091	0.006	0.077	0.866		0.237	0.004	0.054	1.793		Less than Criteria
FEEBRI14-5.060-061	60	61	pCi/g	1.31	J	0.29	0.24	0.50	1.43	J	0.45	0.34	0.73	2.74		Less than Criteria	1.03		0.32	0.01	0.06	1.12		0.33	0.08	0.09	2.15		Less than Criteria	0.981		0.253	0.010	0.075	0.093		0.081	0.001	0.093	0.864		0.234	0.001	0.075	1.938		Less than Criteria
FEEBRIS 12-5.002-003	2	3	pCi/g	1.22		0.16	0.07	0.15	0.88		0.17	0.14	0.29	2.09		Less than Criteria	1.27		0.35	0.01	0.07	0.94		0.27	0.11	0.07	2.21		Less than Criteria	0.535		0.183	0.013	0.057	0.051	U	0.067	0.001	0.102	0.604		0.197	0.002	0.082	1.189	*	Less than Criteria
FEEBRIS 12-5.012-013	12	13	pCi/g	1.15		0.19	0.10	0.21	1.10		0.24	0.16	0.34	2.25		Less than Criteria	1.72		0.49	0.01	0.08	0.87		0.29	0.14	0.07	2.59		Less than Criteria	0.670		0.207	0.015	0.064	0.100		0.087	0.001	0.100	0.763		0.223	0.004	0.056	1.532		Less than Criteria
FEEBRIS 13-3.019-020	19	20	pCi/g	1.50		0.23	0.14	0.30	1.39	J	0.36	0.27	0.56	2.89		Less than Criteria	3.41		0.85	0.01	0.07	1.20		0.36	0.14	0.08	4.61		Less than Criteria	0.951		0.259	0.036	0.103	0.178		0.112	0.006	0.080	0.916		0.251	0.018	0.089	2.045		Less than Criteria
FEEBRIS 13-3.029-030	29	30	pCi/g	0.39	UJ	0.31	0.24	0.50	0.73	J	0.37	0.31	0.68	1.11	*	Less than Criteria	0.79		0.26	0.00	0.06	0.81		0.25	0.11	0.08	1.60		Less than Criteria	0.717		0.214	0.013	0.056	0.044	U	0.057	0.006	0.079	0.885		0.243	0.006	0.063	1.646	*	Less than Criteria
FEEBRIS 14-2.019-020	19	20	pCi/g	1.31		0.18	0.09	0.20	1.33		0.22	0.19	0.40	2.64		Less than Criteria	2.76		0.70	0.01	0.07	1.05		0.32	0.14	0.08	3.81		Less than Criteria	0.748		0.204	0.017	0.064	0.095		0.073	0.003	0.058	0.796		0.211	0.003	0.047	1.639		Less than Criteria
FEEBRIS 14-2.029-031	29	31	pCi/g	1.19		0.19	0.11	0.23	1.14		0.21	0.14	0.31	2.33		Less than Criteria	1.52		0.43	0.01	0.07	1.36		0.38	0.13	0.06	2.88		Less than Criteria	1.032		0.276	0.039	0.109	0.034	U	0.060	0.015	0.108	1.019		0.271	0.011	0.078	2.085	*	Less than Criteria
FEEBRIS 14-4.005-006	5	6	pCi/g	0.90		0.14	0.08	0.17	0.68		0.13	0.21	0.44	1.59		Less than Criteria	1.29		0.39	0.01	0.08	1.10		0.34	0.15	0.09	2.39		Less than Criteria	1.077		0.250	0.030	0.082	0.117		0.083	0.012	0.082	0.729		0.195	0.008	0.059	1.923		Less than Criteria
FEEBRIS 14-4.028-029	28	29	pCi/g	0.82		0.20	0.14	0.29	0.84	J	0.24	0.23	0.51	1.66		Less than Criteria	2.08		0.55	0.00	0.09	1.46		0.39	0.13	0.06	3.54		Less than Criteria	0.945		0.234	0.029	0.083	0.077		0.066	0.005	0.065	1.232		0.275	0.014	0.072	2.254		Less than Criteria
FEEBRIS 14-7.013-014	13	14	pCi/g	0.90		0.15	0.19	0.39	0.48		0.16	0.15	0.32	1.38		Less than Criteria	1.54		0.49	0.04	0.14	0.89		0.32	0.18	0.11	2.43		Less than Criteria	1.068		0.265	0.012	0.052	0.102		0.081	0.005	0.073	1.012		0.256	0.006	0.059	2.183		Less than Criteria
FEEBRIS 14-7.039-040	39	40	pCi/g	1.32		0.23	0.16	0.33	0.99	J	0.30	0.29	0.61	2.31		Less than Criteria	1.80		0.54	0.03	0.14	1.26		0.40	0.17	0.10	3.05		Less than Criteria	0.864		0.224	0.011	0.048	0.071		0.069	0.001	0.085	0.828		0.219	0.001	0.069	1.763		Less than Criteria
FEEBRIS 15-2.024-025	24	25	pCi/g	4.78		0.51	0.15	0.31	1.48	J	0.29	0.29	0.60	6.26		Less than Criteria	115.62		23.75	0.02	0.09	1.84		0.46	0.14	0.10	117.5		Exceeds Criteria	0.980		0.260	0.030	0.082	0.100		0.073	0.019	0.112	0.930		0.249	0.006	0.063	1.969	*	Less than Criteria
FEEBRIS 15-2.043-044	43	44	pCi/g	1.40		0.20	0.12	0.24	1.42		0.25	0.16	0.35	2.82		Less than Criteria	1.36		0.44	0.02	0.11	1.33		0.42	0.17	0.08	2.69		Less than Criteria	0.727		0.195	0.024	0.074	0.017	U	0.037	0.008	0.073	0.817		0.208	0.008	0.059	1.561	*	Less than Criteria
FEEBRIS 16-3.006-007	6	7	pCi/g	1.36		0.24	0.14	0.28	1.61		0.32	0.22	0.46	2.98		Less than Criteria	1.86		0.53	0.02	0.11	1.30		0.39	0.15	0.08	3.16		Less than Criteria	0.692		0.218	0.021	0.081	0.053	U	0.070	0.001	0.106	0.751		0.227	0.006	0.068	1.497	*	Less than Criteria
FEEBRIS 16-3.011-012	11	12	pCi/g	1.17		0.19	0.10	0.21	1.67		0.23	0.16	0.34	2.84		Less than Criteria	1.77		0.52	0.01	0.09	1.37		0.41	0.15	0.08	3.14		Less than Criteria	0.900		0.235	0.026	0.082	0.139		0.093	0.007	0.077	1.054		0.258	0.013	0.075	2.093		Less than Criteria
FEEBRIS 16-3.011-012D	11	12	pCi/g	1.27		0.19	0.10	0.21	1.25		0.26	0.20	0.43	2.52		Less than Criteria	1.86		0.57	0.03	0.13	1.62		0.50	0.19	0.12	3.47		Less than Criteria	0.851		0.229	0.022	0.077	0.160		0.100	0.005	0.072	0.979		0.248	0.003	0.051	1.991		Less than Criteria
FEEBRIS 16-6.006-007	6	7	pCi/g	1.36		0.21	0.11	0.24	1.41		0.26	0.17	0.37	2.77		Less than Criteria	1.67		0.46	0.00	0.06	1.23		0.35	0.13	0.06	2.90		Less than Criteria	1.110		0.260	0.011	0.046	0.046	U	0.055	0.009	0.077	1.022		0.247	0.009	0.062	2.178	*	Less than Criteria
FEEBRIS 16-6.021-022	21	22	pCi/g	0.93		0.15	0.09	0.05	1.26		0.21	0.18	0.37	2.19		Less than Criteria	1.41		0.41	0.00	0.09	1.50		0.41	0.13	0.06	2.91		Less than Criteria	0.584		0.206	0.038	0.112	0.106		0.092	0.007	0.090	0.591		0.210	0.048	0.136	1.281		Less than Criteria
FEEBRIS01-2.008-009	8	9	pCi/g	1.38		0.20	0.11	0.22	1.31	J	0.22	0.24	0.50	2.69		Less than Criteria	0.68		0.25	0.02	0.10	0.38		0.17	0.10	0.10	1.05		Less than Criteria	0.469		0.157	0.013	0.055	0.043	U	0.056	0.001	0.085	0.435		0.149	0.003	0.048	0.946	*	Less than Criteria
FEEBRIS01-2.018-019	18	19	pCi/g	1.32		0.20	0.09	0.19	1.34		0.25	0.20	0.43	2.65		Less than Criteria	0.62		0.22	0.00	0.08	0.34		0.15	0.07	0.05	0.96		Less than Criteria	0.400		0.138	0.016	0.059	0.053	U	0.058	0.010	0.077	0.412		0.139	0.005	0.050	0.866	*	Less than Criteria
FEEBRIS01-2.020-021	20	21	pCi/g	1.22		0.22	0.13	0.27	1.05		0.25	0.23	0.50	2.28		Less than Criteria	0.84		0.27	0.01	0.06	0.57		0.20	0.07	0.08	1.41		Less than Criteria	0.458		0.158	0.012	0.051	0.007	U	0.031	0.007	0.078	0.396		0.145	0.003	0.050	0.862	*	Less than Criteria
FEEBRIS01-2.022-023	22	23	pCi/g	0.23	UJ	0.33	0.27	0.58	0.44	UJ	0.41	0.39	0.90	Non-detect	*	Non-detect	0.13		0.08	0.00	0.07	0.06	U	0.06	0.06	0.07	0.19	*	Less than Criteria	0.149		0.080	0.016	0.059	0.004	U	0.025	0.008	0.068	0.062	U	0.056	0.018	0.072	0.215	*	Less than Criteria
FEEBRIS01-2.023-024	23	24	pCi/g	1.35		0.32	0.19	0.40	1.21	J	0.43	0.38	0.81	2.56		Less than Criteria	0.94		0.30	0.01	0.07	0.56		0.21	0.07	0.08	1.51		Less than Criteria	0.441		0.174	0.018	0.074	0.095		0.092	0.001	0.114	0.355		0.156	0.015	0.092	0.891		Less than Criteria
FEEBRIS01-2.024-025	24	25	pCi/g	1.36		0.20	0.10	0.21	1.13		0.20	0.16	0.34	2.50		Less than Criteria	3.41		0.84	0.01	0.09	1.34		0.38	0.08	0.06	4.74		Less than Criteria	0.756		0.226	0.014	0.059	0.136		0.098	0.004	0.072	1.195		0.300	0.009	0.073	2.087		Less than Criteria
FEEBRIS01-2.028-029	28	29	pCi/g	0.61		0.16	0.12	0.24	0.35	U	0.20	0.23	0.50	0.97	*	Less than Criteria	1.38		0.46	0.02	0.12	0.71		0.29	0.15	0.15	2.10		Less than Criteria	0.726		0.222	0.014	0.060	0.088		0.085	0.001	0.106	0.571		0.194	0.014	0.085	1.385		Less than Criteria
FEEBRIS01-2.033-034	33	34	pCi/g	0.62		0.13	0.09	0.18	0.26	U	0.19	0.16	0.33	0.88	*	Less than Criteria	0.28		0.12	0.00	0.06	0.11	U	0.07	0.06	0.05	0.39	*	Less than Criteria	0.499		0.151	0.013	0.051	0.022	U	0.034	0.003	0.050	0.298		0.112	0.003	0.040	0.819	*	Less than Criteria

Table 2-3: Area 1 Combined Radium, Thorium, and Uranium Results (RI Borings, Phases 1C and 1D, A1 Additional Borings, and Cotter Borings)

DRAFT

Sample Designation	Upper Sample Depth (feet)	Lower Sample Depth (feet)	Units	Radium-226					Radium-228					Combined Radium 226 + 228		Combined Radium relative to 7.9 pCi/g Unrestricted Use Criteria	Thorium-230					Thorium-232					Combined Thorium 230 + 232		Combined Thorium relative to 7.9 pCi/g Unrestricted Use Criteria	Uranium-234					Uranium-235					Uranium-238					Combined Uranium 234 + 235 + 238		Combined Uranium relative to 54.4 pCi/g Unrestricted Use Criteria
				Result	Final Q	CSU[1]	CV	MDA	Result	Final Q	CSU[1]	CV	MDA				Result	Final Q	CSU[1]	CV	MDA	Result	Final Q	CSU[1]	CV	MDA				Result	Final Q	CSU[1]	CV	MDA	Result	Final Q	CSU[1]	CV	MDA	Result	Final Q	CSU[1]	CV	MDA			
FEEBRIS01-2.038-039	38	39	pCi/g	1.02		0.19	0.11	0.24	0.95	J	0.32	0.47	0.76	1.97		Less than Criteria	0.28		0.13	0.01	0.06	0.29		0.13	0.07	0.06	0.57		Less than Criteria	0.314		0.126	0.012	0.049	0.070		0.064	0.003	0.060	0.264		0.115	0.005	0.056	0.648		Less than Criteria
FEEBRIS01-2.038-039D	38	39	pCi/g	1.05		0.25	0.16	0.34	1.20	J	0.42	0.40	0.84	2.25		Less than Criteria	0.40		0.16	0.02	0.08	0.13	U	0.08	0.07	0.06	0.53	*	Less than Criteria	0.303		0.122	0.011	0.047	0.163		0.097	0.005	0.067	0.321		0.126	0.007	0.059	0.786		Less than Criteria
FEEBRIS01-2.039-040	39	40	pCi/g	4.98		0.48	0.12	0.25	1.28	J	0.37	0.35	0.71	6.26		Less than Criteria	416.66	OJ	123.32	0.05	0.80	5.23	OJ	2.46	0.81	0.72	421.9		Exceeds Criteria	3.555		0.668	0.015	0.064	0.337		0.164	0.004	0.079	3.843		0.708	0.007	0.073	7.736		Less than Criteria
FEEBRIS01-2.040-041	40	41	pCi/g	0.39		0.10	0.08	0.16	0.44		0.17	0.15	0.32	0.83		Less than Criteria	0.06	U	0.06	0.02	0.08	0.05	U	0.05	0.07	0.05	Non-Detect	*	Non-detect	0.173		0.091	0.011	0.049	0.067	U	0.064	0.005	0.069	0.205		0.100	0.005	0.055	0.444	*	Less than Criteria
FEEBRIS02-2.005-006	5	6	pCi/g	0.99		0.16	0.10	0.20	1.14		0.19	0.10	0.22	2.14		Less than Criteria	1.24		0.39	0.03	0.12	0.89		0.29	0.09	0.08	2.13		Less than Criteria	0.985		0.245	0.012	0.049	0.101		0.081	0.001	0.087	0.865		0.227	0.001	0.070	1.952		Less than Criteria
FEEBRIS02-2.019-020	19	20	pCi/g	0.96		0.20	0.13	0.28	0.84		0.27	0.19	0.41	1.79		Less than Criteria	0.16		0.08	0.01	0.06	0.13	U	0.08	0.07	0.08	0.29	*	Less than Criteria	0.360		0.121	0.009	0.038	0.009	U	0.022	0.002	0.047	0.306		0.111	0.001	0.054	0.676	*	Less than Criteria
FEEBRIS02-2.020-021	20	21	pCi/g	0.32	U	0.18	0.17	0.36	0.66	UJ	0.41	0.36	0.80	Non-detect	*	Non-detect	0.66		0.22	0.00	0.07	0.46		0.17	0.08	0.08	1.12		Less than Criteria	0.325		0.126	0.015	0.058	0.068		0.066	0.001	0.081	0.338		0.128	0.003	0.046	0.731		Less than Criteria
FEEBRIS02-2.021-022	21	22	pCi/g	1.17		0.21	0.11	0.23	1.44	J	0.28	0.27	0.56	2.62		Less than Criteria	1.36		0.40	0.01	0.08	1.25		0.36	0.08	0.06	2.61		Less than Criteria	0.911		0.237	0.018	0.068	0.070	U	0.066	0.005	0.071	0.766		0.213	0.006	0.058	1.747	*	Less than Criteria
FEEBRIS02-2.022-023	22	23	pCi/g	1.31	J	0.37	0.31	0.65	1.54	J	0.44	0.36	0.78	2.85		Less than Criteria	0.69		0.23	0.01	0.06	0.68		0.22	0.07	0.05	1.37		Less than Criteria	0.386		0.125	0.013	0.050	0.058	U	0.054	0.007	0.062	0.414		0.130	0.004	0.042	0.859	*	Less than Criteria
FEEBRIS02-2.022-023D	22	23	pCi/g	1.51		0.24	0.12	0.25	1.33	J	0.27	0.24	0.50	2.84		Less than Criteria	0.57		0.19	0.01	0.05	0.44		0.16	0.06	0.07	1.00		Less than Criteria	0.458		0.156	0.026	0.081	0.053	U	0.063	0.014	0.092	0.434		0.149	0.007	0.059	0.946	*	Less than Criteria
FEEBRIS02-2.031-032GP	31	32	pCi/g	13.77	J	1.28	0.25	0.52	0.79	UJ	0.58	0.47	0.98	14.56	*	Exceeds Criteria	205.53		43.37	0.01	0.04	1.39		0.33	0.04	0.04	206.9		Exceeds Criteria	0.818		0.170	0.008	0.030	0.034		0.031	0.002	0.030	0.706		0.154	0.004	0.030	1.558		Less than Criteria
FEEBRIS02-3.034-035GP	34	35	pCi/g	3.23		0.52	0.39	0.19	1.64	J	0.49	0.98	1.95	4.86		Less than Criteria	16.79		3.42	0.01	0.04	0.26		0.09	0.04	0.04	17.04		Exceeds Criteria	0.494		0.117	0.009	0.031	0.043		0.034	0.002	0.031	0.445		0.111	0.021	0.050	0.982		Less than Criteria
FEEBRIS02-3.035-036GP	35	36	pCi/g	21.08	J	2.06	0.49	1.02	0.45	UJ	0.78	0.59	1.25	21.53	*	Exceeds Criteria	281.62		53.20	0.00	0.03	2.60		0.49	0.03	0.02	284.2		Exceeds Criteria	1.597		0.263	0.005	0.020	0.166		0.066	0.003	0.032	1.627		0.266	0.003	0.026	3.390		Less than Criteria
FEEBRIS05-3.025-026	25	26	pCi/g	1.28		0.21	0.12	0.25	1.13		0.20	0.22	0.47	2.41		Less than Criteria	4.63		1.01	0.01	0.06	0.43		0.15	0.06	0.05	5.07		Less than Criteria	0.457		0.145	0.020	0.064	0.096		0.073	0.011	0.076	0.402		0.133	0.008	0.055	0.955		Less than Criteria
FEEBRIS05-3.025-026D	25	26	pCi/g	5.32		0.56	0.21	0.42	1.09	J	0.35	0.29	0.62	6.41		Less than Criteria	88.92		18.01	0.00	0.07	0.82		0.25	0.07	0.06	89.7		Exceeds Criteria	0.649		0.173	0.013	0.050	0.060	U	0.057	0.009	0.070	0.707		0.183	0.011	0.059	1.416	*	Less than Criteria
FEEBRIS05-3.028-029	28	29	pCi/g	1,487.21	J	121.47	5.09	10.21	19.82	OJ	6.41	5.36	10.81	1,507		Exceeds Criteria	25,825	OJ	7,538	1.45	17.70	202.82	OJ	78.56	15.40	15.53	26,028		Exceeds Criteria	428.669	J	73.202	1.299	5.593	22.867	OJ	12.502	0.355	6.900	431.061	J	73.499	0.154	8.002	882.597		Exceeds Criteria
FEEBRIS05-3.029-030	29	30	pCi/g	5.60		0.55	0.12	0.25	1.19	J	0.28	0.30	0.63	6.79		Less than Criteria	444	OJ	97.72	0.25	1.12	6.76	OJ	2.48	1.51	0.92	450		Exceeds Criteria	2.863		0.501	0.017	0.063	0.187		0.104	0.007	0.073	2.510		0.456	0.038	0.102	5.560		Less than Criteria
FEEBRIS05-3.029-030D	29	30	pCi/g	0.44		0.12	0.09	0.18	0.36	U	0.21	0.21	0.44	0.80	*	Less than Criteria	0.94		0.31	0.01	0.08	0.45		0.19	0.08	0.10	1.38		Less than Criteria	0.623		0.200	0.018	0.072	0.068	U	0.075	0.001	0.101	0.557		0.189	0.018	0.090	1.248	*	Less than Criteria
FEEBRIS05-3.033-034	33	34	pCi/g	32.62	J	2.44	0.46	0.93	1.96	J	0.43	0.44	0.90	34.58		Exceeds Criteria	1,815	OJ	559	0.54	4.54	14.41	OJ	8.16	3.69	4.00	1,829		Exceeds Criteria	12.391		1.902	0.015	0.065	0.704	O	0.247	0.004	0.080	11.949		1.841	0.007	0.074	25.044		Less than Criteria
FEEBRIS08-1.028-029	28	29	pCi/g	1.27		0.21	0.23	0.47	0.88	J	0.19	0.30	0.64	2.15		Less than Criteria	1.81		0.46	0.02	0.08	0.88		0.26	0.07	0.05	2.69		Less than Criteria	0.861		0.236	0.015	0.062	0.109		0.084	0.003	0.067	0.911		0.243	0.004	0.054	1.882		Less than Criteria
FEEBRIS08-1.040-041	40	41	pCi/g	1.49		0.22	0.13	0.20	1.59		0.27	0.21	0.44	3.08		Less than Criteria	1.57		0.46	0.01	0.09	1.31		0.38	0.09	0.08	2.88		Less than Criteria	0.839		0.234	0.019	0.074	0.078		0.071	0.003	0.067	0.998		0.259	0.004	0.054	1.915		Less than Criteria
FEEBRIS08-1.044-045	44	45	pCi/g	1.29		0.28	0.20	0.42	1.43	J	0.44	0.36	0.76	2.72		Less than Criteria	77.76		16.93	0.01	0.06	0.48		0.19	0.08	0.06	78.2		Exceeds Criteria	0.568		0.170	0.012	0.052	0.089		0.070	0.005	0.064	0.469		0.152	0.005	0.051	1.126		Less than Criteria
FEEBRIS08-1B.028-029GP	28	29	pCi/g	0.96	J	0.19	0.27	0.55	0.48	UJ	0.33	0.27	0.59	1.44	*	Less than Criteria	3.42		0.84	0.02	0.07	0.15		0.08	0.05	0.05	3.57		Less than Criteria	0.352		0.108	0.010	0.039	0.055		0.045	0.004	0.044	0.370		0.111	0.007	0.041	0.776		Less than Criteria
FEEBRIS08-1B.028-029GP-D	28	29	pCi/g	1.73		0.34	0.23	0.48	0.83	J	0.37	0.38	0.82	2.56		Less than Criteria	10.39	Q	2.65	0.01	0.07	0.19		0.11	0.07	0.07	10.6		Exceeds Criteria	0.415		0.105	0.006	0.025	0.046		0.036	0.001	0.039	0.430		0.107	0.002	0.022	0.890		Less than Criteria
FEEBRIS08-1B.029-030GP	29	30	pCi/g	0.58		0.15	0.06	0.14	0.13	U	0.20	0.16	0.36	0.71	*	Less than Criteria	0.81		0.24	0.01	0.05	0.13		0.07	0.05	0.05	0.93		Less than Criteria	0.744		0.169	0.007	0.028	0.056		0.043	0.002	0.034	0.501		0.131	0.003	0.032	1.301		Less than Criteria
FEEBRIS1-2.023-024GP	23	24	pCi/g	1.45		0.26	0.17	0.35	1.27	J	0.33	0.26	0.55	2.72		Less than Criteria	1.09		0.29	0.00	0.03	0.54		0.16	0.04	0.04	1.63		Less than Criteria	0.527		0.125	0.013	0.038	0.043		0.035	0.003	0.035	0.373		0.100	0.004	0.030	0.943		Less than Criteria
FEEBRIS1-2.028-029GP	28	29	pCi/g	0.85		0.24	0.16	0.33	0.23	UJ	0.29	0.24	0.53	1.08	*	Less than Criteria	0.64		0.19	0.01	0.04	0.06	U	0.05	0.04	0.04	0.70	*	Less than Criteria	0.224		0.077	0.009	0.033	0.013	U	0.020	0.002	0.030	0.162		0.064	0.002	0.024	0.399	*	Less than Criteria
FEEBRIS13-6.021-022	21	22	pCi/g	1.42		0.22	0.11	0.22	1.24	J	0.25	0.61	0.78	2.66		Less than Criteria	2.75		0.68	0.02	0.10	1.21		0.34	0.08	0.07	3.95		Less than Criteria	0.913		0.240	0.012	0.052	0.108		0.087	0.001	0.093	1.096		0.269	0.004	0.052	2.116		Less than Criteria
FEEBRIS13-6.021-022D	21	22	pCi/g	1.26		0.19	0.11	0.22	1.10		0.21	0.14	0.30	2.35		Less than Criteria	1.40		0.39	0.00	0.08	1.11		0.32	0.07	0.08	2.51		Less than Criteria	0.996		0.271	0.012	0.085	0.102		0.086	0.004	0.073	1.006		0.272	0.002	0.085	2.105		Less than Criteria
FEEBRIS13-6.039-040	39	40	pCi/g	1.16		0.18	0.10	0.21	1.34		0.24	0.15	0.32	2.50		Less than Criteria	1.38		0.43	0.02	0.11	0.97		0.32	0.13	0.14	2.35		Less than Criteria	0.808		0.316	0.026	0.109	0.086	U	0.112	0.011	0.155	1.044		0.370	0.003	0.157	1.939	*	Less than Criteria
FEEBRIS1C-12.048-049GP	48	49	pCi/g	1.46	J	0.39	0.29	0.60	1.48	J	0.65	0.61	1.29	2.94		Less than Criteria	1.74		0.52	0.02	0.08	0.14	U	0.10	0.12	0.12	1.88	*	Less than Criteria	0.535		0.137	0.010	0.038	0.012	U	0.023	0.004	0.043	0.555		0.140	0.003	0.032	1.102	*	Less than Criteria
FEEBRIS1C-12.049-050GP	49	50	pCi/g	1.53		0.24	0.11	0.23	1.01	J	0.33	0.30	0.62	2.54		Less than Criteria	0.43		0.16	0.00	0.04	0.17		0.09	0.05	0.04	0.60		Less than Criteria	0.612		0.132	0.006	0.024	0.061		0.040	0.001	0.026	0.479		0.113	0.001	0.021	1.152		Less than Criteria
FEEBRIS1C-12B.053-054GP	53	54	pCi/g	1.14		0.29	0.20	0.41	0.63	UJ	0.38	0.32	0.70	1.77	*	Less than Criteria	0.66		0.23	0.02	0.08	0.34		0.14	0.06	0.06	0.99		Less than Criteria	0.621		0.152	0.018	0.051	0.033	U	0.037	0.007	0.052	0.723		0.167	0.009	0.044	1.377	*	Less than Criteria
FEEBRIS1C-12B.054-055GP	54	55	pCi/g	1.86		0.26	0.12	0.25	1.02		0.26	0.20	0.43	2.88		Less than Criteria	9.41		2.17	0.00	0.04	0.39		0.14	0.05	0.04	9.80		Exceeds Criteria	0.523		0.125	0.015	0.042	0.043		0.036	0.004	0.038	0.608		0.137	0.005	0.033	1.174		Less than Criteria
FEEBRIS1C-12C.055-056GP	55	56	pCi/g	31.01	J	2.47	0.51	1.04	1.25	UJ	0.67	0.60	1.23	32.25	*	Exceeds Criteria	398.76		91.99	0.00	0.04	2.19		0.55	0.06	0.04	401.0		Exceeds Criteria	1.826		0.340	0.018	0.054	0.223		0.096	0.001	0.056	1.924		0.354	0.026	0.069	3.972		Less than Criteria
FEEBRIS1C-2RA.028-029GP	28	29	pCi/g	2.17		0.34	0.14	0.18	1.16	J	0.52	0.42	0.90	3.32		Less than Criteria	2.47		0.53	0.00	0.03	0.27		0.09	0.03	0.02	2.73		Less than Criteria	0.467		0.125	0.014	0.045	0.047		0.039	0.002	0.034	0.589		0.145	0.010	0.045	1.103		Less than Criteria
FEEBRIS1C-4R.046-047GP	46	47	pCi/g	1.74		0.23	0.10	0.20	0.65		0.19	0.20	0.43	2.39		Less than Criteria	4.45		1.10	0.01	0.06	0.08	U	0.06	0.06	0.05	4.53	*	Less than Criteria	0.880		0.256	0.019	0.074	0.032	U	0.055	0.001	0.097	0.905		0.260	0.008	0.068	1.817	*	Less than Criteria
FEEBRIS1C-4RB.046-047GP	46	47	pCi/g	1.20		0.19	0.11	0.24	0.66		0.24	0.23	0.49	1.86		Less than Criteria	2.03		0.61	0.01	0.06	0.18	U	0.11	0.07	0.08	2.21	*	Less than Criteria	0.547		0.196	0.016	0.068	0.035	U	0.060	0.001	0.105	0.584		0.205	0.009	0.074	1.166	*	Less than Criteria
FEEBRIS1C-6TI.022-023GP	22	23	pCi/g	1.45		0.20	0.12	0.16	0.84		0.21	0.17	0.36	2.29		Less than Criteria	0.39		0.14	0.00	0.03	0.21		0.09	0.04	0.05	0.60		Less than Criteria	0.603		0.130	0.008	0.029	0.052		0.036	0.002	0.029	0.535		0.120	0.002	0.023	1.190		Less than Criteria
FEEBRISIC-6.019-020	19	20	pCi/g	1.40		0.19	0.11	0.23	1.13		0.23	0.18	0.37	2.54		Less than Criteria	1.29		0.38	0.01	0.06	1.71		0.45	0.08	0.06	3.00		Less than Criteria	1.263		0.297	0.019	0.071	0.101		0.082	0.008	0.082	1.030		0.260	0.012	0.075	2.394		Less than Criteria
FEEBRISIC-6.024-025	24	25	pCi/g	2.65		0.29	0.09	0.19	1.28		0.24	0.23	0.48	3.94		Less than Criteria	51.01		10.82	0.01	0.07	1.43		0.40	0.09	0.09	52.4		Exceeds Criteria	1.462		0.356	0.018	0.073	0.170		0.119	0.001	0.113	1.489		0.359	0.004	0.064	3.120		Less than Criteria
FEEBRISIC-6.025-026	25	26	pCi/g	7.04	J	0.94	0.34	0.71	0.13	UJ	0.63	0.46	1.01	7.17	*	Less than Criteria	239.82		52.04	0.01	0.09	1.09		0.33	0.09	0.07	240.9		Exceeds Criteria	1.078		0.266	0.020	0.072	0.099		0.079	0.005	0.071	1.037		0.262	0.049	0.117	2.214		Less than Criteria
FEEBRISIC-6.026-027	26	27	pCi/g	8.79	J	0.95	0.30	0.62	0.43	UJ	0.71	0.57	1.20	9.22	*	Exceeds Criteria	201.96		39.97	0.00	0.05	0.88		0.25	0.06	0.07	202.8		Exceeds Criteria	1.150		0.272	0.013	0.056	0.041	U	0.049	0.003	0.060	1.120		0.267	0.007	0.061	2.310	*	Less than Criteria
FEEBRISWL-119.001-002	1	2	pCi/g	1.19		0.18	0.09	0.19	0.77		0.15	0.15	0.31	1.96		Less than Criteria	0.45		0.19	0.01	0.07	0.30		0.14	0.08	0.07	0.76		Less than Criteria	0.608		0.203	0.024	0.086	0.015	U	0.035	0.004	0.074	0.864		0.250	0.014	0.086	1.486	*	Less than Criteria
FEEBRISWL119.005-006	5	6	pCi/g	1.35		0.19	0.09	0.19	1.39		0.23	0.17	0.37	2.75		Less than Criteria	1.38		0.38	0.01	0.08	1.29		0.34	0.07	0.06	2.67		Less than Criteria	1.019		0.270	0.028	0.091	0.179		0.114	0.008	0.089	0.957		0.258	0.006	0.066	2.155		Less than Criteria
FEEBRISWL-119.009-010	9	10	pCi/g	1.31		0.21	0.10	0.21	1.26	J	0.28	0.25	0.53	2.57		Less than Criteria	0.55		0.20	0.01	0.06	0.40		0.16	0.07	0.05	0.95		Less than Criteria	0.762		0.209	0.013	0.055	0.029	U	0.049	0.001	0.086	0.806		0.216	0.003	0.048	1.597	*	Less than Criteria
FEEBRISWL-119.009-010D	9	10	pCi/g	1.41		0.21	0.12	0.24	1.32		0.24	0.20	0.42	2.72		Less than Criteria	0.58		0.19	0.01	0.05	0.52		0.17	0.05	0.06	1.10		Less than Criteria	0.578		0.172	0.012	0.051	0.011	U	0.026	0.003	0.054	0.485		0.155	0.001	0.063	1.074	*	Less than Criteria
FEEBRISWL-119.020-021	20	21	pCi/g	1.08		0.19	0.14	0.28	1.11		0.24	0.23	0.49	2.18		Less than Criteria	0.49		0.18	0.01	0.07	0.42		0.16	0.07	0.07	0.91		Less than Criteria	0.306		0.121	0.009	0.065	0.027	U	0.046	0.001	0.081	0.474		0.153	0.005	0.052	0.807	*	Less than Criteria
FEEBRISWL-119.034-035GP	34	35	pCi/g	1.28	J	0.32	0.24	0.51	1.36	J	0.43	0.43	0.91	2.64		Less than Criteria	0.38		0.13	0.01	0.05	0.31		0.11	0.04	0.04	0.69		Less than Criteria	0.600		0.164	0.011	0.043	0.025	U	0.035	0.005	0.054	0.577		0.160	0.001	0.049	1.203	*	Less than Criteria
FEEBRISWL-119.040-041	40	41	pCi/g	0.51		0.17	0.15	0.31	0.88		0.22	0.19	0.41	1.39		Less than Criteria	0.31		0.15	0.00	0.09	0.13	U	0.09	0.09	0.08	0.44	*	Less than Criteria	0.218		0.107	0.014	0.059	0.091		0.080	0.001	0.091	0.121		0.078	0.004	0.051	0.430		Less than Criteria
FEEBRISWL-119.041-042	41	42	pCi/g	1.39		0.23	0.13	0.28	1.24	J	0.26	0.36	0.75	2.63		Less than Criteria	0.63		0.22	0.01	0.06	0.57		0.20	0.07	0.06	1.20		Less than Criteria	0.421		0.145	0.016	0.062	0.110		0.082	0.010	0.081	0.477		0.155	0.005	0.052	1.009		Less than Criteria
FEEBRISWL119.051-052	51	52	pCi/g	0.40		0.09	0.07	0.04	0.52		0.12	0.10	0.22	0.92		Less than Criteria	0.57		0.32	0.07	0.25	0.55		0.30	0.19	0.18	1.12		Less than Criteria	0.408		0.140	0.013	0.052	0.062	U	0.059	0.005	0.064	0.419		0.142	0.003	0.045	0.890	*	Less than Criteria
FEEBRISWL-119B.038-039GP	38	39	pCi/g	1.57		0.33	0.23	0.48	1.44	J	0.37	0.38	0.81	3.01		Less than Criteria	0.65		0.19	0.01	0.05	0.56		0.16	0.05	0.05	1.20		Less than Criteria	0.356		0.099	0.006	0.024	0.027	U	0.028	0.001	0.029	0.349		0.098	0.001	0.034	0.732	*	Less than Criteria
FEEBRISWL-119C.043-044GP	43	44	pCi/g	1.31		0.20	0.13	0.27	0.98		0.21	0.16	0.35	2.30		Less than Criteria	3.03		0.68	0.00	0.04	0.40		0.13	0.04	0.04	3.44		Less than Criteria	0.480		0.118	0.005	0.023	0.020	U	0.024	0.001	0.029	0.527		0.125	0.003	0.029	1.026	*	Less than Criteria
FEEBRISWL-119C.045-046GP	45	46	pCi/g	0.87		0.18	0.16	0.34	0.32	U	0.25	0.21	0.46	1.19	*	Less than Criteria	4.20	Q	1.37	0.01	0.10	0.46		0.23	0.11	0.10	4.67		Less than Criteria	0.477		0.114	0.009	0.032	0.038		0.033	0.000	0.038	0.377		0.098	0.001	0.021	0.892		Less than Criteria
Phase 1D data (and Cotter samples from Core of Phase 1D borings)																																															
FEEBRIS1D-01.007-009	7	9	pCi/g	1.08	U	0.20	1.66	0.28	0.95		0.23	0.27	0.57	2.04	*	Less than Criteria	1.65	J+	0.45	0.08	0.08	0.39	J	0.16	0.01	0.07	2.05		Less than Criteria	0.441	J-	0.163	0.032		0.039	J	0.054	0.007		0.367	J	0.145	0.014		0.85		Less than Criteria
FEEBRIS1D-01.024-027	24	27	pCi/g	1.11	U	0.28	1.56	0.44	0.47	J	0.32	0.28	0.62	1.58	*	Less than Criteria	1.21	J+	0.34	0.07	0.07	0.11	J	0.08	0.01	0.06	1.31		Less than Criteria	0.869	J-	0.219	0.007		0.080	J	0.070	0.001		0.774	J	0.204	0.001		1.72		Less than Criteria
FEEBRIS1D-02.020-023	20	23	pCi/g	1.26		0.18	1.24	0.30	1.12		0.30	0.26	0.54	2.38		Less than Criteria	0.84	J+	0.25	0.05	0.05	0.45	J	0.16	0.00	0.05	1.29		Less than Criteria	0.314	J-	0.135	0.008		0.047	J	0.057	0.003		0.288	J	0.128	0.005		0.65		Less than Criteria
FEEBRIS1D-02.027-030	27	30	pCi/g	1.14	U	0.23	1.51	0.34	1.05		0.35	0.27	0.58	2.19	*	Less than Criteria	0.68	J+	0.24	0.07	0.06	0.18	J	0.11	0.01	0.07	0.87		Less than Criteria	0.250	J-	0.136	0.010		0.078	J	0.085	0.007		0.371	J	0.166	0.007		0.70		Less than Criteria
FEEBRIS1D-02.036-037	36	37	pCi/g	1.01	U	0.30	1.66	0.45	0.85	J	0.45	0.40	0.86	1.86	*	Less than Criteria	0.72	J+	0.26	0.08	0.08	0.70	J	0.25	0.01	0.08	1.42		Less than Criteria	0.252	J-	0.111	0.003		0.043	J	0.056	0.001		0.295	J	0.121	0.005		0.59		Less than Criteria
FEEBRIS1D-03.028-029	28	29	pCi/g	188.12	J+	14.14	20.89	3.24	2.14	U	3.05	2.33	4.76	190.26	*	Exceeds Criteria	615.58	J+	127.85	0.08	0.09	4.07		0.92	0.01	0.0636	620		Exceeds Criteria	9.356		1.518	0.007		0.727		0.249	0.012		9.272		1.505	0.001		19.36		Less than Criteria
FEEBRIS1D-03.041-043	41	43	pCi/g	1.22	U	0.23	1.33	0.32	0.74		0.25	0.20	0.45	1.97	*	Less than Criteria	1.59	J+	0.43	0.07	0.07	0.21	J	0.11	0.00	0.07	1.80		Less than Criteria	0.220	J	0.109	0.008		0.000	UJ	0.043	0.001		0.276	J	0.124	0.001		0.50	*	Less than Criteria
FEEBRIS1D-03.041-043 FD	41	43	pCi/g	0.41	U	0.22	1.50	0.57	0.29	J	0.32	0.26	0.58	0.70	*	Less than Criteria	0.73	J+	0.24	0.06	0.06	0.10	J	0.07	0.00	0.07	0.83		Less than Criteria	0.146	J	0.103	0.002		0.040	J	0.068	0.001		0.057	J	0.065	0.009		0.24		Less than Criteria
FEEBRIS1D-4.061-062	61	62	pCi/g	1.25	U	0.20	1.31	0.21	1.15		0.27	0.23	0.50	2.40	*	Less than Criteria	1.84	J	0.62	0.18	0.18	1.47	J	0.51	0.01	0.15	3.31		Less than Criteria	2.832		1.260	0.058		0.323	J	0.549	0.009		2.776		1.255	0.098		5.93		Less than Criteria
FEEBRIS1D-4.064-065	64	65	pCi/g	0.86		0.15	0.77	0.21	0.70		0.18	0.15	0.32	1.56		Less than Criteria	0.77	J	0.25	0.09	0.11	0.66	J	0.22	0.04	0.12	1.43		Less than Criteria	1.418		0.617	0.048		0.375		0.364	0.004		1.785		0.696	0.035		3.58		Less than Criteria
FEEBRIS1D-5.051-052	51	52	pCi/g	53.91		4.27	7.67	0.75	1.35		0.65	0.70	1.45	55.25		Exceeds Criteria	216.29	J	42.31	0.06	0.05	1.94	J	0.45	0.01	0.06	218		Exceeds Criteria	0.230		0.135	0.042		0.136		0.107	0.011		0.179		0.129	0.062		0.54		Less than Criteria
FEEBRIS1D-5.063-064	63	64	pCi/g	1.06	U	0.18	1.18	0.21	0.84		0.22	0.22	0.471	1.90	*	Less than Criteria	0.45		0.19	0.07	0.09	0.19	J	0.11	0.01	0.09	0.65		Less than Criteria	0.273	J	0.175	0.016		0.059	J	0.072	0.015		0.263	J	0.147	0.007		0.59		Less than Criteria
FEEBRIS1D-6.080-081	80	81	pCi/g	0.59	U	0.22	1.05	0.36	1.11		0.25	0.23	0.50	1.70	*	Less than Criteria	0.42		0.19	0.13	0.14	0.31		0.16	0.05	0.14	0.73		Less than Criteria	2.235		0.447	0.001		0.114		0.092	0.001		2.195		0.441	0.019		4.54		Less than Criteria
FEEBRIS1D-6.085-086	85	86	pCi/g	0.50	U	0.13	1.09	0.20	0.47		0.22	0.23	0.49	0.97	*	Less than Criteria	0.50	J	0.19	0.08	0.07	0.19	J	0.11	0.01	0.07	0.69		Less than Criteria	0.171	J	0.119	0.018		0.019	J	0.046	0.004		0.307	J	0.157	0.011		0.50		Less than Criteria
FEEBRIS1D-7.084-085	84	85	pCi/g	3,630.35		242.46	104.91	11.74	31.85		9.45	8.29	16.66	3,662.19		Exceeds Criteria	16,702.67		3,436.82	20.91	23.01	178.26		53.11	8.73	22.59	16,881		Exceeds Criteria	372.91		166.87	9.887		40.91	J	69.74	1.086		222.72		126.43	9.376		636.5		Exceeds Criteria
FEEBRIS1D-7.093-094	93	94	pCi/g	1.50		0.28	1.37	0.22	0.61		0.31	0.23	0.51	2.11		Less than Criteria	18.03		4.29	0.10	0.10	0.38		0.19	0.02	0.12	18.40		Exceeds Criteria	0.164		0.099	0.001		0.051	J	0.067	0.001		0.216		0.111	0.003		0.43		Less than Criteria
FEEBRIS1D-8.075-076	75	76	pCi/g	4.54		0.47	1.77	0.40	0.94		0.27	0.24	0.50	5.48		Less than Criteria	3.54	J	0.93	0.13	0.15	0.24	J	0.16	0.02	0.13	3.77		Less than Criteria	0.659	UJ	0.476	0.244		0.259	UJ	0.376	0.086		0.585	UJ	0.681	0.391		Non-detect	*	Non-detect
FEEBRIS1D-8.090-091	90	91	pCi/g	0.51	U	0.10	0.69	0.13	0.69		0.18	0.17	0.36	1.19	*	Less than Criteria	0.99	J	0.36	0.12	0.116	0.75	J	0.25	0.01	0.07	1.74		Less than Criteria	0.899	J	0.520	0.031		0.248	J	0.301	0.017		0.825	J	0.496	0.029		1.97		Less than Criteria
FEEBRIS1D-09.078-079	78	79	pCi/g	0.21	U	0.25	2.37	0.43	0.16	U	0.44	0.33	0.74	Non-detect	*	Non-detect	0.34	J+	0.15	0.07	0.07	0.19	J	0.11	0.01	0.07	0.53		Less than Criteria	0.064	J-	0.057	0.007		0.055	J	0.057	0.003		0.040	J	0.046	0.007		0.16		Less than Criteria
FEEBRIS1D-09.088-089	88	89	pCi/g	40.20	J	9.94	4.59	1.05	3.58	U	2.31	0.49	4.24	43.78	*	Exceeds Criteria	905.57	J+	180.92	0.24	0.289	3.76	J	1.08	0.10	0.376	909.3		Exceeds Criteria	3.407	J-	0.989	0.068		0.619	UJ	0.430	0.111		3.229	J	0.961	0.102		7.25	*	Less than Criteria
FEEBRIS1D-09.099-100	99	100	pCi/g	0.66	U	0.10	1.25	0.166	0.48		0.13	0.21	0.29	1.14	*	Less than Criteria	3.41	J+	0.82	0.07	0.08	0.19	J	0.11	0.01	0.08	3.60		Less than Criteria	0.276	J-	0.142	0.036		0.127	J	0.101	0.006		0.275	J	0.126	0.012		0.68		Less than Criteria
FEEBRIS1D-10.046-049	46	49	pCi/g	1.34	U	0.24	1.43	0.34	1.58		0.29	0.25	0.54	2.92	*	Less than Criteria	0.46	J	0.17	0.06	0.06	0.33	J	0.13	0.00	0.05	0.79		Less than Criteria	0.209	J	0.130	0.005		0.063	J+	0.082	0.008		0.458	J	0.198	0.005		0.73		Less than Criteria
FEEBRIS1D-10.074-076	74	76	pCi/g	0.81	U	0.20	1.14	0.26	0.66		0.23	0.19	0.43	1.47	*	Less than Criteria	0.31		0.13	0.06	0.06	0.32		0.13	0.01	0.06	0.62		Less than Criteria	0.376		0.160	0.024		0.155	J+	0.110	0.008		0.332		0.156	0.051		0.86		Less than Criteria
FEEBRIS1D-11.085-086	85	86	pCi/g	24.40	J+	1.86	2.84	0.55	1.10		0.44	0.39	0.80	25.50		Exceeds Criteria	119.05	J+	24.07	0.06	0.07	1.35		0.34	0.00	0.05	120.4		Exceeds Criteria	1.485		0.330	0.001		0.074	J	0.072	0.001		1.412		0.318	0.007		2.97		Less than Criteria
FEEBRIS1D-11.087-088	87	88	pCi/g	0.73	U	0.13	0.96	0.17	0.68		0.18	0.14	0.29	1.42	*	Less than Criteria	1.38	J+	0.36	0.05	0.06	0.26	J	0.11	0.00	0.04	1.64		Less than Criteria	0.859		0.243	0.019		0.065	J	0.074	0.014		0.736		0.223	0.032		1.66		Less than Criteria
FEEBRIS1D-12.061-062	61	62	pCi/g	0.58	U	0.47	2.50	0.74	-0.37	U	0.67	0.36	0.86	Non-detect	*	Non-detect	0.73	J+	0.24	0.07	0.06	0.16	J	0.10	0.00	0.06	0.89		Less than Criteria	0.107	J	0.077	0.004		0.014	J	0.033	0.003		0.077	J	0.066	0.006		0.20		Less than Criteria
FEEBRIS1D-12.074-075	74	75	pCi/g	1.02	U	0.18	1.58	0.23	1.09		0.23	0.19	0.40	2.11	*	Less than Criteria	0.35	J+	0.14	0.05	0.04	0.17	J	0.09	0.01	0.06	0.51		Less than Criteria	0.230		0.112	0.010		0.028	J	0.043	0.003		0.212	J	0.115	0.039		0.47		Less than Criteria
FEEBRIS1D-13.085-086	85	86	pCi/g	1.17	U	0.19	1.56	0.28	1.11		0.25	0.25	0.52	2.28	*	Less than Criteria	0.62	J+	0.21	0.06	0.06	0.52	J	0.18	0.00	0.06	1.13		Less than Criteria	0.300	J-	0.175	0.015		0.059	J	0.101	0.002		0.275	J	0.167	0.014		0.63		Less than Criteria
FEEBRIS1D-13.093-094	93	94	pCi/g	4.22		0.37	1.48	0.28	0.46	J	0.21	0.20	0.358	4.68		Less than Criteria	4.27	J+	0.97	0.11	0.07	0.26	J	0.15	0.01	0.06	4.54		Less than Criteria	2.772	J-	0.584	0.016		0.313	J	0.180	0.008		3.630	J	0.707	0.063		6.71		Less than Criteria
FEEBRIS1D-14.054-056	54	55	pCi/g	0.40	U	0.30	2.37	0.53	0.14	U	0.51	0.38	0.85	Non-detect	*	Non-detect	0.21	J+	0.10	0.07	0.08	0.02	UJ	0.05	0.03	0.09	0.23	*	Less than Criteria	0.215	J-	0.104	0.003		0.012	J	0.030	0.003		0.094	J	0.068	0.003		0.32		Less than Criteria
FEEBRIS1D-14.082-084	82	84	pCi/g	1.31	U	0.27	1.52	0.14	0.87		0.32	0.49	1.03	2.18	*	Less than Criteria	0.74	J+	0.24	0.06	0.05	0.34	J	0.14	0.01	0.06	1.08		Less than Criteria	0.397	J-	0.179	0.008		0.022	J	0.065	0.020		0.410	J	0.183	0.011		0.83		Less than Criteria
FEEBRIS1D-15.077-080	77	80	pCi/g	0.70	U	0.19	1.03	0.30	0.49		0.21	0.26	0.55	1.20	*	Less than Criteria	0.20	J+	0.10	0.05	0.06	0.04	J	0.06	0.04	0.09	0.24		Less than Criteria	0.144	J	0.089	0.010		-0.005	U	0.032	0.005		0.078	J	0.067	0.012		0.22	*	Less than Criteria
FEEBRIS1D-15.085-086	85	86	pCi/g	8.82	J+	0.85	2.85	0.48	0.24	U	0.42	0.32	0.68	9.06	*	Exceeds Criteria	30.86	J+	6.16	0.05	0.05	0.31	J	0.12	0.01	0.06	31.17		Exceeds Criteria	0.462		0.158	0.007		0.036	J	0.050	0.007		0.477		0.161	0.001		0.98		Less than Criteria
FEEBRIS1D-16.050-051	50	51	pCi/g	33.46		2.76	5.55	0.84	0.98		0.65	0.74	1.52	34.44		Exceeds Criteria	971.46	J	198.37	0.06	0.05	6.45	J	1.31	0.01	0.07	977.92		Exceeds Criteria	5.034	J	1.003	0.047		0.303	J	0.191	0.039		4.773	J	0.961	0.063		10.11		Less than Criteria

Table 2-3: Area 1 Combined Radium, Thorium, and Uranium Results (RI Borings, Phases 1C and 1D, A1 Additional Borings, and Cotter Borings)

DRAFT

Sample Designation	Upper Sample Depth (feet)	Lower Sample Depth (feet)	Units	Radium-226 Result	Final Q	CSU[1]	CV	MDA	Radium-228 Result	Final Q	CSU[1]	CV	MDA	Combined Radium 226 + 228		Combined Radium relative to 7.9 pCi/g Unrestricted Use Criteria	Thorium-230 Result	Final Q	CSU[1]	CV	MDA	Thorium-232 Result	Final Q	CSU[1]	CV	MDA	Combined Thorium 230 + 232		Combined Thorium relative to 7.9 pCi/g Unrestricted Use Criteria
FEEBRIS1D-16.059-061	59	61	pCi/g	0.58	U	0.21	1.21	0.30	0.66		0.34	0.33	0.70	1.24	*	Less than Criteria	0.61		0.23	0.08	0.07	0.28		0.14	0.01	0.08	0.89		Less than Criteria
FEEBRIS1D-16.059-061 FD	59	61	pCi/g	0.52	U	0.17	1.20	0.23	0.59		0.28	0.27	0.59	1.11	*	Less than Criteria	0.37		0.24	0.21	0.23	0.27		0.18	0.01	0.13	0.64		Less than Criteria
FEEBRIS1D-17.030-031	30	31	pCi/g	0.38	U	0.21	1.46	0.40	0.39	J	0.41	0.35	0.75	0.77	*	Less than Criteria	0.35	J+	0.15	0.06	0.06	0.15	J	0.09	0.01	0.07	0.51		Less than Criteria
FEEBRIS1D-17.033-036	33	36	pCi/g	0.75	U	0.26	1.54	0.19	0.41	J	0.36	0.32	0.70	1.16	*	Less than Criteria	4.00	J+	0.97	0.08	0.07	0.18	J	0.12	0.04	0.13	4.18		Less than Criteria
FEEBRIS1D-18.013-014	13	14	pCi/g	0.76	U	0.16	1.24	0.20	0.31	J	0.16	0.12	0.27	1.07	*	Less than Criteria	0.56	J+	0.20	0.06	0.05	0.16	J	0.09	0.01	0.06	0.71		Less than Criteria
FEEBRIS1D-18.038-041	38	41	pCi/g	0.52	U	0.20	1.58	0.53	0.26	U	0.35	0.29	0.63	Non-detect	*	Non-detect	5.97	J+	1.38	0.07	0.07	0.05	J	0.06	0.00	0.06	6.03		Less than Criteria
FEEBRIS1D-18.044-046	44	46	pCi/g	1.34		0.21	1.33	0.22	1.40		0.27	0.25	0.52	2.74		Less than Criteria	1.29	J+	0.38	0.07	0.06	0.78	J	0.26	0.00	0.09	2.07		Less than Criteria
FEEBRIS1D-19.061-063	61	63	pCi/g	1.17	U	0.32	2.31	0.429	1.23		0.50	0.46	0.973	2.40	*	Less than Criteria	1.08	J	0.35	0.09	0.08	0.54	J	0.22	0.01	0.09	1.62		Less than Criteria
FEEBRIS1D-19.061-063 FD	61	63	pCi/g	1.28	J+	0.18	1.20	0.20	1.08		0.24	0.27	0.55	2.36		Less than Criteria	0.70		0.24	0.09	0.10	0.24	J	0.13	0.02	0.10	0.94		Less than Criteria
FEEBRIS1D-20.080-081	80	81	pCi/g	0.71	U	0.10	0.75	0.04	0.08	J	0.10	0.08	0.17	0.80	*	Less than Criteria	1.36	J	0.59	0.23	0.27	0.38	J	0.28	0.04	0.28	1.73		Less than Criteria
FEEBRIS1D-20.080-081 FD	80	81	pCi/g	0.83	U	0.13	0.91	0.12	0.05	U	0.15	0.12	0.26	Non-detect	*	Non-detect	1.43		0.51	0.14	0.14	0.14	J	0.12	0.01	0.10	1.57		Less than Criteria
FEEBRIS1D-20.089-090	89	90	pCi/g	1.33	U	0.19	1.44	0.22	1.15		0.23	0.20	0.42	2.47	*	Less than Criteria	1.43		0.49	0.14	0.11	1.20		0.42	0.02	0.15	2.63		Less than Criteria
Area 1 Additional Borings																													
FEEBRISAC-1.010-011	10	11	pCi/g	4,926.29		342.65	139.45	28.69	14.76	U	20.68	15.54	31.25	4,941	*	Exceeds Criteria	7,908	J+	1,823	8.73	11.06	257.04		69.58	5.04	15.70	8,165		Exceeds Criteria
FEEBRISAC-1.030-031	30	31	pCi/g	49.46		3.87	5.65	0.99	0.98	J	0.77	0.57	1.17	50.4		Exceeds Criteria	1,946		436.40	0.10	0.11	10.16		2.21	0.00	0.06	1,956		Exceeds Criteria
FEEBRISAC-2B.010-012	10	12	pCi/g	8.95		0.83	2.16	0.38	0.56	J	0.32	0.39	0.80	9.5		Exceeds Criteria	472.18		110.55	0.08	0.09	2.91		0.74	0.01	0.08	475.08		Exceeds Criteria
FEEBRISAC-2B.023-026	23	26	pCi/g	0.98	U	0.26	1.65	0.41	1.27		0.36	0.37	0.79	2.25	*	Less than Criteria	1.79		0.47	0.07	0.08	0.77		0.23	0.01	0.07	2.56		Less than Criteria
FEEBRISAC-3.005-006	5	6	pCi/g	2,599.36		183.37	112.63	20.25	6.28	U	15.98	12.01	24.24	2,606	*	Exceeds Criteria	17,784	J+	3,962	8.73	11.27	514.88		120.66	2.57	12.02	18,299		Exceeds Criteria
FEEBRISAC-3.044-045	44	45	pCi/g	0.40	U	0.20	1.07	0.31	0.26	J	0.31	0.25	0.55	0.66	*	Less than Criteria	0.59		0.20	0.06	0.07	0.39		0.15	0.01	0.06	0.98		Less than Criteria
FEEBRISAC-4B.013-014	13	14	pCi/g	0.62	U	0.36	1.96	0.63	0.91		0.41	0.47	1.03	1.53	*	Less than Criteria	1.96		0.51	0.06	0.05	0.24		0.11	0.00	0.05	2.20		Less than Criteria
FEEBRISAC-4B.032-033	32	33	pCi/g	1.01	U	0.16	1.12	0.23	1.16		0.19	0.12	0.26	2.17	*	Less than Criteria	4.62	J	1.03	0.06	0.06	0.92	J	0.25	0.01	0.05	5.54		Less than Criteria
FEEBRISAC-4B.032-033 FD	32	33	pCi/g	0.96	U	0.14	0.99	0.16	1.20		0.23	0.21	0.44	2.16	*	Less than Criteria	1.38	J	0.40	0.06	0.06	0.90		0.28	0.00	0.07	2.27		Less than Criteria
FEEBRISAC-5.011-012	11	12	pCi/g	1.11	U	0.16	1.17	0.19	1.27		0.23	0.16	0.34	2.38	*	Less than Criteria	3.28		0.81	0.06	0.06	1.04	J	0.30	0.01	0.06	4.32		Less than Criteria
FEEBRISAC-5.025-026	25	26	pCi/g	0.80	U	0.13	0.94	0.17	0.84		0.18	0.14	0.30	1.65	*	Less than Criteria	1.20		0.31	0.05	0.05	1.03		0.26	0.00	0.03	2.24		Less than Criteria
FEEBRISAC-6.013-016	13	16	pCi/g	1.05	U	0.14	1.28	0.24	1.21		0.21	0.17	0.35	2.26	*	Less than Criteria	0.97		0.31	0.08	0.08	1.25		0.36	0.01	0.08	2.22		Less than Criteria
FEEBRISAC-6.023-026	23	26	pCi/g	0.60	U	0.11	0.88	0.12	0.70		0.16	0.14	0.29	1.30	*	Less than Criteria	1.36	J	0.37	0.07	0.07	0.50	J	0.17	0.01	0.06	1.86		Less than Criteria
FEEBRISAC-7.022-023	22	23	pCi/g	1.20	U	0.22	1.26	0.30	1.40		0.24	0.30	0.63	2.60	*	Less than Criteria	1.45		0.38	0.05	0.05	1.23		0.32	0.00	0.05	2.68		Less than Criteria
FEEBRISAC-7.032-033	32	33	pCi/g	0.73	U	0.21	1.36	0.32	0.90		0.33	0.31	0.66	1.63	*	Less than Criteria	0.86		0.29	0.07	0.07	0.50		0.20	0.03	0.11	1.37		Less than Criteria
Cotter Borings																													
WL102CTA.002-003	2	3	pCi/g	1.03		0.147	0.0289	0.073	0.137	U	0.25	0.196	0.422	1.17	*	Less than criteria	5.81	J+	0.423	0.007	0.023	0.826	J	0.159	0.01	0.0371	6.64		Less than criteria
WL-102-CT-A	4	5	pCi/g	0.581	J+	0.269	0.34	0.143	0.122	UJ	0.433	0.758	0.346	0.703	*	Less than criteria	4.43	J+	0.378	0.05	0.013	0.577		0.136	0.04	0.0104	5.01		Less than criteria
WL-102-CT-A DUP	4	5	pCi/g	6.75	J+	0.577	0.258	0.111	0.054	UJ	0.24	0.417	0.193	6.80	*	Less than criteria	1.82	J+	0.235	0.054	0.016	0.681		0.144	0.05	0.0138	2.50		Less than criteria
WL102CTA.022-023	22	23	pCi/g	1.41		0.19	0.0332	0.085	1.11		0.317	0.194	0.418	2.52		Less than criteria	1.75	J+	0.236	0.007	0.024	1.23		0.198	0.01	0.0444	2.98		Less than criteria
WL106ACT.004-006	4	6	pCi/g	18		0.611	0.0289	0.073	0.767		0.286	0.185	0.401	19		Exceeds criteria	401	J+	3.58	0.012	0.048	1.14		0.19	0.01	0.0238	402		Exceeds criteria
WL-106A-CT	10	12	pCi/g	9.64	J+	0.685	0.28	0.123	0.271	UJ	0.308	0.506	0.234	9.91	*	Exceeds criteria	165	J+	2.6	0.073	0.021	0.831	J	0.184	0.05	0.0093	166		Exceeds criteria
WL-114-CT	7	8	pCi/g	0.981	J+	0.225	0.18	0.074	0.739		0.343	0.508	0.236	1.720		Less than criteria	4.78	J+	0.404	0.041	0.008	0.885		0.175	0.06	0.0157	5.67		Less than criteria
WL114CT.032-033	32	33	pCi/g	0.458		0.104	0.0324	0.08	0.512		0.25	0.167	0.365	0.970		Less than criteria	0.635	J+	0.138	0.015	0.053	0.47		0.118	0.01	0.0357	1.11		Less than criteria
Cotter Samples from Core of Non-Cotter Borings																													
1-2-CT	39	40	pCi/g	0.72	J+	0.222	0.244	0.105	0.506	UJ	0.34	0.532	0.247	1.23	*	Less than criteria	0.855	J+	0.164	0.044	0.01	0.348		0.104	0.03	0.0048	1.203		Less than criteria
1C-6-CT	25	27	pCi/g	26.7	J+	1.16	0.209	0.086	0.293	U	0.327	0.537	0.247	27.0	*	Exceeds criteria	2,450	J+	95.6	2.79	1.18	2.78	U	3.21	2.78	1.17	2,453	*	Exceeds criteria
1D-16-CT	46	47	pCi/g	2.74	J+	0.369	0.258	0.113	0.324	U	0.284	0.456	0.21	3.06	*	Less than criteria	1.84	J+	0.235	0.022	0.007	0.854		0.16	0.04	0.0069	2.69		Less than criteria
1D-7-CT	83	84	pCi/g	1200	J+	9.25	0.286	0.116	4.94	J	0.485	0.361	0.166	1,205		Exceeds criteria	678,000	J+	15,300	475	109	847	J	538	256	108	678,847		Exceeds criteria
5-3-CT-A	28	30	pCi/g	33.7	J+	1.23	0.19	0.079	0.574	J	0.352	0.546	0.255	34.3		Exceeds criteria	3,660	J+	143	7.71	1.76	7.17	U	6.99	9.12	2.48	3,667	*	Exceeds criteria
5-3-CT-B	33	34	pCi/g	73.9	J+	1.8	0.197	0.082	0.397	U	0.297	0.47	0.217	74.3	*	Exceeds criteria	2,310	J+	158	8.12	3.42	0.449	U	6.25	17.7	4.81	2,310	*	Exceeds criteria

Sample Designation	Uranium-234 Result	Final Q	CSU[1]	CV	MDA	Uranium-235 Result	Final Q	CSU[1]	CV	MDA	Uranium-238 Result	Final Q	CSU[1]	CV	MDA	Combined Uranium 234 + 235 + 238		Combined Uranium relative to 54.4 pCi/g Unrestricted Use Criteria
FEEBRIS1D-16.059-061	0.101	J	0.078	0.011		0.119	J	0.095	0.001		0.176	J	0.100	0.003		0.40		Less than Criteria
FEEBRIS1D-16.059-061 FD	0.077		0.069	0.009		0.032	J	0.048	0.003		0.288	J	0.131	0.006		0.40		Less than Criteria
FEEBRIS1D-17.030-031	0.140	J-	0.089	0.001		0.029	J	0.044	0.003		0.127	J	0.084	0.001		0.30		Less than Criteria
FEEBRIS1D-17.033-036	0.852	J-	0.337	0.018		0.037	J	0.102	0.002		0.471	J	0.242	0.007		1.36		Less than Criteria
FEEBRIS1D-18.013-014	0.420	J-	0.161	0.008		0.048	J	0.058	0.003		0.206	J	0.111	0.001		0.67		Less than Criteria
FEEBRIS1D-18.038-041	0.222	J-	0.115	0.006		0.049	J	0.060	0.003		0.108	J	0.080	0.006		0.38		Less than Criteria
FEEBRIS1D-18.044-046	0.311	J-	0.186	0.012		0.120	J	0.131	0.011		0.283	J	0.177	0.011		0.71		Less than Criteria
FEEBRIS1D-19.061-063	0.471	J	0.189	0.008		0.164	J+	0.112	0.011		0.551	J	0.207	0.010		1.19		Less than Criteria
FEEBRIS1D-19.061-063 FD	0.657	J	0.211	0.004		0.191	J+	0.118	0.003		0.578	J	0.197	0.008		1.43		Less than Criteria
FEEBRIS1D-20.080-081	1.920	J	0.828	0.128		0.140	UJ	0.400	0.205		0.934	J	0.593	0.165		3.00	*	Less than Criteria
FEEBRIS1D-20.080-081 FD	2.100		0.789	0.018		0.475		0.397	0.016		1.040		0.536	0.016		3.62		Less than Criteria
FEEBRIS1D-20.089-090	3.364		1.552	0.100		0.336	J	0.571	0.067		3.975		1.701	0.123		7.68		Less than Criteria
Area 1 Additional Borings																		
FEEBRISAC-1.010-011	183.118		41.377	3.478	8.110	30.504	J+	15.955	0.232	11.431	206.199	J+	44.871	0.531	9.227	419.8		Exceeds Criteria
FEEBRISAC-1.030-031	5.584		0.873	0.010	0.047	0.279		0.121	0.003	0.051	5.512		0.863	0.003	0.041	11.37		Less than Criteria
FEEBRISAC-2B.010-012	1.831		0.366	0.008	0.043	0.085	J	0.068	0.004	0.061	1.908		0.377	0.002	0.062	3.82		Less than Criteria
FEEBRISAC-2B.023-026	0.618		0.173	0.011	0.051	0.034	J	0.041	0.002	0.050	0.604		0.171	0.008	0.055	1.26		Less than Criteria
FEEBRISAC-3.005-006	128.951	J	30.573	2.996	6.941	17.672	J+	10.862	0.425	6.810	140.251	J+	32.240	1.134	6.911	286.9		Exceeds Criteria
FEEBRISAC-3.044-045	0.326	J+	0.133	0.031	0.072	0.049	J	0.059	0.010	0.084	0.343		0.135	0.008	0.057	0.72		Less than Criteria
FEEBRISAC-4B.013-014	0.327	J	0.115	0.015	0.056	0.064	J	0.053	0.002	0.045	0.217	J	0.091	0.005	0.042	0.61		Less than Criteria
FEEBRISAC-4B.032-033	0.472	J	0.137	0.012	0.049	-0.003	UJ	0.021	0.004	0.049	0.448	J	0.132	0.006	0.043	0.92	*	Less than Criteria
FEEBRISAC-4B.032-033 FD	0.566	J	0.152	0.008	0.039	0.112	J	0.070	0.001	0.061	0.521	J	0.145	0.006	0.043	1.20		Less than Criteria
FEEBRISAC-5.011-012	0.801	J	0.200	0.012	0.053	0.054	J	0.052	0.004	0.055	0.849	J	0.207	0.003	0.039	1.70		Less than Criteria
FEEBRISAC-5.025-026	0.476	J	0.145	0.041	0.086	0.080	J	0.061	0.005	0.056	0.659	J	0.171	0.007	0.049	1.22		Less than Criteria
FEEBRISAC-6.013-016	0.672	J	0.175	0.009	0.042	0.033	J	0.043	0.001	0.066	0.662	J	0.173	0.003	0.037	1.37		Less than Criteria
FEEBRISAC-6.023-026	0.406	J	0.134	0.014	0.056	0.079	J	0.061	0.002	0.048	0.495	J	0.149	0.003	0.039	0.98		Less than Criteria
FEEBRISAC-7.022-023	0.829	J	0.195	0.011	0.048	0.069	J	0.055	0.004	0.050	0.803	J	0.191	0.004	0.040	1.70		Less than Criteria
FEEBRISAC-7.032-033	0.392	J	0.121	0.010	0.045	0.036	J	0.039	0.003	0.047	0.477	J	0.135	0.007	0.045	0.91		Less than Criteria
Cotter Borings																		
WL102CTA.002-003	0.636		0.167	0.0085	0.0329	0.0495	J	0.055	0.015	0.0709	0.58		0.159	0.0085	0.033	1.27		Less than criteria
WL-102-CT-A	0.507		0.145	0.0311	0.008	0.0209	U	0.037	0.0669	0.0141	0.49		0.143	0.0588	0.014	1.02	*	Less than criteria
WL-102-CT-A DUP	0.535		0.153	0.0328	0.0085	0.011	U	0.028	0.0619	0.0106	0.534		0.153	0.0327	0.008	1.08	*	Less than criteria
WL102CTA.022-023	1.01		0.202	0.0078	0.0458	0.05	J	0.05	0.0097	0.0375	1.05		0.206	0.00779	0.046	2.11		Less than criteria
WL106ACT.004-006	11.3	J	0.82	0.0116	0.0448	0.687	J	0.226	0.0144	0.0557	12.2	J	0.852	0.0116	0.045	24.2		Less than criteria
WL-106A-CT	3.94		0.408	0.06	0.0142	0.242		0.115	0.0746	0.0176	4.67		0.443	0.0316	0.008	8.85		Less than criteria
WL-114-CT	0.722		0.176	0.0686	0.0184	0.0239	U	0.038	0.0601	0.0102	0.779		0.182	0.055	0.012	1.525	*	Less than criteria
WL114CT.032-033	0.432		0.137	0.0084	0.0494	0.0135	J	0.027	0.0105	0.0405	0.319		0.119	0.0146	0.062	0.765		Less than criteria
Cotter Samples from Core of Non-Cotter Borings																		
1-2-CT	0.394		0.133	0.0706	0.0189	0.0136	U	0.027	0.0407	0.0105	0.408		0.134	0.062	0.015	0.816	*	Less than criteria
1C-6-CT	2.09		0.29	0.0457	0.0078	0.0578	U	0.056	0.0649	0.0137	1.81		0.27	0.0612	0.016	3.96	*	Less than criteria
1D-16-CT	0.685		0.166	0.0519	0.011	0.0303	U	0.044	0.0707	0.0167	0.551		0.149	0.0609	0.016	1.266	*	Less than criteria
1D-7-CT	21.3		1.02	0.0555	0.0095	0.758		0.214	0.0455	0.0118	14.6		0.843	0.0365	0.009	36.7		Less than criteria
5-3-CT-A	6.1		0.537	0.0871	0.0259	0.335		0.141	0.0668	0.0114	5.51		0.51	0.08	0.022	11.9		Less than criteria
5-3-CT-B	12.3		0.796	0.101	0.0315	0.668		0.207	0.0727	0.0124	12.1		0.789	0.101	0.031	25.1		Less than criteria

Notes: NDE = gamma log not deep enough. No Log = no log from RI investigation exists. * Indicates that result for one of the two isotopes was non-detect Final Q = final qualifier CSU[1] = combined standard uncertainty (+/- sigma for McLaren/Hart samples) CV = critical value

(highlighted) indicates that combined value is greater than the unrestricted use criteria established by EPA

J = The analyte was analyzed for, and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the environmental sample.

J+ = Same as J qualification but with an indication of positive bias in the sample concentration.

U = The analyte was analyzed for and is not present above the level of the associated value. The associated numerical value indicates the approximate concentration necessary to detect the analyte in the sample.

For McLaren/Hart RI Soil Boring Data:

In calculated combined Ra and combined Th values, if of the the results was <MDA, one-half of the MDA was used in the calculation and the combined value was noted with an *. If both values were <MDA, combined results reported as "Non-detect".

In calculated combined U values, if one or two of the the results was <MDA, one-half of the MDA was used in the calculation and the combined value was noted with an *. If all three values were <MDA, combined results reported as "Non-detect".

Table 2-4: Area 2 Combined Radium, Thorium, and Uranium Results (RI Borings, A2 Additional Borings, and Cotter Borings)

DRAFT

Sample Designation	Upper Sample Depth (feet)	Lower Sample Depth (feet)	Batch ID	Units	Radium-226 Result	Final Q	CSU[1]	CV	MDA	Radium-228 Result	Final Q	CSU[1]	CV	MDA	Combined Radium 226 + 228	Combined Radium relative to 7.9 pCi/g Unrestricted Use Criteria	Thorium-230 Result	Final Q	CSU[1]	CV	MDA	Thorium-232 Result	Final Q	CSU[1]	CV	MDA	Combined Thorium 230 + 232	Combined Thorium relative to 7.9 pCi/g Unrestricted Use Criteria	Uranium-234 Result	Final Q	CSU[1]	CV	MDA	Uranium-235 Result	Final Q	CSU[1]	CV	MDA	Uranium-238 Result	Final Q	CSU[1]	CV	MDA	Combined Uranium 234 + 235 + 238	Combined Uranium relative to 54.4 pCi/g Unrestricted Use Criteria
McLaren/Hart RI Data																																													
WL-207	5	5		pCi/g	0.93	U			0.93	1.59	U			1.59	Non-detect *	Non-detect	1.21		0.70		0.54	1.42		0.75		0.39	2.63	Less than criteria	0.8		0.37		0.22	1.27	U			1.27	0.66		0.33		0.20	2.10 *	Less than criteria
WL-207 DUP (L)	5	5		pCi/g	0.68		0.18		0.24	0.97	U			0.97	1.17 *	Less than criteria	1.12		0.88		0.88	1.92		1.16		0.59	3.04	Less than criteria	0.85		0.38		0.23	0.58	U			0.58	0.89		0.39		0.21	2.03 *	Less than criteria
WL-207	10	10		pCi/g	0.76		0.22		0.33	1.10	U			1.10	1.31 *	Less than criteria	1.78		1.43		1.45	1.37		1.22		1.17	3.15	Less than criteria	0.71		0.34		0.21	0.61	U			0.61	0.81		0.36		0.21	1.83 *	Less than criteria
WL-208	5	5		pCi/g	3.26		0.32		0.37	0.68		0.46		0.66	3.94	Less than criteria	123		23		0.10	1.43		0.42		0.08	124.4	Exceeds criteria	2.05		0.59		0.12	1.18	U			1.18	1.60		0.50		0.10	4.24 *	Less than criteria
WL-208 DUP (L)	5	5		pCi/g	3.40		0.34		0.38	1.03	U			1.03	3.92 *	Less than criteria	94.9		17		0.23	0.82		0.32		0.14	95.7	Exceeds criteria	2.27		0.65		0.19	1.04	U			1.04	2.82		0.76		0.13	5.61 *	Less than criteria
WL-208	9	9		pCi/g	1.35		0.23		0.25	0.74	U			0.74	1.72 *	Less than criteria	10.07		2		0.07	0.36		0.16		0.07	10.43	Exceeds criteria	1.65		0.47		0.19	0.77	U			0.77	1.75		0.48		0.15	3.79 *	Less than criteria
WL-209	0	0		pCi/g	3,720		142		10	21.34	U			21.34	3,731 *	Exceeds criteria	29,240		5,290		0.10	127		23		0.09	29,367	Exceeds criteria	575		180		0.7	263		33		33	294		92		0.7	1,132	Exceeds criteria
WL-209	5	5		pCi/g	2,970		123		7	16.34	U			16.34	2,978 *	Exceeds criteria	38,280		7,750		40.2	138		60		32.2	38,418	Exceeds criteria	335		57		0.19	74.8		22.9		23.8	249		43		0.14	659	Exceeds criteria
WL-209 DUP (F)	5	5		pCi/g	3,140		116		5	16.7		9.3		11.3	3,157	Exceeds criteria	32,680		6,420		29.0	180		65		20.2	32,860	Exceeds criteria	527		87		0.20	62.6		25.4		13.4	287		47		0.15	877	Exceeds criteria
WL-209	25	25		pCi/g	0.85		0.18		0.29	0.92	U			0.92	1.31 *	Less than criteria	26.9		5.4		0.12	0.71		0.27		0.05	27.6	Exceeds criteria	0.46		0.22		0.23	0.84	U			0.84	0.58		0.23		0.12	1.46 *	Less than criteria
WL-209 DUP (F)	25	25		pCi/g	0.62		0.2		0.27	0.85	U			0.85	1.05 *	Less than criteria	12.85		3.7		0.72	0.39	U	0.53		0.84	13.05 *	Exceeds criteria	0.59		0.24		0.09	0.70	U			0.70	0.61		0.24		0.08	1.55 *	Less than criteria
WL-210	0	0		pCi/g	2,280		89		4	9.55	U			9.55	2,285 *	Exceeds criteria	18,190		3,510		15.1	59.2		23.2		17.5	18,249	Exceeds criteria	216		67		0.7	182		22		14	134		42		0.6	532	Exceeds criteria
WL-210	5	5		pCi/g	520		26		3	6.72	U			6.72	523 *	Exceeds criteria	12,400		2,140		0.14	106		19		0.06	12,506	Exceeds criteria	145		25		0.18	10.12	U			10.12	65.5		11.2		0.12	216 *	Exceeds criteria
WL-210 DUP (F)	5	5		pCi/g	458		20		2	4.66	U			4.66	460 *	Exceeds criteria	15,610		2,700		0.11	120		21		0.06	15,730	Exceeds criteria	267		46		0.17	27.2		11.9		5.4	128		22		0.14	422	Exceeds criteria
WL-210	40	40		pCi/g	0.68		0.18		0.31	0.83	U			0.83	1.10 *	Less than criteria	18.2		3.3		0.12	0.37		0.17		0.08	18.6	Exceeds criteria	0.69		0.26		0.12	0.78	U			0.78	0.91		0.31		0.11	1.99 *	Less than criteria
WL-210 DUP (F)	40	40		pCi/g	1.66		0.4		0.59	1.45	U			1.45	2.39 *	Less than criteria	10.8		2.2		0.1	0.82		0.28		0.07	11.6	Exceeds criteria	0.93		0.32		0.11	1.50	U			1.50	0.54		0.23		0.09	2.22 *	Less than criteria
WL-211	5	5		pCi/g	8.52		0.58		0.33	1.15	U			1.15	9.10 *	Exceeds criteria	66.11		11.8		0.15	1.38		0.35		0.08	67.5	Exceeds criteria	2.30		0.58		0.10	0.75	U			0.75	2.61		0.64		0.11	5.29 *	Less than criteria
WL-211	25	25		pCi/g	0.42		0.19		0.31	0.85	U			0.85	0.85 *	Less than criteria	4.97		1.04		0.16	0.32		0.16		0.08	5.29	Less than criteria	0.68		0.28		0.26	0.79	U			0.79	0.66		0.27		0.26	1.74 *	Less than criteria
WL-212	5	5		pCi/g	1.26		0.4		0.46	1.16	U			1.16	1.84 *	Less than criteria	5.73		1.2		0.10	0.29		0.14		0.08	6.02	Less than criteria	1.57		0.46		0.17	1.15	U			1.15	1.66		0.47		0.12	3.81 *	Less than criteria
WL-212	10	10		pCi/g	1.77		0.24		0.28	0.90	U			0.90	2.22 *	Less than criteria	116		20		0.23	0.9		0.29		0.13	117	Exceeds criteria	1.86		0.53		0.14	0.56	U			0.56	1.77		0.51		0.12	3.91 *	Less than criteria
WL-213	0	0		pCi/g	1.00		0.26		0.37	0.90	U			0.90	1.45 *	Less than criteria	24.2		4.7		0.2	1.11		0.41		0.20	25.3	Exceeds criteria	1.64		0.58		0.45	0.88	U			0.88	1.53		0.55		0.42	3.61 *	Less than criteria
WL-213	5	5		pCi/g	1.26		0.23		0.27	0.92	U			0.92	1.72 *	Less than criteria	17.29		3.4		0.16	0.89		0.3		0.15	18.18	Exceeds criteria	1.00		0.38		0.19	0.83	U			0.83	1.53		0.49		0.13	2.95 *	Less than criteria
WL-213	25	25		pCi/g	0.93		0.33		0.52	1.49	U			1.49	1.68 *	Less than criteria	3.13		0.75		0.05	0.52		0.21		0.07	3.65	Less than criteria	1.06		0.36		0.14	1.35	U			1.35	0.45		0.22		0.13	2.19 *	Less than criteria
WL-214	5	5		pCi/g	0.95		0.18		0.22	0.81	U			0.81	1.36 *	Less than criteria	44.4		7.8		0.21	0.41		0.2		0.14	44.8	Exceeds criteria	1.09		0.36		0.12	0.52	U			0.52	0.81		0.3		0.09	2.16 *	Less than criteria
WL-214	25	25		pCi/g	0.52	U			0.52	0.89	U			0.89	Non-detect *	Non-detect	12.8		2.5		0.18	0.36		0.19		0.12	13.2	Exceeds criteria	0.97		0.35		0.11	0.89	U			0.89	0.67		0.28		0.12	2.09 *	Less than criteria
WL-215	0	0		pCi/g	0.70		0.20		0.29	0.73	U			0.73	1.07 *	Less than criteria	5.35		1.14		0.07	0.31		0.15		0.07	5.66	Less than criteria	1.86		0.76		0.48	0.78	U			0.78	1.53		0.68		0.45	3.78 *	Less than criteria
WL-216	5	5		pCi/g	88.4		5.2		0.9	2.21	U			2.21	89.5 *	Exceeds criteria	1,131				0.93	3.05		1.45		0.81	1,134	Exceeds criteria	12.5		4.0		1.90	3.07	U			3.07	11.4		3.8		2.20	25.4 *	Less than criteria
WL-216	25	25		pCi/g	1.03		0.21		0.39	1.62		0.44		0.54	2.65	Less than criteria	1.46		0.46		0.17	1.17		0.39		0.1	2.63	Less than criteria	0.81		0.29		0.09	0.61	U			0.61	0.97		0.32		0.09	2.09 *	Less than criteria
WL-217	5	5		pCi/g	0.60		0.21		0.31	0.81	U			0.81	1.01 *	Less than criteria	0.96		0.3		0.13	0.38	U	0.16		0.06	1.15 *	Less than criteria	0.45		0.2		0.08	0.53	U			0.53	0.51		0.21		0.08	1.23 *	Less than criteria
WL-217	10	10		pCi/g	1.27		0.24		0.29	1.04	U			1.04	1.79 *	Less than criteria	8.95		1.90		0.12	0.72		0.31		0.11	9.67	Exceeds criteria	1.03		0.33		0.17	0.60	U			0.60	0.96		0.31		0.12	2.29 *	Less than criteria
WL-218	0	0		pCi/g	1.06		0.19		0.24	0.82		0.38		0.66	1.88	Less than criteria	1.77		0.57		0.14	0.77		0.32		0.07	2.54	Less than criteria	1.53		0.59		0.24	0.58	U			0.58	1.12		0.48		0.16	2.94 *	Less than criteria
WL-218	5	5		pCi/g	0.85		0.20		0.41	1.01		0.48		0.70	1.86	Less than criteria	1.19		0.43		0.14	0.67		0.3		0.12	1.86	Less than criteria	0.73		0.28		0.12	0.84	U			0.84	0.81		0.3		0.12	1.96 *	Less than criteria
WL-218	40	40		pCi/g	0.68		0.23		0.43	1.16	U			1.16	1.26 *	Less than criteria	7.27		1.51		0.1	0.58		0.25		0.09	7.85	Less than criteria	0.84		0.32		0.12	0.73	U			0.73	0.53		0.24		0.11	1.74 *	Less than criteria
WL-219	5	5		pCi/g	1.12		0.26		0.33	1.17		0.59		0.77	2.29	Less than criteria	1.07		0.4		0.15	1.12		0.42		0.14	2.19	Less than criteria	0.91		0.31		0.09	0.80	U			0.80	1.09		0.35		0.09	2.40 *	Less than criteria
WL-219	10	10		pCi/g	0.62		0.22		0.41	1.04	U			1.04	1.14 *	Less than criteria	0.64		0.25		0.08	0.44		0.2		0.07	1.08	Less than criteria	1.16		0.56		0.39	0.62	U			0.62	0.60		0.38		0.33	2.07 *	Less than criteria
WL-220	5	5		pCi/g	0.81		0.23		0.36	1.22	U			1.22	1.42 *	Less than criteria	1.53		0.46		0.11	0.69		0.27		0.10	2.22	Less than criteria	1.16		0.36		0.09	0.79	U			0.79	1.00		0.33		0.09	2.56 *	Less than criteria
WL-220	25	25		pCi/g	0.78		0.24		0.38	1.25		0.38		0.56	2.03	Less than criteria	0.56		0.27		0.11	0.22		0.16		0.1	0.78	Less than criteria	0.89		0.33		0.12	0.67	U			0.67	0.95		0.34		0.13	2.18 *	Less than criteria
WL-221	5	5		pCi/g	0.75		0.2		0.34	1.12	U			1.12	1.31 *	Less than criteria	4.28		0.94		0.24	0.7		0.28		0.24	5.0	Less than criteria	1.12		0.38		0.13	0.64	U			0.64	0.82		0.31		0.13	2.26 *	Less than criteria
WL-221	35	35		pCi/g	0.33	U			0.33	1.09	U			1.09	Non-detect *	Non-detect	1.24		0.41		0.16	0.63		0.27		0.14	1.87	Less than criteria	0.52		0.21		0.1	0.79	U			0.79	0.50		0.21		0.11	1.42 *	Less than criteria
WL-222	0	0		pCi/g	2.94		0.59		0.53	1.75	U			1.75	3.82 *	Less than criteria	131		25		0.19	1.31		0.40		0.2	132	Exceeds criteria	2.26		0.79		0.25	1.99	U			1.99	3.36		1.04		0.42	6.62 *	Less than criteria
WL-222	5	5		pCi/g	1.80		0.26		0.29	0.83		0.44		0.70	2.63	Less than criteria	81.4		15.4		0.76	1.3		0.38		0.17	82.7	Exceeds criteria	1.46		0.43		0.13	0.64	U			0.64	1.21		0.38		0.09	2.99 *	Less than criteria
WL-222	30	30		pCi/g	0.82		0.39		0.60	1.27	U			1.27	1.46 *	Less than criteria	0.88		0.32		0.21	1.0		0.3		0.15	1.9	Less than criteria	0.51		0.26		0.12	1.22	U			1.22	0.40		0.23		0.12	1.52 *	Less than criteria
WL-223	5	5		pCi/g	1.73		0.27		0.30	1.14	U			1.14	2.30 *	Less than criteria	9.16		1.97		0.12	0.64		0.3		0.12	9.80	Exceeds criteria	1.44		0.41		0.11	0.75	U			0.75	1.22		0.36		0.10	3.04 *	Less than criteria
WL-223	22	22		pCi/g	0.52		0.19		0.33	0.88	U			0.88	0.96 *	Less than criteria	0.68		0.28		0.12	0.18		0.13		0.1	0.86	Less than criteria	2.37		0.62		0.14	0.60	U			0.60	1.93		0.54		0.15	4.60 *	Less than criteria
WL-224	5	5		pCi/g	0.84		0.21		0.28	1.23		0.47		0.67	2.07	Less than criteria	2.85		1.31		1.15	0.35	U	0.49		0.91	3.03 *	Less than criteria	0.75		0.5		0.68	0.71	U			0.71	0.63		0.41		0.40	1.74 *	Less than criteria
WL-224	35	35		pCi/g	1.00		0.22		0.37	1.19		0.41		0.90	2.19	Less than criteria	4.08		1.71		0.84	0.28	U	0.42		0.62	4.22 *	Less than criteria	1.13		0.96		0.80	0.69	U			0.69	0.77		0.78		0.52	2.25 *	Less than criteria
WL-225	5	5		pCi/g	1.07		0.27		0.40	1.18	U			1.18	1.66 *	Less than criteria	2.84		1.44		1.32	1.76		1.07		0.62	4.60	Less than criteria	3.17		1.69		1.22	0.75	U			0.75	1.29		1.04		1.01	4.84 *	Less than criteria
WL-225	35	35		pCi/g	0.51	U			0.51	1.50	U			1.50	Non-detect *	Non-detect	0.91		0.91		0.23	0.33		0.17		0.16	1.24	Less than criteria	0.72		0.42		0.40	0.93	U			0.93	0.16	U	0.36		0.77	1.27 *	Less than criteria
WL-226	10	10		pCi/g	1.4		0.27		0.34	0.95		0.46		0.82	2.4	Less than criteria	14.1		4		1.1	0.32	U	0.51		0.85	14.3 *	Exceeds criteria	1.38		0.62		0.52	0.80	U			0.80	1.63		0.65		0.29	3.41 *	Less than criteria
WL-226	20	20		pCi/g	3.26		0.44		0.40	1.12	U			1.12	3.82 *	Less than criteria	173		31		1.0	0.69	U	0.68		0.85	173 *	Exceeds criteria	6.02		2.2		1.31	0.87	U			0.87	6.32		2.24		0.91	12.78 *	Less than criteria
WL-227	5	5		pCi/g	1.32		0.22		0.29	1.35		0.43		0.73	2.67	Less than criteria	20.4		4.7		0.9	0.5	U	0.52		0.53	20.7 *	Exceeds criteria	1.68		0.67		0.57	0.66	U			0.66	2.01		0.71		0.32	4.02 *	Less than criteria
WL-227	40	40		pCi/g	0.43		0.18		0.24	0.79	U			0.79	0.83 *	Less than criteria	2.78		1.32		0.94	0.51	U	0.53		0.55	3.04 *	Less than criteria	0.66		0.43		0.55	0.54	U			0.54	0.27	U	0.30		0.53	1.07 *	Less than criteria
WL-228	5	5		pCi/g	0.79		0.20		0.30	1.29		0.41		0.62	2.08	Less than criteria	2.72		1.45		1.05	0.13	U	0.34		0.79	2.79 *	Less than criteria	1.50		1.09		1.37	0.51	U			0.51	1.84		1.19		1.3	3.60 *	Less than criteria
WL-228	15	15		pCi/g	0.64		0.25		0.37	1.12	U			1.12	1.20 *	Less than criteria	2.13		0.76		0.46	0.62		0.39		0.37	2.75	Less than criteria	0.6	U	0.46		0.74	0.75	U			0.75	0.26	U	0.39		0.78	Non-detect *	Non-detect
WL-229	5	5		pCi/g	1.15		0.28		0.70	1.24	U			1.24	1.77 *	Less than criteria	4.97		1.89		0.97	1.47		0.97		0.89	6.44	Less than criteria	0.82		0.47		0.52	0.64	U			0.64	1.45		0.6		0.39	2.59 *	Less than criteria
WL-229	20	20		pCi/g	0.38		0.19		0.34	0.96	U			0.96	0.86 *	Less than criteria	1.17		0.89		1.02	0.55	U	0.58		0.69	1.45 *	Less than criteria	0.79		0.46		0.56	0.64	U			0.64	0.54		0.36		0.39	1.65 *	Less than criteria
WL-230	5	5		pCi/g	1.67		0.26		0.34	1.16	U			1.16	2.25 *	Less than criteria	26.8		6.4		1.3	0.51	U	0.63		0.87	27.1 *	Exceeds criteria	2.23		0.81		0.49	0.63	U			0.63	0.92		0.48		0.16	3.47 *	Less than criteria
WL-230	35	35		pCi/g	0.53		0.22		0.36	0.89	U			0.89	0.98 *	Less than criteria	1.33		0.98		1.25	0.1	U	0.29		0.75	1.38 *	Less than criteria	1.75		1.18		1.18	0.69	U			0.69	2.05		1.23		0.46	4.15 *	Less than criteria
WL-231	0	0		pCi/g	0.91		0.22		0.29	0.92	U			0.92	1.37 *	Less than criteria	1.21		0.39		0.20	0.08	U	0.1		0.19	1.25 *	Less than criteria	3.18		1.06		0.32	0.85	U			0.85	2.04		0.79		0.26	5.65 *	Less than criteria
WL-231	5	5		pCi/g	4.06		0.37		0.28	1.02	U			1.02	4.57 *	Less than criteria	94.5		17.4		1.0	1.11		0.85		0.83	95.6	Exceeds criteria	6.97		2.76		2.14	0.73	U			0.73	3.86		2.03		2.18	11.20 *	Less than criteria
WL-231	10	10		pCi/g	1.37		0.24		0.40	0.75	U			0.75	1.75 *	Less than criteria	10.2		3.0		1.4	0.06	U	0.28		0.87	10.2 *	Exceeds criteria	2.29		0.82		0.53	0.79	U			0.79	2.01		0.74		0.15	4.70 *	Less than criteria
WL-233	27	27		pCi/g	4.44		0.46		0.38	1.11	U			1.11	5.00 *	Less than criteria	427		80		0.70	1.19		0.83		0.56	428	Exceeds criteria	4.58		2.18		1.64	1.02	U			1.02	4.48		2.17		1.80	9.57 *	Less than criteria
WL-233	30	30		pCi/g	0.79		0.20		0.41	1.05	U			1.05	1.32 *	Less than criteria	9.93		2.72		0.9	0.82		0.64		0.49	10.75	Exceeds criteria	2.60		1.76		1.20	0.64	U			0.64	1.99		1.49		1.93	4.91 *	Less than criteria
WL-234	10	10		pCi/g	3,060		116		4	14.5		7.9		10.3	3,075	Exceeds criteria	57,300		19,300		238	148	U	173		240	57,374 *	Exceeds criteria	128		39		5	774		150		12	138		42		5.0	1,040	Exceeds criteria
WL-234 DUP (F)	10	10		pCi/g	1,260		49		3	6.62	U			6.62	1,263 *	Exceeds criteria	12,000		3,670		116	58.1	U	84.6		98.7	12,029 *	Exceeds criteria	45.4		9.7		0.5	97.6		11.2		7.9	60.7		12.4		1.1	204	Exceeds criteria
WL-234	20	20		pCi/g	0.66	U			0.66	1.25	U			1.25	Non-detect *	Non-detect	16.2		3.2		0.04	0.67		0.23		0.07	16.9	Exceeds criteria	0.94		0.45		0.37	0.86	U			0.86	0.98		0.44		0.28	2.35 *	Less than criteria
WL-234 DUP (F)	20	20		pCi/g	1.18		0.26		0.39	1.23	U			1.23	1.80 *	Less than criteria	11.3		2.2		0.5	0.85		0.43		0.38	12.2	Exceeds criteria	1.64		1.29		0.99	0.85	U			0.85	2.11		1.47		0.99	4.18 *	Less than criteria
WL-235	0	0		pCi/g	0.90		0.21		0.32	1.19		0.45		0.56	2.09 *	Less than criteria	12.4		2.48		0.13	1.03		0.31		0.10	13.4	Exceeds criteria	0.97		0.45		0.31	0.56	U			0.56	0.77		0.4		0.37	2.02 *	Less than criteria
WL-235	5	5		pCi/g	0.74		0.46		0.56	1.58	U			1.58	1.53 *	Less than criteria	3.21		1.45		1.16	0.18	U	0.38		0.83	3.30 *	Less than criteria	1.47		0.66		0.61	1.63	U			1.63	0.91		0.5		0.50	3.20 *	Less than criteria
WL-235	30	30		pCi/g	1.09		0.25		0.43	0.93	U			0.93	1.56 *	Less than criteria	3.15		1.43		1.0	0.01	U	0.28		0.94	3.16 *	Less than criteria	1.25		0.53		0.41	0.84	U			0.84	1.31		0.53		0.24	2.98 *	Less than criteria
WL-236	5	5		pCi/g	1.03		0.23		0.34	1.00	U			1.00	1.53 *	Less than criteria	5.92		1.49		0.97	0.62	U	0.46		0.69	6.23 *	Less than criteria	1.43		1.22		1.41	0.72	U			0.72	1.56		1.21		0.60	3.35 *	Less than criteria
WL-236	35	35		pCi/g	1.01		0.24		0.35	1.23	U			1.23	1.63 *	Less than criteria	4.9		1.33		1.01	0.9	U	0.63		1.02	5.4 *	Less than criteria	2.37		1.43		0.54	0.69	U			0.69	1.95		1.29		0.82	4.67 *	Less than criteria
WL-239	5	5		pCi/g	0.96		0.11		0.10	1.13		0.19		0.17	2.09 *	Less than criteria	0.5		0.2		0.12	0.26		0.13		0.07	0.8	Less than criteria	1.24		0.46		0.19	0.35	U			0.35	1.22		0.45		0.14	2.64 *	Less than criteria
WL-239	25	25		pCi/g	0.90		0.08		0.06	0.72		0.13		0.12	1.62	Less than criteria	0.58		0.26		0.25	0.31		0.17		0.14	0.89	Less than criteria	0.83		0.46		0.46	0.25	U			0.25	0.48		0.36		0.47	1.44 *	Less than criteria
WL-241	5	5		pCi/g	12.9		0.54		0.1	0.24	U			0.24	13.0 *	Exceeds criteria	343		66		0.11	3.84		0.9		0.05	347	Exceeds criteria	4.51		1.20		0.15	0.38	U			0.38	3.90		1.07		0.18	8.60 *	Less than criteria
WL-241	15	15		pCi/g	1.04		0.09		0.07	0.96		0.16		0.16	2.00	Less than criteria	0.57		0.21		0.13	0.18		0.11		0.08	0.75	Less than criteria	0.59		0.29		0.20	0.23	U			0.23	0.64		0.30		0.13	1.35 *	Less than criteria
WL-242	0	0		pCi/g	1.57		0.26		0.51	0.77	U			0.77	1.96 *	Less than criteria	8.63		2.62		0.76	0	U	0		0.34	8.63 *	Exceeds criteria	1.83		0.5		0.17						1.63		0.46		0.13	3.46	Less than criteria
WL-242	2	2		pCi/g	2.42		0.45		0.59	1.57	U			1.57	3.21 *	Less than criteria	21.3		5.3		1.11	0.52	U	0.58		0.75	21.6 *	Exceeds criteria	1.35		0.43		0.1						0.75		0.3		0.1	2.10	Less than criteria
WL-243	0	0		pCi/g	4.78		0.44		0.33	1.13		0.54		0.84	5.91	Less than criteria	265		50		0.22	6.73		1.36		0.15	272	Exceeds criteria	3.99		0.98		0.24						3.63		0.91		0.18	7.62	Less than criteria
WL-244	0	0		pCi/g	1.54		0.22		0.33	1.05	U			1.05	2.07 *	Less than criteria	20.8		4.1		0.71	0.78		0.68		0.65	21.6	Exceeds criteria	0.88		0.3		0.12						1.35		0.4		0.09	2.23	Less than criteria
WL-245	0	0		pCi/g	0.95		0.26		0.34	1.20	U			1.20	1.55 *	Less than criteria	3.92		0.93		0.16	0.38		0.2		0.11	4.30	Less than criteria	0.93		0.32		0.23						0.71		0.27		0.18	1.64	Less than criteria
WL-246	0	0		pCi/g	1.04		0.26		0.37	1.07	U			1.07	1.58 *	Less than criteria	2.91		0.82		0.3	0.63		0.31		0.15	3.54	Less than criteria	0.94		0.32		0.14						0.73		0.28		0.18	1.67	Less than criteria
A2 Additional Borings (and Cotter samples from A2 Additional Borings)																																													
FEEBRISAC-8.024-026	24	26	15-12062	pCi/g	1.21	U	0.30	2.79	0.34	1.32		0.34	0.22	0.49	2.52 *	Less than criteria	2.17	J+	0.54	0.06	0.07	0.75	J+	0.23	0.01	0.06	2.93	Less than criteria	0.69		0.19	0.02	0.05	0.19	J	0.10	0.00	0.06	0.70		0.19	0.01	0.05	1.58	Less than criteria
FEEBRISAC-8.035-036	35	36	15-12062	pCi/g	0.70	U	0.13	0.92	0.16	0.43		0.13	0.10	0.22	1.14 *	Less than criteria	0.71	J+	0.26	0.07	0.08	0.35	J+	0.16	0.02	0.09	1.07	Less than criteria	0.51		0.16	0.03	0.07	0.12	J	0.08	0.01	0.08	0.53		0.17	0.03	0.08	1.15	Less than criteria
FEEBRISAC-9.025-028	25	28	15-12034	pCi/g	0.90	U	0.18	1.12	0.26	0.97		0.22	0.17	0.36	1.86 *	Less than criteria	0.37	J	0.15	0.06	0.07	0.13	J	0.09	0.03	0.09	0.50	Less than criteria	0.21	J	0.10	0.01	0.06	0.02	J	0.03	0.00	0.05	0.24	J	0.10	0.01	0.05	0.47	Less than criteria
FEEBRISAC-9.025-028 FD	25	28	15-12034	pCi/g	0.73	U	0.19	1.42	0.34	0.80		0.23	0.19	0.42	1.53 *	Less than criteria	0.41	J	0.14	0.04	0.04	0.23		0.10	0.00	0.04	0.64	Less than criteria	0.20	J	0.09	0.02	0.06	0.03	J	0.04	0.01	0.06	0.16	J	0.08	0.01	0.06	0.39	Less than criteria
FEEBRISAC-9.032-033	32	33	15-12034	pCi/g	1.02	U	0.31	2.01	0.17	0.70	J	0.49	0.42	0.90	1.72 *	Less than criteria	0.85		0.25	0.04	0.05	0.85		0.24	0.01	0.06	1.70	Less than criteria	0.67	J	0.16	0.01	0.05	0.07	J	0.05	0.00	0.04	0.64	J	0.16	0.01	0.05	1.38	Less than criteria
FEEBRISAC-10.012-013	12	13	15-12063	pCi/g	1.66		0.22	1.17	0.23	0.48		0.21	0.17	0.37	2.15	Less than criteria	12.19	J+	3.02	0.10	0.12	0.37	J+	0.17	0.05	0.13	12.6	Exceeds criteria	1.28		0.30	0.05	0.10	0.18	J	0.11	0.01	0.09	1.55	J+	0.34	0.01	0.05	3.01	Less than criteria
FEEBRISAC-10.026-028	26	28	15-12063	pCi/g	0.77	U	0.14	1.09	0.18	0.66		0.16	0.10	0.22	1.44 *	Less than criteria	0.62	J+	0.19	0.05	0.05	0.41	J+	0.14	0.01	0.05	1.03	Less than criteria	0.52	J	0.24	0.05	0.12	0.05	J	0.08	0.01	0.14	0.77	J+	0.30	0.01	0.14	1.34	Less than criteria
FEEBRISAC-11.008-009	8	9	15-12064	pCi/g	0.57	U	0.23	1.89	0.44	0.13	U	0.35	0.27	0.61	Non-detect *	Non-detect	0.29	J	0.12	0.05	0.05	0.14	J	0.08	0.01	0.05	0.42	Less than criteria	0.33	J+	0.11	0.01	0.05	0.03	J	0.03	0.00	0.04	0.16	J	0.07	0.00	0.05	0.52	Less than criteria
FEEBRISAC-11.017-019	17	19	15-12064	pCi/g	0.95	U	0.18	1.22	0.24	0.72		0.23	0.22	0.47	1.67 *	Less than criteria	0.49	J	0.16	0.06	0.07	0.30	J	0.12	0.03	0.08	0.79	Less than criteria	0.48	J+	0.14	0.02	0.05	0.05	J	0.05	0.01	0.06	0.41	J	0.13	0.00	0.04	0.94	Less than criteria
FEEBRISAC-12.002-004	2	4	15-12064	pCi/g	2.85		0.28	1.19	0.19	0.36		0.16	0.17	0.35	3.21	Less than criteria	43.95	J	10.91	0.09	0.10	0.41	J	0.19	0.01	0.09	44.4	Exceeds criteria	1.04	J+	0.24	0.05	0.09	0.04	J	0.04	0.01	0.06	0.87	J	0.21	0.01	0.04	1.95	Less than criteria
FEEBRISAC-12.010-011	10	11	15-12064	pCi/g	0.88	U	0.15	0.93	0.17	0.58		0.17	0.17	0.35	1.46 *	Less than criteria	4.44	J	0.96	0.06	0.07	0.23	J	0.10	0.01	0.06	4.68	Less than criteria	0.51	J+	0.16	0.02	0.06	0.01	J	0.02	0.00	0.05	0.48		0.15	0.01	0.05	1.00	Less than criteria
FEEBRISAC-13.020-022	20	22	15-12062	pCi/g	8.46		0.90	3.78	0.78	0.33	U	0.54	0.42	0.91	8.78 *	Exceeds criteria	104	J+	20.72	0.04	0.05	0.66	J+	0.18	0.00	0.04	105	Exceeds criteria	1.97		0.33	0.02	0.04	0.33		0.11	0.00	0.04	1.80		0.31	0.00	0.03	4.10	Less than criteria
FEEBRISAC-13.031-033	31	33	15-12062	pCi/g	0.68	U	0.37	2.02	0.56	-0.03	U	0.17	0.44	0.98	Non-detect *	Non-detect	2.01	J+	0.46	0.05	0.05	0.21	J+	0.09	0.02	0.06	2.21	Less than criteria	0.29		0.11	0.03	0.06	0.10	J	0.07	0.00	0.06	0.31		0.11	0.00	0.04	0.69	Less than criteria
FEEBRISAC-14.013-014	13	14	15-12064	pCi/g	0.71	U	0.32	3.18	0.81	0.05	U	0.58	0.43	0.96	Non-detect *	Non-detect	2.99	J	1.26	0.47	0.60	2.57	J	1.12	0.03	0.42	5.56	Less than criteria	0.33	J+	0.12	0.02	0.05	0.07	J	0.06	0.00	0.05	0.21		0.10	0.02	0.07	0.61	Less than criteria
FEEBRISAC-14.025-026	25	26	15-12064	pCi/g	0.28	U	0.08	0.77	0.17	0.55		0.13	0.09	0.20	0.84 *	Less than criteria	0.48	J	0.17	0.05	0.05	0.40	J	0.15	0.01	0.05	0.89	Less than criteria	0.43	J+	0.13	0.02	0.05	0.05	J	0.05	0.01	0.06	0.37	J	0.12	0.00	0.05	0.85	Less than criteria
FEEBRISAC-15.026-027	26	27	15-12064	pCi/g	0.66	U	0.18	1.53	0.32	0.62		0.27	0.21	0.45	1.28 *	Less than criteria	0.18		0.08	0.04	0.04	0.09	J	0.06	0.00	0.04	0.27	Less than criteria	0.38	J+	0.12	0.03	0.06	0.05	J	0.04	0.00	0.05	0.25		0.09	0.01	0.04	0.67	Less than criteria
FEEBRISAC-15.032-034	32	34	15-12064	pCi/g	0.56	U	0.18	1.05	0.27	0.35	J	0.29	0.25	0.55	0.91 *	Less than criteria	1.45	J	0.39	0.06	0.06	0.34	J	0.14	0.01	0.06	1.79	Less than criteria	0.30	J+	0.11	0.03	0.06	0.11	J	0.07	0.00	0.04	0.28	J	0.10	0.02	0.07	0.69	Less than criteria
FEEBRISAC-15.032-034 FD	32	34	15-12064	pCi/g	0.31	U	0.12	0.59	0.20	0.33	J	0.16	0.15	0.32	0.64 *	Less than criteria	0.44	J	0.16	0.06	0.06	0.50	J	0.17	0.01	0.07	0.94	Less than criteria	0.47	J+	0.14	0.03	0.06	0.05	J	0.05	0.00	0.05	0.41	J	0.13	0.01	0.04	0.93	Less than criteria
FEEBRISAC-16.019-020	19	20	15-12064	pCi/g	554		39.48	20.98	4.76	13.81		2.52	2.57	5.18	568	Exceeds criteria	8,710		1,811	6.23	7.84	43.68		17.25	2.11	9.28	8,753	Exceeds criteria	310	J+	53.7	5.25	9.90	29.7	J	13.4	0.93	7.87	266	J	47.9	4.21	10.4	606	Exceeds criteria
FEEBRISAC-16.022-023	22	23	15-12064	pCi/g	358		23.76	13.03	1.71	8.01		1.40	1.35	2.71	366	Exceeds criteria	5,166	J	1,048	6.75	6.74	30.48	J	14.03	2.93	10.25	5,197	Exceeds criteria	294	J+	55.6	2.74	5.90	14.8	J	10.5	0.93	9.16	248	J	49.0	0.73	5.88	557	Exceeds criteria
FEEBRISAC-16.022-023 FD	22	23	15-12064	pCi/g	317		24.70	25.03	4.34	10.62		3.50	4.32	8.28	327	Exceeds criteria	12,250	J	2,514	7.26	7.52	68.71	J	22.88	1.93	9.12	12,319	Exceeds criteria	442	J+	72.6	3.07	7.06	24.7	J	12.9	0.18	9.26	432	J	71.2	1.07	6.54	899	Exceeds criteria
FEEBRISAC-16.029-030	29	30	15-12064	pCi/g	1.17		0.19	1.16	0.26	0.97		0.21	0.17	0.35	2.14	Less than criteria	15.91	J	3.84	0.08	0.08	1.07	J	0.34	0.02	0.09	16.98	Exceeds criteria	0.92	J+	0.21	0.02	0.05	0.10	J	0.07	0.00	0.05	0.76	J	0.19	0.00	0.04	1.77	Less than criteria
FEEBRISAC-17.008-010	8	10	15-12064	pCi/g	0.83		0.14	0.82	0.08	0.32	J	0.20	0.17	0.38	1.16	Less than criteria	1.61	J	0.56	0.11	0.11	0.30	J	0.17	0.01	0.10	1.91	Less than criteria	0.88	J+	0.25	0.03	0.06	0.05	J	0.07	0.00	0.10	0.74		0.23	0.01	0.06	1.68	Less than criteria
FEEBRISAC-17.032-033	32	33	15-12062	pCi/g	0.39	U	0.18	1.30	0.34	0.39	J	0.27	0.25	0.55	0.78 *	Less than criteria	0.45	J+	0.16	0.07	0.08	0.14	J+	0.08	0.04	0.09	0.59	Less than criteria	0.27		0.12	0.03	0.07	0.10	J	0.08	0.02	0.09	0.29		0.12	0.02	0.08	0.67	Less than criteria

Table 2-4: Area 2 Combined Radium, Thorium, and Uranium Results (RI Borings, A2 Additional Borings, and Cotter Borings)

DRAFT

Sample Designation	Upper Sample Depth (feet)	Lower Sample Depth (feet)	Batch ID	Units	Radium-226 Result	Final Q	CSU[1]	CV	MDA	Radium-228 Result	Final Q	CSU[1]	CV	MDA	Combined Radium 226 + 228		Combined Radium relative to 7.9 pCi/g Unrestricted Use Criteria
FEEBRISAC-18.002-005	2	5	15-12062	pCi/g	206	J	13.96	12.52	2.17	8.16		1.44	1.50	3.03	215		Exceeds criteria
FEEBRISAC-18.002-005 FD	2	5	15-12062	pCi/g	333	J	22.18	17.29	1.66	9.19		1.62	1.30	2.62	343		Exceeds criteria
FEEBRISAC-18.010-011	10	11	15-12062	pCi/g	184		14.82	19.11	2.97	6.53		2.39	2.06	4.17	190		Exceeds criteria
FEEBRISAC-19.005-006	5	6	15-12063	pCi/g	1,005		66.26	19.31	2.47	8.07		1.99	1.70	3.41	1,013		Exceeds criteria
FEEBRISAC-19.036-037	36	37	15-12062	pCi/g	1.20		0.18	1.13	0.24	1.17		0.21	0.19	0.41	2.37		Less than criteria
FEEBRISAC-20.023-024	23	24	15-12063	pCi/g	580		38.54	18.16	3.74	8.43		1.74	2.00	4.02	588		Exceeds criteria
FEEBRISAC-20.047-049	47	49	15-12063	pCi/g	1.33		0.20	1.05	0.25	1.55		0.25	0.19	0.40	2.88		Less than criteria
FEEBRISAC-20.047-049 FD	47	49	15-12063	pCi/g	1.40	U	0.37	2.67	0.46	1.56		0.44	0.40	0.86	2.95	*	Less than criteria
FEEBRISAC-21.012-013	12	13	15-12106	pCi/g	272		18.78	27.10	3.26	8.48		2.28	2.37	4.82	280		Exceeds criteria
FEEBRISAC-21.030-032	30	32	15-12062	pCi/g	1.11	U	0.32	2.34	0.44	0.75		0.35	0.50	1.04	1.86	*	Less than criteria
FEEBRISAC-21.040-042	40	42	15-12062	pCi/g	0.80	U	0.12	1.07	0.18	0.49		0.18	0.16	0.35	1.29	*	Less than criteria
FEEBRISAC-21A.013-014	13	14	15-12106	pCi/g	376		30.43	51.89	7.58	6.84	J	6.11	4.74	9.69	383		Exceeds criteria
FEEBRISAC-21A.047-048	47	48	15-12106	pCi/g	1.55		0.20	1.07	0.20	1.01		0.21	0.17	0.36	2.55		Less than criteria
FEEBRISAC-22.018-019	18	19	15-12064	pCi/g	14.77		1.17	2.89	0.40	0.58	J	0.36	0.30	0.63	15.36		Exceeds criteria
FEEBRISAC-22.041-042	41	42	15-12064	pCi/g	1.26	U	0.36	1.87	0.63	1.65		0.55	0.51	1.09	2.90	*	Less than criteria
FEEBRISAC-23.023-024	23	24	15-12063	pCi/g	344		24.34	22.56	3.52	1.51	U	3.11	2.34	4.74	346	*	Exceeds criteria
FEEBRISAC-23.067-068	67	68	15-12063	pCi/g	0.47	U	0.10	0.61	0.15	0.38		0.12	0.14	0.29	0.84	*	Less than criteria
FEEBRISAC-24.004-005	4	5	15-12063	pCi/g	1,188		78.28	21.06	3.17	9.53		2.22	1.87	3.75	1,198		Exceeds criteria
FEEBRISAC-24.014-015	14	15	15-12063	pCi/g	56.22		4.19	7.60	1.50	29.12		2.34	1.83	3.70	85.35		Exceeds criteria
FEEBRISAC-24.039-041	39	41	15-12063	pCi/g	1.08	U	0.26	2.46	0.39	1.11		0.44	0.37	0.79	2.19	*	Less than criteria
FEEBRISAC-24.047-048	47	48	15-12063	pCi/g	0.51	U	0.26	1.74	0.39	0.60		0.29	0.23	0.52	1.11	*	Less than criteria
FEEBRISAC-25.037-038	37	38	15-12062	pCi/g	1.25	U	0.20	1.53	0.28	1.50		0.27	0.19	0.41	2.75	*	Less than criteria
FEEBRISAC-25.043-045	43	45	15-12062	pCi/g	1.27	U	0.21	1.74	0.24	1.19		0.29	0.23	0.50	2.46	*	Less than criteria
FEEBRISAC-26A.004-005	4	5	15-12106	pCi/g	12.48		1.48	4.14	0.74	0.94	J	0.62	0.52	1.09	13.42		Exceeds criteria
FEEBRISAC-26A.037-038	37	38	15-12106	pCi/g	2.41		0.28	1.38	0.26	1.40		0.30	0.26	0.54	3.81		Less than criteria
Cotter Borings																	
WL-209-CT	1	3	160156091	pCi/g	882	J+	4.87	0.151	0.066	5.48	J	0.486	0.347	0.16	887		Exceeds criteria
WL-209-CT DUP	1	3	160156091	pCi/g	855	J+	4.86	0.136	0.057	4.57	J	0.453	0.349	0.161	860		Exceeds criteria
WL209CT.009-010	9	10	160-16191-1	pCi/g	460	J	3.84	0.08	0.185	45	J	1.37	0.193	0.416	505		Exceeds criteria
WL209CT.021-023	21	23	160-16191-1	pCi/g	0.756	J	0.137	0.047	0.11	0.23	J	0.239	0.18	0.39	0.99		Less than criteria
WL209CT.021-023 FD	21	23	160-16191-1	pCi/g	0.59		0.118	0.037	0.088	0.418	J	0.227	0.154	0.337	1.01		Less than criteria
WL209CT.026-027	26	27	160-16191-1	pCi/g	0.493	J	0.116	0.046	0.107	0.546	J	0.241	0.157	0.344	1.039		Less than criteria
WL-234-CT	8	10	160156071	pCi/g	1,040	J+	8.62	0.257	0.102	3.82	J	0.456	0.399	0.184	1,044		Exceeds criteria
WL-234-CT DUP	8	10	160156071	pCi/g	757	J+	7	0.24	0.096	1.92	J	0.346	0.376	0.173	759		Exceeds criteria
WL234CT.018-019	18	19	160-16191-1	pCi/g	110	J	1.6	0.05	0.117	0.633	J	0.251	0.159	0.348	111		Exceeds criteria
WL234CT.044-045	44	45	160-16191-1	pCi/g	0.992		0.149	0.034	0.084	0.39	J	0.221	0.15	0.33	1.38		Less than criteria
Cotter Samples from Core of Non-Cotter Borings																	
WL-210-CT (AC-24)	4	5	160156091	pCi/g	633	J+	4.06	0.122	0.051	1.5	J	0.314	0.374	0.173	635		Exceeds criteria
AC24-WL210CT.045-046	45	46	160-16191-1	pCi/g	0.489		0.107	0.031	0.078	0.248	J	0.221	0.162	0.355	0.737		Less than criteria
AC25-WL235CT.021-022	21	22	160-16191-1	pCi/g	0.994		0.156	0.043	0.102	0.674		0.271	0.168	0.372	1.668		Less than criteria

Sample Designation	Thorium-230 Result	Final Q	CSU[1]	CV	MDA	Thorium-232 Result	Final Q	CSU[1]	CV	MDA	Combined Thorium 230 + 232	Combined Thorium relative to 7.9 pCi/g Unrestricted Use Criteria
FEEBRISAC-18.002-005	1,752	J+	368	7.28	7.73	22.98	J+	11.52	0.34	5.38	1,775	Exceeds criteria
FEEBRISAC-18.002-005 FD	2,167	J+	449	6.71	6.65	31.21	J+	13.66	0.55	6.05	2,199	Exceeds criteria
FEEBRISAC-18.010-011	3,414	J+	743	7.26	7.18	22.48	J+	12.60	3.61	11.46	3,436	Exceeds criteria
FEEBRISAC-19.005-006	976	J+	201	5.63	5.29	9.76	J+	6.73	0.29	4.61	986	Exceeds criteria
FEEBRISAC-19.036-037	1.39	J+	0.38	0.06	0.06	1.07	J+	0.30	0.01	0.05	2.46	Less than criteria
FEEBRISAC-20.023-024	6,737	J+	1,397	7.63	8.09	40.44	J+	16.57	1.51	8.50	6,777	Exceeds criteria
FEEBRISAC-20.047-049	1.54	J+	0.38	0.04	0.04	1.06	J+	0.27	0.01	0.04	2.60	Less than criteria
FEEBRISAC-20.047-049 FD	1.32	J+	0.34	0.05	0.05	1.20	J+	0.30	0.02	0.07	2.52	Less than criteria
FEEBRISAC-21.012-013	3491	J+	788	6.81	10.58	136.70		41.32	0.87	8.75	3,628	Exceeds criteria
FEEBRISAC-21.030-032	22.62	J+	4.71	0.12	0.10	1.17	J+	0.39	0.01	0.10	23.79	Exceeds criteria
FEEBRISAC-21.040-042	5.61	J+	1.21	0.04	0.04	0.53	J+	0.16	0.00	0.05	6.14	Less than criteria
FEEBRISAC-21A.013-014	4,112	J+	908	7.61	9.60	101.67	J	32.57	2.37	11.09	4,214	Exceeds criteria
FEEBRISAC-21A.047-048	1.96	J+	0.48	0.05	0.05	0.87	J	0.24	0.01	0.05	2.82	Less than criteria
FEEBRISAC-22.018-019	128.54		26.34	0.05	0.06	0.69		0.20	0.02	0.07	129	Exceeds criteria
FEEBRISAC-22.041-042	1.58		0.40	0.04	0.04	1.13		0.29	0.00	0.04	2.72	Less than criteria
FEEBRISAC-23.023-024	1,458	J+	314	8.57	9.68	12.66	J+	9.39	3.27	10.78	1471	Exceeds criteria
FEEBRISAC-23.067-068	4.77	J+	1.10	0.05	0.06	0.33	J+	0.13	0.01	0.06	5.11	Less than criteria
FEEBRISAC-24.004-005	6,029	J+	902	7.36	6.86	54.15	J+	18.45	0.38	5.97	6,083	Exceeds criteria
FEEBRISAC-24.014-015	20.50	J+	4.72	0.26	0.22	10.05	J+	2.27	0.11	0.37	30.55	Exceeds criteria
FEEBRISAC-24.039-041	0.99	J+	0.28	0.05	0.04	0.80	J+	0.22	0.00	0.04	1.79	Less than criteria
FEEBRISAC-24.047-048	0.56	J+	0.19	0.05	0.05	0.35	J+	0.14	0.00	0.06	0.90	Less than criteria
FEEBRISAC-25.037-038	0.79	J+	0.22	0.05	0.05	0.27	J+	0.11	0.02	0.07	1.07	Less than criteria
FEEBRISAC-25.043-045	4.52	J+	1.00	0.05	0.05	1.03	J+	0.27	0.01	0.05	5.55	Less than criteria
FEEBRISAC-26A.004-005	245.54	J+	58.15	0.06	0.06	2.09		0.57	0.01	0.08	248	Exceeds criteria
FEEBRISAC-26A.037-038	10.09	J+	2.30	0.05	0.05	1.49		0.39	0.00	0.05	11.58	Exceeds criteria
Cotter Borings												
WL-209-CT	1,470,000	J+	19,600	363	82.9	1,150		556	361	82.5	1,471,150	Exceeds criteria
WL-209-CT DUP	256,000	J+	7,560	308	70.5	420	J	305	166	70.1	256,420	Exceeds criteria
WL209CT.009-010	9330	J+	121	0.507	2.18	5.51	J	2.96	0.357	1.88	9,336	Exceeds criteria
WL209CT.021-023	0.799	J+	0.162	0.0129	0.0501	0.629		0.142	0.0074	0.0242	1.428	Less than criteria
WL209CT.021-023 FD	0.792	J+	0.158	0.016	0.0554	0.656		0.143	0.0071	0.0375	1.448	Less than criteria
WL209CT.026-027	0.547	J+	0.13	0.0099	0.0428	0.462		0.119	0.007	0.0368	1.009	Less than criteria
WL-234-CT	644,000	J+	9,870	113	47.8	662		321	208	47.6	644,662	Exceeds criteria
WL-234-CT DUP	65,500	J+	2,850	267	87.4	202	J	165	170	38.9	65,702	Exceeds criteria
WL234CT.018-019	4290	J+	81.5	0.504	2.17	3.81	J	2.44	0.24	1.64	4,294	Exceeds criteria
WL234CT.044-045	1.18	J+	0.194	0.0073	0.0383	0.976		0.175	0.0072	0.0236	2.16	Less than criteria
Cotter Samples from Core of Non-Cotter Borings												
WL-210-CT (AC-24)	57,000	J+	2,070	104	23.8	318	J	157	103	23.6	57,318	Exceeds criteria
AC24-WL210CT.045-046	0.517	J+	0.127	0.0071	0.0374	0.2		0.0785	0.0071	0.0231	0.7	Less than criteria
AC25-WL235CT.021-022	4.24	J+	0.362	0.01	0.0431	1.02		0.177	0.0071	0.0371	5.26	Less than criteria

Sample Designation	Uranium-234 Result	Final Q	CSU[1]	CV	MDA	Uranium-235 Result	Final Q	CSU[1]	CV	MDA	Uranium-238 Result	Final Q	CSU[1]	CV	MDA	Combined Uranium 234 + 235 + 238		Combined Uranium relative to 54.4 pCi/g Unrestricted Use Criteria
FEEBRISAC-18.002-005	116	J	30.06	3.40	7.82	25.44	J	13.92	0.47	7.68	112	J	29.46	1.02	7.10	253		Exceeds criteria
FEEBRISAC-18.002-005 FD	180	J	42.12	2.95	9.99	32.55	J	16.74	0.53	8.58	208	J	46.35	1.99	9.94	420		Exceeds criteria
FEEBRISAC-18.010-011	133		30.89	3.30	7.55	16.58	J	10.37	0.61	7.43	154		34.04	0.65	5.24	303		Exceeds criteria
FEEBRISAC-19.005-006	74.84		23.09	3.80	8.76	4.49	J	6.25	0.96	9.47	75.02	J+	23.01	1.25	7.65	154		Exceeds criteria
FEEBRISAC-19.036-037	0.77		0.21	0.02	0.06	0.12	J	0.08	0.00	0.05	0.76		0.20	0.01	0.05	1.64		Less than criteria
FEEBRISAC-20.023-024	423		83.61	5.59	12.40	39.08	J	19.65	0.61	9.69	391	J+	78.47	1.62	9.83	853		Exceeds criteria
FEEBRISAC-20.047-049	0.85	J	0.21	0.02	0.05	0.10	J	0.07	0.01	0.06	0.78	J+	0.20	0.02	0.07	1.73		Less than criteria
FEEBRISAC-20.047-049 FD	0.89		0.22	0.02	0.04	0.11	J	0.08	0.00	0.05	0.72	J+	0.20	0.00	0.06	1.72		Less than criteria
FEEBRISAC-21.012-013	956		144.05	3.38	7.87	66.83	J+	22.81	0.45	7.18	869	J+	132.47	0.95	6.64	1,892		Exceeds criteria
FEEBRISAC-21.030-032	4.56		0.91	0.07	0.15	0.55	J	0.28	0.01	0.16	4.03		0.83	0.03	0.16	9.14		Less than criteria
FEEBRISAC-21.040-042	1.09	J	0.24	0.03	0.06	0.10	J	0.07	0.01	0.06	1.07	J	0.23	0.01	0.05	2.26		Less than criteria
FEEBRISAC-21A.013-014	1,711	J	263	6.59	13.57	203	J+	49.99	1.45	12.12	1,823	J+	279	3.86	13.13	3,736		Exceeds criteria
FEEBRISAC-21A.047-048	0.51	J	0.14	0.02	0.05	0.05	J+	0.05	0.01	0.06	0.43	J+	0.13	0.01	0.05	0.99		Less than criteria
FEEBRISAC-22.018-019	3.70	J+	0.57	0.02	0.04	0.25	J	0.10	0.00	0.05	3.44	J	0.53	0.00	0.03	7.40		Less than criteria
FEEBRISAC-22.041-042	0.87	J+	0.23	0.05	0.10	0.10	J	0.08	0.01	0.08	0.65		0.20	0.04	0.10	1.63		Less than criteria
FEEBRISAC-23.023-024	47.12		18.05	3.96	9.06	10.56	J	9.12	0.74	8.92	42.91	J+	17.01	1.30	7.90	101		Less than criteria
FEEBRISAC-23.067-068	0.38	J	0.14	0.02	0.06	0.11	J	0.08	0.00	0.06	0.34	J+	0.13	0.01	0.05	0.83		Less than criteria
FEEBRISAC-24.004-005	48.45		17.67	4.10	9.17	10.56	J	9.11	1.39	10.28	56.79	J+	19.23	1.90	8.73	116		Exceeds criteria
FEEBRISAC-24.014-015	5.92		1.43	0.12	0.25	0.70	J	0.47	0.04	0.39	7.56	J+	1.68	0.03	0.25	14.2		Less than criteria
FEEBRISAC-24.039-041	0.75		0.21	0.03	0.07	0.08	J	0.07	0.01	0.06	0.85	J+	0.22	0.01	0.05	1.67		Less than criteria
FEEBRISAC-24.047-048	0.80		0.22	0.03	0.06	0.19	J	0.10	0.00	0.06	0.76	J+	0.21	0.01	0.06	1.75		Less than criteria
FEEBRISAC-25.037-038	0.61		0.17	0.02	0.04	0.10	J	0.07	0.00	0.07	0.47		0.14	0.01	0.04	1.18		Less than criteria
FEEBRISAC-25.043-045	0.62		0.18	0.03	0.06	0.19	J	0.11	0.00	0.08	0.67		0.19	0.01	0.05	1.48		Less than criteria
FEEBRISAC-26A.004-005	4.93		0.77	0.03	0.07	0.36	J+	0.14	0.01	0.07	4.83	J+	0.75	0.01	0.05	10.12		Less than criteria
FEEBRISAC-26A.037-038	0.75	J	0.18	0.02	0.05	0.06	J+	0.05	0.00	0.05	0.89	J+	0.20	0.01	0.05	1.70		Less than criteria
Cotter Borings																		
WL-209-CT	107	J	3.62	0.21	0.0584	5.22	J	0.896	0.22	0.0514	102	J	3.53	0.199	0.0532	214.2		Exceeds criteria
WL-209-CT DUP	101	J	3.58	0.23	0.0649	5.15	J	0.9	0.12	0.0305	107	J	3.68	0.0946	0.0245	213.2		Exceeds criteria
WL209CT.009-010	0.29		0.112	0.01	0.0492	0.0269	J	0.038	0.01	0.0403	0.507		0.148	0.00837	0.0324	0.82		Less than criteria
WL209CT.021-023	0.483	J	0.143	0.01	0.0591	-0.00485	U	0.00686	0.01	0.0672	0.548		0.151	0.00805	0.0472	1.026	*	Less than criteria
WL209CT.021-023 FD	0.219	J	0.0943	0.01	0.0457	0.025	J	0.0353	0.01	0.0375	0.509		0.143	0.00778	0.0456	0.753		Less than criteria
WL209CT.026-027	0.444		0.134	0.01	0.0461	0.0126	J	0.0252	0.01	0.0378	0.352		0.12	0.00784	0.046	0.809		Less than criteria
WL-234-CT	53.8	J	2.22	0.12	0.025	2.81	J	0.565	0.09	0.022	50.1	J	2.14	0.139	0.0353	106.7		Exceeds criteria
WL-234-CT DUP	44.2	J	1.92	0.13	0.0325	2.05	J	0.463	0.12	0.0202	43.3	J	1.9	0.119	0.028	89.6		Exceeds criteria
WL234CT.018-019	0.2		0.0941	0.01	0.0333	0.0336	J	0.0486	0.02	0.0785	0.186		0.0914	0.00859	0.0504	0.4		Less than criteria
WL234CT.044-045	0.545		0.152	0.01	0.0479	0.0131	J	0.0262	0.01	0.0393	0.72		0.174	0.0115	0.0545	1.28		Less than criteria
Cotter Samples from Core of Non-Cotter Borings																		
WL-210-CT (AC-24)	58.9	J	2.32	0.1	0.0178	2.84	J	0.57	0.15	0.0313	58.7	J	2.32	0.14	0.0355	120.4		Exceeds criteria
AC24-WL210CT.045-046	0.797		0.184	0.01	0.0601	0.0526	J	0.0526	0.01	0.0394	1.08		0.213	0.00819	0.0316	1.93		Less than criteria
AC25-WL235CT.021-022	0.769		0.186	0.01	0.0582	0.0531	J	0.056	0.01	0.0635	0.894		0.2	0.00868	0.0335	1.716		Less than criteria

Notes: NDE = gamma log not deep enough. No Log = no log from RI investigation exists. * Indicates that result for one of the two isotopes was non-detect Final Q = final qualifier CSU[1] = combined standard uncertainty (+/- sigma for McLaren/Hart samples) CV = critical value

(highlighted) indicates that combined value is greater than the unrestricted use criteria established by EPA

J = The analyte was analyzed for, and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the environmental sample.

J+ = Same as J qualification but with an indication of positive bias in the sample concentration.

U = The analyte was analyzed for and is not present above the level of the associated value. The associated numerical value indicates the approximate concentration necessary to detect the analyte in the sample.

For McLaren/Hart RI Soil Boring Data:

- In calculated combined Ra and combined Th values, if of the the results was <MDA, one-half of the MDA was used in the calculation and the combined value was noted with an *. If both values were <MDA, combined results reported as "Non-detect".
- In calculated combined U values, if one or two of the the results was <MDA, one-half of the MDA was used in the calculation and the combined value was noted with an *. If all three values were <MDA, combined results reported as "Non-detect".

Table 2-5: Summary Statistics for Radium and Thorium Results - Areas 1 and 2

	Radium-226	Radium-228	Thorium-230	Thorium-232
Area 1				
Number of values	178	178	178	178
Median value	1.17	1.41	1.44	0.58
Average - single normally distributed population	81.3	2.38	547	7.77
Standard Deviation	510.5	2.96	2,851	47.28
Maximum value	4,926	31.8	25,825	515
95% UCL - single population	248	2.38	1,478	23.2
Weighted Bimodal Mean	81	1.7	550	7.8
Weighted Bimodal 95% UCL	890	5.2	1,900	46
Area 2				
Number of values	118	118	118	118
Median value	1.06	2.34	5.16	0.78
Average - single normally distributed population	152	2.34	1,706	10.5
Standard Deviation	572.8	4.23	7,148	33.6
Maximum value	3,720	29.1	57,300	240
95% UCL - single population	382	4.04	4,574	24
Weighted Bimodal Mean	150	2.4	1,500	11
Weighted Bimodal 95% UCL	340	82	4,000	29

All results except for number of values are in units of pCi/g.

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Table 2-6: Summary of Thorium-230 Decay and Radium-226 In-Growth Over Time - Area 1

Time (years)	Thorium-230 pCi/g	Radium -226 From Initial Ra_{226} (pCi/g)	Radium -226 Ingrowth from Th_{230} (pCi/g)	Radium -226 Total (pCi/g)
0	547	81	0	81
30	547	80	7	87
100	547	78	23	101
200	546	75	45	120
500	545	65	106	172
1,000	542	53	191	244
2,000	538	34	314	348
3,000	533	22	391	414
5,000	524	9	470	480
7,000	515	4	498	502
10,000	502	1	504	506
15,000	480	0	489	489
20,000	460	0	469	469
30,000	422	0	430	430
40,000	387	0	395	395
50,000	355	0	362	362
80,000	274	0	279	279

Constants	half life (y)	lambda (1/y)	Specific Mass to Activity (µg/pCi)
Th_{230} Half-Life	80,000	8.664E-06	4.95E-05
Ra_{226} Half-Life	1,602	4.327E-04	1.01E-06

Initial Values (from the RI report Appendix A Table A.2-5)

Thorium 230	547	pCi/g	Average activity level for Area 1
Radium-226	81	pCi/g	Average activity level for Area 1

Th-230(pCi/g) = Initial_Th230(pCi/g)*EXP[-Lambda_Th(1/y)*Time(y)]

Ra-226(pCi/g) = {Initial_Ra226(pCi/g) x EXP[-Lambda_Ra(1/y) x Time(y)]} + {[Lambda_Ra(1/y) x Initial_Th230(pCi/g)] / [Lambda_Ra(1/y) - Lambda_Th(1/y)]} x {EXP[-Lambda_Th(1/y) x Time(y)] - EXP[-Lambda_Ra(1/y) x Time(y)])}

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Table 2-7: Summary of Thorium-230 Decay and Radium-226 In-Growth Over Time - Area 2

Time (years)	Thorium-230 pCi/g	Radium -226: From Initial Ra_{226} (pCi/g)	Ingrowth from Th_{230} (pCi/g)	Total (pCi/g)
0	1,706	152	0	152
30	1,706	150	22	172
100	1,705	146	72	218
200	1,703	139	141	281
500	1,699	122	331	454
1,000	1,691	99	596	695
2,000	1,677	64	978	1,042
3,000	1,662	42	1,221	1,262
5,000	1,634	17	1,467	1,484
7,000	1,606	7	1,554	1,562
10,000	1,564	2	1,573	1,575
15,000	1,498	0	1,526	1,526
20,000	1,435	0	1,464	1,464
30,000	1,316	0	1,342	1,342
40,000	1,206	0	1,231	1,231
50,000	1,106	0	1,129	1,129
80,000	853	0	870	870

Constants	half life (y)	lambda (1/y)	Specific Mass to Activity (µg/pCi)
Th_{230} Half-Life	80,000	8.664E-06	4.95E-05
Ra_{226} Half-Life	1,602	4.327E-04	1.01E-06

Initial Values (from the RI report Appendix A Table A.2-5)

Thorium 230	1,706	pCi/g	Average activity level for Area 2
Radium-226	152	pCi/g	Average activity level for Area 2

Th-230(pCi/g) = Initial_Th230(pCi/g)*EXP[-Lambda_Th(1/y)*Time(y)]

Ra-226(pCi/g) = {Initial_Ra226(pCi/g) x EXP[-Lambda_Ra(1/y) x Time(y)]} + {[Lambda_Ra(1/y) x Initial_Th230(pCi/g)] / [Lambda_Ra(1/y) - Lambda_Th(1/y)]} x {EXP[-Lambda_Th(1/y) x Time(y)] - EXP[-Lambda_Ra(1/y) x Time(y)])}

Table 2-8: Buffer Zone Crossroad Property Combined Radium, Thorium, and Uranium Results

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Sample Designat	Boring	Upper Sample Depth (feet)	Lower Sample Depth (feet)	Units	Radium-226 Result	Final Q	+/- Sigma	CV	MDA	Radium-228 Result	Final Q	+/- Sigma	CV	MDA	Combined Radium 226 + 228		Combined Radium relative to 7.9 pCi/g Unrestricted Use Criteria	Thorium-230 Result	Final Q	+/- Sigma	CV	MDA	Thorium-232 Result	Final Q	+/- Sigma	CV	MDA	Combined Thorium 230 + 232	Combined Thorium relative to 7.9 pCi/g Unrestricted Use Criteria	Uranium-234 Result	Final Q	+/- Sigma	CV	MDA	Uranium-235 Result	Final Q	+/- Sigma	CV	MDA	Uranium-238 Result	Final Q	+/- Sigma	CV	MDA	Combined Uranium 234 + 235 + 238		Combined Uranium relative to 54.4 pCi/g Unrestricted Use Criteria
McLaren/Hart RI	McLaren/Hart RI Data																																														
FP1 0-3	FP-1	0.25	0.25	pCi/g	7.23	U			7.23	2.13	U			2.13	Non-detect	*	Non-detect	12.8		2.8		0.2	1.1		0.38		0.22	13.9	Exceeds criteria	0.73		0.19		0.08	0.15		0.08		0.07	0.81		0.21		0.09	1.69		Less than criteria
FP1 0-3	FP-1	0.25	0.25	pCi/g	7.19		3.98		4.63	2.06	U			2.06	8.22	*	Exceeds criteria	1.39		0.33		0.06	1.06		0.27		0.05	2.45	Less than criteria	0.84		0.2		0.07	0.15		0.07		0.05	0.8		0.19		0.06	1.79		Less than criteria
FP1 12-24	FP-1	2	2	pCi/g	4.94	U			4.94	2.29	U			2.29	Non-detect	*	Non-detect	1.16		0.29		0.06	0.84		0.23		0.05	2.00	Less than criteria	0.69		0.18		0.04	0.13		0.07		0.05	0.75		0.19		0.06	1.57		Less than criteria
FP2 0-3	FP-2	0.25	0.25	pCi/g	6.28	U			6.28	2.85	U			2.85	Non-detect	*	Non-detect	2.92		0.63		0.1	1.08		0.29		0.14	4.00	Less than criteria	1.08		0.24		0.07	0.14		0.08		0.1	1.17		0.26		0.09	2.39		Less than criteria
FP2 12-24	FP-2	2	2	pCi/g	7.99		4.85		4.93	2.61	U			2.61	9.30	*	Exceeds criteria	1.24		0.31		0.12	1.13		0.29		0.1	2.37	Less than criteria	0.78		0.21		0.1	0.26		0.11		0.08	0.94		0.24		0.1	1.98		Less than criteria
FP3 0-3	FP-3	0.25	0.25	pCi/g	6.23	U			6.23	2.05	U			2.05	Non-detect	*	Non-detect	1.26		0.31		0.11	0.85		0.23		0.1	2.11	Less than criteria	0.69		0.18		0.07	0.063		0.051		0.057	0.79		0.2		0.05	1.54		Less than criteria
FP3 12-24	FP-3	2	2	pCi/g	4.24	U			4.24	1.66	U			1.66	Non-detect	*	Non-detect	1.26		0.31		0.07	0.91		0.24		0.05	2.17	Less than criteria	1.94		0.4		0.07	0.38		0.13		0.05	2.62		0.51		0.07	4.94		Less than criteria
FP4 0-3	FP-4	0.25	0.25	pCi/g	9.06		3.81		3.62	2.6	U			2.6	10.36	*	Exceeds criteria	2.61		0.57		0.07	1.16		0.3		0.06	3.77	Less than criteria	1.01		0.23		0.04	0.11		0.07		0.06	0.96		0.23		0.05	2.08		Less than criteria
FP4 12-24	FP-4	2	2	pCi/g	5.58	U			5.58	1.73	U			1.73	Non-detect	*	Non-detect	2.2		0.49		0.07	1.28		0.32		0.05	3.5	Less than criteria	0.71		0.19		0.06	0.095		0.064		0.061	0.84		0.21		0.06	1.65		Less than criteria
FP5 0-3	FP-5	0.25	0.25	pCi/g	4.08		3.1		2.99	0.94	U			0.94	4.55	*	Less than criteria	28.6		5.2		0.08	1.38		0.34		0.08	30.0	Exceeds criteria	0.84		0.2		0.05	0.062		0.047		0.05	1.05		0.23		0.04	1.95		Less than criteria
FP5 12-24	FP-5	2	2	pCi/g	6.04	U			6.04	1.96	U			1.96	Non-detect	*	Non-detect	5.31		1.03		0.09	1.2		0.3		0.02	6.5	Less than criteria	1.11		0.32		0.08	0.22		0.13		0.09	1.2		0.33		0.09	2.53		Less than criteria
FP6 0-3	FP-6	0.25	0.25	pCi/g	5.59	U			5.59	1.56	U			1.56	Non-detect	*	Non-detect	1.2		0.29		0.06	0.95		0.24		0.06	2.2	Less than criteria	0.73		0.18		0.07	0.07		0.06		0.1	0.91		0.21		0.06	1.71		Less than criteria
FP6 12-24	FP-6	2	2	pCi/g	3.25	U			3.25	1.95	U			1.95	Non-detect	*	Non-detect	1.8		0.39		0.05	1.2		0.28		0.05	3.0	Less than criteria	0.86		0.21		0.04	0.093		0.061		0.025	1.07		0.25		0.05	2.02		Less than criteria
FP7 0-3	FP-7	0.25	0.25	pCi/g	4.72		2.89		3.49	1.78	U			1.78	5.61	*	Less than criteria	2.08		0.43		0.07	1.14		0.27		0.05	3.22	Less than criteria	0.88		0.26		0.06	0.15		0.1		0.04	0.82		0.25		0.07	1.85		Less than criteria
FP7 12-24	FP-7	2	2	pCi/g	6.63	U			6.63	2.13	U			2.13	Non-detect	*	Non-detect	1.51		0.32		0.03	0.10		0.23		0.03	1.61	Less than criteria	0.65		0.25		0.15	0.05		0.08		0.14	0.71		0.26		0.13	1.41		Less than criteria
FP8 0-3	FP-8	0.25	0.25	pCi/g	5.22	U			5.22	1.68	U			1.68	Non-detect	*	Non-detect	21.8		3.8		0.09	1.57		0.35		0.09	23.37	Exceeds criteria	0.95		0.28		0.06	0.11		0.09		0.08	0.81		0.25		0.08	1.87		Less than criteria
FP8 1-2	FP-8	2	2	pCi/g	5.78	U			5.78	2.92	U			2.92	Non-detect	*	Non-detect	2.04		0.42		0.082	1.29		0.29		0.067	3.33	Less than criteria	0.93		0.34		0.21	0.07		0.18		0.32	1.3		0.42		0.24	2.30		Less than criteria
WL-201	WL-201	5	5	pCi/g	1.06		0.22		0.34	1.13	U			1.13	1.63	*	Less than criteria	1.06		0.31		0.15	0.32		0.15		0.13	1.38	Less than criteria	1.30	U			1.30	0.22	U	0.17		0.22	1.19		0.4		0.17	1.95	*	Less than criteria
WL-201	WL-201	15	15	pCi/g	0.47		0.16		0.24	0.73	U			0.73	0.84	*	Less than criteria	0.63		0.23		0.11	0.28		0.15		0.08	0.91	Less than criteria	2.35	U			2.35	0.13	U	0.079		0.13	0.31		0.18		0.12	1.55	*	Less than criteria
WL-202	WL-202	5	5	pCi/g	0.75		0.41		0.54	1.59	U			1.59	1.55	*	Less than criteria	0.83		0.29		0.11	0.44		0.20		0.09	1.27	Less than criteria	1.27		0.77		1.02	0.17	U	0.076		0.17	0.88		0.37		0.12	2.24	*	Less than criteria
WL-202	WL-202	15	15	pCi/g	0.81	U			0.81	1.18	U			1.18	Non-detect	*	Non-detect	0.26		0.14		0.08	0.16		0.11		0.08	0.42	Less than criteria	3.75	U			3.75	0.12	U	0.003		0.12	0.24		0.16		0.10	2.18	*	Less than criteria
WL-203	WL-203	0	0	pCi/g	1.07		0.24		0.38	1.28	U			1.28	1.71	*	Less than criteria	3.03		0.88		0.15	0.43		0.24		0.12	3.46	Less than criteria	1.46		1.06		1.43	0.31		0.25		0.27	1.95		0.63		0.20	3.72		Less than criteria
WL-203	WL-203	5	5	pCi/g	0.94		0.22		0.33	0.99	U			0.99	1.44	*	Less than criteria	0.8		0.27		0.1	0.14		0.1		0.06	0.9	Less than criteria	1.48	U			1.48	0.18		0.17		0.15	0.95		0.38		0.11	1.87	*	Less than criteria
WL-203	WL-203	15	15	pCi/g	0.53		0.21		0.33	0.98	U			0.98	1.02	*	Less than criteria	0.41		0.18		0.11	0.23		0.13		0.08	0.64	Less than criteria	1.86	U			1.86	0.16	U	0.11		0.16	0.60		0.27		0.12	1.61	*	Less than criteria
WL-204	WL-204	5	5	pCi/g	1.06		0.22		0.31	0.99		0.45		0.56	2.05		Less than criteria	0.77		0.26		0.09	0.47		0.2		0.06	1.24	Less than criteria	1.03	U			1.03	0.22		0.18		0.15	0.77		0.33		0.08	1.51	*	Less than criteria
WL-204	WL-204	25	25	pCi/g	0.77		0.20		0.36	0.85		0.36		0.72	1.62		Less than criteria	0.43		0.19		0.08	0.32		0.16		0.07	0.75	Less than criteria	1.04	U			1.04	0.11	U	0.06		0.11	0.36		0.2		0.09	0.94	*	Less than criteria
WL-205	WL-205	5	5	pCi/g	0.95		0.22		0.26	1.19	U			1.19	1.55	*	Less than criteria	0.80		0.28		0.11	0.66		0.25		0.08	1.46	Less than criteria	1.48		0.81		0.92	0.15		0.14		0.15	1.76		0.5		0.09	3.39		Less than criteria
WL-205	WL-205	15	15	pCi/g	0.90		0.26		0.34	0.95	U			0.95	1.38	*	Less than criteria	1.01				0.25	0.95		0.38		0.15	1.96	Less than criteria	1.76		1.18		1.52	0.18		0.15		0.14	0.95		0.34		0.10	2.89		Less than criteria
WL-206	WL-206	0	0	pCi/g	17.2		1.2		0.4	1.21	U			1.21	17.8	*	Exceeds criteria	429		135		0.7	11.2		4.4		0.6	440	Exceeds criteria	2.53	U			2.53	0.33	U	0.22		0.33	4.17		1.04		0.26	5.60	*	Less than criteria
WL-206	WL-206	5	5	pCi/g	1.20		0.37		0.57	1.58	U			1.58	1.99	*	Less than criteria	7.51		1.54		0.23	1.12		0.4		0.15	8.63	Exceeds criteria	4.01	U			4.01	0.19		0.1		0.06	1.17		0.27		0.06	3.37	*	Less than criteria
WL-206	WL-206	10	10	pCi/g	0.72		0.18		0.28	0.96	U			0.96	1.20	*	Less than criteria	1.66		0.51		0.21	0.82		0.33		0.16	2.48	Less than criteria	1.83		0.79		1.04	0.064	U	0.05		0.064	0.6		0.17		0.04	2.46	*	Less than criteria
RC-01	RC-01	0	0.25	pCi/g	0.15	U			0.15	1.83		1.83		0.71	1.91	*	Less than criteria	2.75		2.75		0.09	1.4		1.4		0.07	4.2	Less than criteria	1		1		0.15	0.13	U			0.13	0.92		0.92		0.1	1.99	*	Less than criteria
RC-02	RC-02	0	0.25	pCi/g	0.13	U			0.13	1.47		1.47		0.68	1.54	*	Less than criteria	30.6		30.6		0.1	1.28		1.28		0.14	31.9	Exceeds criteria	1.06		1.06		0.05	0.14		0.14		0.1	1.08		1.08		0.05	2.28		Less than criteria
RC-03	RC-03	0	0.25	pCi/g	0.14	U			0.14	1.67		1.67		0.68	1.74	*	Less than criteria	6.3		6.3		0.2	0.97		0.97		0.23	7.3	Less than criteria	0.8		0.8		0.11	0.12	U			0.12	0.89		0.89		0.08	1.75	*	Less than criteria
RC-04	RC-04	0	0.25	pCi/g	0.13	U			0.13	1.92		1.92		0.69	1.99	*	Less than criteria	2.6		2.6		0.18	1.25		1.25		0.07	3.9	Less than criteria	0.93		0.93		0.14	0.064		0.064		0.058	0.94		0.94		0.05	1.93		Less than criteria
RC-05	RC-05	0	0.25	pCi/g	0.1	U			0.1	1.59		1.59		0.66	1.64	*	Less than criteria	2.48		2.48		0.08	1.21		1.21		0.09	3.69	Less than criteria	0.91		0.91		0.16	0.14		0.14		0.14	0.69		0.69		0.09	1.74		Less than criteria
RC-06	RC-06	0	0.25	pCi/g	0.12	U			0.12	1.26		1.26		0.72	1.32	*	Less than criteria	4.6		4.6		0.1	1.18		1.18		0.04	5.8	Less than criteria	0.97		0.97		0.13	0.18	U			0.18	0.96		0.96		0.05	2.02	*	Less than criteria
RC-07	RC-07	0	0.25	pCi/g	0.12	U	0.378		0.12	0.96		0.96		0.68	1.02	*	Less than criteria	2.84		2.84		0.16	1.56		1.56		0.08	4.40	Less than criteria	0.63		0.63		0.13	0.05	U			0.05	0.897		0.897		0.32	1.55	*	Less than criteria

Notes: No Log = no log from RI investigation exists. * Indicates that result for one of the two isotopes was non-detect Final Q = final qualifier CSU[1] = combined standard uncertainty (+/- sigma for McLaren/Hart samples) CV = critical value

(highlighted) indicates that combined value is greater than the unrestricted use criteria established by EPA

J = The analyte was analyzed for, and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the environmental sample.

J+ = Same as J qualification but with an indication of positive bias in the sample concentration.

U = The analyte was analyzed for and is not present above the level of the associated value. The associated numerical value indicates the approximate concentration necessary to detect the analyte in the sample.

For McLaren/Hart RI Soil Boring Data:

- In calculated combined Ra and combined Th values, if of the the results was <MDA, one-half of the MDA was used in the calculation and the combined value was noted with an *. If both values were <MDA, combined results reported as "Non-detect".
- In calculated combined U values, if one or two of the the results was <MDA, one-half of the MDA was used in the calculation and the combined value was noted with an *. If all three values were <MDA, combined results reported as "Non-detect".

Table 2-9: Summary Comparison of Soil Sample Results to RCRA Toxicity Characteristic Regulatory Levels

EPA HW No.	Contaminant	Regulatory Level (mg/L)	x DAF of 20	Maximum Concentration in Soil (mg/kg)[1]	Location and Depth (ft)
D004	Arsenic	5.0	100	**610**	AC-16 @ 19-20
D005	Barium	100.0	2,000	**11,000**	AC-23 @ 23-24 & WL-234-CT @ 18-19
D006	Cadmium	1.0	20	**57**	1D-15 @ 77-80
D007	Chromium	5.0	100	**890**	WL-208 @ 20
D008	Lead	5.0	100	**30,000**	1C-6-CT @ 25-27
D009	Mercury	0.2	4	**12**	1D-15 @77-80
D010	Selenium	1.0	20	**250**	WL-114 @ 0 & AC-16 @ 19-20
D011	Silver	5.0	100	8.8 J-	1D-3 @ 28-29
D012	Endrin	0.02	0	0.18	WL-218 @ 25
D013	Lindane (gamma BHC)	0.4	8	ND	
D014	Methoxychlor	10.0	200	0.0057	WL-227 @ 40
D015	Toxaphene	0.5	10	ND	
D016	2,4-D	10.0	200	NA	
D017	2,4,5-TP (Silvex)	1.0	20	NA	
D018	Benzene	0.5	10	**120 J**	Wl-208 @ 20
D019	Carbon tetrachloride	0.5	10	ND	ND
D020	Chlordane	0.03	0.6	0.015	WL-104 @ 25
D021	Chlorobenzene	100.0	2,000	180	WL-230 @ 16
D022	Chloroform	6.0	120	**890**	Wl-208 @ 20
D023	o-Cresol (2-Methylphenol)	200.0	4,000	0.17 J	WL-213 @ 25
D024	m-Cresol (3-Methylphenol)	200.0	4,000	NA	NA
D025	p-Cresol (4-Methylphenol)	200.0	4,000	5.8 JY	WL-210 @ 15
D026	Cresol	200.0	4,000	NA	NA
D027	1,4-Dichlorobenzene	7.5	150	**530 Y ***	WL-230 @ 16
D028	1,2-Dichloroethane	0.5	10	ND	ND
D029	1,1-Dichloroethylene	0.7	14	ND	ND
D030	2,4-Dinitrotoluene	0.13	3	ND	
D031	Heptachlor (and its epoxide)	0.008	0	ND	
D032	Hexachlorobenzene	0.13	3	ND	
D033	Hexachlorobutadiene	0.5	10	ND	
D034	Hexachloroethane	3.0	60	ND	
D035	Methyl ethyl ketone (2-butanone)	200.0	4,000	52	WL-208 @ 15
D036	Nitrobenzene	2.0	40	ND	
D037	Pentachlorophenol	100.0	2,000	0.085 J	WL-208 @ 28
D038	Pyridine	5.0	100	NA	
D039	Tetrachloroethylene	0.7	14	ND	
D040	Trichloroethylene	0.5	10	6.0 JY	WL-210 @ 15
D041	2,4,5-Trichlorophenol	400.0	8,000	ND	
D042	2,4,6-Trochlorophenol	2.0	40	ND	
D043	Vinyl chloride	0.2	4	ND	

Notes: [1]Bolded maximum concentrations indicate that the measured contaminant concentration is greater than the Regulatory Level times a Dilution-Attenuation Factor (DAF) of 20.

J - Estimated value, as result was below laboratory reporting limit.

Y - Estimated value, as all surrogate compounds were diluted beyond detection limits.

* Result is from EPA Method 8270. A result of 2,100 Y was obtained from the EPA Method 8260 analysis of this sample.

Table 2-10: Baseline Perimeter Air Monitoring Results for Radon

DRAFT

Station No.	Test Duration 5/1/15 – 7/23/15 Result (pCi/L)	Test Duration 7/23/15 – 10/14/15 Result (pCi/L)	Test Duration 10/14/15 – 1/7/16 Result (pCi/L)	Average (1/2 RL for NDs)	Average (RLs for NDs)
1	<0.4	<0.4	0.5	0.30	0.43
2	<0.4	0.7	0.6	0.50	0.57
3	<0.4	<0.4	<0.4	0.20	0.40
4	<0.4	0.4	<0.4	0.27	0.40
5	<0.4	<0.4	<0.4	0.20	0.40
6	<0.4	0.5	0.4	0.37	0.43
7	<0.4	0.7	0.5	0.47	0.53
8	<0.4	0.5	<0.4	0.30	0.43
9	<0.4	<0.4	<0.4	0.20	0.40
10	<0.4	0.5	0.4	0.33	0.43
10 DUP			<0.4		
11	<0.4	<0.4	<0.4	0.23	0.40
11 DUP		0.4			
12	<0.4	<0.4	0.5	0.30	0.43
12 DUP	<0.4				
13	<0.4	<0.4	<0.4	0.20	0.40

Notes:
According to EPA (2012b), about 0.4 pCi/L of Radon is normally found in outside air.
EPA Off-site air montioring results reported radon levels at its reference station (No. 5) of 0.11 to 1.45 with a median of 0.30 pCi/L.

Table 2-11: Summary of Gross Alpha Results in Particulate Air Samples

On-Site Perimeter Monitoring Stations

Summary Statistic	Station 1 (pCi/m^3)	Station 2 (pCi/m^3)	Station 3 (pCi/m^3)	Station 4 (pCi/m^3)	Station 5 (pCi/m^3)	Station 6 (pCi/m^3)	Station 7 (pCi/m^3)
Detections	9/9	5/9	9/9	9/9	9/9	9/9	9/9
Minimum Concentration	1.45E-03	1.54E-03 J+	1.52E-03	1.28E-03	1.40E-03	5.27E-04 J+	1.37E-03
Median Concentration	3.49E-03	3.15E-03	3.59E-03	3.85E-03	4.31E-03	4.27E-03	4.01E-03
Maximum Concentration	5.31E-03 J+	4.57E-03 J+	5.64E-03 J+	6.09E-03 J+	5.38E-03 J+	5.05E-03 J+	5.70E-03 J+

Summary Statistic	Station 8 (pCi/m^3)	Station 9 (pCi/m^3)	Station 10 (pCi/m^3)	Station 11 (pCi/m^3)	Station 12 (pCi/m^3)	Station 13 (pCi/m^3)
Detections	9/9	8/9	9/9	9/9	9/9	9/9
Minimum Concentration	1.50E-03	2.43E-03 J+	1.09E-03	1.95E-03	1.58E-03	1.40E-03
Median Concentration	4.57E-03	3.72E-03	3.15E-03	4.07E-03	4.26E-03	3.68E-03
Maximum Concentration	5.75E-03 J+	4.57E-03 J+	4.46E-03 J+	6.16E-03 J+	5.72E-03 J+	5.61E-03 J+

EPA Off-Site (TetraTech, 2015)

Summary Statistic	Station 1 (pCi/m^3)	Station 2 (pCi/m^3)	Station 3 (pCi/m^3)	Station 4 (pCi/m^3)	Station 5 (background) (pCi/m^3)
Detections	36/44	34/44	30/44	40/64	32/44
Minimum Concentration	1.99E-04 U	1.93E-04 U	1.02E-04 U	1.17E-04 U	1.10E-04 U
Median Concentration	6.42E-04	6.25E-04	6.32E-04	6.06E-04	6.97E-04
Maximum Concentration	1.63E-03 J	1.68E-03 J	1.58E-03 J	1.38E-03 J	1.65E-03 J

Table 2-12: Summary of Gross Beta Results in Particulate Air Samples

On-Site Perimeter Monitoring Stations

Summary Statistic	Station 1 (pCi/m^3)	Station 2 (pCi/m^3)	Station 3 (pCi/m^3)	Station 4 (pCi/m^3)	Station 5 (pCi/m^3)	Station 6 (pCi/m^3)	Station 7 (pCi/m^3)
Detections	9/9	5/9	9/9	9/9	9/9	9/9	9/9
Minimum Concentration	1.84E-02	1.94E-02	2.05E-02	1.76E-02	1.73E-02	4.06E-03 J+	1.56E-02
Median Concentration	3.39E-02	3.25E-02	3.25E-02	3.49E-02	3.57E-02	3.71E-02	3.18E-02
Maximum Concentration	4.45E-02 J+	3.93E-02 J+	4.60E-02 J+	4.77E-02 J+	4.31E-02 J+	4.43E-02 J+	4.34E-02 J+

Summary Statistic	Station 8 (pCi/m^3)	Station 9 (pCi/m^3)	Station 10 (pCi/m^3)	Station 11 (pCi/m^3)	Station 12 (pCi/m^3)	Station 13 (pCi/m^3)
Detections	9/9	8/9	9/9	9/9	9/9	9/9
Minimum Concentration	1.89E-02	2.21E-02 J+	1.53E-02	2.03E-02 J+	2.15E-02	1.86E-02
Median Concentration	3.55E-02	3.19E-02	2.60E-02	3.36E-02	3.79E-02	3.37E-02
Maximum Concentration	4.36E-02 J+	4.01E-02 J+	3.80E-02 J+	4.76E-02 J+	4.46E-02 J+	4.43E-02 J+

EPA Off-Site (TetraTech, 2015)

Summary Statistic	Station 1 (pCi/m^3)	Station 2 (pCi/m^3)	Station 3 (pCi/m^3)	Station 4 (pCi/m^3)	Station 5 (background) (pCi/m^3)
Detections	44/44	44/44	44/44	64/64	44/44
Minimum Concentration	1.15E-02	4.13E-03 J	1.32E-02 J	1.16E-02 J	1.21E-02 J
Median Concentration	1.98E-02	2.05E-02	2.04E-02	1.87E-02	1.93E-02
Maximum Concentration	3.95E-02	4.36E-02	3.96E-02	4.15E-02	4.31E-02

Table 2-13: Thorium-230 Statistics for Particulate Air Samples (May, June, September and December, 2015)

Summary Statistic	Station 1 (pCi/m^3)	Station 2 (pCi/m^3)	Station 3 (pCi/m^3)	Station 4 (pCi/m^3)	Station 5 (pCi/m^3)	Station 6 (pCi/m^3)	Station 7 (pCi/m^3)
Detections	4/4	4/4	4/4	4/4	4/4	4/4	4/4
Minimum Concentration	1.75E-05 J	8.08E-06	1.90E-05	3.14E-05	2.85E-05 J+	1.05E-05 J	2.93E-05
Median Concentration	2.91E-05	2.76E-05	4.37E-05	4.34E-05	3.16E-05	4.55E-05	4.74E-05
Maximum Concentration	6.58E-05 J+	5.18E-05 J+	7.03E-05 J+	4.94E-05 J+	7.02E-05 J+	8.06E-05 J+	7.22E-05 J+

Summary Statistic	Station 8 (pCi/m^3)	Station 9 (pCi/m^3)	Station 10 (pCi/m^3)	Station 11 (pCi/m^3)	Station 12 (pCi/m^3)	Station 13 (pCi/m^3)
Detections	4/4	4/4	4/4	4/4	4/4	4/4
Minimum Concentration	1.93E-05	2.34E-05 J+	2.66E-05	2.23E-05	3.51E-05 J	1.78E-05
Median Concentration	4.48E-05	3.05E-05	5.20E-05	5.64E-05	6.50E-05	3.12E-05
Maximum Concentration	5.87E-05 J+	4.84E-05 J+	7.20E-05 J+	8.19E-05 J+	8.64E-05 J+	4.39E-05 J

Table 2-14: Uranium-238 Statistics for Particulate Air Samples (May, June, September and December, 2015)

Summary Statistic	Station 1 (pCi/m^3)	Station 2 (pCi/m^3)	Station 3 (pCi/m^3)	Station 4 (pCi/m^3)	Station 5 (pCi/m^3)	Station 6 (pCi/m^3)	Station 7 (pCi/m^3)
Detections	4/4	4/4	4/4	4/4	4/4	4/4	4/4
Minimum Concentration	2.45E-05 J+	1.84E-05 J+	2.99E-05 J+	2.43E-05 J+	1.38E-05 J	2.09E-05	2.12E-05 J+
Median Concentration	2.86E-05	3.05E-05	3.23E-05	3.10E-05	3.07E-05	2.41E-05	2.93E-05
Maximum Concentration	3.36E-05	3.43E-05	5.08E-05 J	3.65E-05 J	4.28E-05 J	3.19E-05	4.32E-05 J

Summary Statistic	Station 8 (pCi/m^3)	Station 9 (pCi/m^3)	Station 10 (pCi/m^3)	Station 11 (pCi/m^3)	Station 12 (pCi/m^3)	Station 13 (pCi/m^3)
Detections	4/4	4/4	4/4	4/4	4/4	4/4
Minimum Concentration	2.30E-05 J+	2.36E-05 J+	2.60E-05 J+	2.39E-05 J+	2.23E-05 J+	1.95E-05 J
Median Concentration	2.91E-05	3.32E-05	3.49E-05	2.91E-05	2.61E-05	2.69E-05
Maximum Concentration	4.61E-05 J	3.57E-05 J+	4.34E-05 J+	3.96E-05	4.13E-05	3.49E-05

Table 2-15: Total Radium Statistics for Particulate Air Samples (May, June, September and December, 2015)

Summary Statistic	Station 1 (pCi/m^3)	Station 2 (pCi/m^3)	Station 3 (pCi/m^3)	Station 4 (pCi/m^3)	Station 5 (pCi/m^3)	Station 6 (pCi/m^3)	Station 7 (pCi/m^3)
Detections	2/4	3/4	3/4	3/4	3/4	2/4	3/4
Minimum Concentration	6.58E-05 J	1.64E-04	7.11E-05	1.44E-04	4.93E-05	-1.94E-04	2.19E-04
Median Concentration	1.56E-04	1.71E-04	1.73E-04	2.22E-04	1.06E-04	2.20E-04	2.83E-04
Maximum Concentration	3.22E-04	3.27E-04	3.23E-04	3.18E-04	1.34E-04	3.50E-04	3.94E-04

Summary Statistic	Station 8 (pCi/m^3)	Station 9 (pCi/m^3)	Station 10 (pCi/m^3)	Station 11 (pCi/m^3)	Station 12 (pCi/m^3)	Station 13 (pCi/m^3)
Detections	4/4	0/4	2/4	4/4	1/4	3/4
Minimum Concentration	5.86E-05	2.75E-05	-1.43E-05	1.95E-04	2.61E-05	1.15E-04
Median Concentration	1.62E-04	4.44E-05	1.20E-04	2.43E-04	1.33E-04	1.82E-04
Maximum Concentration	2.71E-04	8.41E-05	2.26E-04	3.73E-04	2.38E-04	3.50E-04

Table 2-16: Summary of EPA Off-Site Isotopic and Radium Results

SUMMARY STATISTICS OF URANIUM-238 RESULTS	Station 1 (pCi/m^3)	Station 2 (pCi/m^3)	Station 3 (pCi/m^3)	Station 4 (pCi/m^3)	Station 5 (reference) (pCi/m^3)
Detections	19/44	24/44	22/44	21/64	14/44
Minimum Concentration	-1.61E-04 U	-8.55E-05 U	-4.42E-05 U	-1.34E-05 U	-2.39E-05 U
Median Concentration	9.38E-05	1.24E-04	1.12E-04	1.03E-04	1.02E-04
Maximum Concentration	6.22E-04 J	1.08E-03 J	3.86E-04 J	3.07E-04 J	2.25E-04 J
SUMMARY STATISTICS OF THORIUM-230 RESULTS	**Station 1** (pCi/m^3)	**Station 2** (pCi/m^3)	**Station 3** (pCi/m^3)	**Station 4** (pCi/m^3)	**Station 5 (reference)** (pCi/m^3)
Detections	42/44	39/44	42/44	55/64	42/44
Minimum Concentration	1.77E-04 U	2.63E-04 J	1.37E-04 J	1.81E-04 J	2.71E-04 U
Median Concentration	4.71E-04	5.66E-04	5.10E-04	5.38E-04	5.17E-04
Maximum Concentration	4.37E-03	1.36E-03 J	8.86E-04 J	1.80E-03 J	1.99E-03 J
SUMMARY STATISTICS OF TOTAL ALPHA-EMITTING RADIUM RESULTS	**Station 1** (pCi/m^3)	**Station 2** (pCi/m^3)	**Station 3** (pCi/m^3)	**Station 4** (pCi/m^3)	**Station 5 (reference)** (pCi/m^3)
Detections	3/43	4/43	3/43	3/63	2/43
Minimum Concentration	-2.50E-04 U	-6.83E-04 U	1.56E-04 U	-4.86E-04 U	-4.34E-04 U
Median Concentration	4.49E-04	4.55E-04	3.05E-04	4.58E-04	4.68E-04
Maximum Concentration	1.10E-03 J	1.80E-03 JG	2.01E-03	3.66E-03 J	4.40E-03

Source: TetraTech, 2015

Table 3-1: Preliminary Identification of Potential Chemical-Specific ARARs and TBC Criteria

Citation	Chemical	Medium	Requirement	Preliminary Determination	Remarks
Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40 CFR 192), Subpart A, Standards for the Control of Residual Radioactive Material from Inactive Uranium Processing Sites	Radon-222	Air	The annual average release rate of radon-222 to the atmosphere applied over the entire surface of a disposal site should not exceed 20 pCi/m2-s, and the annual average concentration of radon-222 in air at or above any location outside the disposal site should not be increased by more than 0.5 pCi/L.	Not applicable but potentially relevant and appropriate	The West Lake Landfill OU-1 Site is not a designated Title I uranium mill tailings site; therefore, this requirement would not be applicable. The radiologically impacted materials at the Site are a small fraction of an overall matrix of municipal solid waste, debris and fill materials. Therefore, the waste materials at the Site are not similar to uranium mill tailings. These regulations are applicable to uncontrolled areas, whereas the current and future uses of Areas 1 and 2 are restricted. As these regulations address radon emissions, which is a concern for OU-1, they are considered potentially relevant and appropriate to the ROD-selected remedy and the partial excavation alternatives.
Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40 CFR 192), Subpart A, Standards for the Control of Residual Radioactive Material from Inactive Uranium Processing Sites	Radium, Uranium, and trace metals	Ground-water	Establishes maximum concentration for groundwater protection. Maximum constituent concentration: Combined Ra_{226} and Ra_{228} — 5 pCi/L Combined U_{234} and U_{238} — 30 pCi/L Gross alpha (excluding radon & uranium) — 15 pCi/L Arsenic — 0.05 mg/L Barium — 1.0 mg/L Cadmium — 0.01 mg/L Chromium — 0.05 mg/L Lead — 0.05 mg/L Mercury — 0.002 mg/L Selenium — 0.01 mg/L Silver — 0.05 mg/L Nitrate (as N) — 10 mg/L Molybdenum — 0.1 mg/L	Not applicable but potentially relevant and appropriate	The West Lake Landfill OU-1 Site is not a designated Title I uranium mill tailings site; therefore, this requirement would not be applicable. As potential leaching of radionuclides and trace metals from the radiologically impacted materials at the Site is a possible issue of concern, these standards are potentially relevant and appropriate to the ROD-selected remedy and the partial excavation alternatives.

Table 3-1: Preliminary Identification of Potential Chemical-Specific ARARs and TBC Criteria

Citation	Chemical	Medium	Requirement	Preliminary Determination	Remarks
Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40 CFR 192), Subpart B, Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites	Radium-226 (Radium-228)	Soil	Residual concentrations of radium-226 in soil at a designated uranium processing site should not exceed background by more than 5 pCi/g in the top 15 cm of soil or 15 pCi/g in each 15 cm layer below the top layer, averaged over an area of 100 m^2. (Similar limits are indirectly indicated for radium-228 in Subpart E, which addresses thorium by-product material.)	Neither applicable nor relevant and appropriate to Areas 1 & 2 Potentially relevant and appropriate for radiologically impacted soil on Buffer Zone/ Crossroad Property	The West Lake Landfill OU-1 Site is not a designated Title I uranium mill tailings site; therefore this requirement would not be applicable. The radiologically impacted materials at the Site are a small fraction of an overall matrix of municipal solid waste, debris and fill materials. Therefore, the waste materials at the Site are not similar to uranium mill tailings. These regulations are applicable to uncontrolled areas whereas current and future uses of Areas 1 and 2 are restricted. Consequently, these regulations are not relevant and appropriate to Areas 1 and 2. They are potentially relevant and appropriate for impacted soil on the Buffer Zone/ Crossroad Property.
Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40 CFR 192), Subpart D, Standards for Management of Uranium Byproduct Materials Pursuant to Section 84 of the Atomic Energy Act of 1954, as amended; Subpart E, Standards for Management of Thorium Byproduct Materials Pursuant to Section 84 of the Atomic Energy Act of 1954, as amended	Radiation	Any	Processing operations during and prior to the end of the closure period at a facility managing uranium and thorium by-product materials should be conducted in a manner that provides reasonable assurance that the annual dose equiva-lent does not exceed 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other organ of any member of the public as a result of exposures to the planned discharge of radioactive material to the general environment (excluding radon-222, radon-220, and their decay products).	Neither applicable but potentially relevant and appropriate	The West Lake Landfill OU-1 Site is not a designated Title I uranium mill tailings site; therefore, this requirement would not be applicable. The radiologically impacted materials at the Site are a small fraction of an overall matrix of municipal solid waste, debris and fill materials. Therefore, the waste materials at the Site are not similar to uranium mill tailings. As alpha and gamma radiation is a potential exposure route for OU-1, these regaulations are considered to be potentially relevant and appropriate.
National Emissions Standards for Hazardous Air Pollutants (40 CFR 61), Subpart T, National Emissions Standards for Radon Emissions from disposal of Uranium Mill Tailings	Radon-222	Air	Radon-222 emissions to ambient air from uranium mill tailings piles that are no longer operational should not exceed 20 pCi/m^2-s.	Potentially relevant and appropriate	The West Lake Landfill OU-1 Site is not a designated uranium mill tailings site, so this requirement would not be applicable; however it could be considered relevant and appropriate because a portion of the waste materials at the Site do emit radon.

Table 3-1: Preliminary Identification of Potential Chemical-Specific ARARs and TBC Criteria

Citation	Chemical	Medium	Requirement	Preliminary Determination	Remarks
National Primary Drinking Water Regulations 40 CFR Part 141	Various	Water	Establishes standards including maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs) for public drinking water systems	Potentially relevant and appropriate	These standards are only applicable to public drinking water systems; however, MCLs and non-zero MCLGs may potentially be relevent and appropriate standards for groundwater.

Contaminant	MCLG (mg/L)	MCL (mg/L)
Trace metals		
Antimony	0.006	0.006
Asbestos	7 x 10^6 fibers/liter	7 mfl
Barium	2	2
Beryllium	0.004	0.004
Cadmium	0.005	0.005
Chromium (total)	0.1	0.1
Copper	1.3	1.3
Cyanide	0.2	0.2
Fluoride	4.0	4.0
Lead	0.015	zero
Mercury (inorganic)	0.002	0.002
Nitrate (as N)	10	10
Nitrite (as N)	1	1
Selenium	0.05	0.05
Thallium	0.0005	0.002
Organic Chemicals		
Alachlor	zero	0.002
Atrazine	0.003	0.003
Benzene	zero	0.005
Benzo(a)pyrene (PAHs)	zero	0.0002
Carbofuran	0.04	0.04
Carbon tetrachloride	zero	0.005
Chlordane	zero	0.002
Chlorobenzene	0.1	0.1
2,4-D	0.07	0.07
Dalapon	0.2	0.2
1,2-Dibromo-3-chloropropane	zero	0.0002
o-Dichlorobenzene	0.6	0.6
p-Dichlorobenzene	0.075	0.075
1,2-Dichloroethane	zero	0.005
1,1-Dichloroethylene	0.007	0.007

Table 3-1: Preliminary Identification of Potential Chemical-Specific ARARs and TBC Criteria

Citation	Chemical	Medium	Requirement			Preliminary Determination	Remarks
National Primary Drinking Water Regulations 40 CFR Part 141 (cont.)			cis-1,2-Dichloroethene	0.07	0.07		
			trans-1,2-Dichloroethene	0.1	0.1		
			Dichloromethane	zero	0.005		
			1,2-Dichloropropane	zero	0.005		
			Di(2-ethylhexyl) adipate	0.4	0.4		
			Di(2-ethylhexyl) phthalate	zero	0.006		
			Dinoseb	0.007	0.007		
			Dioxin (2,3,7,8-TCDD)	zero	3E-08		
			Diquat	0.02	0.02		
			Endothall	0.1	0.1		
			Endrin	0.002	0.002		
			Ethylbenzene	0.7	0.7		
			Ethylene dibromide	zero	0.00005		
			Glyphosate	0.7	0.7		
			Heptachlor	zero	0.0004		
			Heptachlor epoxide	zero	0.0002		
			Hexachlorobenzene	zero	0.001		
			Hexachlorocyclopentadiene	0.05	0.05		
			Lindane	0.0002	0.0002		
			Methoxychlor	0.04	0.04		
			Oxamyl (Vydate)	0.2	0.2		
			PCBs	zero	0.0005		
			Pentachlorophenol	zero	0.001		
			Picloram	0.5	0.5		
			Simazine	0.004	0.004		
			Styrene	0.1	0.1		
			Tetrachloroethylene	zero	0.005		
			Toluene	1	1		
			Toxaphene	zero	0.003		
			2,4,5-TP (Silvex)	0.05	0.05		
			1,2,4-Trichlorobenzene	0.07	0.07		
			1,1,1-Trichloroethane	0.2	0.2		
			1,1,2-Trichloroethane	0.003	0.005		
			Trichloroethylene	zero	0.005		
			Vinyl chloride	zero	0.002		
			Xylenes (total)	10	10		

Table 3-1: Preliminary Identification of Potential Chemical-Specific ARARs and TBC Criteria

Citation	Chemical	Medium	Requirement			Preliminary Determination	Remarks
National Primary Drinking Water Regulations 40 CFR Part 141 (cont.)			Radionuclides (picocuries per liter [pCi/L])				
			Alpha particles	zero	15		
			Beta particles and photon emitters (millirems per year)	zero	4		
			Radium 226 and Radium 228 (combined)		5		
			Uranium (ug/L)	zero	30		
NRC Standards for Protection Against Ionizing Radiation (10 CFR 20 Subpart C), Maximum Permissible Exposure Limits	Radiation	Any	For persons inside a controlled area, the maximum permissible whole-body dose due to all external sources of radiation within a controlled area is limited to 5 rems/year or the sum of the deep-dose equivalent and the committed dose equivalent to any indvidual organ or tissue other than the lens of the eye being equal to 50 rems. The annual limits to the lens of the eye , to the skin of the whole body, and the skin of the extremities are a lends dose equivalent of 15 rems and a shallow-dose equivalent of 50 rem to the skin of the whole body or to the skin of any extremity. (Note: a controlled area is an area that requires control of access, occupancy, and working conditions for radiation protection purposes.)			Potentially relevant and appropriate	Because the site is not licensed by NRC, these requirements are not applicable. As these regulations address sources of ionizing radiation, they are potentially relevant and appropriate as they provide standards for protection from radiation for workers inside Areas 1 and 2 during any remedial actions that may be undertaken.
NRC Standards for Protection Against Ionizing Radiation (10 CFR 20 Subpart D), Maximum Permissible Exposure Limits	Radiation	Any	For persons outside a controlled area, the maximum permissible whole-body dose due to sources in or migrating from the controlled area is limited to 0.002 rem in any 1 hour, and 0.1 rem in any one hour. (Notes: a controlled area is an area that requires control of access, occupancy, and working conditions for radiation protection purposes; 0.5 rem = 500 mrem.)			Potentially relevant and appropriate	Because the site is not licensed by NRC, these requirements are not applicable. As these regulations address sources of ionizing radiation, they are potentially relevant and appropriate of workers and the public outside of Areas 1 and 2 during any remedial actions that may be taken.

Table 3-1: Preliminary Identification of Potential Chemical-Specific ARARs and TBC Criteria

Citation	Chemical	Medium	Requirement	Preliminary Determination	Remarks
NRC Standards for Protection Against Ionizing Radiation (10 CFR 20 Appendix B) Annual Liimits on Intake (ALIs) Derived Air Concentrations (DACs) Effluent Concentrations	Specific radionuclides (see table)	Air	The concentrations above natural background of radionuclides in air ouside a controlled area, averaged over any calendar quarter, should not exceed the following limits:	Potentially relevant and appropriate	Because the site is not licensed by NRC, these requirements are not applicable. These requirements would be potentially relevant and appropriate to protection of the public during implementation of any remedial action. Specifically, these regulations potentially may require perimeter monitoring to be undertaken during any activities that may expose or disturb the radiologically-impacted materials at the Site.

Isotope	Effluent Concentration Limit (uCi/mL) Air	Water
Actinium-227	1 x 10-15	5 x 10-9
Lead-210	6 x 10-13	1 x 10-8
Protactinium-231	8 x 10-15	6 x 10-9
Radium-226	9 x 10-13	6 x 10-8
Radium-228	2 x 10-12	6 x 10-8
Radon-222	1 x 10-8	NA
Thorium-230	3 x 10-14	1 x 10-7
Thorium-232	6 x 10-15	3 x 10-8
Uranium-234	5 x 10-14	3 x 10-7
Uranium-235	6 x 10-14	3 x 10-7
Uranium-238	6 x 10-14	3 x 10-7

NA = not applicable because radon-222 is a gas.

Citation	Chemical	Medium	Requirement	Preliminary Determination	Remarks
Missouri Water Quality Standards 10 CSR 20-7.031(5)	Inorganics Trace metals Organics Pesticides Man-made Volatiles PAHs Phthalates Others	Ground-water	Water contaminants shall not cause or contribute to an exceedance of the following (Table A) standards:		These standards are only applicable to public drinking water systems; however, these standards may potentially be relevent and appropriate standards for groundwater.

Inorganics (mg/L)	
Fluoride	4
Nitrate	10
Trace metals (ug/L)	
Antimony	6
Arsenic	50
Barium	2,000
Beryllium	4
Boron	2,000
Cadmium	5
Chromium III	100
Cobalt	1,000
Copper	1,300
Iron	300
Lead	15

Table 3-1: Preliminary Identification of Potential Chemical-Specific ARARs and TBC Criteria

Citation	Chemical	Medium	Requirement		Preliminary Determination	Remarks
Missouri Water Quality Standards 10 CSR 20-7.031(5) (cont.)			Manganese	50		
			Mercury	2		
			Nickel	100		
			Selenium	50		
			Silver	50		
			Thallium	2		
			Zinc	5,000		
			Organics (ug/L)			
			Acrolein	320		
			Bis-2-chloroisopropyl ether	1,400		
			2, chlorophenol	0.1		
			2,4-dichlorophenol	93		
			2,4-dinitrophenol	70		
			2,4-dimethylphenol	540		
			2,4,5-trichlorophenol	2,600		
			2,4,6-trichlorophenol	2		
			2-methyl-4,6-dinitrophenol	13		
			Ethylbenzene	700		
			Hexachlorocyclopentadiene	50		
			Isophorone	36		
			Nitrobenzene	17		
			Phenol	300		
			Dichloropropene	87		
			Para(1,4)-dichlorobenzene	75		
			Other Dichlorobenzenes	600		
			1,2,4-trichlorobenzene	70		
			1,2,4,5-tetrachlorobenzene	2.3		
			pentachlorobenzene	3.5		
			1,1,1-trichloroethane	200		
			1,1,2-trichloroethane	0.04		
			2,4-dinitrotoluene	0.04		
			1,2-diphenylhydrazine	0.04		
			di (2-ethylhexyl) adipate	400		
			Pesticides (ug/L)			
			2,4-D	70		
			2,4,5-TP	50		
			Alachlor	2		

Table 3-1: Preliminary Identification of Potential Chemical-Specific ARARs and TBC Criteria

Citation	Chemical	Medium	Requirement		Preliminary Determination	Remarks
Missouri Water Quality			Atrazine	3		
Standards 10 CSR 20-7.031(5)			Carbofuran	40		
(cont.)			Dalapon	200		
			Dibromochloropropane	0.2		
			Dinoseb	7		
			Diquat	20		
			Endothall	100		
			Ethylene dibromide	0.05		
			Oxamyl (vydate)	200		
			Picloram	500		
			Simazine	4		
			Glyphosate	700		
			Bioaccumulatie Anthropogenic Toxics (ug/L)			
			PCBs	0.000045		
			DDT	0.00059		
			DDE	0.00059		
			DDD	0.00083		
			Endrin	2		
			Endrin aldehyde	0.75		
			Aldrin	0.00013		
			Dieldrin	0.00014		
			Heptachlor	0.4		
			Heptachlor epoxide	0.2		
i			Methoxychlor	40		
			Toxaphene	3		
			Lindane (gamma-BHC)	0.2		
			Alpha,beta,delta-BHC	0.0022		
			Chlordane	2		
			Benzidine	0.00012		
			2,3,7,8-TCDD (dioxin)	1.3E-08		
			Pentachlorophenol	1		

Table 3-1: Preliminary Identification of Potential Chemical-Specific ARARs and TBC Criteria

Citation	Chemical	Medium	Requirement		Preliminary Determination	Remarks
Missouri Water Quality Standards 10 CSR 20-7.031(5) (cont.)			Anthropogenic Carcinogens (ug/L)			
			Acrylonitrile	0.058		
			Hexachlorobenzene	1		
			Bis (2-chloroethyl) ether	0.03		
			Bis (chloromethyl) ether	0.00013		
			Hexachloroethane	1.9		
			3,3'-dichlorobenzidine	0.04		
			Hexachlorobutadiene	0.456		
			n-nitrosodimethylamine	0.0007		
			Volatile Organic Compounds (ug/L)			
			Chlorobenzene	100		
			Carbon Tetrachloride	5		
			Trihalomethanes	80		
			Bromoform	4.3		
			Chlorodibromomethane	0.41		
			Dichlorobromomethane	0.56		
			Chloroform	5.7		
			Methyl Bromide	48		
			Methyl Chloride	5		
			Methylene Chloride	4.7		
			1,2-dichloroethane	5		
			1,1,2,2-tetrachloroethane	0.17		
			1,1-dichloroethylene	7		
			1,2-trans-dichloroethylene	100		
			1,2-cis-dichloroethylene	70		
			Trichloroethylene	5		
			Tetrachloroethylene	0.8		
			Benzene	5		
			Toluene	1,000		
			Xylenes (total)	10,000		
			Vinyl chloride	2		
			Styrene	100		
			1,2-dichloropropane	0.52		

Table 3-1: Preliminary Identification of Potential Chemical-Specific ARARs and TBC Criteria

Citation	Chemical	Medium	Requirement		Preliminary Determination	Remarks
Missouri Water Quality Standards 10 CSR 20-7.031(5) (cont.)			Polynuclear Aromatic Hydrocarbons (ug/L)			
			Anthracene	9,600		
			Fluoranthene	300		
			Fluorene	1,300		
			Pyrene	960		
			Benzo(a)pyrene	0.2		
			Other polynuclear aromatic hydrocarbons	0.0044		
			Acenaphthene	1,200		
			Phthalate Esters (ug/L)			
			Bis(2-ethylhexyl) phthalate	6		
			Butylbenzyl phthalate	3,000		
			Diethyl phthalate	23,000		
			Dimethyl phthalate	313,000		
			Di-n-butyl phthalate	2,700		
			Health Advisory Levels (ug/L)			
			Ametryn	60		
			Baygon	3		
			Bentazon	20		
			Bis-2-chloroisopropyl ether	300		
			Bromacil	90		
			Bromochloromethane	90		
			Bromomethane	10		
			Butylate	350		
			Carbaryl	700		
			Carboxin	700		
			Chloramben	100		
			o-chlorotoluene	100		
			p-chlorotoluene	100		
			Chlorpyrifos	20		
			DCPA (dacthal)	4,000		
			Diazinon	0.6		
			Dicamba	200		
			Diisopropyl methylphosphonate	600		
			Dimethyl methylphosphonate	100		
			1,3-dinitrobenzene	1		
			Diphenamid	200		
			Diphenylamine	200		

Table 3-1: Preliminary Identification of Potential Chemical-Specific ARARs and TBC Criteria

Citation	Chemical	Medium	Requirement		Preliminary Determination	Remarks
Missouri Water Quality Standards 10 CSR 20-7.031(5) (cont.)			Disulfoton	0.3		
			1,4-dithiane	80		
			Diuron	10		
			Fenamiphos	2		
			Fluometron	90		
			Fluorotrichloromethane	2,000		
			Fonofos	10		
			Hexazinone	200		
			Malathion	200		
			Maleic hydrazide	4,000		
			MCPA	10		
			Methyl parathion	2		
			Metolachlor	70		
			Metribuzin	100		
			Naphthalene	20		
			Nitroguanidine	700		
			p-nitrophenol	60		
			Paraquat	30		
			Pronamide	50		
			Propachlor	90		
			Propazine	10		
			Propham	100		
			2,4,5-T	70		
			Tebuthiuron	500		
			Terbacil	90		
			Terbufos	0.9		
			1,1,1,2-Tetrachloroethane	70		
			1,2,3-trichloropropane	40		
			Trifluralin	5		
			Trinitroglycerol	5		
			Trinitrotoluene	2		

Table 3-1: Preliminary Identification of Potential Chemical-Specific ARARs and TBC Criteria

Citation	Chemical	Medium	Requirement		Preliminary Determination	Remarks
Missouri Public Drinking Water Program - Contaminant Levels and Monitoring (10 CSR 60-4)	Inorganics, Synthetic Organic Compounds, Radionuclides, Secondary Contaminants, and Volatile Organic Compounds		Maximum contaminant levels for public water systems.		Not applicable	These standards apply to public water systems and therefore are not applicable to the West Lake Landfill OU-1 Site. As these standards provide for maximum concentrations in drinking water and the alluvial aquifer could be used for drinking water outside of the West Lake Landfill boundaries; these standards are potentially relevant and appropriate for groundwater at the Site.
			Maximum Contaminant Levels		Potentially relevant and appropriate	
			Inorganics			
			Antimony	0.006 mg/L		
			Arsenic	0.01 mg/L		
			Asbestos	7×10^6 fibers/L		
			Barium	2 mg/L		
			Beryllium	0.004 mg/L		
			Cadmium	0.005 mg/L		
			Chromium	0.1 mg/L		
			Cyanide	0.2 mg/L		
			Fluoride	4.0 mg/L		
			Mercury	0.002 mg/L		
			Nitrate (as N)	10 mg/L		
			Nitrite (as N)	1 mg/L		
			Total Nitrate + Nitrite (as N)	10 mg/L		
			Selenium	0.05 mg/L		
			Thallium	0.002 mg/L		
			Synthetic Organic Compounds			
			Alachlor	0.002 mg/L		
			Atrazine	0.003 mg/L		
			Benzo(a)pyrene	0.0002 mg/L		
			Carbonfugran	0.04 mg/L		
			Chlordane	0.002 mg/L		
			Dalapon	0.2 mg/L		
			Di(2-ethylhexyl) adipate	0.4 mg/L		
			Dibromochloropropane (DBCP)	0.0002 mg/L		
			Di(2-ethylhexyl) phthalate	0.006 mg/L		
			Dinoseb	0.007 mg/L		
			Diquat	0.02 mg/L		
			Endothall	0.1 mg/L		
			Endrin	0.002 mg/L		
			2,4-D	0.07 mg/L		
			Ethylene dibromide (EDB)	0.00005 mg/L		
			Glyphosoate	0.7 mg/L		
			Heptachlor	0.0004 mg/L		
			Heptachlor Epoxide	0.0002 mg/L		

Table 3-1: Preliminary Identification of Potential Chemical-Specific ARARs and TBC Criteria

Citation	Chemical	Medium	Requirement		Preliminary Determination	Remarks
Missouri Public Drinking Water Program - Contaminant Levels and Monitoring (10 CSR 60-4) (cont.)			Hexachlorobenzene	0.001 mg/L		
			Hexachlorocyclopentadiene	0.05 mg/L		
			Lindane	0.0002 mg/L		
			Methoxychlor	0.04 mg/L		
			Oxamyl (Vydate)	0.2 mg/L		
			Picloram	0.5 mg/L		
			Polychlorinated biphenyls (PCBs)	0.0005 mg/L		
			Pentachlorophenol	0.001 mg/L		
			Simazine	0.004 mg/L		
			Toxaphene	0.003 mg/L		
			2,3,7,8-TCDD (Dioxin)	0.00000003 mg/L		
			2,4,5-TP (Silvex)	0.05 mg/L		
			<u>Radionuclides</u>			
			Combined Ra_{226} and Ra_{228}	5 pCi/L		
			Gross alpha (excluding radon & urnaium)	15 pCi/L		
			Uranium	30 ug/L		
			<u>Secondary Contaminants</u>			
			Aluminum	0.05 - 0.2 mg/L		
			Chloride	250 mg/L		
			Copper	1.0 mg/L		
			Fluoride	2.0 mg/L		
			Iron	0.3 mg/L		
			Manganese	0.05 mg/L		
			Silver	0.1 mg/L		
			Sulfate	250 mg/L		
			Total Dissolved Solid (TDS)	500 mg/L		
			Zinc	5 mg/L		
			<u>Volatile Organic Compounds</u>			
			Benzene	0.005 mg/L		
			Carbon tetrachloride	0.005 mg/L		
			1,2-dichloroethane	0.005 mg/L		
			1,1-dichloroethylene	0.007 mg/L		
			para-dichlorobenzene	0.075 mg/L		
			1,1,1-trichloroethane	0.2 mg/L		
			Trichloroethylene	0.005 mg/L		
			Vinyl chloride	0.002 mg/L		
			cis-1,2-dichloroethylene	0.07 mg/L		

Table 3-1: Preliminary Identification of Potential Chemical-Specific ARARs and TBC Criteria

Citation	Chemical	Medium	Requirement		Preliminary Determination	Remarks
Missouri Public Drinking Water Program - Contaminant Levels and Monitoring (10 CSR 60-4) (cont.)			Dichloromethane	0.005 mg/L		
			1,2-dichloropropane	0.005 mg/L		
			Ethylbenzene	0.7 mg/L		
			Monodichlorobenzene	0.1 mg/L		
			o-dichlorobenzene	0.6 mg/L		
			Styrene	0.1 mg/L		
			Tetrachloroethylene	0.005 mg/L		
			Toluene	1 mg/L		
			1,2,4-Trichlorobenzene	0.07 mg/L		
			1,1,2-Trichloroethane	0.005 mg/L		
			trans-1,2-dischloroethylene	0.1 mg/L		
			Xylenes (total)	10 mg/L		
OSWER Directive No. 9200.4-25	Radium-226 Radium-228 Thorium-230 Throium-228	Soil	Clarifies EPA's position on the use of the soil cleanup criteria in 40 CFR Part 192 at CERCLA sites with radioactive contamination. In particular it clarifies the intent of 40 CFR Part 192 in setting remediation levels for subsurface soil, Also, Thorium-230 and Thorium-232 should be cleaned up to the same concentrations as their radium progeny (5 and 15 pCi/g).		Not an ARAR but potentially a TBC for the Buffer Zone/ Crossroad Property	As this is only guidance, it is not an ARAR. As 40 CFR 192 is considered to be potentially relevant and appropriate for the radiologically-impacted soil on the Buffer Zone/Crossroad Property, this guidance would be a TBC for alternatives that include excavation of soil from these properties.
			Radium 226 +228	5 pCi/g plus background		
			Thorium 230 +232	5 pCi/g plus background		

Table 3-2: Preliminary Identification of Potential Location-Specific ARARs and TBC Criteria

Citation	Location	Requirement	Preliminary Determination	Remarks
Archeological and Historic Preservation Act (54 USC 312508; PL 113-287; 128 Stat. 3256)	Land	Data recovery and preservation activities should be conducted if prehistoric, historical, and archaelogical data might be destroyed as a result of a federal, federally assisted, or federally licensed activity or program.	Potentially applicable	No destruction of such data is expected to result from remedial action. The Site has been considerably disturbed by past human activities and is therefore not expected to contain any such data. However, if these data were affected, *e.g.*, at any potential off-site borrow area, the requirement would be applicable.
Endangered Species Act, as amended [16 USC 1531-1544; 50 CFR Part 17]	Any	Federal agencies should ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify any critical habitat.	Potentially applicable	No critical habitat has been identified in the affected area, and no adverse impacts to threatened or endangered species are expected to result from any remedial action. However, if such species were affected, the requirement would be applicable. An assessment of the potential for occurrences of threatened or endangered species was performed during the RI. No federal listed or proposed threatened and endangered species or their habitats were identified at or in the vicinity of the Site.
Missouri Wildlife Code (1989) (RSMo. 252.240; 3 CSR 10-4.111), Endangered Species	Any	Endangered species, i.e., those designated by the U.S. Department of the Interior and the Missouri Department of Conservation as threatened or endangered (see1978 Code, RSMo. 252.040), should not be pursued, taken, possessed, or killed.	Potentially applicable	No critical habitat has been identified in the affected area, and no adverse impacts to threatened or endangered species are expected to result from any remedial action. However, if such species were affected, the requirement would be applicable.
Floodplain Management [Executive Order 11988; 40 CFR 6.302(b)]	Floodplain	Federal agencies should avoid, to the maximum extent possible, any adverse impacts associated with direct and indirect development of a floodplain.	Potentially applicable	This requirement may be applicable to any remedial action for the Buffer Zone/Crossroad Property. Mitigative measures would be taken to minimize any adverse impacts.

Table 3-2: Preliminary Identification of Potential Location-Specific ARARs and TBC Criteria

Citation	Location	Requirement	Preliminary Determination	Remarks
Governor's Executive Order 82-19	Floodplain	Potential effects of actions taken in a floodplain should be evaluated to avoid adverse impacts.	Potentially applicable	This requirement may be applicable to any remedial action for the Buffer Zone/Crossroad Property. Mitigative measures would be taken to minimize any adverse impacts.
Clean Water Act (33 USC 1344); Disposal Sites Specifications(40 CFR 230), Dredged or Fill Material Discharges (Section 404 Program); Definitions, Exempt Activities Not Requiring Permits (40 CFR 232); State Program Regulations (40 CFR 233); General Regulatory Policies (33 CFR 320); Nationwide Permits (33 CFR 330)	Wetland	Dredge or fill material is not to be discharged into a wetland (as defined by the U.S. Army Corps of Engineers) without a permit.	Potentially applicable	This requirement could be applicable to any off-site borrow area if the location selected contains any wetlands or if the borrow activities could indirectly impact wetlands. No wetlands have been identified on-site.
Farmland Protection Policy Act (7 USC 4201 et seq.) Farmland Protection [7 CFR 658; 40 CFR 6.302(c)]	Farmland (prime, unique, or of state and local importance)	Federal agencies should take steps to ensure that federal actions do not cause U.S. farmland to be irreversibly converted to nonagricultural uses in cases in which other national interests do not override the importance of the protection of farmland or otherwise outweigh the benefits of maintaining farmland resources. Criteria developed by the U.S. Soil Conservation Service are to be used to identify and take into account the adverse effects of federal programs on farmland preservation. Federal agencies should consider alternative actions that could lessen adverse effects and should ensure that programs are compatible with state and local government and private programs and policies to protect farmland.	Potentailly applicable	This requirement would be applicable for any potential soil borrow area off-site. Mitigative measures and restoration activities would also be conducted at any off-site borrow area, as appropriate, to minimize any adverse impacts to farmland.

Table 3-2: Preliminary Identification of Potential Location-Specific ARARs and TBC Criteria

Citation	Location	Requirement	Preliminary Determination	Remarks
RCRA Subtitle D (40 CFR Part 258 Subpart B) and MDNR Solid Waste Regulations (10 CSR 80-3.010 (4)(B)(1))	Proximity of solid waste landfills to the end of runways used for turbojet aircraft	Requires new or existing municipal solid waste landfills or lateral expansions that are located within 10,000 ft of any airport runway end used by turbojet aircraft to demonstrate that the units are designed and operated so that the municipal solid waste landfill unit does not pose a bird hazard to aircraft.	Not applicable Potentially relevant and appropriate to the ROD-remedy and "complete rad removal" and partial excavation alternatives	As the OU-1 portion of the West Lake landfill closed in the 1970's, this requirement is not applicable to Areas 1 and 2. The ROD-remedy, "complete rad removal", and partial excavation alternatives include regrading of existing solid waste in Areas 1 and 2. This requirement may potentially be relevant and appropriate to these alternatives.
RCRA Subtitle D (40 CFR Part 258 Subpart B) and MDNR Solid Waste Regulations (10 CSR 80-3.010 (4)(B))	Landfill site selection	Sets forth criteria for site selection for new landfills and horizontal expansions of existing sanitary landfills and requirements for design and operation plans for sanitary landfills. Site selection criteria include (1) proximity to airport runways (see discussion above), floodplains, wetlands, seismic zones and faults, and unstable areas. Also sets out required demonstrations for liners placed near the depth of groudnwater.	Not applicable nor relevant and appropriate	No new landfills or horizontal expansion of existing landfills would be constructed under any of the remedial alternatives.
Missouri Guidance for Conducting and Reporting Detailed Geologic and Hydrogeologic Investigations at a Proposed Solid-Waste Disposal Area 10 CSR 80-2.015 Appendix 1	Landfill site selection	Provides general procedures for characterization of potential solid waste landfill sites	Not applicable nor relevant and appropriate	No new solid waste diposal areas would be proposed under any of the remedial alternatives.

Table 3-3: Preliminary Identification of Potential Action-Specific ARARs and TBC Criteria

Citation	Action	Medium	Requirement	Preliminary Determination	Remarks
Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40 CFR 192), Subpart A, Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites	Radioactive waste disposal		Control of residual radioactive materials at designated uranium processing or depository sites should be designed to be effective for at least 200 years and up to 1,000 years, to the extent reasonably achievable. In addition, the control should be designed such that releases of radon-222 from the residual radioactive material would not exceed an average rate of 20 pCi/m2-s or increase the annual average concentration in air outside the disposal site by more than 0.5 pCi/L. Because this standard applies to design, monitoring after disposal is not required to demonstrate compliance.	Not applicable but potentially relevant and appropriate in part for ROD-remedy and partial excavation alternatives	The West Lake Landfill OU-1 Site is not a designated Title I uranium mill tailings site; therefore, this requirement would not be applicable. These regulations are applicable to uncontrolled areas, whereas the current and future uses of Areas 1 and 2 are restricted. As OU-1 does contain radiologically-impacted materials, these requirements may potentially be relevant; however, the radiologically-impacted materials at the Site are a small fraction of an overall matrix of municipal solid waste, debris and fill materials. Although the waste materials are not similar to uranium tailings, the wastes do contain radium and thorium; therefore the longevity standard is potentially relevant and appropriate. As the radiologically-impacted materials do emit radon, the radon standard is potentially relevant and appropriate. For the ROD-remedy and partial excavation alternatives, radiologically-impacted materials will remain past the post-closure period for a solid waste landfill and longevity considerations should be factored into the cover design.
Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40 CFR 192), Subpart D, Standards for Management of Uranium Byproduct Materials Pursuant to Section 84 of the U.S. Atomic Energy Act of 1954, as amended; Subpart E, Standards for Management of Thorium Byproduct Materials Pursuant to Section 84 of the U.S. Atomic Energy Act of 1954, as amended.	Radioactive waste disposal		Disposal areas for uranium and thorium by-product materials should be designed to be effective for at least 200 years and up to 1,000 years, to the extent reasonably achievable. In addition, the control should be designed so that releases of radon-222 and radon-220 from these materials (*i.e.* , excluding the cover) would not exceed an average of 20 pCi/m2-s. The standard applies to design, so monitoring for radon after installation of an appropriately designed cover is not required. (This requirement does not apply to any portion of the Site that contains residual surface and subsurface concentrations of radium-226 and radium-228 at or below those identified in Subparts B and E, respectively, which were described under potential chemical-specific ARARs and TBCs.)	Not applicable but potentially relevant and appropriate in part for the ROD-remedy and partial excavation alternatives	The West Lake Landfill OU-1 Site is not a designated Title I uranium mill tailings site. Therefore, this requirement would not be applicable. These regulations are applicable to uncontrolled areas whereas the current and future uses of Areas 1 and 2 are restricted. As OU-1 does contain radiologically impacted materials, these requirements may potentially be relevant; however, the radiologically-impacted materials at the Site are a small fraction of an overall matrix of municipal solid waste, debris and fill materials. Although the waste materials at West Lake Site are not similar to uranium mill tailings, the wastes do contain radium . and thorium; therefore the longevity standard is potentially relevant and appropriate. As the radiologically impacted materials will remain on-site beyond the 30-year post-closure period for a solid waste landfill, the 200/1000 year period, this standard is considered to be potentially relevant and appropriate.

Table 3-3: Preliminary Identification of Potential Action-Specific ARARs and TBC Criteria

Citation	Action	Medium	Requirement	Preliminary Determination	Remarks
Resource Conservation and Recovery Act (RCRA) Subtitle C (40 CFR 240 et seq.)	Hazardous waste management		Establishes standards for identification of and treatment, storage and disposal of hazardous wastes including hazardous wastes disposed in landfills. Standards for Identification of hazardous wastes (40 CFR 261) Standards for Generators of hazardous wastes (40 CFR 262) Standards for Transporters of hazardous wastes (40 CFR 263) Use and Management of Containers (40 CFR 264 Subpart I) Land Disposal Restrictions (40 CFR 264 Subpart N) Staging Piles (40 CFR 264.554)	Possibly applicable in the event that hazardous wastes or materials that potentially could be hazardous wastes are encountered during remedy implementation	The radiologically-impacted materials in Areas 1 and 2 do not meet the criteria for classification as hazardous wastes; however, other waste materials in Areas 1 or 2 may meet these criteria and as such these requirements may be applicable. The Subtitle D standards are considered to be the appropriate criteria for final cover design.
Solid Waste Disposal Act, as amended (42 USC 6901 et seq.); Criteria for Municipal Solid Waste Landfills (40 CFR 258), Subpart F, Closure and Post-Closure Care	Solid waste disposal		Criteria for closure of a landfill unit and post-closure care requirements are specified. Cover system design requirements at closure include (1) an infiltration layer constructed of a minimum of 18 in. of earthen material with a permeability less than or equal to the permeability of the bottom liner system or no greater than 1 x 10-5 cm/s, whichever is less, and (2) an erosion protectin layer of earthen material capable of supporting native plant growth; or equivalents approved by the director of an approved state program. Post-closure care requires maintenance of the integrity of the final cover system, the leachate collection system, ground-water monitoring, and gas monitoring for a period of 10 years or as necessary to protect human health and the envrionment. Management of the leachate may be terminated if the owner/ operator demonstrates that leachate no longer poses a threat to human health and the environment	Neither applicable nor relevant and appropriate	Neither applicable nor relevant and appropriate as solid waste landfills in Missouri are regulated by the Missouri solid waste regulations.
Missouri Radiation Regulations; Protection Against Ionizing Radiation (19 CSR 20-10.090), Disposal of Radioactive Wastes	Radioactive waste disposal		Radioactive waste material should not be disposed of by dumping or burial in soil, except at sites approved by and registered with the Missouri Department of Health; a permit should be obtained for holding and preparation of such material prior to disposal; and no releases to air or water should cause exposure of any person above the limits specified in 10-CSR 20-10.040.	Potentially applicable to the "complete rad removal" and partial excavation with off-site disposal alternatives	Certain of these requirements would be potentially applicable if one of the alternatives involving off-site disposal were to be implemented
Missouri Radiation Regulations; Protection Against Ionizing Radiation (19 CSR 20-10.070), Storage of Radioactive Materials	Radioactive waste storage		Radioactive materials should be stored in a manner that will not result in the exposure of any person, during routine access to a controlled area, in excess of the limits identified in 19 CSR 20-10.040 (see related discussion for contaminant-specific requirements); a facility used to store materials that may emit radioactive gases or airborne particulate matter should be vented to ensure that the concentration of such substances in air does not constitute a radiation hazard; and provisions should be made to minimize hazards to emergency workers in the event of a fire, earthquake, flood, or windstorm.	Potentially applicable	These requirements would be applicable to the temporary storage of radiologically-impacted soils that might be generated during any remedial action.

Table 3-3: Preliminary Identification of Potential Action-Specific ARARs and TBC Criteria

Citation	Action	Medium	Requirement	Preliminary Determination	Remarks
Missouri Solid Waste Rules (10 CSR 80), Chapter 3, Sanitary Landfills, 3.010(17), Cover	Solid waste disposal		The landfill should be covered to minimize fire hazard, infiltration of precipitation, odors and blowing litter; control gas venting and vectors; discourage scavenging; and provide a pleasing appearance. Final slope of the top shall be a minimum of 5%. No slopes shall ever exceed 33 1/3 % and slopes shall not exceed 25% without a detailed slope stability analysis. The final cover should be at least 2 ft of compacted clay with a permeability of 1 x 10^{-5} cm/sec or less overlain by 1 ft of soil capable of supporting vegetative growth.	Only applicable if Areas 1 or 2 are re-opened to accept additional solid wastes. Potentially relevant and appropriate for design of the final cover	These requirements are not applicable as they only apply to landfills in operation after 10-9-91. These requirements would be applicable to regrading of Areas 1 and 2 after removal of radiologically-impacted material under the "complete rad removal" and partial excavation alternatives. These regulations would also be applicable to the final slopes and cover design for Areas 1 and 2 under the ROD-selected remedy , "complete rad removal", and partial excavation alternatives except that the slopes would be a minimum of 2% (seee discussion in text).
Missouri Solid Waste Rules (10 CSR 80), Chapter 4, Demolition Landfills, 4.010(17), Cover	Solid waste disposal		The landfill should be covered to minimize fire hazard, infiltration of precipitation, odors and blowing litter; control gas venting and vectors; discourage scavenging; and provide a pleasing appearance. Final slope of the top shall be a minimum of 5%. No slopes shall ever exceed 33 1/3 % and slopes shall not exceed 25% without a detailed slope stability analysis. The final cover should be at least 1 ft of compacted clay with a permeability of 1 x 10^{-5} cm/sec or less overlain by 2 ft of soil capable of supporting vegetative growth.	Only applicable if Areas 1 or 2 are re-opened to accept additional solid wastes. Potentially relevant and appropriate for design of the final cover	These requirements are not applicable as they only apply to landfills in operation after 10-9-91. These requirements would be applicable to regrading of Areas 1 and 2 after removal of radiologically-impacted material under the "complete rad removal" and partial excavation alternatives. These regulations would also be applicable to the final slopes and cover design for Areas 1 and 2 under the ROD-selected remedy , "complete rad removal", and partial excavation alternatives except that the slopes would be a minimum of 2% (seee discussion in text).
Noise Control Act, as Amended; Noise Pollution and Abatement Act (42 USC 4901 et seq)	Construction activities		The public should be protected from noises that jeopardize human health or welfare.	Potentially applicable	These requirements would be applicable to any remedial action.
CERCLA Offsite Rule 40 CFR 300.440	Off-site disposal		Wastes can only be disposed at offsite facilities operating in compliance with applicable regulations as verified by EPA.	Applicable to off-site disposal	These requirements would be applicable to the "complete rad removal" and partial excavation with off-site disposal alternatives.
DOT and NRC regulations for shipment of radioactive materials 49 CFR Parts 171-180 and 10 CFR Part 71	Off-site disposal		Specifies requirements for shipment of radioactive materials including hazard communications, labeling, manifests, security, emergency response, and planning.	Applicable to off-site disposal	These requirements would be applicable to the "complete rad removal" and partial excavation with off-site disposal alternatives.
Offsite disposal Waste Acceptance Criteria	Off-site disposal		Lists the types of materials and activity levels of waste materials that can be accepted by off-site disposal facilities.	Applicable to off-site disposal	These requirements would be applicable to the "complete rad removal" and partial excavation with off-site disposal alternatives.
National Emissions Standards for Hazardous Air Pollutants - Asbestos 40 CFR Part 61	Asbestos management	Waste	Requirements for management of regulated asbestos containing materials (RACM)	Potentially applicable if RACM are encountered during remedy implementation	Standards for demolition and renovation may be applicable in the event that RACM is encountered during remedy implementation.
National Ambient Air Quality Standards	Radionuclides	Air	Air quality standards	Potentially applicable	Potential standards for air emissions during remedy

Table 3-3: Preliminary Identification of Potential Action-Specific ARARs and TBC Criteria

Citation	Action	Medium	Requirement	Preliminary Determination	Remarks
40 CFR 50	Radon and Particulates				implementation.
PCB Spill Cleanup Policy 40 CFR 761 Subpart G Cleanup Site Characterization Sampling for PCB Remediation Waste 40 CFR 761 Subpart N Sampling to Verify Completion of Self-Implementing Cleanup and On-Site Disposal of Bulk PCB Remediation Waste and Porous Surfaces 40 CFR 761 Subpart O Sampling Non-Porous Surfaces for Measurement-Based Use, Reuse and On-Site or Off-Site Disposal 40 CFR 761 Subpart P Sampling Non-Liquid, Non-Metal PCB Bulk Product Waste for Purposes of Characterization for PCB Disposal and Sampling PCB Remediation Waste Destined for Off-Site Disposal 40 CFR 761 Subpart R Double Wash/Rinse Method for Decontaminating Non-Porous Surfaces 40 CFR 761 Subpart S	PCB cleanup and management	Soil or waste	Requirements for cleanup of PCB wastes	Potentially applicable if PCBs are encountered during remedy implementation	Sets out procedures for cleanup of PCB wastes.
Missouri Storm Water Regulations 10 CSR 20-6.200		Storm-water	Requirements for control of stormwater runoff	Potentially applicable	Substantive requirements are potentially applicable for control of storm water runoff during and after remedy construction.
De Minimis Emissions Levels 10 CSR 10-6.020(3)(A)	PM-10 Non-methane organic compounds (NMOC)		Air quality standards	Potentially applicable	Potential standards for air emissions during remedy implementation.
Sampling Methods for Air Pollution Sources 10 CSR 10-6.030		Air	Stack emissions sampling procedures	Potentially applicable	Potentially applicable if a landfill gas flare is constructed and operated as part of the remedy.
Controlling Emissions During Episodes of High Air Pollution Potential 10 CSR 10-6.130		Air	Requirements for controlling emissions during air pollution events	Potentially applicable	Potentially could require shut down of remedy implementation construction operations during a purple or maroon air quality event.
Restriction of Particulate Matter to the Ambient Air Beyond the Premises of Origin 10 CSR-6.170	Particulate Matter	Air	Requirements for controlling emissions	Potentially applicable	Potentially applicable to the control of fugitive dust emissions during remedy construction activities.

Table 3-3: Preliminary Identification of Potential Action-Specific ARARs and TBC Criteria

Citation	Action	Medium	Requirement	Preliminary Determination	Remarks
Closure and Post-Closure Plan Laidlaw Waste Systems (Bridgeton), Inc. Sanitary Landfill, December 1996, Revised September 1997, Revised April 1998, Revised April 2016	Landfill cover		Sets out closure and post-closure procedures for the West Lake Landfill, in particluar, the final cover, grading and vegetation plan.	Potential TBC	Sets out the procedures to be used at the Landfill to comply with the MDNR Solid Waste Regulations. This document should be considered in the design and construction of any cover system or drainage improvements that may be constructed for Areas 1 and 2 or if aditional waste materials are placed in these areas as part of a remedial action. This docment will also need to be considered if any regrading and/or landfill cover improvements are implemented for Areas 1 or 2.

Table 6-1: Summary of Estimated Costs

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Estimated Cost	No Action Alternative		ROD-Selected Remedy		"Complete Rad Removal" 7.9 pCi/g Excavation Alternative		Partial Excavation Alternatives: 52.9 pCi/g		Partial Excavation Alternatives: 1,000 pCi/g	
	i = 7%	*i = 1.5%*	*i = 7%*	*i = 1.5%*	*i = 7%*	*i = 1.5%*	*i = 7%*	*i = 1.5%*	*i = 7%*	*i = 1.5%*
Capital ($M)	0		67		616		313		361	
Operation, Maintenance, and Monitoring ($1,000/yr)	35 every 5 years		167 - 326		167 - 326		167 - 326		167 - 326	
30 year:										
Present Worth ($M)	0.1	0.2	64	70	420	566	265	305	275	342
Non-discounted Total ($M)	0.2	0.2	73	73	619	619	318	318	365	365
200 year:										
Present Worth ($M)	0.1	0.4	64	77	421	573	265	312	276	349
Non-discounted Total ($M)	1	1	102	102	649	649	348	348	395	395
1,000 year:										
Present Worth ($M)	0.1	0.5	64	78	421	573	265	312	276	350
Non-discounted Total ($M)	7	7	241	241	788	788	487	487	534	534

Note: These cost estimates are feasibility level cost estimates; that is they were developed to a level of accuracy such that the actual costs incurred to implement the alternatives should fall within a range bounded by 50% above and 30% below these estimates.

Table 6-2: Comparison of USEI Waste Acceptance Criteria to Projected OU-1 RIM Concentrations

DRAFT

"Complete Rad Removal" Alternative (removal of RIM to 7.9 pCi/g total Thorium or Radium)

USEI Category	WAC Criteria		OU-1 RIM Concentrations per Conveyance or Container					
	Maximum Concentration of Insitu Material	Sum of Concentrations of Parents and all Progeny	Activity Concentration (pCi/g)		Mass Concentration (ppm)		Series Activity, Assuming Equilibrium with Parent (pCi/g)	
Radionuclide			Area 1	Area 2	Area 1	Area 2	Area 1[a]	Area 2[a]
Unimportant Quantities of Source Material Uniformly Dispersed in Soil or Other Media								
Natural uranium in equilibrium with progeny[b]	<500 ppm Unat or 167 pCi ^{238}U/g	≤ 3,000 pCi/g	4.0	51.1	5.6	72.5	16 (3 dtrs)	204 (3 dtrs)
^{230}Th	0.1 ppm or ≤ 2,000 pCi/g	NC [c]	52	300	0.003	0.015	52 (0 dtrs)	300 (0 dtrs)
Natural thorium (^{232}Th + ^{228}Th)	<500 ppm or 110 pCi/g	≤ 2,000 pCi/g	3.9	8.6	17.9	39.0	39 (9 dtrs)	86 (9 dtrs)
Mixture of Thorium and Uranium	Sum of ratios ≤ 1	≤ 2,000 pCi/g	0.04	0.27	NA [d]	NA [d]	0.1	0.3[e]
Naturally Occurring Radioactive Material other than Uranium and Thorium Uniformly Dispersed in Soil or Other Media								
^{226}Ra w/ progeny in bulk form	500 pCi/g	≤ 4,500 pCi/g	33.4	129	0.00003	0.00013	200 (5 dtrs)	773 (5 dtrs)
^{210}Pb with ^{210}Bi and ^{210}Po	1,500 pCi/g	≤ 1,500 pCi/g	6.2	27.1	0.0000001	0.0000004	19 (2 dtrs)	81 (2 dtrs)

a () in this column indicate the number decays the parent atom undergoes before becoming a stable isotope.
b 238U used as surrogate for U nat. Assumes natural isotopic abundance of 238U, 235U and 234U.
c NC = Not calculated. Daughter activity accounted for in Radium-226 line item.
d NA = Not applicable, see activity concentration.
e Insitu activity in Area 2 may exceed WAC at times. Must control excavation and handling while monitoring outbound loads.

Table 6-3: Comparison of USEI Waste Acceptance Criteria to Projected OU-1 RIM Concentrations

DRAFT

Partial Excavation of Shallow RIM with Activities above 52.9 pCi/g total Thorium or Radium

USEI Category	WAC Criteria		OU-1 RIM Concentrations per Conveyance or Container					
	Maximum Concentration of Insitu Material	Sum of Concentrations of Parents and all Progeny	Activity Concentration (pCi/g)		Mass Concentration (ppm)		Series Activity, Assuming Equilibrium with Parent (pCi/g)	
Radionuclide			Area 1	Area 2	Area 1	Area 2	Area 1[a]	Area 2[a]
Unimportant Quantities of Source Material Uniformly Dispersed in Soil or Other Media								
Natural uranium in equilibrium with progeny[b]	<500 ppm Unat or 167 pCi ^{238}U/g	≤ 3,000 pCi/g	19	91	27	130	76 (3 dtrs)	363 (3 dtrs)
^{230}Th	0.1 ppm or ≤ 2,000 pCi/g	NC [c]	250	529	0.01	0.03	250 (0 dtrs)	529 (0 dtrs)
Natural thorium (^{232}Th + ^{228}Th)	<500 ppm or 110 pCi/g	≤ 2,000 pCi/g	18.5	15.2	84	69	185 (9 dtrs)	152 (9 dtrs)
Mixture of Thorium and Uranium	Sum of ratios ≤ 1	≤ 2,000 pCi/g	0.20	0.48	NA [d]	NA [d]	0.3	0.5[e]
Naturally Occurring Radioactive Material other than Uranium and Thorium Uniformly Dispersed in Soil or Other Media								
^{226}Ra w/ progeny in bulk form	500 pCi/g	≤ 4,500 pCi/g	157	229	0.00016	0.00023	939 (5 dtrs)	1373 (5 dtrs)
^{210}Pb with ^{210}Bi and ^{210}Po	1,500 pCi/g	≤ 1,500 pCi/g	29	48	0.0000004	0.0000006	87 (2 dtrs)	144 (2 dtrs)

a () in this column indicate the number decays the parent atom undergoes before becoming a stable isotope.
b 238U used as surrogate for U nat. Assumes natural isotopic abundance of 238U, 235U and 234U.
c NC = Not calculated. Daughter activity accounted for in Radium-226 line item.
d NA = Not applicable, see activity concentration.
e Insitu activity in Area 2 may exceed WAC at times. Must control excavation and handling while monitoring outbound loads.

Table 6-4: Comparison of USEI Waste Acceptance Criteria to Projected OU-1 RIM Concentrations

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Partial Excavation of RIM with Activities above 1,000 pCi/g total Thorium or Radium

USEI Category Radionuclide	WAC Criteria: Maximum Concentration of Insitu Material	WAC Criteria: Sum of Concentrations of Parents and all Progeny	Activity Concentration (pCi/g): Area 1	Activity Concentration (pCi/g): Area 2	Mass Concentration (ppm): Area 1	Mass Concentration (ppm): Area 2	Series Activity, Assuming Equilibrium with Parent (pCi/g): Area 1[a]	Series Activity, Assuming Equilibrium with Parent (pCi/g): Area 2[a]
Unimportant Quantities of Source Material Uniformly Dispersed in Soil or Other Media								
Natural uranium in equilibrium with progeny[b]	<500 ppm Unat or 167 pCi ^{238}U/g	≤ 3,000 pCi/g	5.3	99.4	7.5	142.6	21 (3 dtrs)	397 (3 dtrs)
^{230}Th	0.1 ppm or ≤ 2,000 pCi/g	NC[c]	76	694	0.0038	0.034	76 (0 dtrs)	694 (0 dtrs)
Natural thorium (^{232}Th + ^{228}Th)	<500 ppm or 110 pCi/g	≤ 2,000 pCi/g	5.2	16.7	23.5	75.7	52 (9 dtrs)	167 (9 dtrs)
Mixture of Thorium and Uranium	Sum of ratios ≤ 1	≤ 2,000 pCi/g	0.06	0.58	NA[d]	NA[d]	0.1	0.6[e]
Naturally Occurring Radioactive Material other than Uranium and Thorium Uniformly Dispersed in Soil or Other Media								
^{226}Ra w/ progeny in bulk form	500 pCi/g	≤ 4,500 pCi/g	42.8	241	0.00004	0.00024	257 (5 dtrs)	1447 (5 dtrs)
^{210}Pb with ^{210}Bi and ^{210}Po	1,500 pCi/g	≤ 1,500 pCi/g	8.16	53	0.0000001	0.0000007	24 (2 dtrs)	158 (2 dtrs)

a () in this column indicate the number decays the parent atom undergoes before becoming a stable isotope.
b 238U used as surrogate for U nat. Assumes natural isotopic abundance of 238U, 235U and 234U.
c NC = Not calculated. Daughter activity accounted for in Radium-226 line item.
d NA = Not applicable, see activity concentration.
e Insitu activity in Area 2 may exceed WAC at times. Must control excavation and handling while monitoring outbound loads.

Table 7-1: Summary of Comparative Analysis of Alternatives DRAFT

Evaluation Criteria	No Action	ROD-Selected Remedy	52.9 Partial Excavation	1,000 Partial Excavation	"Complete Rad Removal"
THRESHOLD CRITERIA					
Overall Protection of Human Health and the Environment	Per the BRA, OU-1 does not currently pose unacceptable risks. Potential risks to a future groundskeeper may exceed EPA's acceptable risk range. Therefore, the No Action alternative is not protective.	All of the active remedial alternatives would be protective of human health and the environment. All remedial alternatives eliminate or reduce potential exposures to (1) external gamma radiation, (2) radon emissions, (3) inhalation or ingestion of contaminated soil or wastes, (4) dermal contact with contaminated soil or waste, and (5) dispersal of contaminants in fugitive dust. All of the remedial alternatives would reduce potential infiltration of precipitation into the waste and thereby reduce the potential for leaching to groundwater. All remedial alternatives include institutional controls to ensure that only land and resource uses that are consistent with the remedy and protective of human health and the environment are allowed in the future.			
Compliance with ARARs					
Compliance with Chemical-Specific ARARs	Chemical-specific ARARs are currently being met, however, continued compliance with these standards cannot be ensured without installation and maintenance of additional engineering controls and enforcement of institutional controls.	All of the remedial alternatives would comply with chemical-specific ARARs, including (1) UMTRCA standards for radon emissions, maximum concentrations for groundwater protection, and cleanup of contaminated land, as modified by the EPA OSWER Directives regarding use of these standards at Superfund sites (Buffer Zone and Crossroad Property); (2) radon NESHAP; (3) Nuclear Regulatory Commission (NRC) radiation protection standards, and (4) Missouri maximum contaminant levels (MCLs).			
Compliance with Location-Specific ARARs	Conditions associated with OU-1 comply with the location-specific ARARs	All of the remedial alternatives would meet the location-specific ARARs found in the Missouri solid waste regulations standards for landfills located within the 100-year floodplain or within 10,000 feet of an airport runway. Waste excavation under the complete and partial excavation alternatives and waste regrading activities under all of the alternatives would need to be performed in a manner that minimizes attractions for birds. Specifically, an avian management plan that incorporates the various techniques described in Section 4.3.6.2 of this FFS would need to be developed and approved by EPA and MDNR.			

Evaluation Criteria	No Action	ROD-Selected Remedy	52.9 Partial Excavation	1,000 Partial Excavation	"Complete Rad Removal"
Compliance with ARARs (cont.)					
Compliance with Action-Specific ARARs	No actions would be taken under this alternative and therefore, there are no action-specific ARARs.	Would meet action-specific ARARs, including the Missouri solid waste regulations closure and post-closure standards; the NRC radiation protection standards; the UMTRCA standards for longevity of disposal facilities; and the Missouri noise protection standards during implementation of a remedial action and closure of Areas 1 and 2.	Would meet action-specific ARARs, including the Missouri solid waste regulation closure and post-closure standards; the NRC radiation protection standards; the UMTRCA standards for longevity of disposal facilities; the Missouri noise protection standards during implementation of a remedial action and closure of Areas 1 and 2; DOT and NRC standards for shipment of radioactive wastes; and offsite disposal facility waste acceptance criteria.		
PRIMARY BALANCING CRITERIA					
Long-Term Effectiveness and Permanence					
Magnitude of residual risks	Projected long-term risks to a site groundskeeper exceed EPA's acceptable risk range.	All of the alternatives would result in projected long-term risks that far are below EPA's target risk range of 10^{-4} to 10^{-6}.			
Adequacy and reliability of controls	Not applicable as no controls would be implemented.	Engineering measures would be augmented and supported by existing and additional institutional controls which also have been used at numerous solid waste and NCP sites.			

Evaluation Criteria	No Action	ROD-Selected Remedy	52.9 Partial Excavation	1,000 Partial Excavation	"Complete Rad Removal"
Long-Term Effectiveness and Permanence (cont.)					
Climate Change and Tornado Impacts	Not applicable as no engineered controls would be implemented.	• Increased temperatures or decreased precipitation could damage the vegetation cover or dry out the low-permeability layer included in the landfill cover included as part of all of the alternatives. • Increased heavy precipitation could erode the vegetation layer and potentially the underlying low-permeability layer; however, the presence of the underlying rock/rubble layer is expected to prevent exposure of the underlying waste materials, except for the "complete rad removal" alternative, which does not include the rock/rubble layer. • None of the alternatives are expected to be impacted by flooding that may occur in the area because Areas 1 and 2 are not located in the floodplain.			
Impacts from a Subsurface Heating Event	The only impact that may occur from subsurface heating is a temporary, localized increase in radon emissions; however, the total emissions from the Site during such an event is projected to remain below the UMTRCA standard and radon NESHAP.				
Thermal Isolation Barrier (IB) interaction	Not applicable as no engineered controls would be implemented.	• No adverse impacts or unacceptable risks are expected to result if an SSR or SSE were to extend into in Area 1; therefore, regardless of the location or type of IB that may be installed, or even if no barrier is installed, no unacceptable risks are expected to occur. • Installation of an IB is not expected to impact the performance of any of the alternatives; however, implementation of any of the excavation alternatives could impact the integrity of or potentially destroy an IB.			
Environmental Justice	A screening level analysis did not identify any environmental justice concerns relative to the Site. However, EPA did identify a need to utilize more traditional communication methods (US Mail) to inform residents of the Terrisan Reste mobile home park.				
Reduction of Toxicity, Mobility or Volume through Treatment					
	Not applicable as no actions would be implemented.	• None of the alternatives include treatment technologies that would reduce the toxicity, mobility or volume of waste material through treatment as a primary component. Treatment technologies are generally not applicable to the site wastes due to the nature and overall large volume of wastes, combined with the fact that radionuclides are naturally occurring elements that cannot be fully neutralized or destroyed by treatment. • All of the alternatives include off-site treatment and disposal of hazardous wastes in accordance with the RCRA regulations if any such wastes are encountered during implementation of the remedy.			

Evaluation Criteria	No Action	ROD-Selected Remedy	52.9 Partial Excavation	1,000 Partial Excavation	"Complete Rad Removal"
Short-Term Effectiveness					
Protection of the community during any remedial action					
Potential radiological or chemical exposures	Not applicable as no engineered controls would be implemented.	None of the alternatives are expected to pose unacceptable risks to the general public during remedy implementation. Projected total carcinogenic risks are less than 1 x 10^{-7} and projected hazard indices for non-carcinogenic effects were less than 0.001 for all of the alternatives.			
Waste excavation volumes (yards)	Not applicable as no waste would be moved	126,000	501,000	825,000	1,572,000
Projected incidence of transportation-related accidents	Not applicable as no engineered controls would be implemented	0.61	10.6	16.6	34.9
Greenhouse gas emissions (tons)	Not applicable as no actions would be taken	19,000	43,000	53,000	83,000
Environmental Justice	A screening level analysis did not identify any environmental justice concerns relative to the Site; however, EPA did identify a need to utilize more traditional communication methods (US Mail) to inform residents of the Terrisan Reste mobile home park.				
Protection of workers					
Protection of workers during remedial actions	Not applicable as no actions would be taken	Remediation workers could be exposed to gamma radiation resulting in potential cancer risks above the upper bound of EPA's target risk range of 10^{-4} and also to non-carcinogenic risks with a hazard index greater than 1 during implementation of any of the remedial alternatives. None of the alternatives are expected to result in radiation doses (TEDEs) greater than the 5,000 mrem/yr limit established by OSHA and NRC.			
Carcinogenic Risks	Not applicable	9.23 x 10^{-5}	1.18 x 10^{-3}	2.38 x 10^{-3}	2.19 x 10^{-3}
TEDEs	Not applicable	187	720	867	405
Hazard indices	Not applicable	1.22	1.22	1.22	1.22
Industrial accident incidence	Not applicable	2.76	8.47	11.7	17.8
Time until RAOs are achieved					
Time until RAOs are achieved	No Action will not achieve RAOs.	RAOs would be achieved upon completion of construction. No potential threats would remain after implementation of any of the alternatives.			
Construction completion (years) including design)	Not applicable as no construction would be performed.	2.7	5.9	9	13.4

Evaluation Criteria	No Action	ROD-Selected Remedy	52.9 Partial Excavation	1,000 Partial Excavation	"Complete Rad Removal"
Implementability					
Technical Feasibility	Not applicable as no actions would be taken	All of the alternatives are constructible.			
Reliability of the technologies	Not applicable as no engineered controls would be implemented.	Landfill cover systems have been used extensively and with proper inspection and maintenance have been demonstrated to be reliable. Stormwater controls and environmental monitoring are commonly used techniques that have been demonstrated to be reliable.	• Excavation and offsite disposal is a common and reliable technology. • Landfill cover systems have been used extensively and with proper inspection and maintenance have been demonstrated to be reliable. • Stormwater controls and environmental monitoring are commonly used and demonstrated reliable techniques. • Per the FAA, the reliability of most bird mitigation technologies are questionable. • There is uncertainty regarding the actual volumes of RIM that would need to be removed and the volume of daily cover that would be added resulting in uncertainty the actual disposal volume. • The ability to remove deeper occurrences of RIM adjacent to other (OU-2) solid waste units is a technical difficulty with this alternative and might result in schedule delays. • Reductions in the number of IM containers or rail cars or the frequency of exchange of full and empty rail cars could impact the schedule for this alternative. • Excavation of RIM would also present significant implementability concerns associated with the excavation and handling of contaminated materials; management of fugitive dust and potential odors; mitigation of bird hazards; management and treatment of stormwater exposed to RIM during excavation; management of RIM that fails the paint filter liquids test; and the identification, segregation, and disposal offsite of any hazardous wastes or regulated asbestos containing materials that may be encountered during RIM excavation. • Excavation of RIM would also present significant implementability concerns associated with the excavation and handling of contaminated materials; management of fugitive dust and potential		

Evaluation Criteria	No Action	ROD-Selected Remedy	52.9 Partial Excavation	1,000 Partial Excavation	"Complete Rad Removal"
Implementability (cont.)					
Reliability of the technologies (cont.)			• odors; mitigation of bird hazards; management and treatment of stormwater exposed to RIM during excavation; management of RIM that fails the paint filter liquids test; and the identification, segregation, and disposal offsite of any hazardous wastes or regulated asbestos containing materials that may be encountered during RIM excavation.		
Ease of undertaking additional remedial actions	Not applicable as no actions would be taken under this alternative.	• The only future actions anticipated to be required for all of the alternatives are ongoing inspection, monitoring, maintenance and, if needed, repair of the final landfill covers. Each of these future actions can be easily implemented. • All of the alternatives include a provision for a contingent landfill gas control system in the event the monitoring of subsurface occurrences of landfill gas or radon indicates a need for such a system. Implementation of such a system is expected to be simple and straightforward and should not pose any difficulties			
Monitoring considerations	No monitoring would be performed.	Performance of all the alternatives can be monitored and potential risk of exposure in the event of failure of any of the alternatives would be low.			
Administrative Feasibility	Not applicable as no engineered controls or additional institutional controls would be implemented.	All of the alternatives could require: • coordination and permitting with MSD for disposal of leachate during construction; • access to Crossroad Property for investigation/removal of soil; • coordination with Earth City Flood Control District for design and operation of long-term stormwater management systems; and • preparation and approval of a traffic control plan for St. Charles Rock Road.			
Administrative Feasibility (cont.)			Alternatives that include off-site disposal would also require • Routine approval and verification of current acceptability for off-site disposal from EPA. • Use of the Clean Harbors facility for disposal would require approval by the Rocky Mountain Low Level Radioactive Waste Compact.		
Availability of Specialized Services and Materials	Not applicable as no engineered controls would be implemented.	Specialized personnel, equipment, and materials are readily available to implement the cover systems, institutional controls, and monitoring components of the remedial alternatives. The implementability and potential costs for all of the remedial alternatives will be influenced by the availability and location of clean fill materials and/or offsite soil borrow sources at the time the selected alternative is implemented.			

<table>
<tr><th>Evaluation Criteria</th><th>No Action</th><th>ROD-Selected Remedy</th><th>52.9 Partial Excavation</th><th>1,000 Partial Excavation</th><th>“Complete Rad Removal”</th></tr>
<tr><td colspan="6">Implementability (cont.)</td></tr>
<tr><td>Availability of Materials, Equipment, and Personnel</td><td>Not applicable as no engineered controls would be implemented.</td><td>Preliminary discussions with MSD indicate that it is willing and has sufficient capacity to accept leachate or stormwater that may be generated during construction. Alternatively, off-site disposal facilities are available to accept these materials if necessary</td><td colspan="3">• Materials, equipment and personnel required for excavation of the RIM and transport of RIM to an offsite disposal facility are readily available.
• Only a limited number of offsite disposal facilities exist that can accept excavated RIM from the West Lake Landfill. At this time, it is difficult to evaluate which disposal facilities that can currently accept wastes from the West Lake Landfill may be available in the future, or what their respective future capacities or waste acceptance criteria may be.
• The volumetric rate of acceptance for all offsite disposal facilities would also be a function of the availability of IM containers and the number of railcars that could be loaded at or near the Site, as well as the number of railcars that could be unloaded at or near the disposal facility.
• Preliminary discussions with MSD indicate that it is willing and has sufficient capacity to accept leachate or stormwater that may be generated during construction. Alternatively, off-site disposal facilities are available to accept these materials if necessary.</td></tr>
<tr><td>Availability of Technologies</td><td>Not applicable as no engineered controls would be implemented.</td><td>Technologies for this alternative are generally available and sufficiently demonstrated. No prospective technologies are anticipated as part of this alternative.</td><td colspan="3">Technologies included as part of these alternatives are generally available and sufficiently demonstrated. No prospective technologies are anticipated. Use of physical separation techniques could, if effective, reduce the overall cost of this alternative; however, the potential effectiveness, implementability, risks and cost of such techniques cannot be determined from available information. An on-site pilot-scale test would be necessary to make such determinations.</td></tr>
</table>

Table 7-1: Summary of Comparative Analysis of Alternatives (cont.)

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Evaluation Criteria	No Action	ROD-Selected Remedy	52.9 Partial Excavation	1,000 Partial Excavation	"Complete Rad Removal"
Cost					
Capital cost	$0	$67,000,000	$313,000,000	$361,000,000	$616,000,000
O&M costs	$35,000 every 5 years	$167,000 – 326,000	$167,000 – 326,000	$167,000 – 326,000	$167,000 – 326,000
Present Worth Costs					
30 years					
(i=7%)	$100,000	$64,000,000	$265,000,000	$275,000,000	$420,000,000
(i=1.5%)	$200,000	$70,000,000	$305,000,000	$342,000,000	$566,000,000
Total (non-discounted)	$200,000	$73,000,000	$318,000,000	$365,000,000	$619,000,000
200 years					
(i=7%)	$100,000	$64,000,000	$265,000,000	$276,000,000	$421,000,000
(i=1.5%)	$400,000	$77,000,000	$312,000,000	$349,000,000	$573,000,000
Total (non-discounted)	$1,000,000	$102,000,000	$348,000,000	$395,000,000	$649,000,000
1,000 years					
(i=7%)	$100,000	$64,000,000	$265,000,000	$276,000,000	$421,000,000
(i=1.5%)	$500,000	$78,000,000	$312,000,000	$350,000,000	$573,000,000
Total (non-discounted)	$7,000,000	$241,000,000	$487,000,000	$534,000,000	$788,000,000

FIGURES

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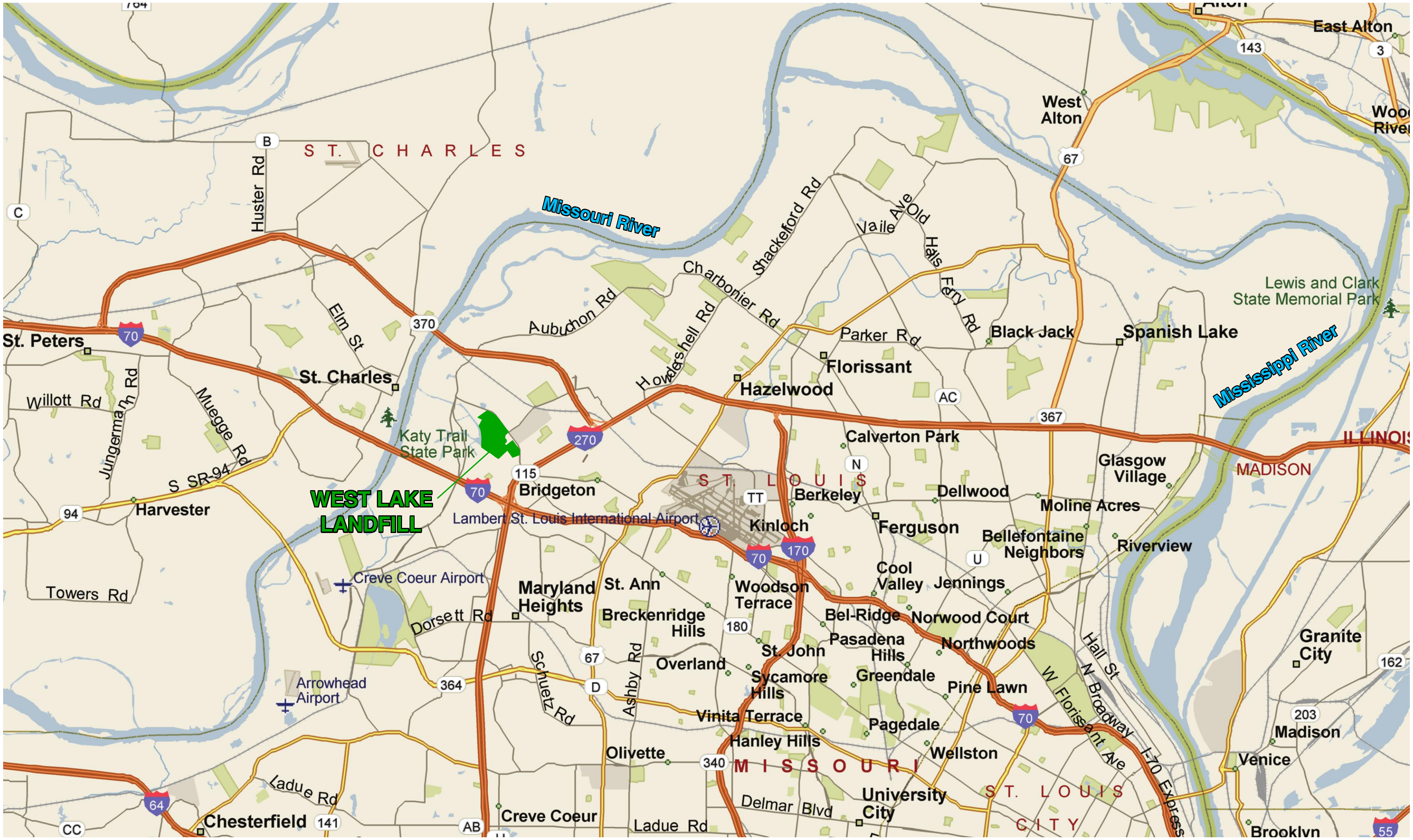

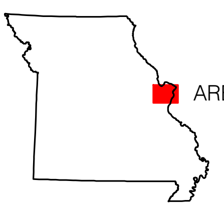

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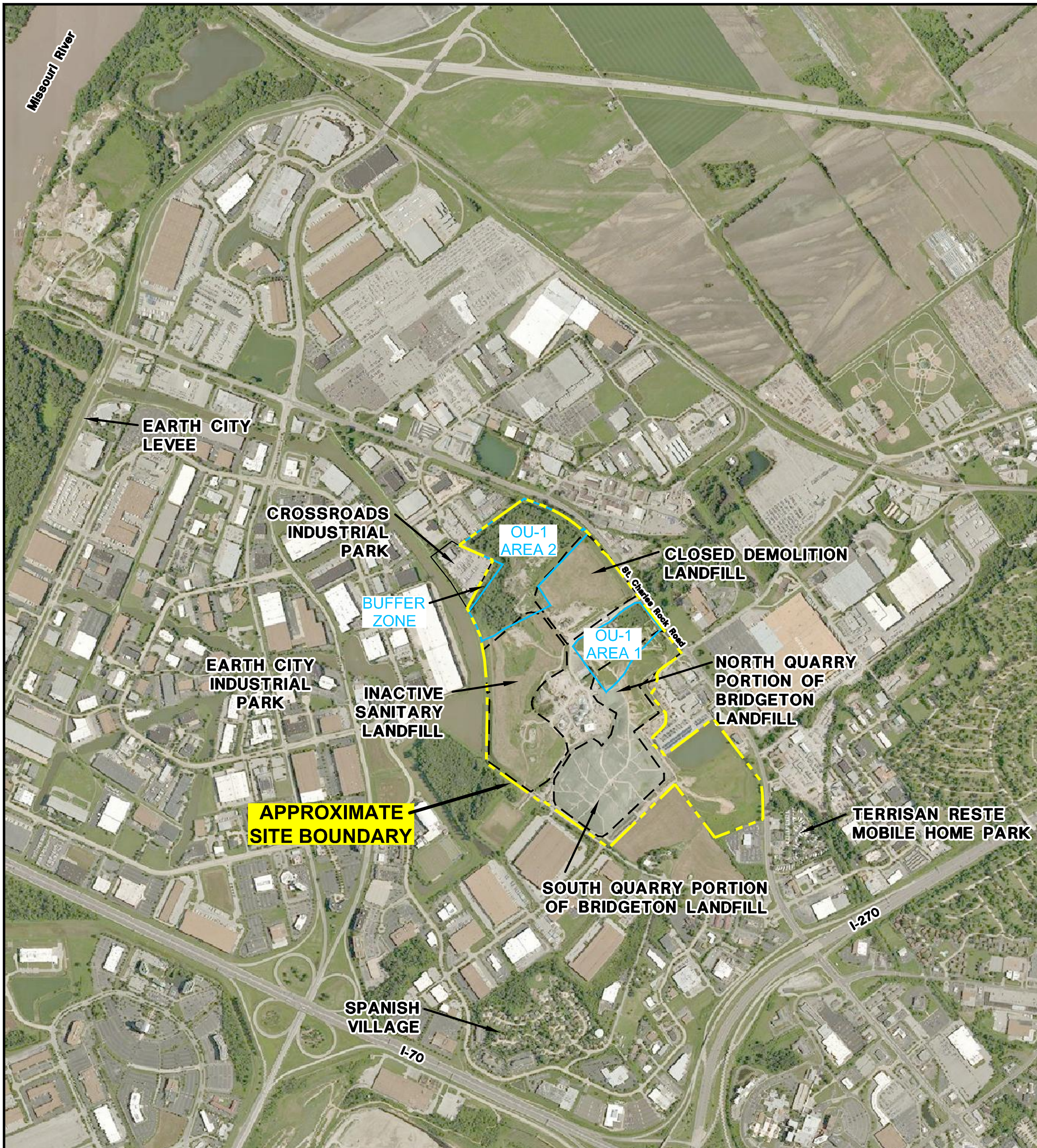
Figure 2-1

Site Vicinity Map

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.



Source: USGS Aerial Photography

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Figure 2-2

Site Location Map

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

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M:\clients\EMSI\westlake\2016\Final-FS\Section-2\FIG2-3-Landfill Operations.dwg

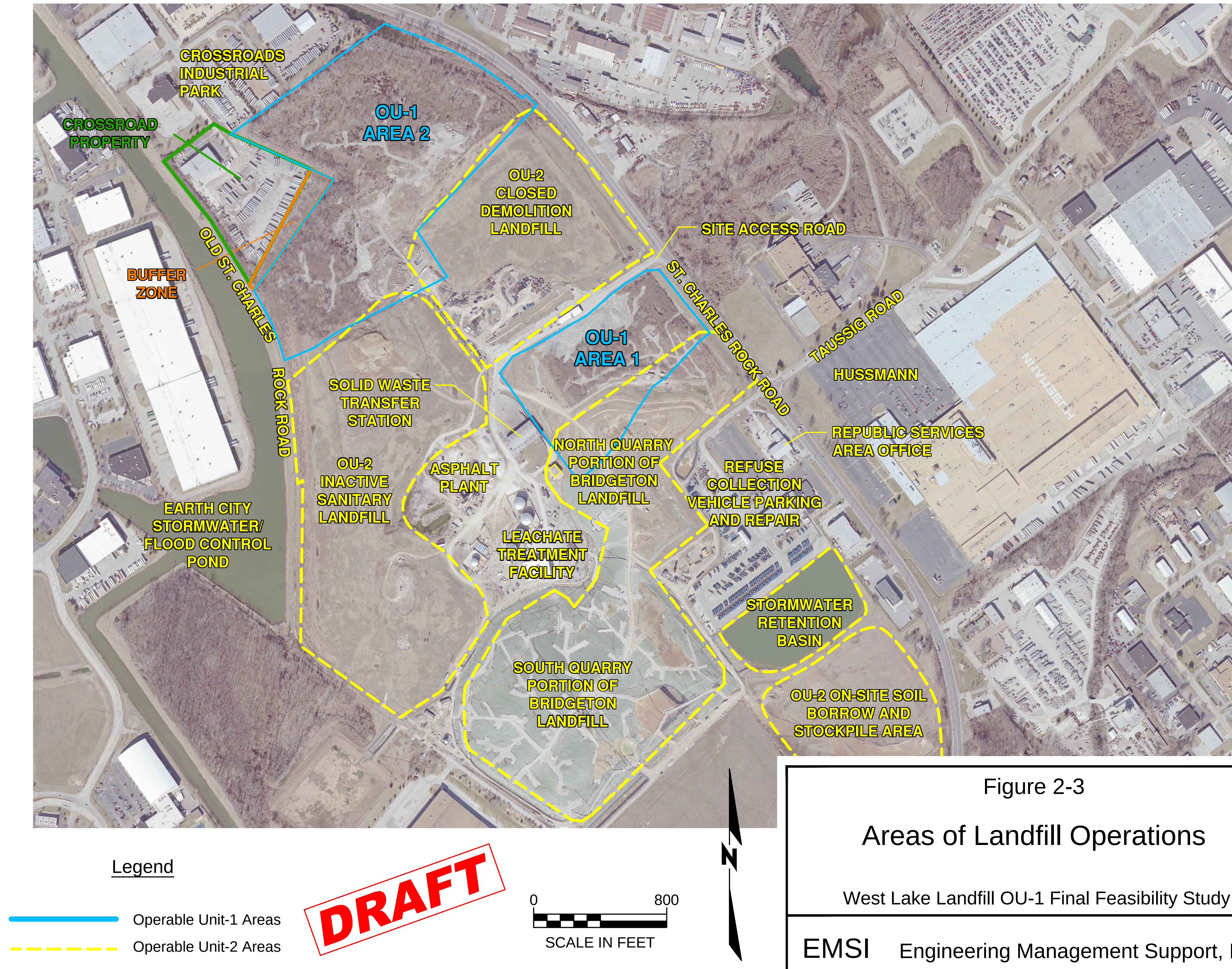

Figure 2-3

Areas of Landfill Operations

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

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LEGEND

440 CONTOUR ELEVATION (FEET ABOVE MEAN SEA LEVEL)

NOTES:

- AERIAL TOPOGRAPHY PROVIDED BY COOPER AERIAL SURVEYS CO. AND IS DATED FEBRUARY 27, 2016
- ALL ELEVATIONS ARE ABOVE MEAN SEA LEVEL (AMSL)

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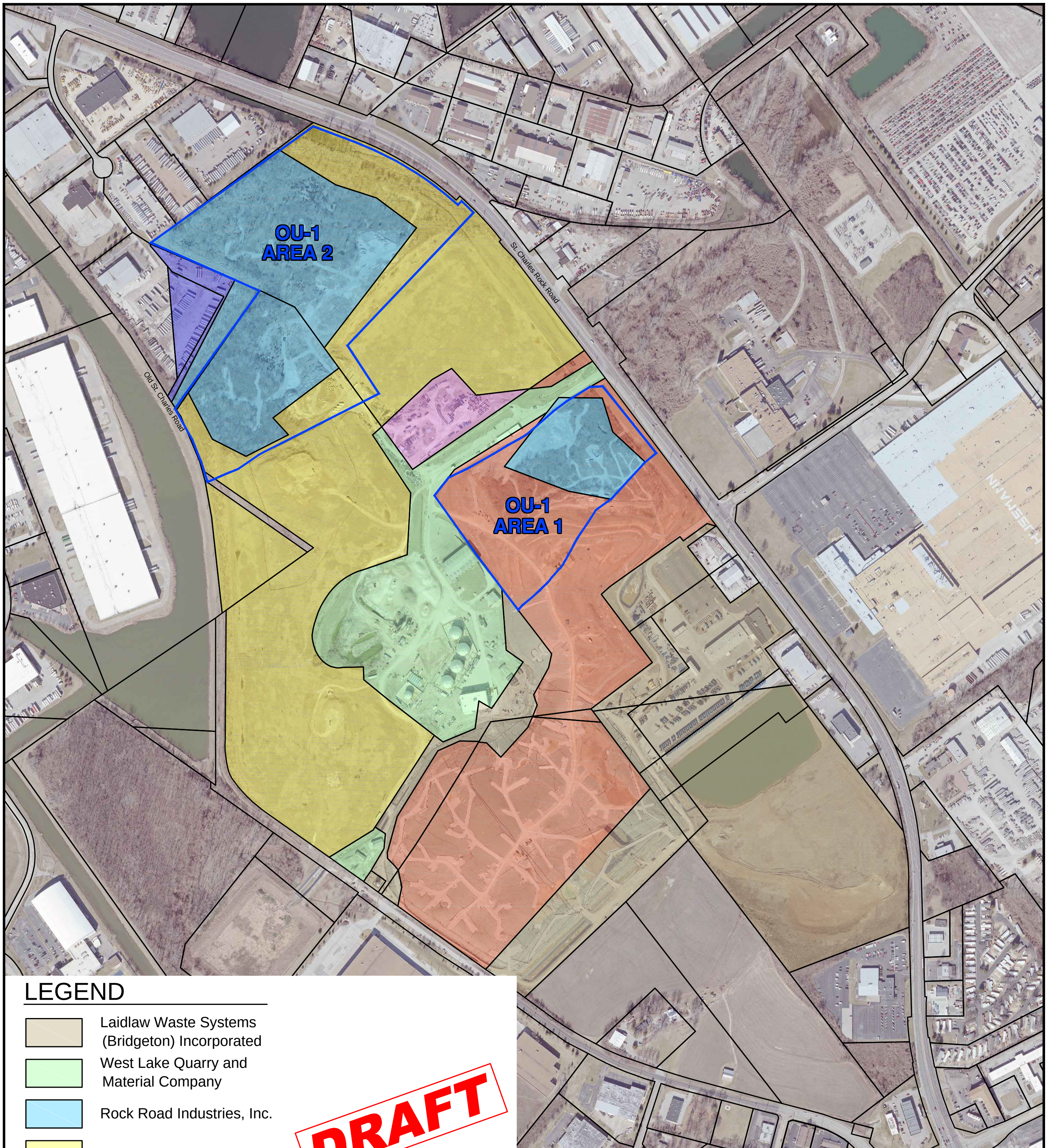
Figure 2-4

Site Topography

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.



LEGEND

- Laidlaw Waste Systems (Bridgeton) Incorporated
- West Lake Quarry and Material Company
- Rock Road Industries, Inc.
- West Lake Landfill, Inc.
- West Lake Landfill, Inc. et al.
- Bridgeton Transfer Station LLC
- Crossroad Properties LLC

Notes:
2. Parcels from Saint Louis County Missouri, GIS Department
1. Aerial provided by Cooper Aerial Surveys Company (February, 2016)

Figure 2-5

Landfill Property Ownership

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

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M:\clients\EMSI\westlake\2016\Final-FS\Section-2\FIG2-6-Zoning.dwg

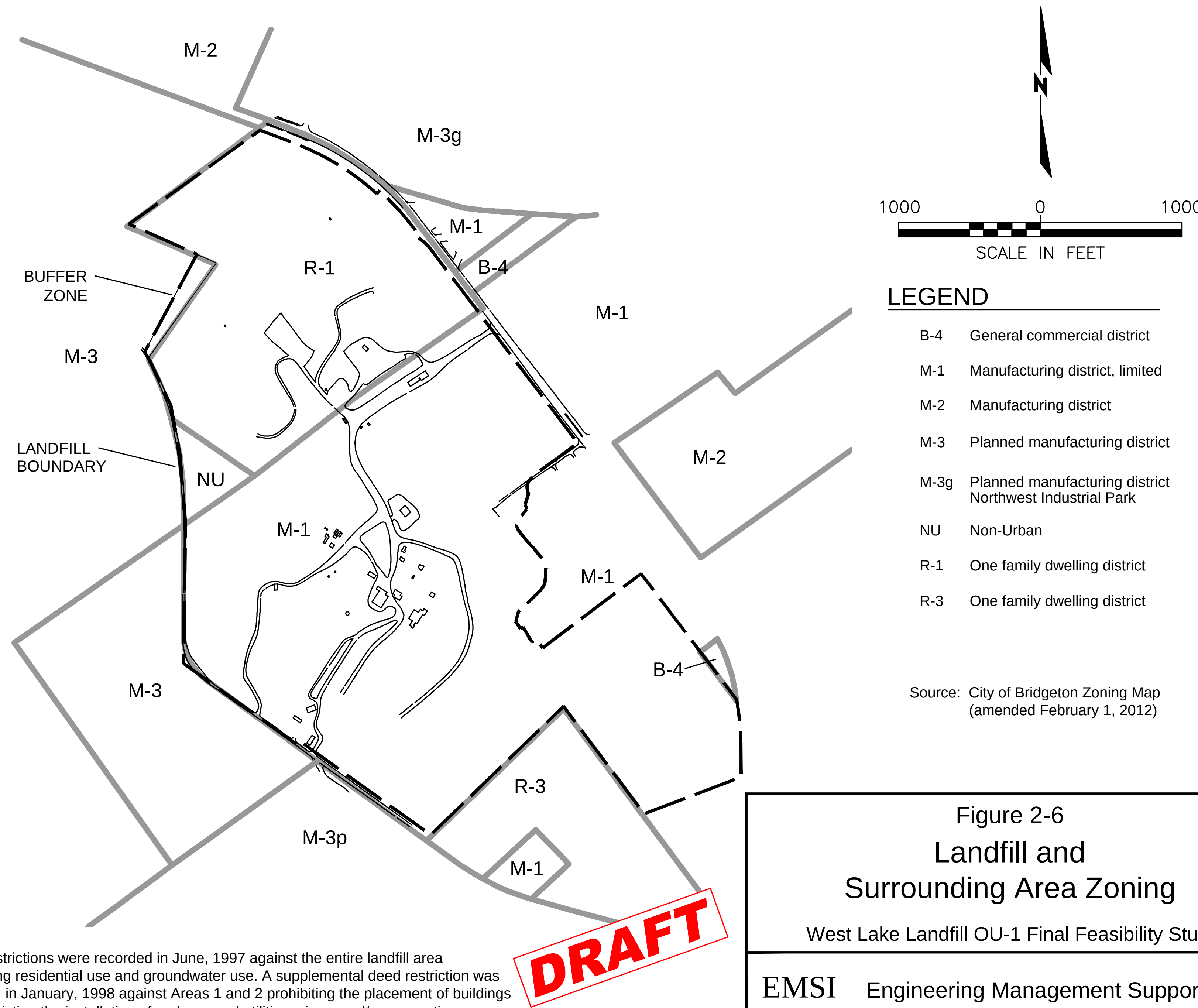

Figure 2-6

Landfill and Surrounding Area Zoning

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

NOTE:

Deed restrictions were recorded in June, 1997 against the entire landfill area prohibiting residential use and groundwater use. A supplemental deed restriction was recorded in January, 1998 against Areas 1 and 2 prohibiting the placement of buildings and restricting the installation of underground utilities, pipes, and/or excavation.

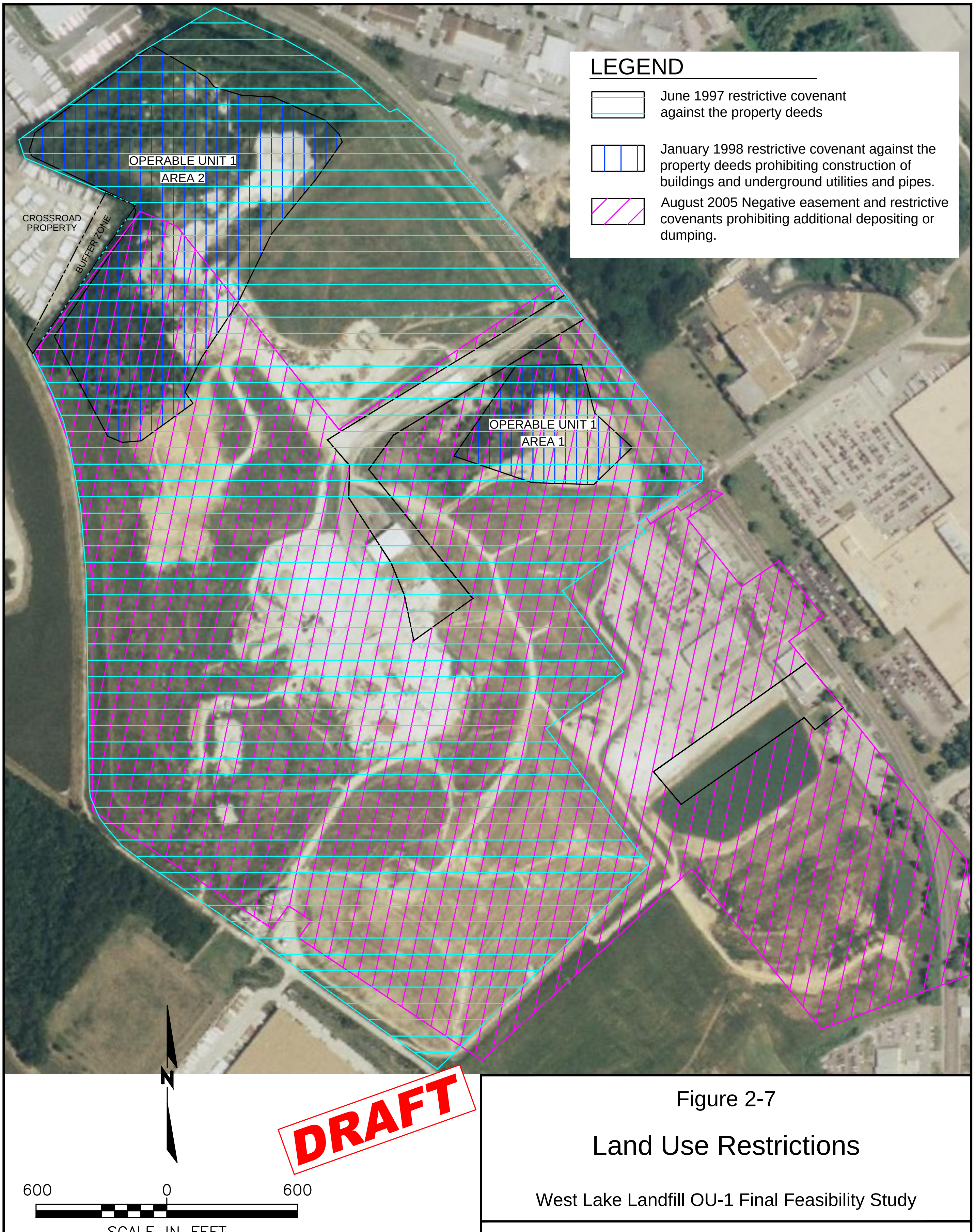

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Figure 2-7

Land Use Restrictions

West Lake Landfill OU-1 Final Feasibility Study

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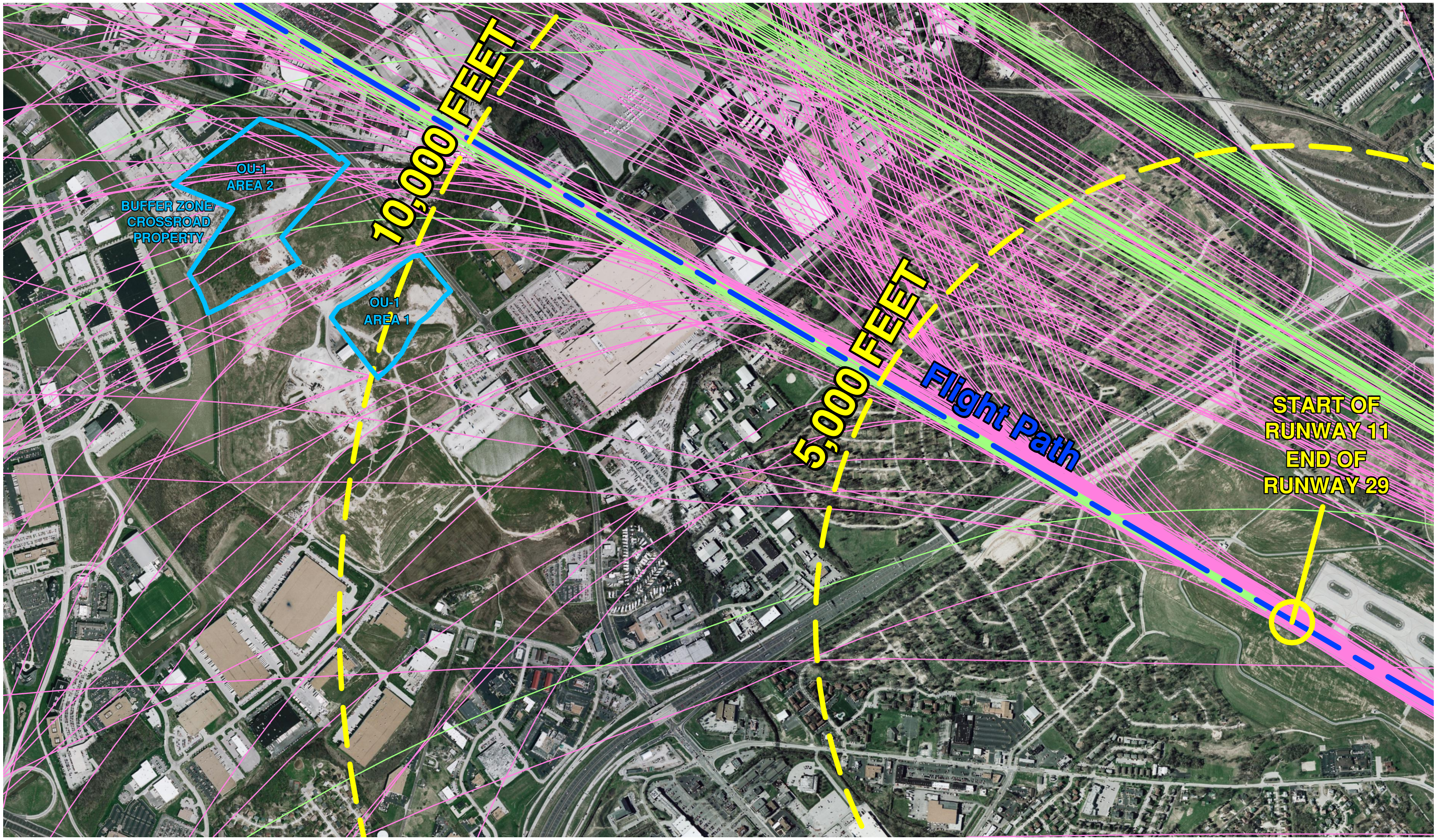
M:\clients\EMSI\westlake\2016\Final-FS\Section-2\FIG2-8-Airport-Setbacks.dwg plotted: 07/19/2016



Source: Google Earth

Legend

West Flow Radar Tracks (From Lambert-St Louis International Airport 14 CFR Part 150 Study)

East Flow Radar Tracks (To Lambert-St Louis International Airport 14 CFR Part 150 Study)

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Figure 2-8

Setback From Airport Runway

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAS)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

	1% annual chance floodplain boundary
	0.2% annual chance floodplain boundary
	Floodway boundary
	Zone D boundary
	Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.
	CBRS and OPA boundary
	International, State, or County boundary
	Corporate, Extraterritorial Jurisdiction, or Urban Growth boundary
	Area Not Included boundary
	Military Reservation, Native American Lands boundary
513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*
	* Referenced to the North American Vertical Datum of 1988
A — A	Cross section line
23 ---- 23	Transect line
87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}76^{000m}$E	1000-meter Universal Transverse Mercator grid values, zone 15
600000 FT	5000-foot grid ticks: Missouri State Plane coordinate system, east zone (FIPSZONE 2401), Transverse Mercator projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
● M1.5	River Mile
	Aqueduct, Culvert, Flume, Penstock, or Storm Sewer
	Road or Railroad Bridge

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
AUGUST 2, 1995

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

February 4, 2015 – to update corporate limits, to change Base Flood Elevations, to add Special Flood Hazard Areas, to change Special Flood Hazard Areas, to change zone designations, to add roads and road names, to incorporate previously issued Letters of Map Revision, to reflect updated topographic information.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0039K

FIRM
FLOOD INSURANCE RATE MAP

ST. LOUIS COUNTY, MISSOURI
AND INCORPORATED AREAS

PANEL 39 OF 445
(SEE LOCATOR DIAGRAM OR MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

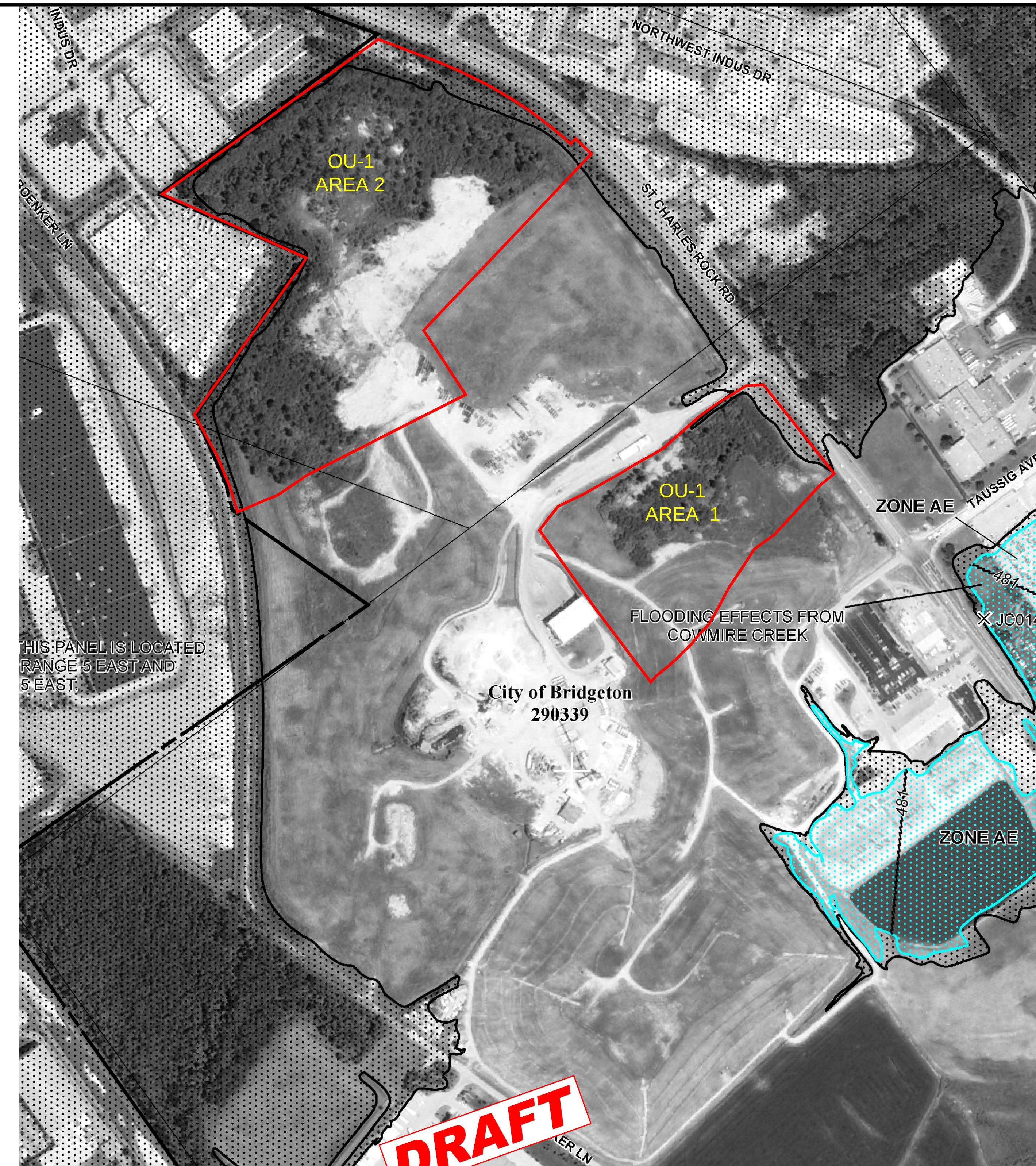
COMMUNITY	NUMBER	PANEL	SUFFIX
BRIDGETON, CITY OF	290339	0039	K
CHAMP, VILLAGE OF	290909	0039	K
MARYLAND HEIGHTS, CITY OF	290889	0039	K
ST. LOUIS COUNTY	290327	0039	K

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
29189C0039K

MAP REVISED
FEBRUARY 4, 2015

Federal Emergency Management Agency



Source: FIRM Map 29189C0039K

0 600
SCALE IN FEET

N

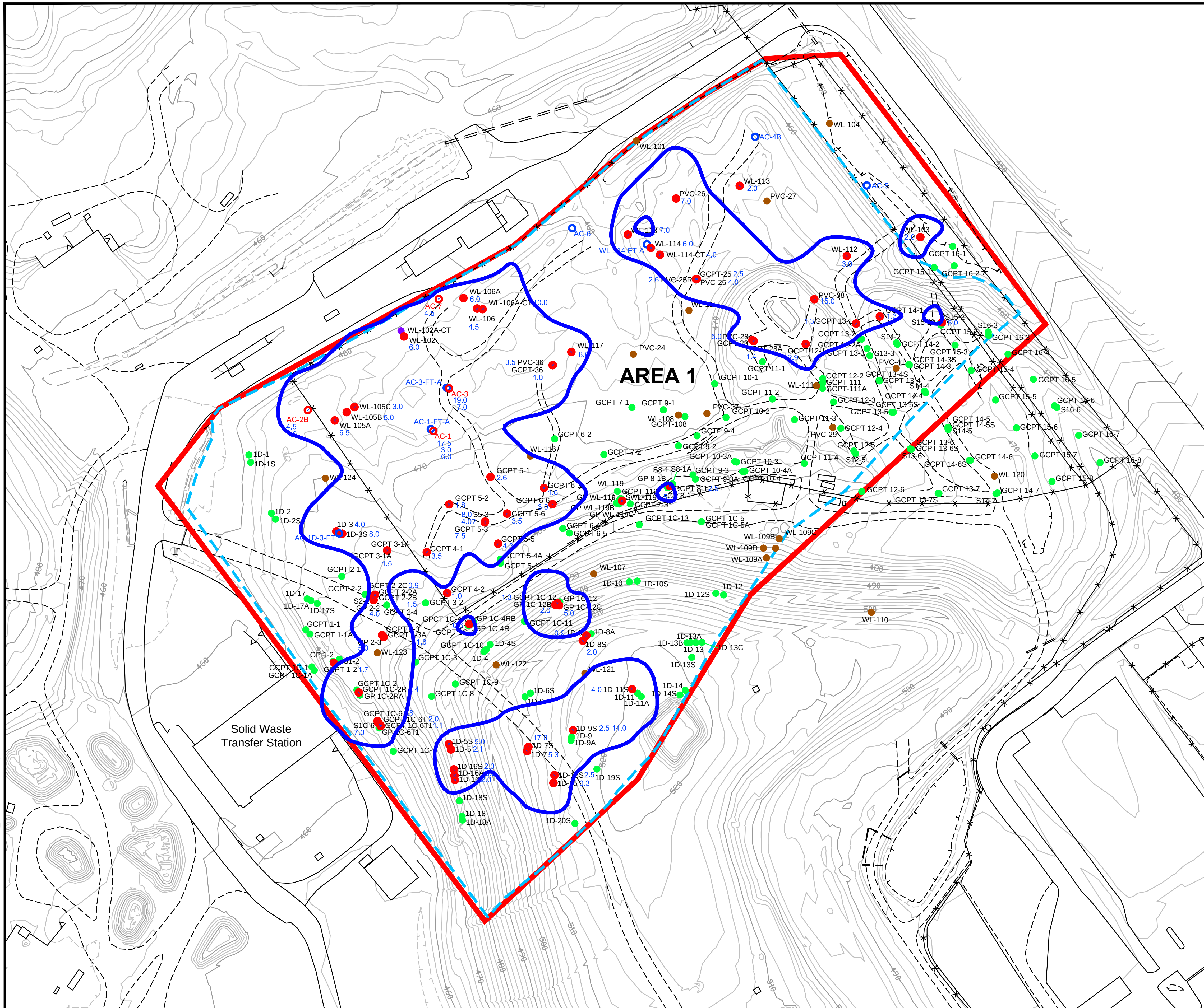
Figure 2-9

FEMA FIRM Map
City of Bridgeton Area

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

M:\clients\EMSI\westlake\2016\Final-FS\Section-2\FIG-2-9-Flood-Plain.dwg



LEGEND

- OU-1 AREA 1 BOUNDARY
- APPROXIMATE EDGE OF REFUSE
- RI SOIL BORING
- PHASE 1 SOIL BORING
- COTTER SOIL BORING
- ADDITIONAL SOIL BORING
- PRESENCE OF RIM
- 5.0 THICKNESS OF RIM (IN FEET)
- GEOSTATISTICAL-BASED ESTIMATE OF RIM EXTENT

150 0 150

SCALE IN FEET

NOTES:

- AERIAL TOPOGRAPHY PROVIDED BY COOPER AERIAL SURVEYS CO. AND IS DATED FEBRUARY 27, 2016
- ALL ELEVATIONS ARE ABOVE MEAN SEA LEVEL (AMSL)

Figure 2-10

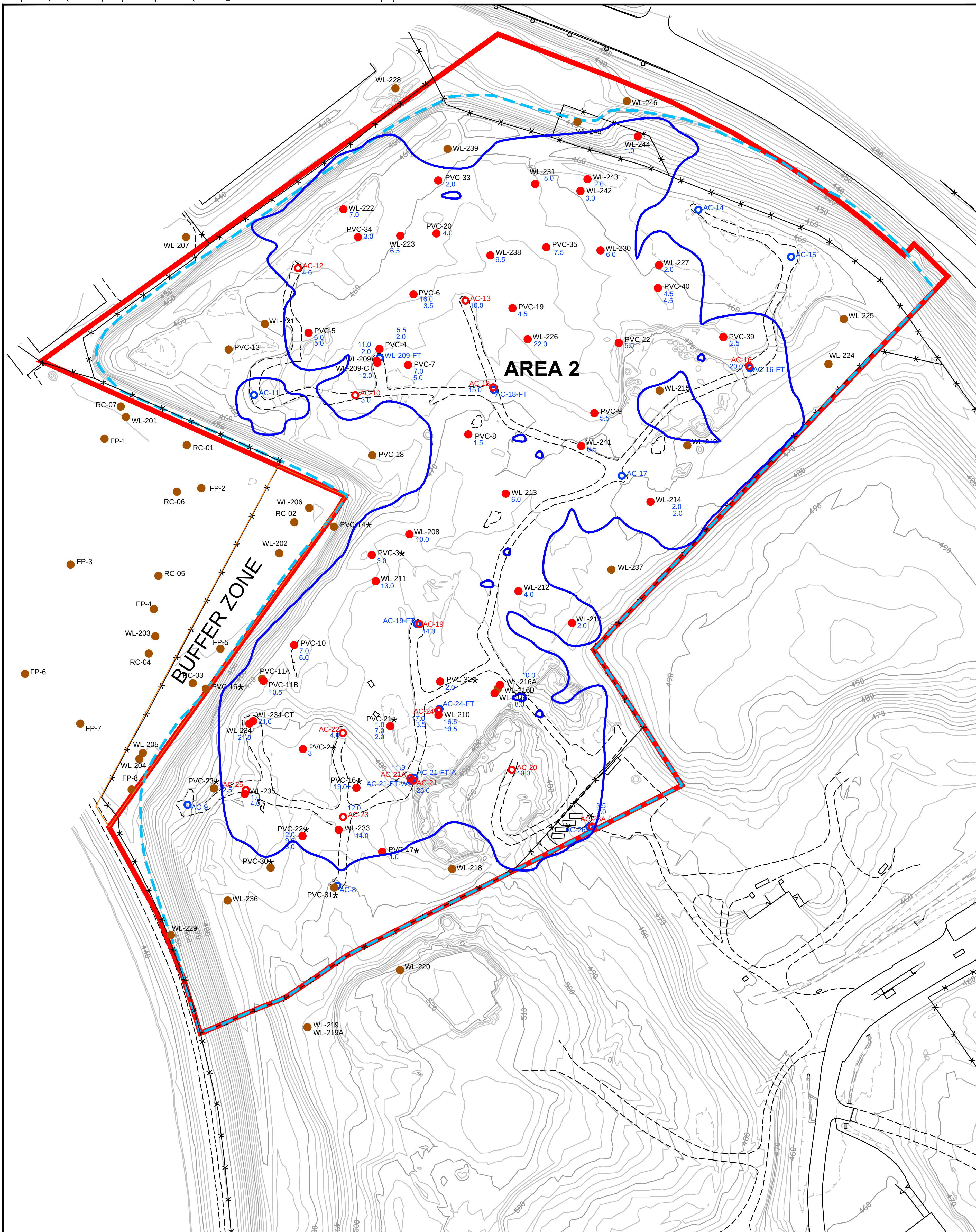
Approximate Extent of RIM Area 1

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

M:\clients\EMSI\westlake\2016\Final-FS\Section-2\FIG-2-10_2-11-Extent-RIM.dwg

M:\CLIENTS\EMSI\WESTLAKE\2016\FINAL-FS\SECTION-2\FIG-2-10_2-11-EXTENT-RIM.DWG-AREA2 NO-YELLOW 07/19/2016 4:05PM



LEGEND

- OU-1 AREA 2 BOUNDARY
- APPROXIMATE EDGE OF REFUSE
- * LOCATION APPROXIMATE-NO SURVEY DATA AVAILABLE
- RI SOIL BORING
- COTTER SOIL BORING
- ADDITIONAL SOIL BORING
- PRESENCE OF RIM
- 5.0 THICKNESS OF RIM (IN FEET)
- GEOSTATISTICAL-BASED ESTIMATE OF RIM EXTENT

DRAFT

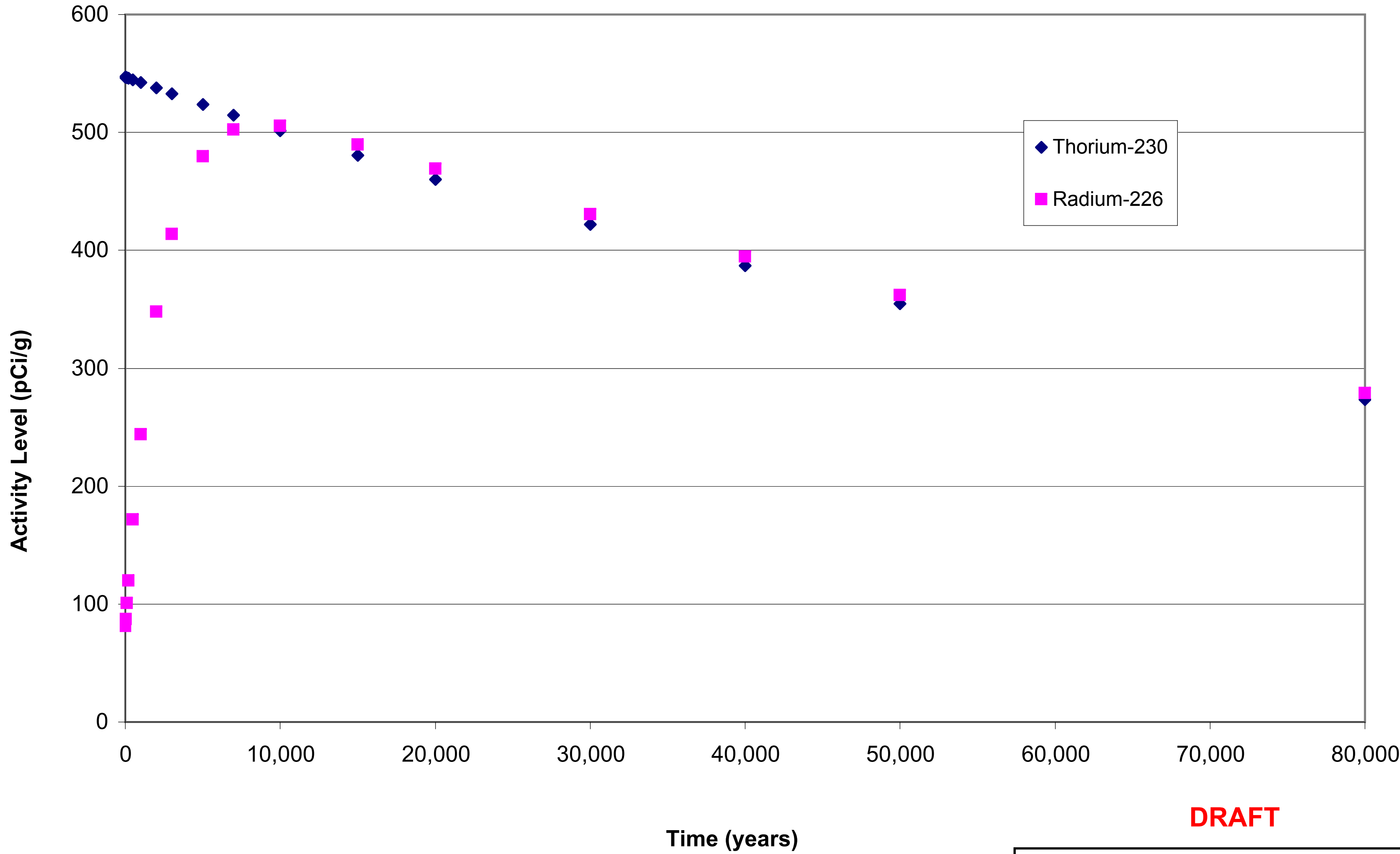
NOTES:
- AERIAL TOPOGRAPHY PROVIDED BY COOPER AERIAL SURVEYS CO. AND IS DATED FEBRUARY 27, 2016
- ALL ELEVATIONS ARE ABOVE MEAN SEA LEVEL (AMSL)

N

200 0 200
SCALE IN FEET

Figure 2-11
Approximate Extent of RIM
Area 2
West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.



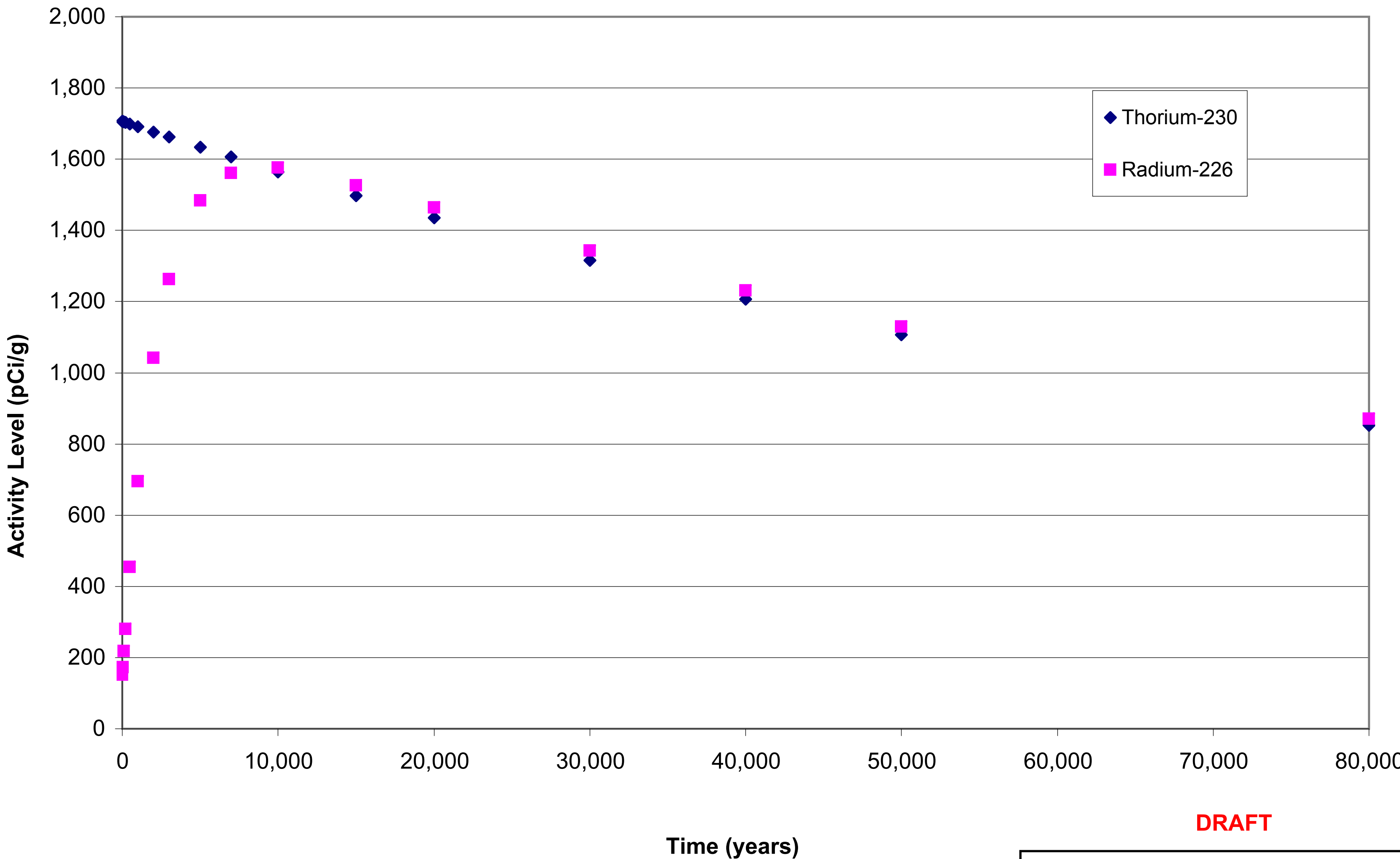
DRAFT

Figure 2-12

Thorium-230 Decay and Radium-226 Ingrowth Over Time Area 1

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.



DRAFT

Figure 2-13

Thorium-230 Decay and Radium-226 Ingrowth Over Time Area 2

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

M:\clients\EMSI\westlake\2016\Final-FS\Section-2\FIG-2-14-Buffer-Zone_Crossroad.dwg

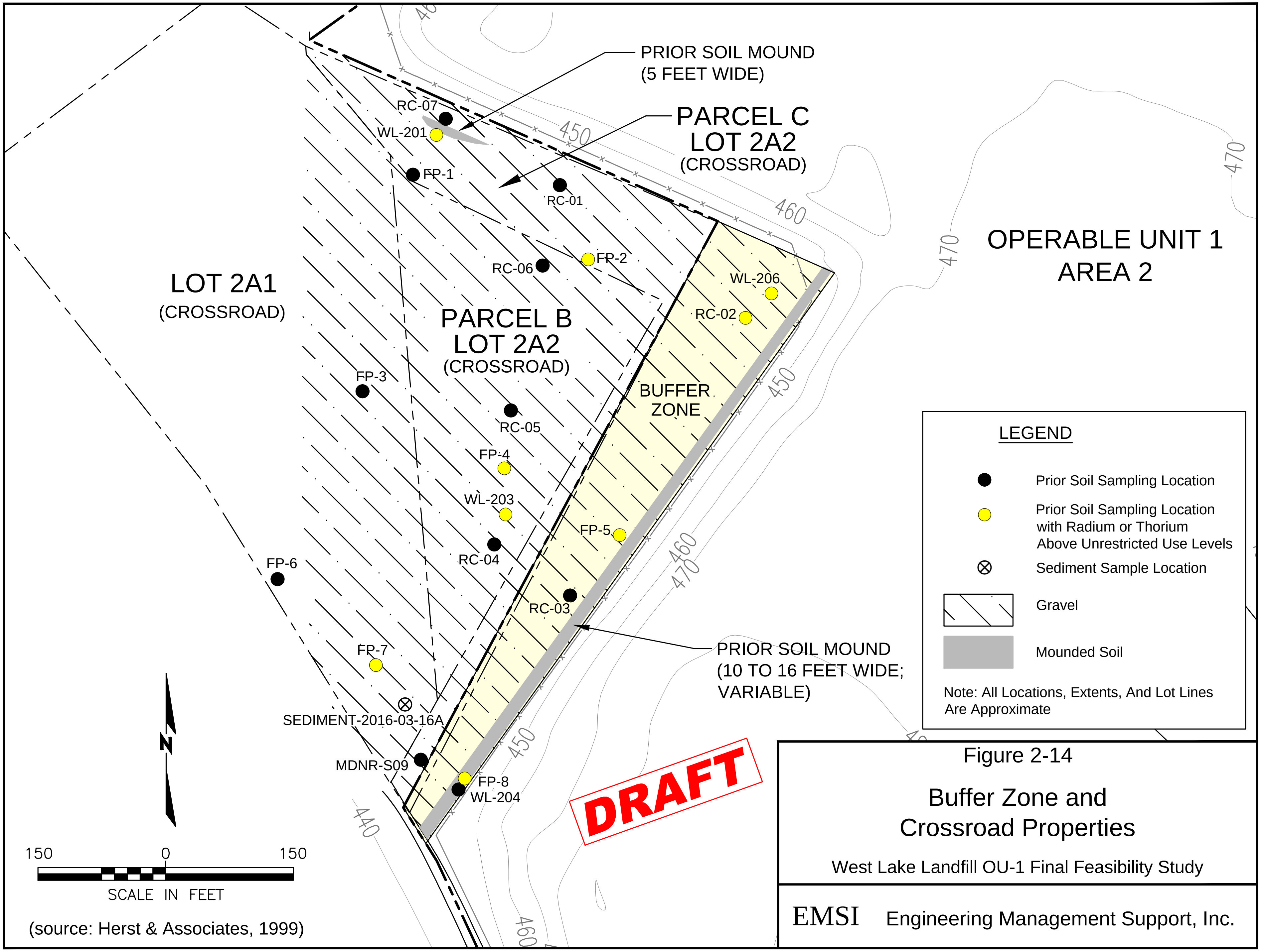


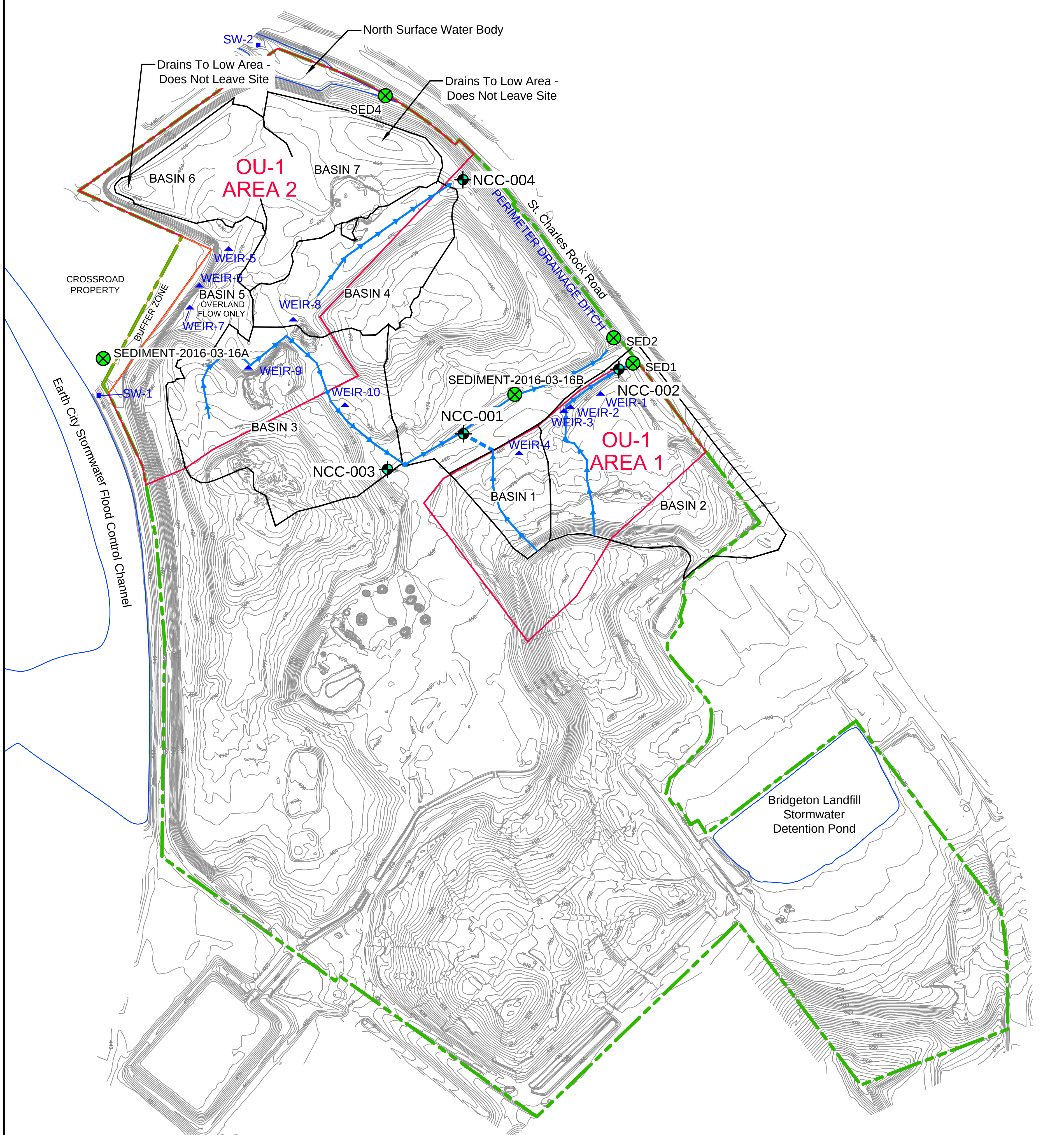
Figure 2-14

Buffer Zone and
Crossroad Properties

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

M:\CLIENTS\EMSI\WESTLAKE\2016\FINAL-FS\SECTION-2\FIG-2-15-SW-SED-MON-LOCS.DWG-LAYOUT 09/30/2016 3:17PM



LEGEND

(green dash-dot line)	Landfill Boundary
(thin gray line)	2015 Topography (2' Contour)
500	2015 Topography (10' Contour)
(black line)	Watershed Catchment Area
(blue arrow line)	Flow Path
(blue dashed line)	Culvert
NCC-001	Sampling Location
SED2	Sediment Sample Location
WEIR-3	Rainwater runoff and sediment sampling locations
SW-1	Surface water sampling location

N

500 0 500

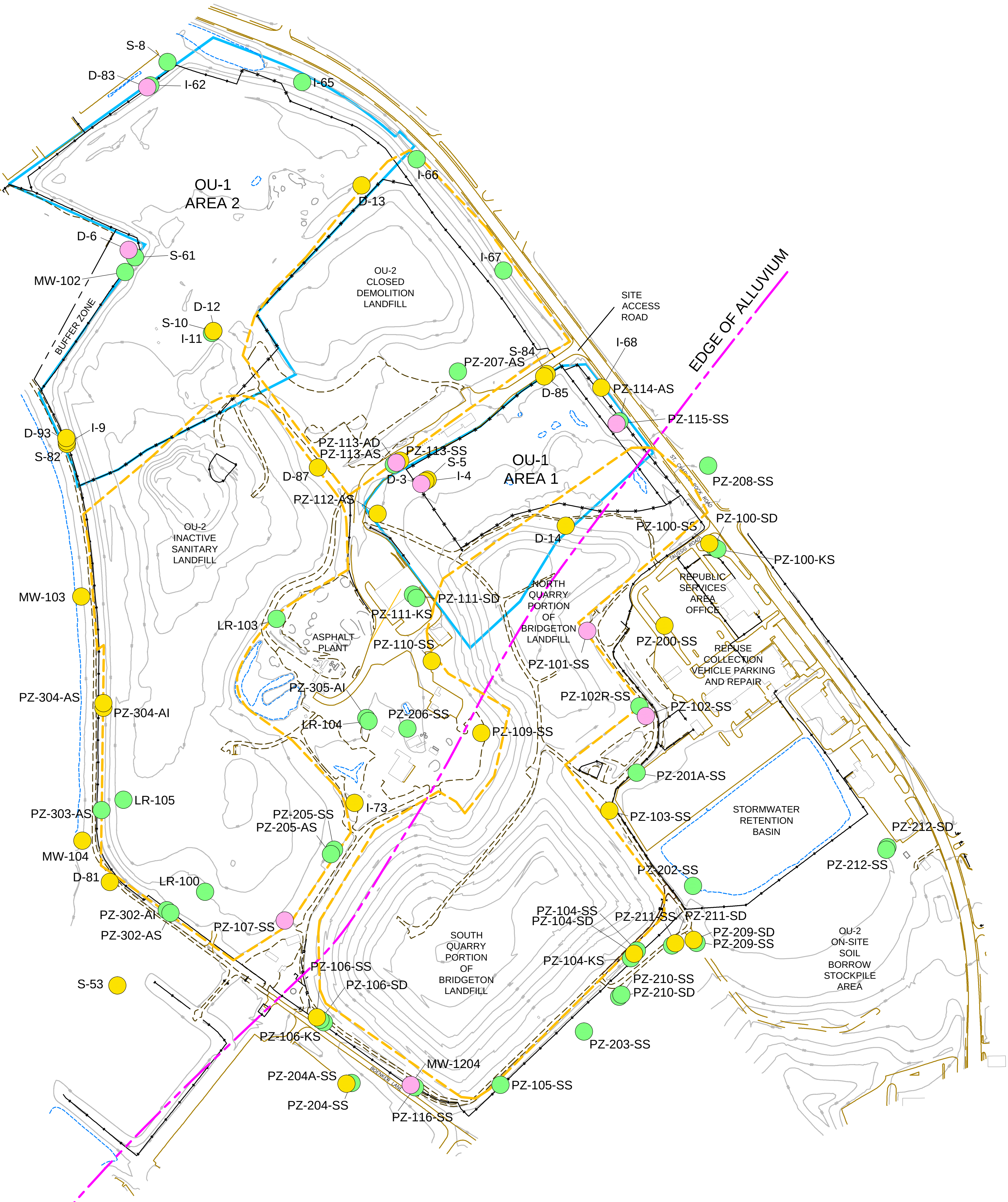
SCALE IN FEET

NOTES:
2015 TOPOGRAPHY PROVIDED BY COOPER AERIAL SURVEYS, INC. AND IS DATED MARCH 10, 2015

Figure 2-15
Stormwater, Surface Water and Sediment Monitoring Locations
West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

M:\CLIENTS\EMSI\WESTLAKE\2016\FINAL-FS\SECTION-2\FIG-2-16-COM-TOT-RAD-226-228-PYG.DWG-1 09/30/2016 3:16PM



RADIUM EXPLANATION

- (pink) Total Radium greater than the Maximum Contaminant Level of 5 pCi/L for combined Radium-226 and Radium-228 (all sampling dates)
- (yellow) Total Radium greater than the Maximum Contaminant Level of 5 pCi/L for combined Radium-226 and Radium-228 (at least one sampling data but not all sampling dates)
- (green) Total Radium less than the Maximum Contaminant Level of 5 pCi/L for combined Radium-226 and Radium-228 (all sampling dates)

LEGEND

- Operable Unit-1 Area
- Paved Road
- Unpaved Road

WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
SS: St. Louis Formation Well
SD: Salem Formation Well
KS: Keokuk Formation Well

DRAFT

NOTES:

1. Horizontal Coordinates Based on State Plane Missouri East Zone NAD 27
2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

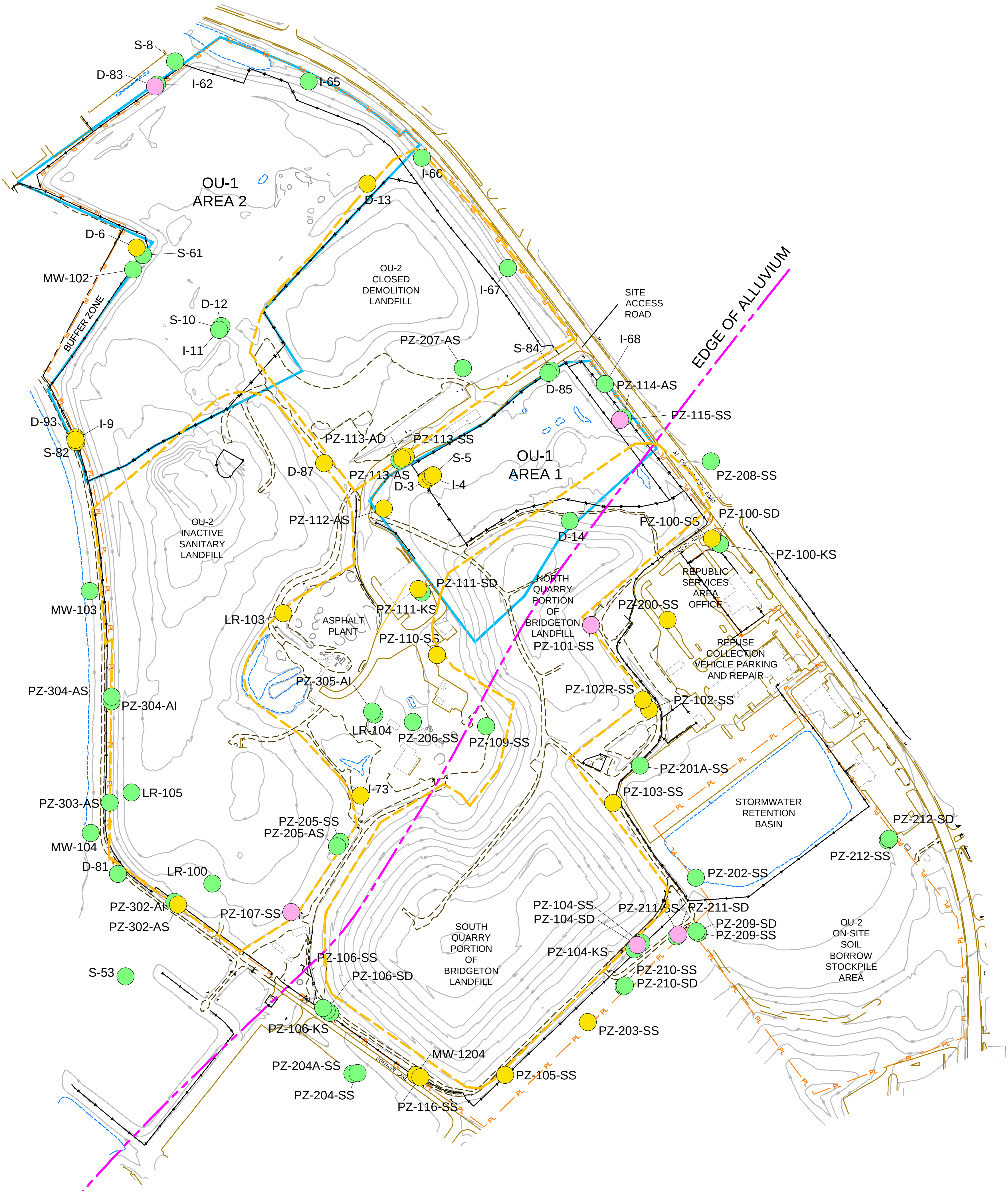
NORTH

0 250 500
SCALE IN FEET

Figure 2-16
Combined Total Radium-226 + Total Radium-228 in Groundwater, August 2012 Through February 2014

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.



LEGEND

- Operable Unit-1 Area
- Paved Road
- Unpaved Road

RADIUM EXPLANATION

- Dissolved Radium greater than the Maximum Contaminant Level of 5 pCi/L for combined Radium-226 and Radium-228 (all sampling dates)
- Dissolved Radium greater than the Maximum Contaminant Level of 5 pCi/L for combined Radium-226 and Radium-228 (at least one sampling data but not all sampling dates)
- Dissolved Radium less than the Maximum Contaminant Level of 5 pCi/L for combined Radium-226 and Radium-228 (all sampling dates)

WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
SS: St. Louis Formation Well
SD: Salem Formation Well
KS: Keokuk Formation Well

DRAFT

NOTES:

1. Horizontal Coordinates Based on State Plane Missouri East Zone NAD 27
2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

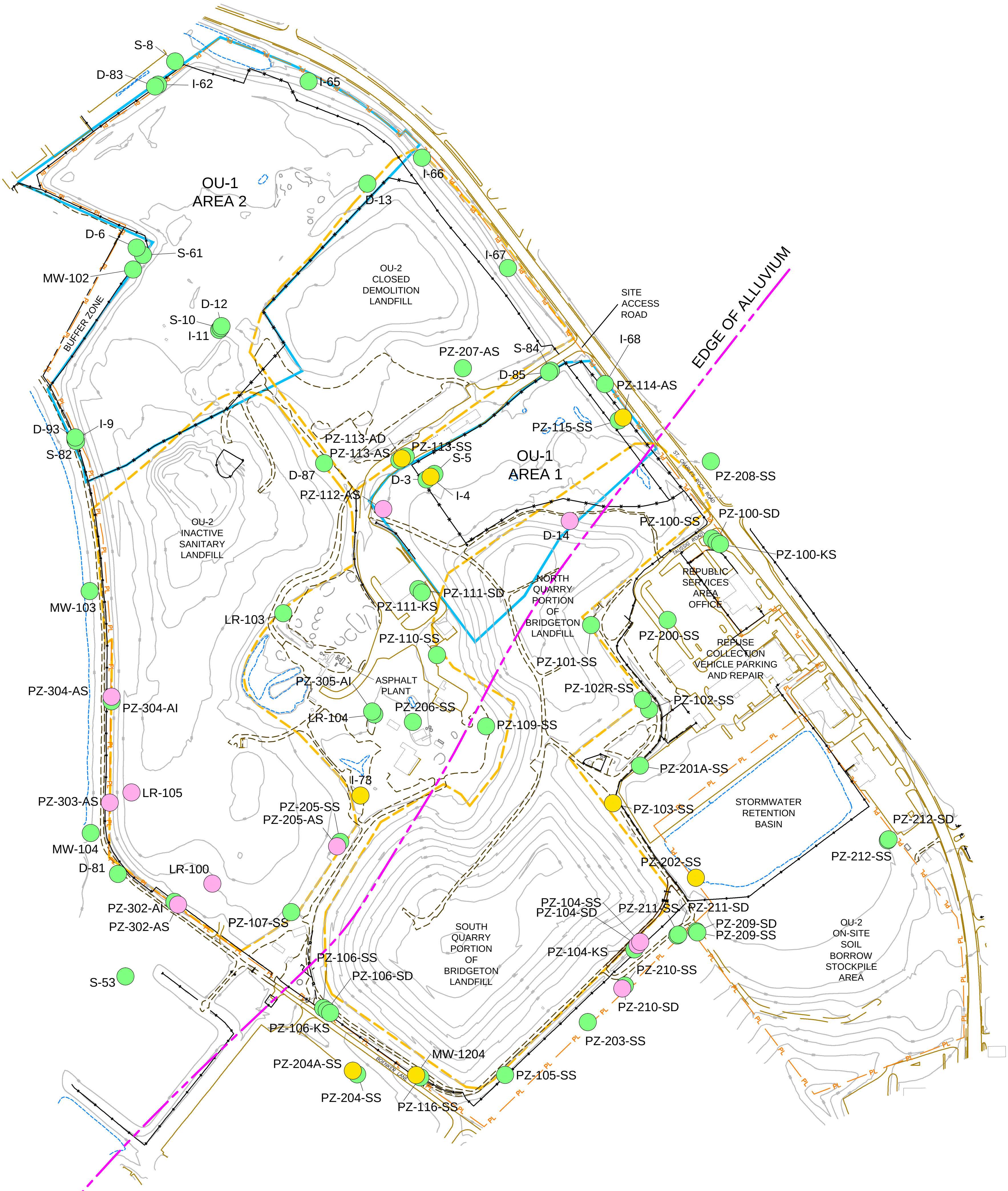
NORTH

0 250 500
SCALE IN FEET

Figure 2-17
Combined Dissolved Radium-226 + Dissolved Radium-228 in Groundwater, August 2012 Through February 2014

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.



LEGEND

- Operable Unit-1 Area
- Paved Road
- Unpaved Road

BENZENE EXPLANATION

- Benzene greater than the Maximum Contaminant Level of 5 $\mu g/L$ for Benzene (all sampling dates)
- Benzene greater than the Maximum Contaminant Level of 5 $\mu g/L$ for Benzene (at least one sampling data but not all sampling dates)
- Benzene less than the Maximum Contaminant Level of 5 $\mu g/L$ for Benzene (all sampling dates)

WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
SS: St. Louis Formation Well
SD: Salem Formation Well
KS: Keokuk Formation Well

DRAFT

NORTH

0 250 500
SCALE IN FEET

NOTES:

1. Horizontal Coordinates Based on State Plane Missouri East Zone NAD 27
2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

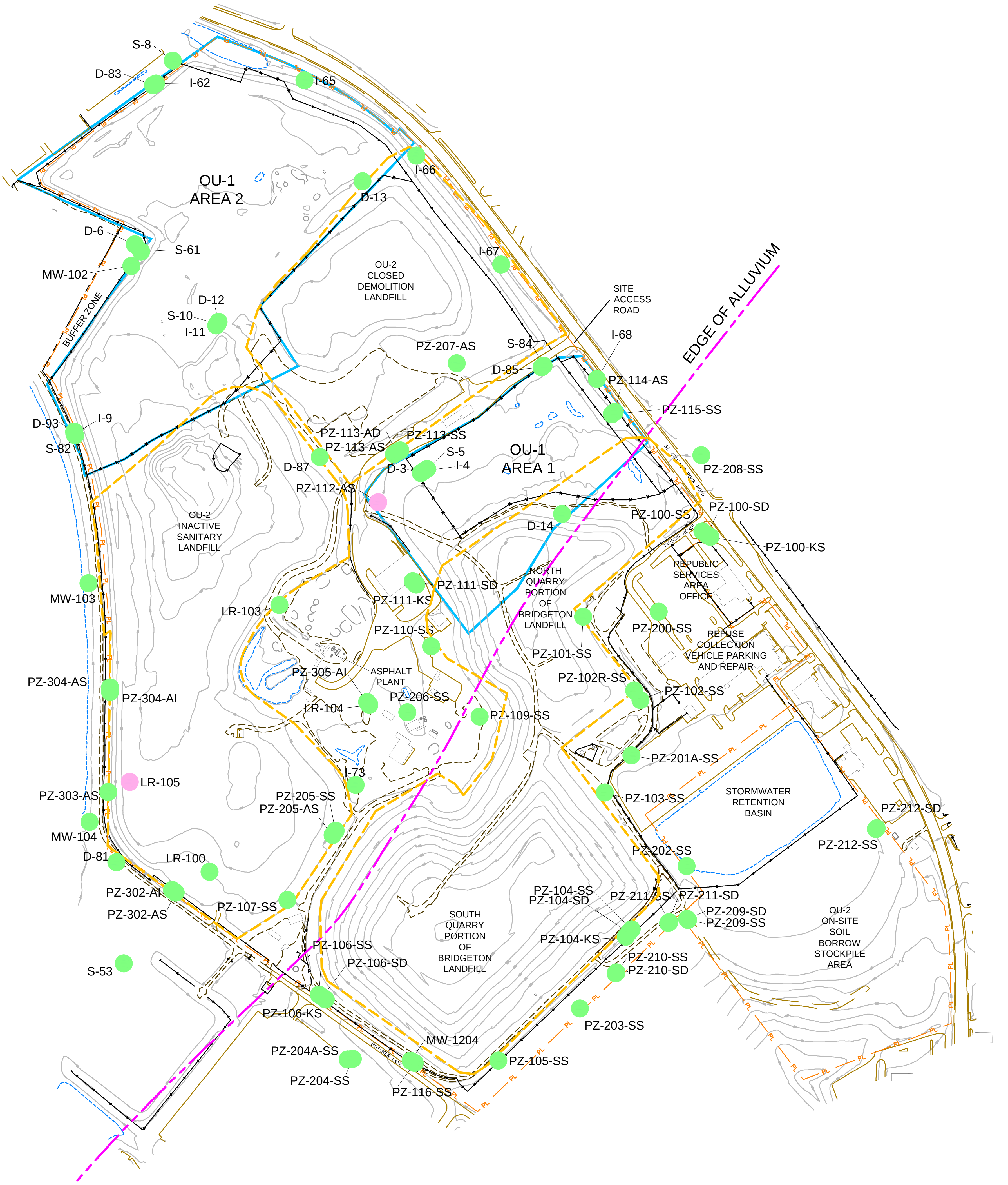
Figure 2-18

Benzene in Groundwater, August 2012 Through November 2013

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

M:\CLIENTS\EMSI\WESTLAKE\2016\FINAL-FS\SECTION-2\FIG-2-19-HIST-CHLOROBENZENE_PYG.DWG-WO-TOPO 09/30/2016 3:25PM



LEGEND

- Operable Unit-1 Area
- Paved Road
- Unpaved Road

CHLOROBENZENE EXPLANATION

- Total Chlorobenzene greater than the Maximum Contaminant Level of 100 $\mu g/L$ for Chlorobenzene (all sampling dates)
- Total Chlorobenzene greater than the Maximum Contaminant Level of 100 $\mu g/L$ for Chlorobenzene (at least one sampling data but not all sampling dates)
- Total Chlorobenzene less than the Maximum Contaminant Level of 100 $\mu g/L$ for Chlorobenzene (all sampling dates)

DRAFT

WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
SS: St. Louis Formation Well
SD: Salem Formation Well
KS: Keokuk Formation Well

NOTES:

1. Horizontal Coordinates Based on State Plane Missouri East Zone NAD 27
2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

NORTH

0 250 500
SCALE IN FEET

Figure 2-19

Chlorobenzene in Groundwater, August 2012 Through November 2013

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

M:\CLIENTS\EMSI\WESTLAKE\2016\FINAL-FS\SECTION-2\FIG-2-20-HIST-VINYL_PYG.DWG-WO-TOPO 09/30/2016 3:25PM

LEGEND

- Operable Unit-1 Area
- Paved Road
- Unpaved Road

VINYL CHLORIDE EXPLANATION

- Total Vinyl Chloride greater than the Maximum Contaminant Level of 2 $\mu g/L$ for Vinyl Chloride (all sampling dates)
- Total Vinyl Chloride greater than the Maximum Contaminant Level of 2 $\mu g/L$ for Vinyl Chloride (at least one sampling data but not all sampling dates)
- Total Vinyl Chloride less than the Maximum Contaminant Level of 2 $\mu g/L$ for Vinyl Chloride (all sampling dates)

DRAFT

WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
SS: St. Louis Formation Well
SD: Salem Formation Well
KS: Keokuk Formation Well

NOTES:

1. Horizontal Coordinates Based on State Plane Missouri East Zone NAD 27
2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

NORTH

0 250 500
SCALE IN FEET

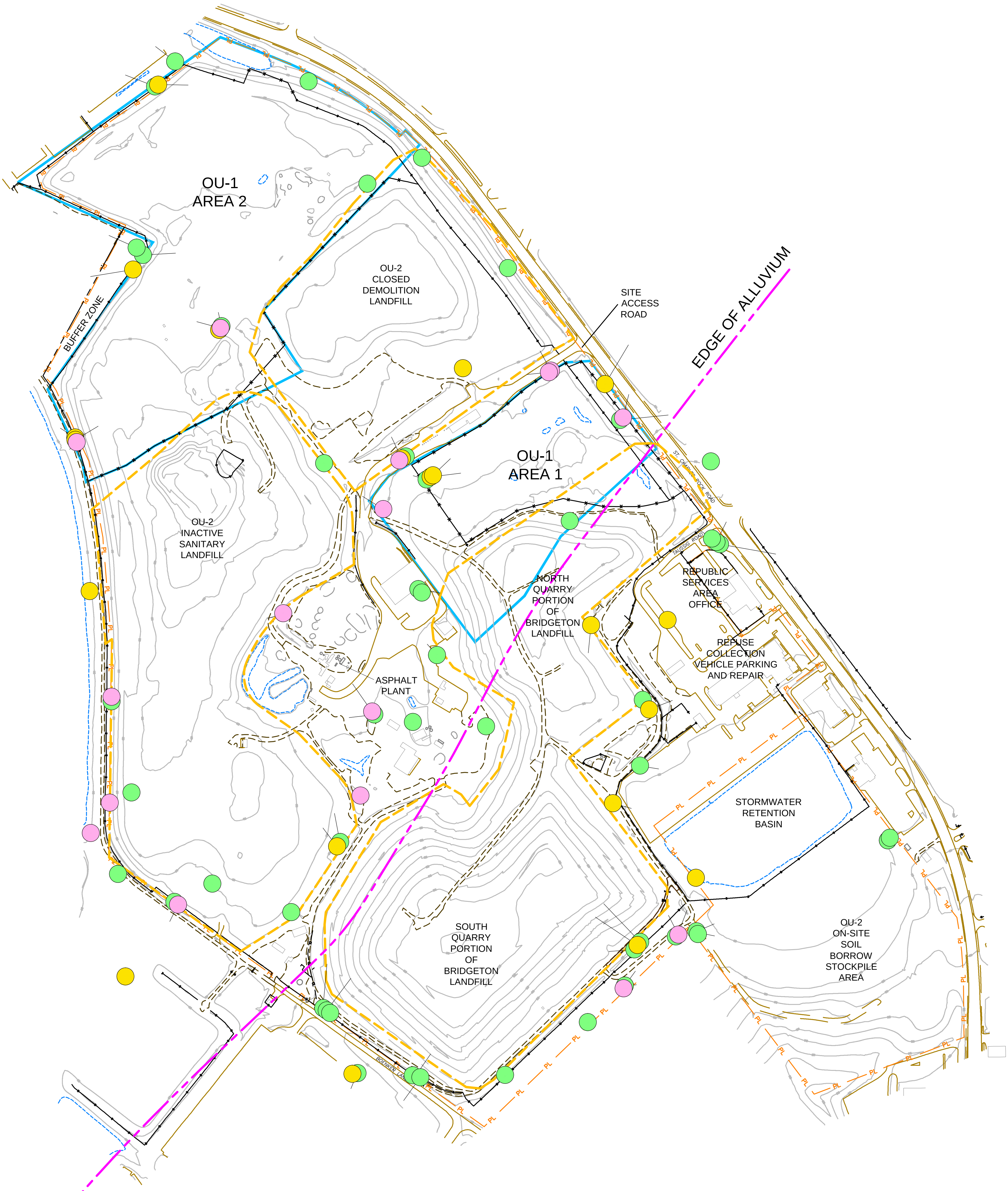
Figure 2-20

Vinyl Chloride in Groundwater, August 2012 Through November 2013

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

M:\CLIENTS\EMSI\WESTLAKE\2016\FINAL-FS\SECTION-2\FIG-2-21-HIST-ARSENIC_PYG.DWG-WO-TOPO 09/30/2016 3:24PM



ARSENIC EXPLANATION

- Total Arsenic greater than the Maximum Contaminant Level of 10 μg/L for Arsenic (all sampling dates)
- Total Arsenic greater than the Maximum Contaminant Level of 10 μg/L for Arsenic (at least one sampling data but not all sampling dates)
- Total Arsenic less than the Maximum Contaminant Level of 10 μg/L for Arsenic (all sampling dates)

LEGEND

- Operable Unit-1 Area
- Paved Road
- Unpaved Road

WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
SS: St. Louis Formation Well
SD: Salem Formation Well
KS: Keokuk Formation Well

DRAFT

NOTES:

1. Horizontal Coordinates Based on State Plane Missouri East Zone NAD 27
2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

NORTH

0 250 500
SCALE IN FEET

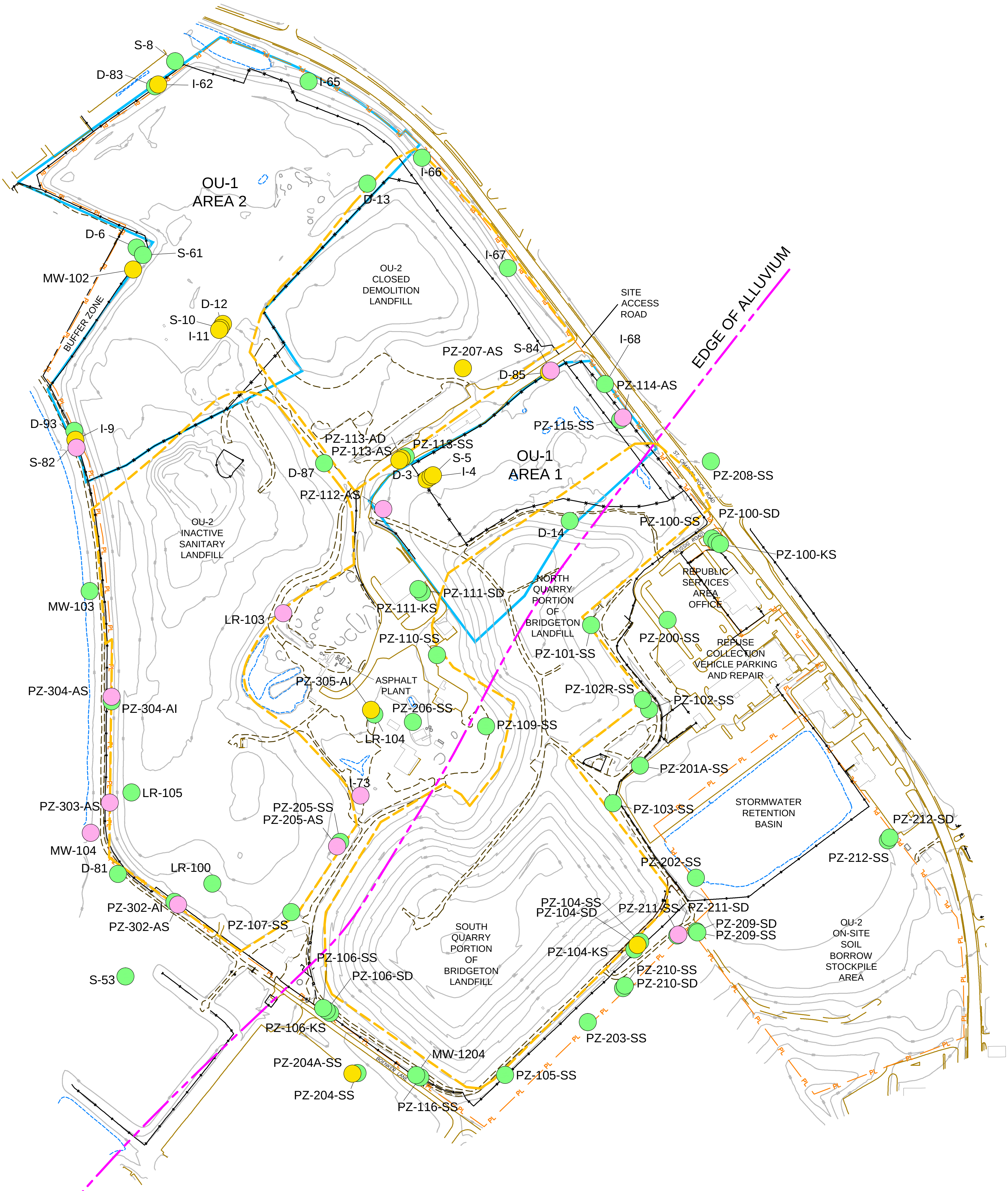
Figure 2-21

Total Arsenic in Groundwater, August 2012 Through November 2013

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

M:\CLIENTS\EMSI\WESTLAKE\2016\FINAL-FS\SECTION-2\FIG-2-22-HIST-DISS-ARSENIC_PYG.DWG-WO-TOPO 09/30/2016 3:23PM



ARSENIC EXPLANATION

- Dissolved Arsenic greater than the Maximum Contaminant Level of 10 *μg*/L for Arsenic (all sampling dates)
- Dissolved Arsenic greater than the Maximum Contaminant Level of 10 *μg*/L for Arsenic (at least one sampling data but not all sampling dates)
- Dissolved Arsenic less than the Maximum Contaminant Level of 10 *μg*/L for Arsenic (all sampling dates)

LEGEND

- Operable Unit-1 Area
- Paved Road
- Unpaved Road

DRAFT

WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
SS: St. Louis Formation Well
SD: Salem Formation Well
KS: Keokuk Formation Well

NOTES:

1. Horizontal Coordinates Based on State Plane Missouri East Zone NAD 27
2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

NORTH

0 250 500
SCALE IN FEET

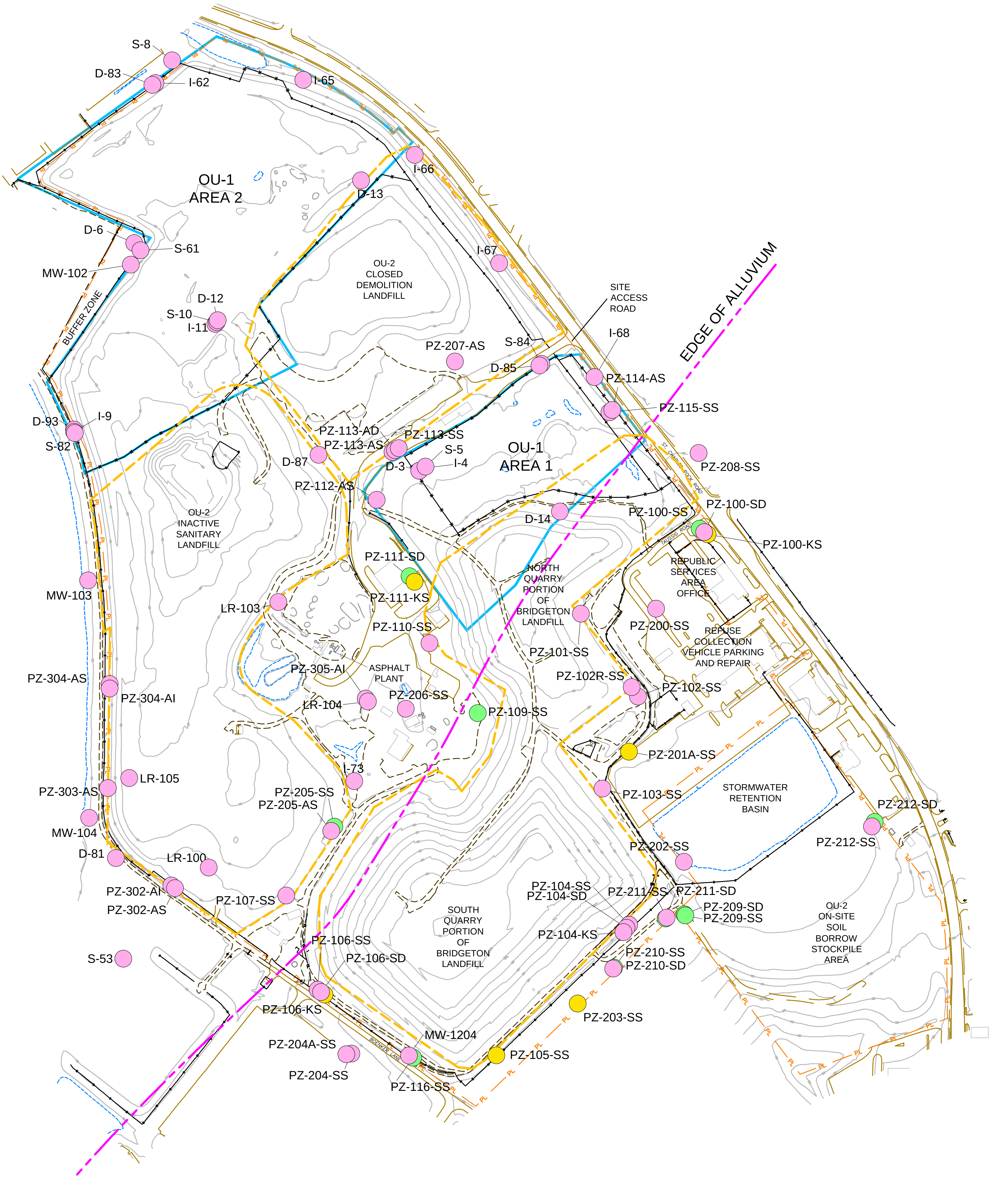
Figure 2-22

Dissolved Arsenic in Groundwater, August 2012 Through November 2013

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

M:\CLIENTS\EMSI\WESTLAKE\2016\FINAL-FS\SECTION-2\FIG-2-23-HIST-FE_PYG.DWG-WO-TOPO 09/30/2016 3:22PM



IRON EXPLANATION

- Total Iron greater than the Maximum Contaminant Level of 300 μg/L for Iron (all sampling dates)
- Total Iron greater than the Maximum Contaminant Level of 300 μg/L for Iron (at least one sampling data but not all sampling dates)
- Total Iron less than the Maximum Contaminant Level of 300 μg/L for Iron (all sampling dates)

LEGEND

- Operable Unit-1 Area
- Paved Road
- Unpaved Road

WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
SS: St. Louis Formation Well
SD: Salem Formation Well
KS: Keokuk Formation Well

DRAFT

NOTES:

1. Horizontal Coordinates Based on State Plane Missouri East Zone NAD 27
2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

NORTH

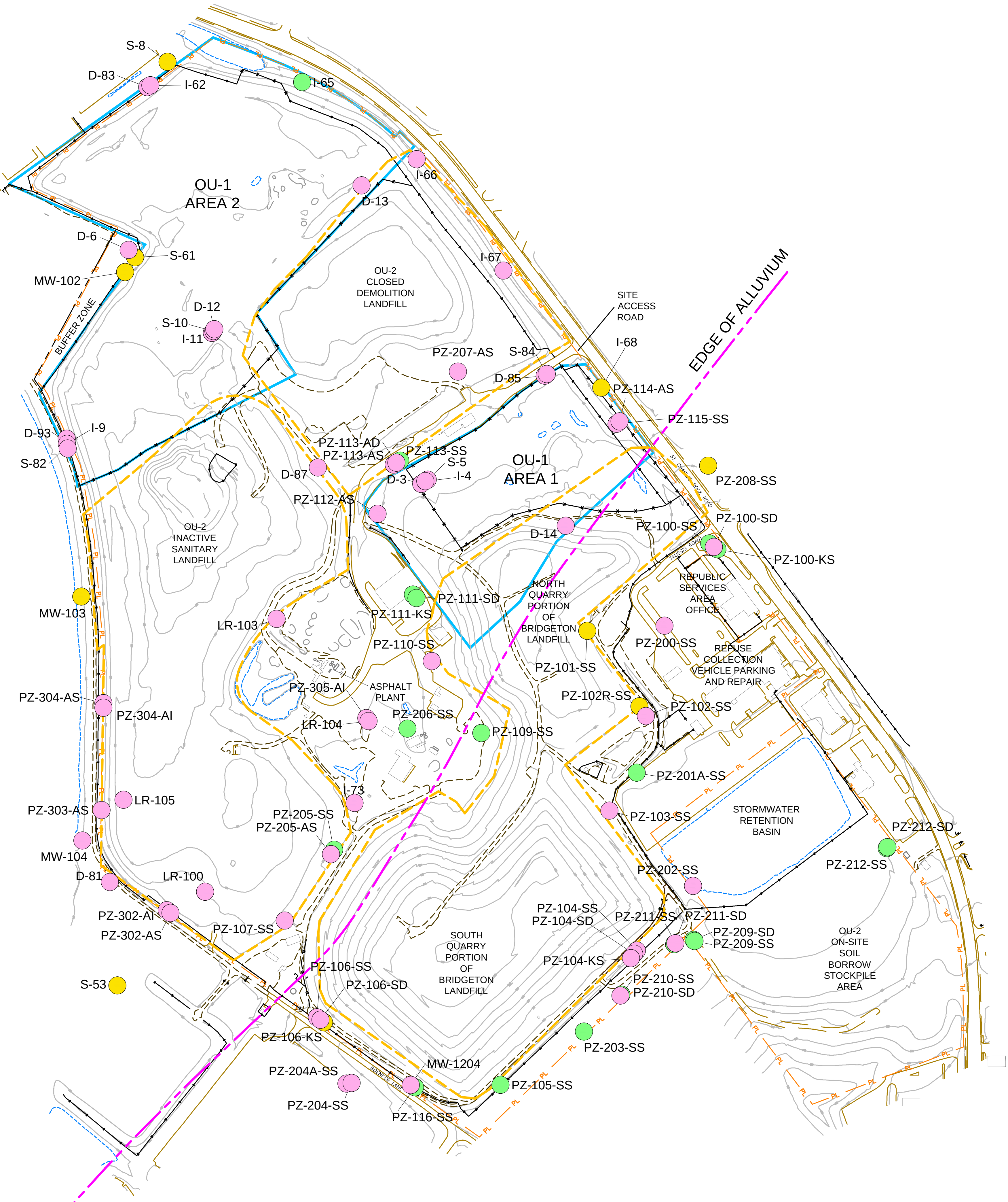
0 250 500
SCALE IN FEET

Figure 2-23

Total Iron in Groundwater,
August 2012 Through November 2013

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.



LEGEND

- Operable Unit-1 Area
- Paved Road
- Unpaved Road

IRON EXPLANATION

- Dissolved Iron greater than the Maximum Contaminant Level of 300 $\mu g/L$ for Iron (all sampling dates)
- Dissolved Iron greater than the Maximum Contaminant Level of 300 $\mu g/L$ for Iron (at least one sampling data but not all sampling dates)
- Dissolved Iron less than the Maximum Contaminant Level of 300 $\mu g/L$ for Iron (all sampling dates)

WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
SS: St. Louis Formation Well
SD: Salem Formation Well
KS: Keokuk Formation Well

DRAFT

NOTES:

1. Horizontal Coordinates Based on State Plane Missouri East Zone NAD 27
2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

NORTH

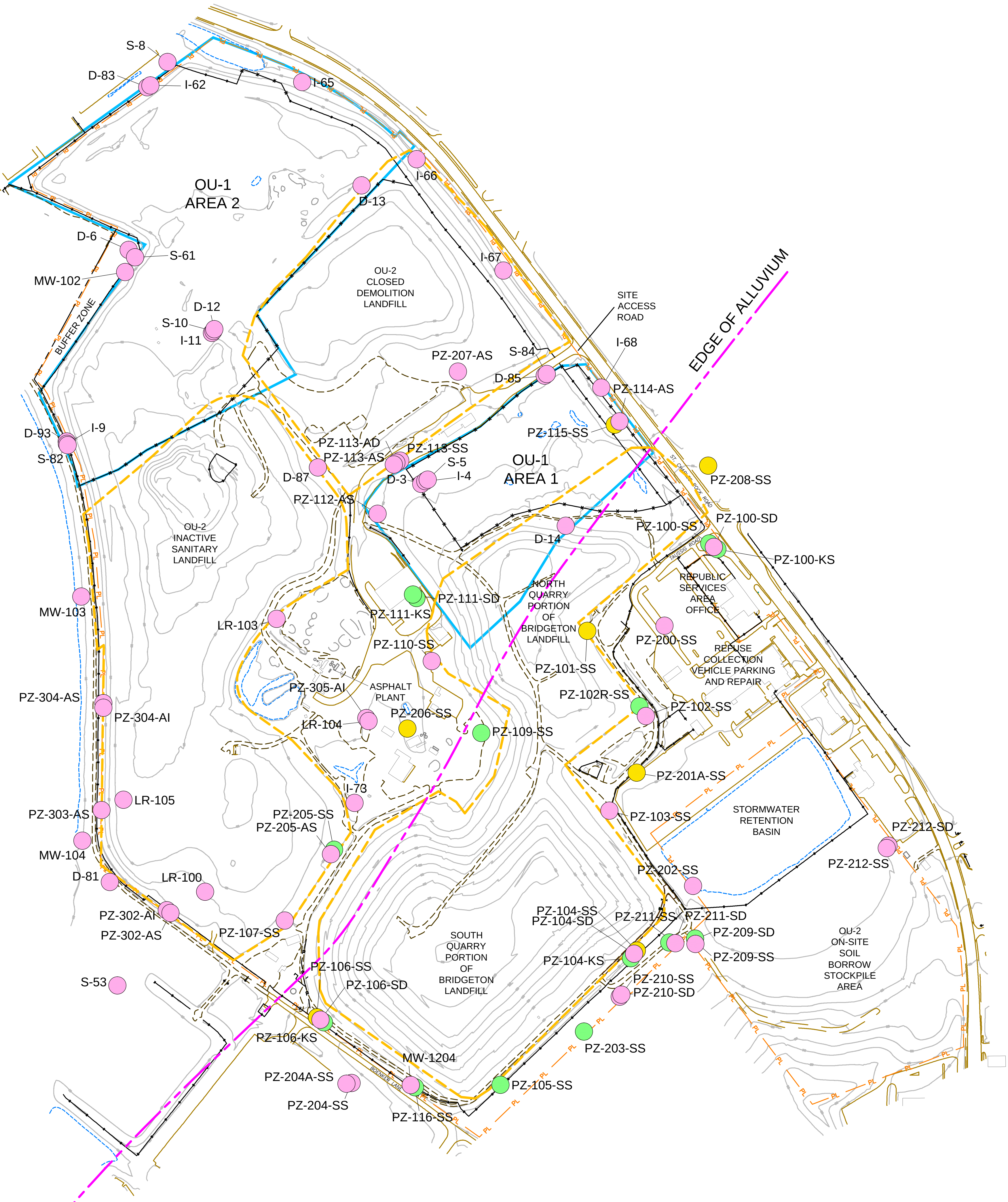
0 250 500
SCALE IN FEET

Figure 2-24

Dissolved Iron in Groundwater, August 2012 Through November 2013

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.



LEGEND

- Operable Unit-1 Area
- Paved Road
- Unpaved Road

MANGANESE EXPLANATION

- Total Manganese greater than the Maximum Contaminant Level of 50 $\mu g/L$ for Manganese (all sampling dates)
- Total Manganese greater than the Maximum Contaminant Level of 50 $\mu g/L$ for Manganese (at least one sampling data but not all sampling dates)
- Total Manganese less than the Maximum Contaminant Level of 50 $\mu g/L$ for Manganese (all sampling dates)

DRAFT

WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
SS: St. Louis Formation Well
SD: Salem Formation Well
KS: Keokuk Formation Well

NOTES:

1. Horizontal Coordinates Based on State Plane Missouri East Zone NAD 27
2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

NORTH

0 250 500
SCALE IN FEET

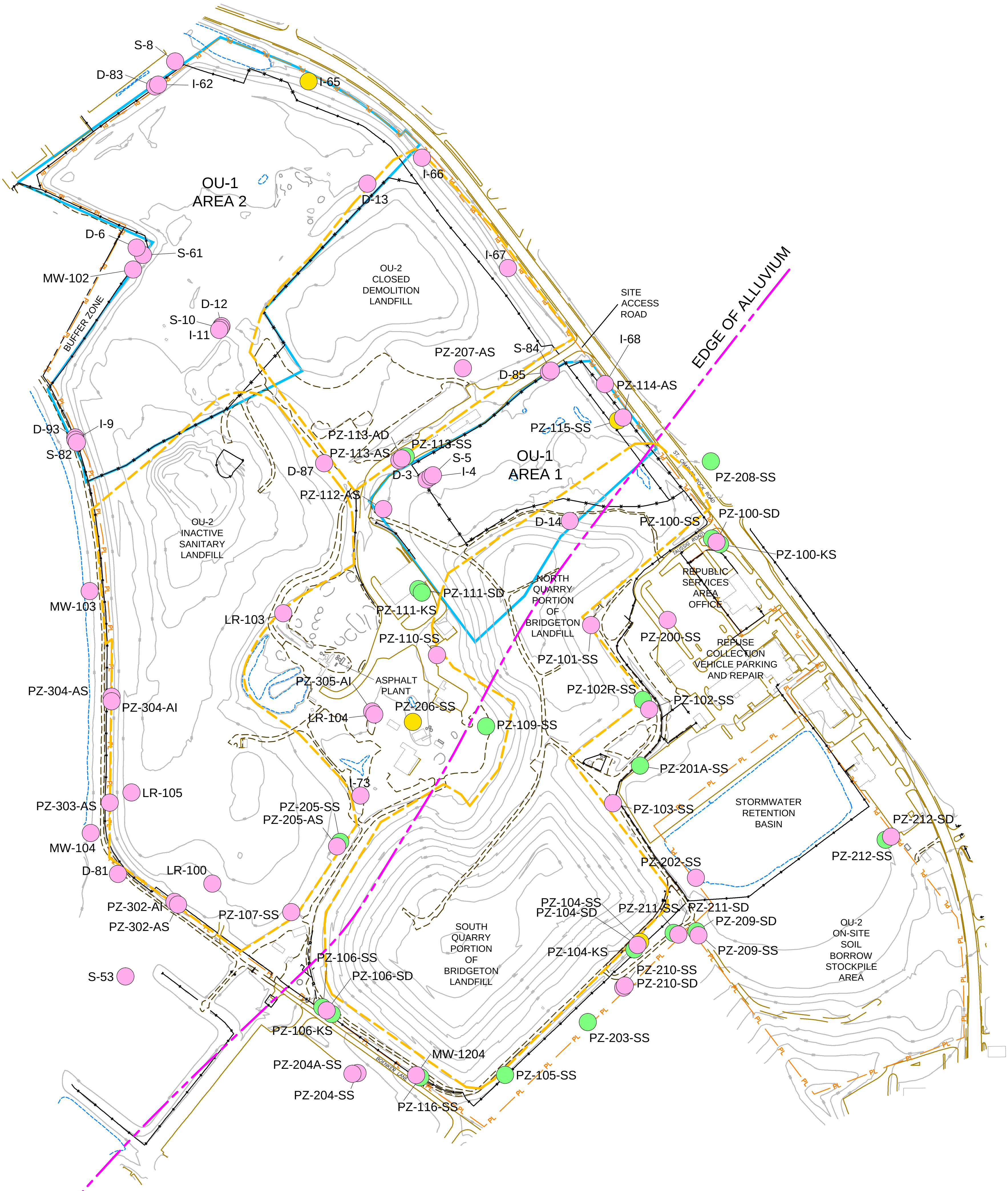
Figure 2-25

Total Manganese in Groundwater, August 2012 Through November 2013

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

M:\CLIENTS\EMSI\WESTLAKE\2016\FINAL-FS\SECTION-2\FIG-2-26-HIST-DISS-MANG_PYG.DWG-WO-TOPO 09/30/2016 3:20PM



LEGEND

- Operable Unit-1 Area
- Paved Road
- Unpaved Road

MANGANESE EXPLANATION

- Dissolved Manganese greater than the Maximum Contaminant Level of 50 $\mu g/L$ for Manganese (all sampling dates)
- Dissolved Manganese greater than the Maximum Contaminant Level of 50 $\mu g/L$ for Manganese (at least one sampling data but not all sampling dates)
- Dissolved Manganese less than the Maximum Contaminant Level of 50 $\mu g/L$ for Manganese (all sampling dates)

DRAFT

WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
SS: St. Louis Formation Well
SD: Salem Formation Well
KS: Keokuk Formation Well

NOTES:

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2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

NORTH

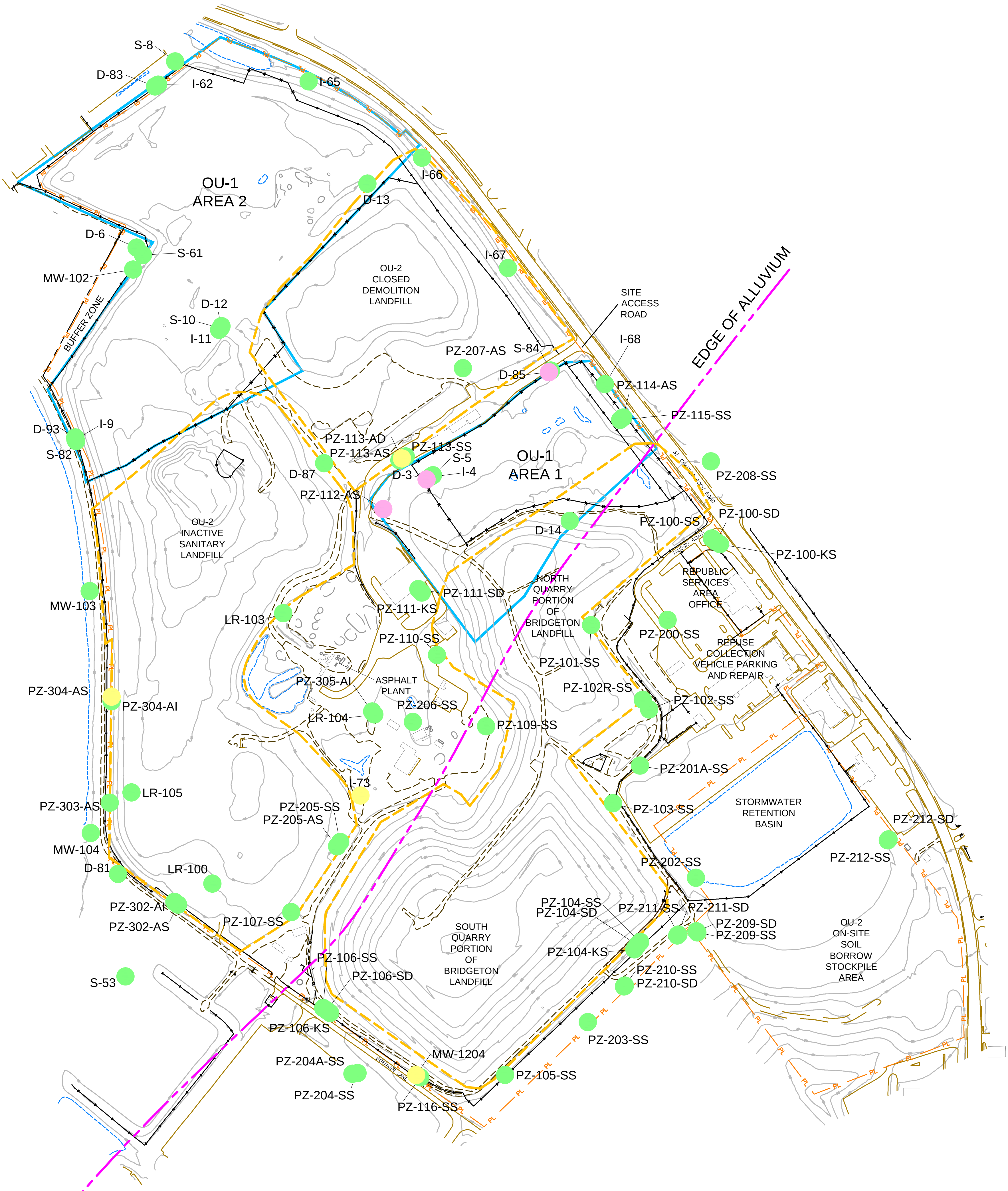
0 250 500
SCALE IN FEET

Figure 2-26

Dissolved Manganese in Groundwater, August 2012 Through November 2013

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.



BARIUM EXPLANATION

- Total Barium greater than the Maximum Contaminant Level of 2,000 $\mu g/L$ for Barium (all sampling dates)
- Total Barium greater than the Maximum Contaminant Level of 2,000 $\mu g/L$ for Barium (at least one sampling data but not all sampling dates)
- Total Barium less than the Maximum Contaminant Level of 2,000 $\mu g/L$ for Barium (all sampling dates)

LEGEND

- Operable Unit-1 Area
- Paved Road
- Unpaved Road

WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
SS: St. Louis Formation Well
SD: Salem Formation Well
KS: Keokuk Formation Well

DRAFT

NOTES:

1. Horizontal Coordinates Based on State Plane Missouri East Zone NAD 27
2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

NORTH

0 250 500
SCALE IN FEET

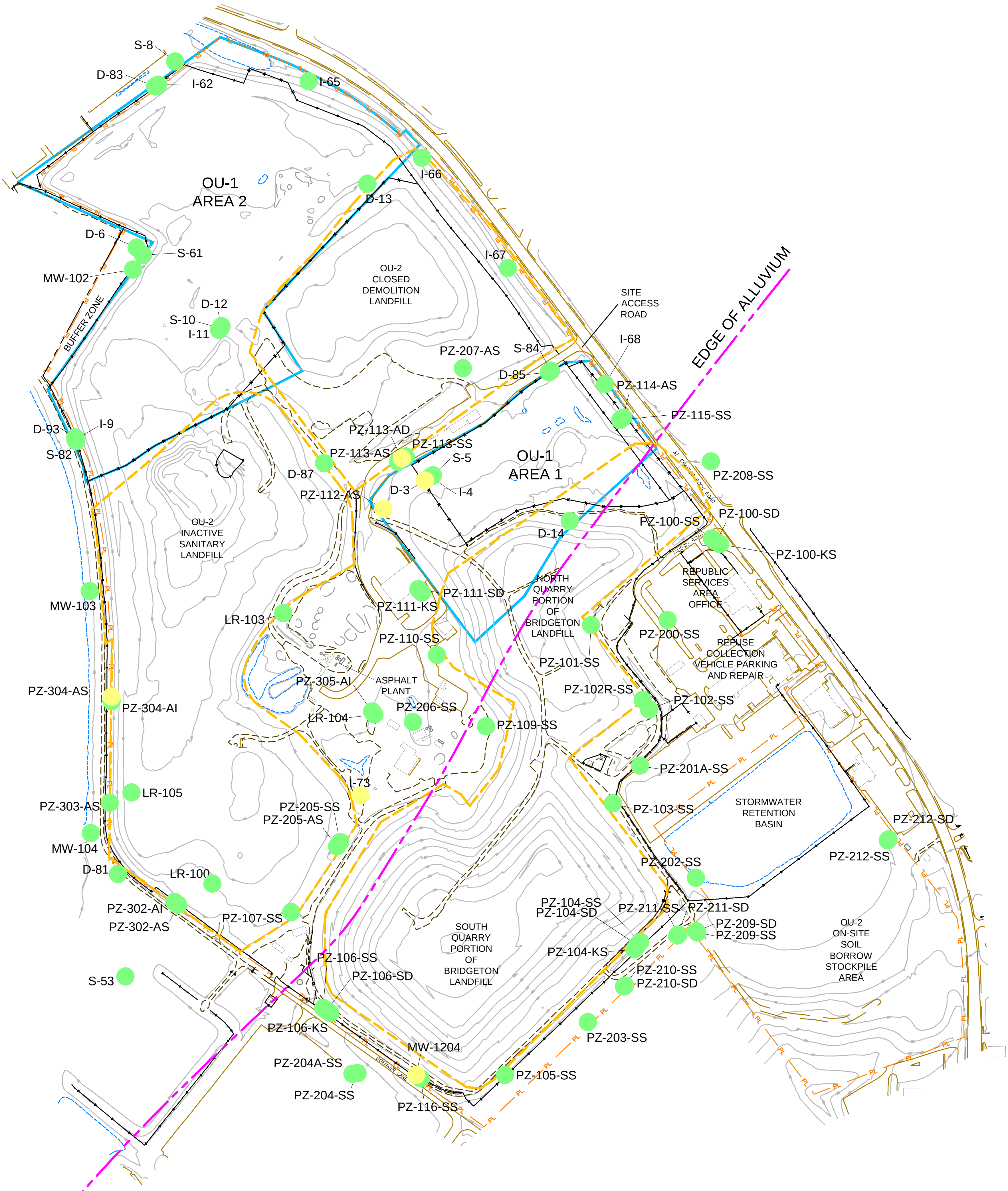
Figure 2-27

Total Barium in Groundwater,
August 2012 Through November 2013

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

M:\CLIENTS\EMSI\WESTLAKE\2016\FINAL-FS\SECTION-2\FIG-2-28-HIST-DISS-BARIUM_PYG.DWG-WO-TOPO 09/30/2016 3:19PM



BARIUM EXPLANATION

- Dissolved Barium greater than the Maximum Contaminant Level of 2,000 μg/L for Barium (all sampling dates)
- Dissolved Barium greater than the Maximum Contaminant Level of 2,000 μg/L for Barium (at least one sampling data but not all sampling dates)
- Dissolved Barium less than the Maximum Contaminant Level of 2,000 μg/L for Barium (all sampling dates)

LEGEND

- Operable Unit-1 Area
- Paved Road
- Unpaved Road

DRAFT

WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
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NOTES:

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3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

NORTH

0 250 500
SCALE IN FEET

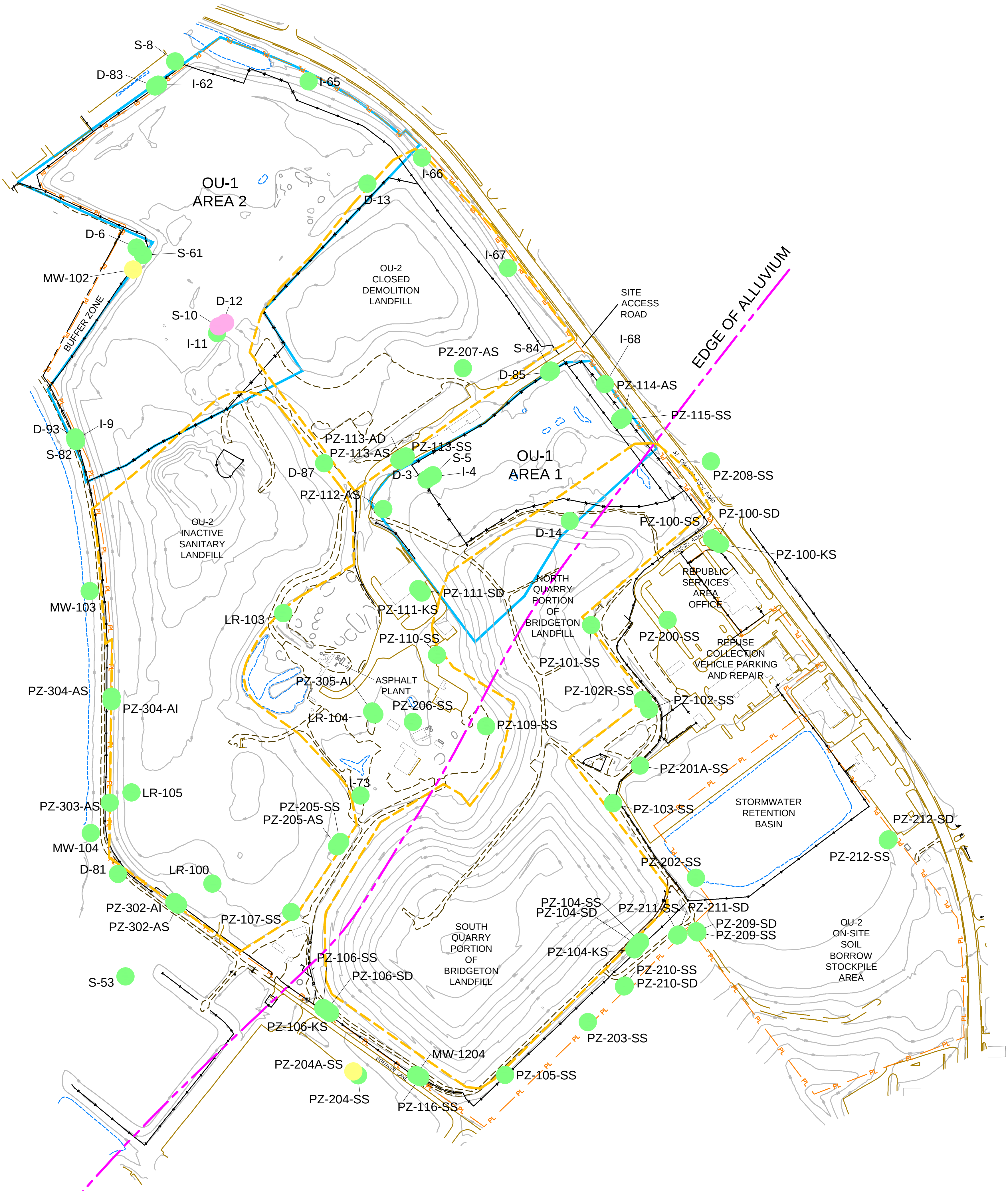
Figure 2-28

Dissolved Barium in Groundwater, August 2012 Through November 2013

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

M:\CLIENTS\EMSI\WESTLAKE\2016\FINAL-FS\SECTION-2\FIG-2-29-HIST-SULFATE_PYG.DWG-WO-TOPO 09/30/2016 3:18PM



SULFATE EXPLANATION

- Total Sulfate greater than the Maximum Contaminant Level of 250 mg/L for Sulfate (all sampling dates)
- Total Sulfate greater than the Maximum Contaminant Level of 250 mg/L for Sulfate (at least one sampling data but not all sampling dates)
- Total Sulfate less than the Maximum Contaminant Level of 250 mg/L for Sulfate (all sampling dates)

LEGEND

- Operable Unit-1 Area
- Paved Road
- Unpaved Road

DRAFT

WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
SS: St. Louis Formation Well
SD: Salem Formation Well
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NOTES:

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2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

NORTH

0 250 500
SCALE IN FEET

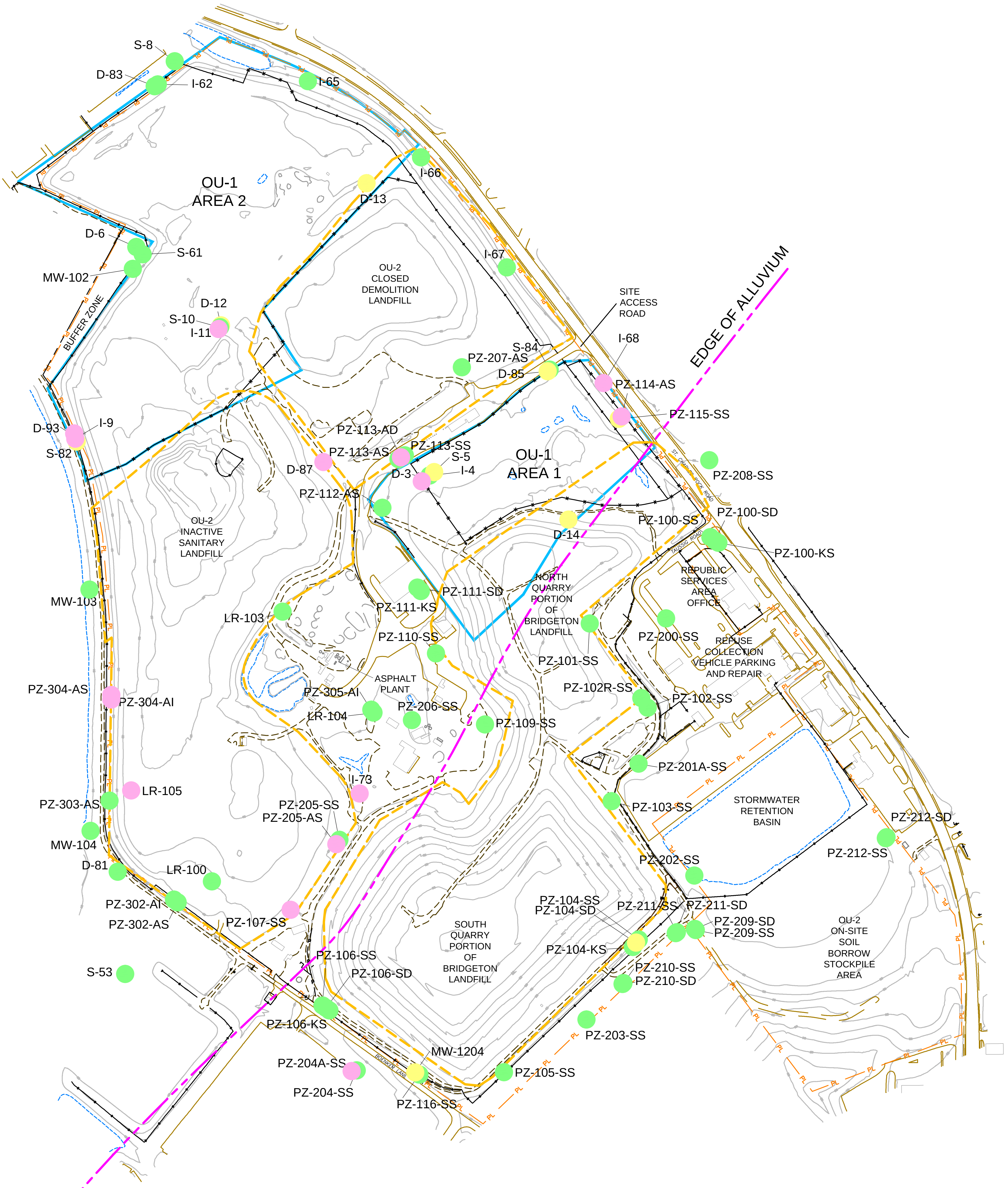
Figure 2-29

Sulfate in Groundwater, August 2012 Through November 2013

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

M:\CLIENTS\EMSI\WESTLAKE\2016\FINAL-FS\SECTION-2\FIG-2-30-HIST-CHLORIDE_PYG.DWG-WO-TOPO 09/30/2016 5:44PM



LEGEND

- Operable Unit-1 Area
- Paved Road
- Unpaved Road

CHLORIDE EXPLANATION

- Chloride greater than the Maximum Contaminant Level of 250 mg/L for Chloride (all sampling dates)
- Chloride greater than the Maximum Contaminant Level of 250 mg/L for Chloride (at least one sampling data but not all sampling dates)
- Chloride less than the Maximum Contaminant Level of 250 mg/L for Chlorobenzene (all sampling dates)

DRAFT

WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
SS: St. Louis Formation Well
SD: Salem Formation Well
KS: Keokuk Formation Well

NOTES:

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2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

NORTH

0 250 500
SCALE IN FEET

Figure 2-30

Chloride in Groundwater,
August 2012 Through November 2013

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	IMPLEMENTABILITY SCREENING COMMENTS
No Action	See Figure 4-1 in FS (EMSI, 2006)			
Institutional Controls[1]	See Figure 4-1 in FS (EMSI, 2006)			
Monitoring	Long-term performance monitoring	Groundwater, surface water, sediment, landfill gas, and radon gas monitoring	Monitoring to evaluate site conditions over time and/or remedial action performance.	Potentially applicable.
	Short-term monitoring during construction	Perimeter environmental media air monitoring	Monitoring station contains low volume air sampler to collect airborne particulates and organic vapor samples for analysis of VOCs and radionuclide activity; continuous radon monitor; and radiation dosimeter. Data to be collected pre-, during, and post-remedial action.	Potentially applicable. Would be required during construction of any remedy to monitor doses, activities, and concentrations at the fenceline and areas where workers will frequent, to assure that non-remediation workers present in other portions of the landfill site are not exposed, and to assure that remediation workers are not exposed to unnecessary radiation exposure.
		Work zone monitoring	Site workers would participate in medical and dosimetry monitoring programs. Breathing zone samplers might be assigned to selected workers to evaluate intake of airborne particulates and radon. Equipment and workers leaving radiologically-controlled area will be surveyed and decontaminated, if necessary.	Potentially applicable. Would be required during construction of any remedy.
		Excavation guidance/ clearance monitoring	Use of walkover field radiological survey equipment and solids sampling to identify impacted materials above cleanup levels to guide excavation equipment. Final walkover radiological scans of exposed faces and base of excavated areas and sampling of soil/trash at base of excavation to document that RIM have been removed.	Potentially applicable. Would be required during construction of any remedy if RIM were to be relocated.
		Waste acceptance monitoring	If excavated RIM were to be disposed off-site, each load of material removed from the site would be scanned to ensure that the radiological Waste Acceptance Criteria of the facility where the RIM would disposed would be met.	Potentially applicable. Would be required if RIM is to be disposed off-site.
		Post cover construction radon flux monitoring	Use of Large Area Activated Charcoal Canisters (LAACCs) to measure radon flux of the cover surface after construction is complete.	Potentially applicable. Would be required during construction of any remedy if radionuclides remain under the cover.

[1] Indicates that General Response Action or remedial technology is component of presumptive remedy for CERCLA municipal landfill sites (USEPA, 1993)

[2] Treatment technology or remedial technology specified in Technology Reference Guide for Radioactively Contaminated Media, EPA 402-R-07-004, October 2007.

(hatched box) Technology and/or Process Option screened out on the basis of technical implementability.

Figure 4-1
Technical Implementability Screening of Remediation Technologies and Process Options
West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	IMPLEMENTABILITY SCREENING COMMENTS
Containment	See Figure 4-1 in FS (EMSI, 2006) for Surface Controls/Diversions, Surface Water/Sediment Control/Barriers, and Dust Controls			
	Capping and Covers[1,2]	Soil, clay, and vegetation; asphalt or concrete; synthetic membrane material; and multilayer, multimedia material	Capping can limit contaminant mobility and mitigate potential migration via air, surface water, and groundwater by attenuating radon emissions and controlling particulate resuspension, storm water run-on and runoff, and precipitation-enhanced percolation and leaching. These processes can be implemented with conventional equipment.	Potentially applicable.
	Land Encapsulation[2]	On-site: New Cell[2]	New cell would be constructed in area of the site outside geomorphic flood plain. Cell would consist of engineered liner and a final cover consistent with both MDNR solid waste regulations and UMTRCA requirements.	EPA requested that a new on-site cell be evaluated in the SFS (EMSI, 2011) but is not requiring its consideration in the FFS.
		Off-site Licensed Facility[2]	This option would involve incorporation of removed material at an existing acceptable permitted commercial disposal facility. Land based disposal can reduce the mobility of contaminated material and mitigate potential exposures and migration by controlling the contaminant source. In addition to engineering requirements, constraints include issues such as transportation routes and risks, costs for off-site disposal and regulatory community acceptance.	EPA has requested that this be evaluated as potentially applicable. Waste Acceptance Criteria of disposal facility must be met for all material prior to the material being transported. Wastes hauled offsite to an offsite licensed facility must be shipped in appropriate containers and USDOT requirements for shipping must be met.
	Cryogenic Barriers[2]	Subsurface Cryogenic Barrier[2]	Provides containment and reduces the mobility of radionuclide contaminants by freezing contaminated subsurface soils to create an ice barrier around a contaminated zone. Rows of freeze pipes are inserted in an array outside and beneath the contaminated zone and the array of pipes connected to a refrigeration plant. Coolants typically consist of salt water, propylene glycol or calcium chloride.	Soil moisture content of 14 to 18% is considered optimal. Thorough subsurface characterization including identification of all subsurface structures is needed for proper design. Because containment by other barrier methods such as slurry walls and grout curtains becomes more cost effective after 8 or 9 years of operation, cryogenic barriers might be more applicable to containment of short-lived radionuclides such as tritium. Large volume of RIM in several areas would need to be refrigerated and soils containing radionuclides are comingled with municipal solid waste and construction debris. Consequently, this option was eliminated from further consideration.

MATCH A

[1] Indicates that General Response Action or remedial technology is component of presumptive remedy for CERCLA municipal landfill sites (USEPA, 1993)

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(hatched box) Technology and/or Process Option screened out on the basis of technical implementability.

Figure 4-1
Technical Implementability Screening of Remediation Technologies and Process Options
West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

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GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	IMPLEMENTABILITY SCREENING COMMENTS
MATCH A				
Containment	Vertical Barriers[2]	Slurry Wall[2]	Mixture of soil and bentonite is used to construct a low conductivity wall that is typically keyed-into bedrock or an impermeable hydrostratigraphic layer. Wall is normally installed by introducing bentonite slurry into a trench as the trench is excavated to hydraulically shore the trench to prevent collapse. Soil from the excavation is mixed above ground with bentonite and the mixture is placed back into the trench, displacing the slurry.	Would be difficult to implement in landfill containing municipal solid waste and construction and demolition debris. Consequently, this option was eliminated from further consideration.
		Grout curtain[2]	Grout is injected into the natural formation in-situ to fill interstitial void spaces and significantly reduce the hydraulic conductivity of the soil, forming a vertical barrier to groundwater flow.	Only applicable to low permeable zones. Would be difficult to implement in landfill containing municipal solid waste and construction and demolition debris. Consequently, this option was eliminated from further consideration.
		Sheet Pile Cutoff Wall[2]	Sheet piling barriers are constructed by driving individual sections of interlocking steel sheets into the ground using impact or vibratory hammers to form an impermeable barrier. Joints between individual sheet piles can be filled with grout to provide a better seal.	Would be difficult to implement in landfill containing municipal solid waste and construction and demolition debris. Consequently, this option was eliminated from further consideration.
Physical/Chemical Treatment	Solidification/ Stabilization[2]	Cement Solidification/ Stabilization[2]	The cement solidification/stabilization process involves the addition of agents including Portland cement, gypsum and pozzolanic-based materials such as fly ash, blast furnace slag, kiln dust, and pumice with a waste to form a densified and hardened soil mass that limits the solubility or mobility of the waste constituents. It is conducted either in-situ by injecting a cement-based agent into the contaminated materials or ex-situ by excavating the materials, machine-mixing them with a cement-based agent, and depositing the solidified mass in a designated area. Is best suited to fine-grained soil with small pores.	Potentially applicable for use at an off-site licensed disposal facility if hazardous wastes are encountered that need to undergo solidification/stabilization or encapsulation at the off-site facility prior to disposal.
		Chemical Solidification/ Stabilization[2]	Similar to cement solidification/stabilization except agents include thermoplastic polymers, thermosetting polymers, and other proprietary additives. Is best suited to highly porous, coarse-grained, low-level radioactive waste in permeable matrices.	Potentially applicable for use at an off-site licensed disposal facility if hazardous wastes are encountered that need to undergo solidification/stabilization or encapsulation at the off-site facility prior to disposal.
MATCH B				

[1] Indicates that General Response Action or remedial technology is component of presumptive remedy for CERCLA municipal landfill sites (USEPA, 1993)

[2] Treatment technology or remedial technology specified in Technology Reference Guide for Radioactively Contaminated Media, EPA 402-R-07-004, October 2007.

(hatched box) Technology and/or Process Option screened out on the basis of technical implementability.

Figure 4-1
Technical Implementability Screening of Remediation Technologies and Process Options
West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

MATCH B

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	IMPLEMENTABILITY SCREENING COMMENTS
Physical/Chemical Treatment	Chemical Separation[2] (screened out)	Solvent/Chemical Extraction[2] (screened out)	An ex-situ chemical separation technology that separates hazardous contaminants from soils, sludges, and sediments using solvent/chemical extraction to reduce the volume of waste that must be subsequently treated or disposed. Solvents that have been used to remove radionuclide contaminants include complexing agents such as EDTA; inorganic salts; organic solvents; and sulfuric, hydrochloric, and nitric mineral acids. When contaminants have been sufficiently extracted, solvent is separated from the soil and distilled or removed by precipitation. Distilled vapor consists of relatively pure solvent that is recycled into the extraction process. The liquid residue containing concentrated contaminants undergoes further treatment or disposal. If multiple radionuclides or metals are targeted for removal, multiple solvent extraction steps may be required using multiple solvents.	To be considered for potential removal of radionuclides from the soil component of the RIM, would require pilot-testing of a dry soil separation technology to remove comingled municipal solid waste and debris greater than 2.4 inches in diameter to obtain representative soil samples for bench- and pilot-testing. Since multiple radionuclides would be targeted for removal, multiple solvent extraction steps would be required using multiple solvents, each requiring treatability testing. Removal percentages cited in the literature for uranium, radium-226, and thorium-232 would not meet the criteria that would allow for unrestricted use. Consequently, this option was eliminated from further consideration.
	Physical Separation[2]	Dry Soil Separation[2]	Dry soil separation involves screening and sieving soils to separate finer fractions, such as silt and clay, from coarser fractions of the soil. Since contaminants tend to bind to the fine fraction of a soil, the purpose of solids separation processes is to concentrate the contaminants to a smaller volume of soil that would subsequently be treated or disposed. Large debris would be removed and rocks, concrete, and asphalt would be crushed before fixed, vibrating, or rotation (trommel) screening. The segmented gate technology uses conveyor belts and gamma radiation detectors to separate dry materials. Shredders may be employed prior to screening.	Data are not available to assess potential effectiveness, implementability or cost at this time. Full-scale pilot testing would be required using representative material from Areas 1 and/or 2 to assess the degree to which the radiologically-impacted soil fraction of RIM can be separated from the overall matrix of landfilled refuse, debris and fill materials, and unimpacted soil and quarry spoils. Potentially applicable for reducing the volume of RIM that needs to be addressed under the "complete rad removal" and partial excavtion alternatives if results of pilot-testing indicate that the separated non-soil fraction of RIM does not exhibit radionuclide concentrations exceeding the EPA - specified activity levels for the "complete rad removal" and partial excavation alternatives. It may be difficult to identify soil with a thorium-230 concentration that would allow for unrestricted use using gamma radiation detectors. Worker exposures, dust creation, and bird nuisance potential would increase.
		Soil Washing[2] (screened out)	A process in which water, with or without surfactants, is mixed with contaminated soil and debris to produce a slurry feed that is scrubbed to remove contaminated fine soil particles (silts and clays) from granular soil particles. Clean soil (sands and gravels) is returned to the excavation area, while remaining smaller volume of contaminated soil fines and process water are further treated and/or disposed.	Despite many bench- and pilot-scale tests, soil washing has not been fully demonstrated as a technology for reducing the volume of radionuclide-contaminated soil. Consequently, this option was eliminated from further consideration.

MATCH C

MATCH C

[1] Indicates that General Response Action or remedial technology is component of presumptive remedy for CERCLA municipal landfill sites (USEPA, 1993)

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(Hatched box) Technology and/or Process Option screened out on the basis of technical implementability.

Figure 4-1
Technical Implementability Screening of Remediation Technologies and Process Options
West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

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GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	IMPLEMENTABILITY SCREENING COMMENTS
MATCH C	MATCH C			
Physical/Chemical Treatment	Physical Separation[2]	Flotation[2]	Radionuclide-contaminated soil is pretreated to remove coarse material and separated fine silt and clay soil particles are mixed with water to form a slurry. Flotation agent is added to the slurry. Small air bubbles passed upward through the slurry adhere to the floating particles, transport them to the surface, producing a foam containing the radionuclide-contaminated soil particles that is mechanically skimmed from the surface and further treated in a subsequent process to remove the radionuclides.	Flotation is most effective at separating soil particles in the very fine 0.0004 to 0.004 inch size range. For soils that include a wider range of particle sizes, flotation would need to be combined with other treatment processes. Has been employed extensively in the mining industry to segregate metal-containing fines, but has not been fully demonstrated for reducing the volume of radionuclide-contaminated soil. Consequently, this option was eliminated from further consideration.
	Virtrification[2]	In-situ Vitrification[2]	Vitrification involves heating contaminated media to extremely high temperatures, then cooling to form a dense, glassified solid mass, trapping and greatly reducing the mobility of radioactive contaminants. In-situ vitrification uses a square array of 4 graphite electrodes that allows a melt width of approximately 20 to 40 ft; the array is lowered progressively, as the melt grows, to the desired treatment depth. Offgas treatment may be required, depending on the amount/types of organics and metals that may volatilize.	Void volumes and percentages of metals, rubble, and combustible organics (e.g., methane in landfill gas) in contaminated media need to be considered - soils and waste containing greater than 55% inorganic debris and/or rubble are difficult to treat. Should not be used on contaminated soils with organic contents higher than 10%. Soils should have greater that 30% glass-forming materials (i.e., SiO2) to effectively immobilize radionuclides. RIM volume not expected to have greater than 30% glass-forming materials. Consequently, this option was eliminated from further consideration.
		Ex-situ Vitrification[2]	In the ex-situ vitrification configuration, waste is fed to a furnace (e.g., joule-process heating; plasma; electric arc; microwave; and coal-, gas-, or oil-fired cyclone furnace) on either a batch or continuous feed basis.	Not retained, see in-situ vitrification.
	Apatite/Phosphate Based Treatment	Mixing/Injection of crystalline minerals with wastes or groundwater	In an isomorphous mineral, such as apatite, certain ions or molecules can enter and be incorporated into the crystal-lattice of a mineral solid without causing any marked change in the crystal morphology or other physical properties of the mineral. Apatite or other phosphate-based materials or solutions would be added to the solid phase materials or to groundwater containing radionuclides in sufficient quantities and under appropriate geochemical conditions necessary to promote apatite crystallization, potentially resulting in incorporation of Site-related radionuclides such as thorium, radium and uranium into the apatite crystals. Incorporation of radionuclides into the crystalline matrix would reduce the potential for leaching of such radionuclides.	There is no demonstrated application of use of apatite and/or other phosphate-based materials for treatment to MSW. Uncertainty whether apatite solids or solutions could be delivered and homogeneously distributed within an overall heterogeneous matrix of MSW. Concerns about unintended consequences that could result from physical disturbance or modification of the geochemical conditions within the landfill from application of apatite based treatment technologies.

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(Hatched box) Technology and/or Process Option screened out on the basis of technical implementability.

Figure 4-1
Technical Implementability Screening of Remediation Technologies and Process Options
West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	IMPLEMENTABILITY SCREENING COMMENTS
Biological Treatment	Phytoremediation[2]	Phytoextraction[2]	Phytoextraction is the uptake of contaminants by plant roots and the translocation/accumulation of contaminants in plant shoots and leaves. Plants are subsequently harvested from the growing area, dried, and disposed. Will produce harvested biomass residual waste that will require further treatment and/or disposal. Based on bench and field-testing, most promising candidates for phytoextraction are cesium and strontium.	Treatment technology is limited to shallow soils and sediments. RIM in Areas 1 and 2 is present at depths greater than 20 feet and is comingled with municipal solid waste and construction debris. Will not be effective year-round because of limited growing season. Little full-scale operating experience and technology not effective for removal of uranium and thorium radionuclides. Consequently, this option was eliminated from further consideration.
		Phytostabilization[2]	Phytostabilization is the production of chemical compounds by plants to immobilize contaminants at the interface of roots and soil.	Treatment technology is limited to shallow soils and sediments. RIM in Areas 1 and 2 is present at depths greater than 20 feet and is comingled with municipal solid waste and construction debris. Will not be effective year-round because of limited growing season. Little full-scale operating experience. Technology not effective for removal of uranium and thorium radionuclides. Consequently, this option was eliminated from further consideration.
Removal	Excavation	Backhoe, bulldozer, scraper and front-end loader	Excavation can limit contaminant mobility and mitigate potential exposures at the affected area by removing the contaminant source. This technology can be implemented with conventional equipment.	Potentially applicable.
	Physical Separation	Dry Soil Separation	Since most contaminants tend to bind to the fine fraction of soils either chemically or physically, process involves screening and sieving soils to separate finer (silt and clay) fractions from coarser (sands and gravels) fractions of the soil. Separating the finer fraction of the soil can concentrate the contaminants to a smaller volume.	Because RIM at the Site occurs in soil that is intermixed with and interspersed within the overall matrix of landfilled refuse, debris, fill materials, and soil and quarry spoils, prior to a dry soil separation process being employed, the interstitial soil materials would need to be separated from the other landfilled materials using additional solids separation processes. Solids separation processes can include hand picking for large bulky items and hazardous materials such as propane tanks; magnetic separation for ferrous metals and contaminants associated with ferrous metals; eddy current separation for non-ferrous metals (*e.g.*, inducing an electric current to separate aluminum cans from other recyclables); air classification for papers and plastics; and various fixed, vibrating, or rotating screens. Concern that moist soil containing RIM could continue to adhere to landfilled materials after solids separation process(es).

MATCH D

MATCH D

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(hatched) Technology and/or Process Option screened out on the basis of technical implementability.

Figure 4-1
Technical Implementability Screening of Remediation Technologies and Process Options
West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

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GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	IMPLEMENTABILITY SCREENING COMMENTS
MATCH D	MATCH D			
Removal	Physical Separation	Rotating Screen - Trommel	Revolving cylindrical sieve (trommel) screens are commonly used during landfill mining and reclamation projects to separate materials by size, with the soil fraction passing through the screen. Metal conveyor flights on the inside surface of the screen direct the non-soil fraction to the discharge end of the rotating cylinder. Trommel screens are typically used downstream in series with a shear shredder to reduce volume fed to the trommel, break up pockets/clumps of organic and matted materials and soil, dislodge smaller materials that may be hidden in among larger materials, and pulverize materials such as brick and large chunks of concrete that contain rebar and to provide a stream of more uniformly-sized material such that fines and the soil fraction of the waste can be more easily separated.	Large landfilled objects such as white goods and steel beams need to be hand-picked from the waste stream prior to shear shredding. Would require full-scale pilot test at the Site during RD to assess whether the RIM soil can be separated from the overall matrix of landfilled refuse, debris, fill materials, and soil and quarry spoils. Non-soil MSW material (wire, rebar, plastics) can get jammed in the screen requiring personnel to enter the screen to remove the material, potentially increasing exposure to RIM. Concern that moist soil containing RIM could continue to adhere to landfilled materials after shear shredding and trommel screening. Therefore, potentially applicable to partial excavation alternatives; likely not applicable for complete rad removal alternative.
		Radiological Segregation/ Separation	Refinement of dry soil separation process using radiation detectors to further separate materials. Radionuclide-contaminated soil is first excavated and screened to remove large rocks and debris. Large rocks are crushed and placed with soil on a conveyor belt which carries the soil under radiation detectors that measure and record the level of radiation in the material. Radioactive batches of material on the conveyor belt are tracked and mechanically diverted through automated gates, which separate the soil into contaminated and clean segments.	Large debris needs to be removed before processing the soil and crushed rocks, concrete, or asphalt. Screening to size the feed material to a diameter of less than 0.5 inches is desirable; material greater than 1.5 inches cannot be processed without crushing. Optimal soil moisture content is between 5 and 15 percent. System is best suited to sort a dry matrix contaminated with no more than two radionuclides with different gamma energies that can be transported by conveyor belts. Since limited to gamma-emitting radionuclides; RIM with Th-230 restricts use. Therefore, potentially applicable to 1,000 pCi/gm criteria partial excavation alternative; likely not applicable for 52.9 pCi/gm criteria partial excavation and complete rad removal alternatives.
	Tranportation (hauling of waste material)	Truck	Includes off-road haul trucks that would move materials within a large construction or mining site; semi-trailer bottom-, end-, and side-dump trucks; standard dump; and transfer truck and pup vehicles for transporting loose material such as sand, gravel, asphalt, soil or waste materials on roads and highways.	Potentially applicable. If waste materials were to be transported to an off-site disposal facility, trucks can be used as the sole method of transportation to the facility, or alternatively to transfer materials to another transportation method such as rail. If hauled offsite, wastes with radionuclides must be placed in appropriate containers and USDOT requirements for shipping must be met.
MATCH E	MATCH E			

[1] Indicates that General Response Action or remedial technology is component of presumptive remedy for CERCLA municipal landfill sites (USEPA, 1993)

[2] Treatment technology or remedial technology specified in Technology Reference Guide for Radioactively Contaminated Media, EPA 402-R-07-004, October 2007.

(hatched box) Technology and/or Process Option screened out on the basis of technical implementability.

Figure 4-1
Technical Implementability Screening of Remediation Technologies and Process Options
West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	IMPLEMENTABILITY SCREENING COMMENTS
MATCH E	MATCH E			
Removal	Tranportation (hauling of waste material)	Rail	Bulk waste material is placed directly into 90-100 ton gondola rail cars if a rail spur is extended on-site; or a truck-to-rail transloading operation is used. Truck-to-rail involves loading of rail cars at a non-shared dedicated rail spur or siding. For loading of bulk material, a back-on transloading ramp is located perpendicular to the rail cars and end dump trucks discharge material into the gondolas after backing onto the ramp. After filling, covers are bolted onto the gondolas to keep the bulk material in-place in route to a disposal facility. Alternatively, end-dump truck trailers can be lined with IP-1 DOT bags, filled with bulk waste material, the bags "zippered" shut, and the bags dumped into a gondola car at the transloading ramp. Another transloading operation involves loading bulk waste material into intermodal containers, hauling the containers on a flat-bed truck to the truck-to-rail transloading station, and stacking multiple intermodal containers on a flat railcar for rail transportation to the disposal facility.	Potentially applicable. Wastes hauled offsite to an offsite licensed facility must be shipped in appropriate containers and USDOT requirements for shipping must be met. Would require lease of nearby rail spur and a truck-to-rail transloading facility as spur does not exist on-site. Extension of a rail spur on-site would be difficult to implement. Number of rail cars per day would be constrained by the length of spur and railroad switching limitations.
	Diposal	Off-site Disposal in licensed facility	This option would involve incorporation of removed material at an existing acceptable permitted commercial disposal facility. Waste must meet the Waste Acceptance Criteria (WAC) of the facility before being transported from the Site.	Currently only four facilities in US that potentially could accept RIM from the Site. Distances to facilities range from 520 to 1,600 miles, likely requiring transportation by rail. Since there is no rail spur at the Site, RIM would need to be trucked from the Site to a truck-to-rail transloading operation set-up at a leased rail spur location for loading onto railcars. Rail transport would require a dedicated fleet of railcars, subject to the switching frequency of the railroad serving the leased rail spur, and a continuous flow of RIM from the Site to the rail spur.
	Storm Water Management	Implement Best Management Practices to route runon around working areas.	Involves use of diversion ditches, earthern berms, culverts, sumps, and pumps if necessary.	Potentially applicable.
		Implement Best Management Practices to minimize waste exposure to direct precipitation.	Involves use of selective excavation, staging, daily soil cover, and tarps.	Potentially applicable.
MATCH F		MATCH F		

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West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

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MATCH F

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	IMPLEMENTABILITY SCREENING COMMENTS
Removal	Storm Water Management	Enclose excavation within temporary structure to minimize waste exposure to direct precipitation (screened out)	Involves use of rigid-frame structure with fabric roofing that can be constructed over the excavation area and moved as work progresses. Maximum width of available structures is 200 feet, but reasonable max width is 140 feet. Length is added in 15-foot segments and is unlimited. Frame height can accommodate arm-height of heavy equipment. Building ends can be open or equipped with access doors. Ventilation can be provided to remove landfill emissions, engine exhaust, and ambient heat. Structure can be segmented such that it can be partially disassembled, lifted by crane to a new location, and reassembled. Foundation must be supported with piers or grade beam. Structures are designed for flat or uniform grade not to exceed 6% along length. Foundation width (side-to-side) must be level, or beam leg height must be adjusted so building does not lean.	Not practical because surface topography of landfills undulates and slope exceeds 6% in some areas. Considerable regrading would be needed to accommodate foundation, exposing organic waste to precipitation. Width of RIM in Areas 1 and 2 plus layback for overburden ranges from 250 to 1,050 feet. Thus, structure would need to be moved several times, overlapping excavated and backfilled areas every time. Even if the available structures could be partially disassembled, relocated, and reassembled, sufficient foundation beams and/or piers would be required to support the new locations. That would necessitate over-excavating soils and trash and/or installing foundation piers on 15-foot centers through base of landfills. Overall timeframe for remediation would be lengthened. Consequently, this option was eliminated from further consideration.
		Implement Best Management Practices to collect, detain, treat, and release runoff.	Involves use of sumps, pumps, pipelines, lined impoundments or temporary storage tanks, outlet structures to regulate discharge rate to design storm flow, and flow and water quality monitoring. If treatment is necessary, conventional processes such as gravity precipitation and/or filtration may be used and NPDES permit or discharge to a POTW would be necessary.	Potentially applicable.
Nuisance Control Technologies	Bird Nuisance Mitigation	Implement Best Management Practices	Involves use of selective excavation techniques to minimize exposure of in-place waste, temporarily staging excavated waste in as small an area as practical, daily cover of waste material with soil or tarp, and rapid recovering of exposed waste whenever practicable.	Particularly applicable to landfill regrading projects.

MATCH G

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Figure 4-1
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GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	IMPLEMENTABILITY SCREENING COMMENTS
MATCH G	MATCH G			
Nuisance Control Technologies	Bird Nuisance Mitigation	Enclose excavation within temporary structure	Involves use of rigid-frame structure with fabric roofing that can be constructed over the excavation area and moved as work progresses. Maximum width of available structures is 200 feet, but reasonable max width is 140 feet. Length is added in 15-foot segments and is unlimited. Frame height can accommodate arm-height of heavy equipment. Building ends can be open or equipped with access doors, but if left open, birds will enter. Ventilation can be provided to remove landfill emissions, engine exhaust, and ambient heat. Structure can be segmented such that it can be partially disassembled, lifted by crane to a new location, and reassembled. Foundation must be supported with piers or grade beam. Structures are designed for flat or uniform grade not to exceed 6% along length. Foundation width (side-to-side) must be level, or beam leg height must be adjusted so building does not "lean".	Not practical because surface topography of landfills undulates and slope exceeds 6% in some areas. Considerable regrading would be needed to accommodate foundation, exposing organic waste to birds in the process. Width of RIM in Areas 1 and 2 plus layback for overburden ranges from 250 to 1,050 feet. Thus, structure would need to be moved several times, overlapping excavated and backfilled areas every time. Even if the available structures could be partially disassembled, relocated, and reassembled, sufficient foundation beams and/or piers would be required to support the new locations. That would necessitate over-excavating soils and trash and/or installing foundation piers on 15-foot centers through base of landfills. Overall timeframe for remediation would be lengthened. Consequently, this option was eliminated from further consideration.
		Erect wire or monofilament grids over exposed refuse	Involves use of stainless steel wire, monofilament, or Kevlar lines placed in parallel, or in spoke configurations to prevent bird access. Parallel spacings of between 10 and 50 feet should be effective for most birds near site. Lines must be placed above the maximum height of working equipment. Line length would depend on strength of the wire/filament used, poles and pole anchors, and available space for poles.	Potentially applicable. The size of open excavations may limit the constructability of wire or monofilament grids.
		Use of visual deterrents such as predator birds or effigies of predator birds	Involves use of predator birds and/or visual devices such as statues, flags, and kites of predator hawks, eagles, or owls as deterrents for birds.	Potentially applicable. Visual deterrents can be successful short-term, but not long term because birds habituate to the deterrent. Frequent relocation of predatory birds and predator effigies may help, but long-term effectiveness in not assured.
		Use of auditory "frightening" devices such as pyrotechnics, exploders, bird alarm calls, or sound generators.	Involves use of big "bang" devices such as pyrotechnics, cracker shells, racket bombs, screamer shells, whistle bombs, propane exploders, and recordings of bird distress calls. All can be successful short-term to frighten birds away, but over time, birds habituate to the deterrent.	Potentially applicable except for loud "bang" noises that will be a nuisance to nearby land owners, including the Airport Authority. Frequent repositioning and/or altering the timing of auditory activation may help, but long-term effectiveness in not assured.
		Use of EPA-registered chemical frightening agents or toxicants.	Involves use of EPA-registered gull toxicant DRC-1339 and/or Avitrol® . DRC-1339 is applied to bread baits and causes renal failure, killing birds within days of ingestion. Avitrol® is a chemical frightening agent that causes birds to fly erratically and emit distress calls, frightening unaffected birds. Affected birds typically die within 4 hours. Avitrol® has not been formally evaluated for dispersing gulls.	Not likely applicable because killing or disorienting birds does not address the concern about congregating birds within the flight path of aircraft. Consequently, this option was eliminated from further consideration.
MATCH H	MATCH H			

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Figure 4-1
Technical Implementability Screening of Remediation Technologies and Process Options
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GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	IMPLEMENTABILITY SCREENING COMMENTS
MATCH H	MATCH H			
Nuisance Control Technologies	Fugitive Dust/Odor Control	Implement Best Management Practices	Involves use of selective excavation techniques to minimize exposure of in-place waste, temporarily staging excavated waste in as small an area as practical, daily cover of waste material with soil or tarp, and rapid recovering of exposed waste whenever practicable.	Particularly applicable to landfill regrading projects.
		Water spray/mist, foam, or other agents	Use of water mist/spray and/or foam agents to reduce dust and mask odors; including temporary misting systems on staged waste piles, water or foam spraying on excavation surfaces or staged waste, and water trucks for dust control on roads.	For exposed waste, water would have minimal effect on odor control, may freeze during cold season, and runoff may need to be collected if not absorbed by the waste. Foam would not present runoff concerns. Foam delivery equipment would need to be setup adjacent to excavations and staged waste areas.
		Enclose excavation within temporary structure (screened out)	Involves use of rigid-frame structure with fabric roofing that can be constructed over the excavation area and moved as work progresses. (see description above under Bird Nuisance Mitigation)	Not practical for the same reasons discussed above.
		Enclose waste sorting/loading within temporary structure	For the partial excavation and “complete rad removal” alternatives, excavated waste that would be staged and sorted prior to shipment off-site for disposal would be enclosed within a temporary tensioned fabric frame structure. Loading of trucks or intermodal containers for transport of RIM to the off-site disposal facility would also be performed in this structure. The structure would include a concrete floor working surface and include ventilation and emissions control facilities to reduce/eliminate fugitive dust and odor concerns associated with staged waste.	Temporary structure would require us of a large area (3-4 acres) of the West Lake Landfill site not within OU-1 and therefore use of and approval of the landowner. Structure would need to be on-site throughout the entire off-site shipping of RIM campaign. Significant lead time needed for procurement of structure and emissions control facilities, site preparation, and structure erection.

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M:\clients\EMSI\westlake\2016\Final-FS\Section-4\WL-Fig-4-2-Waste-Separation.dwg plotted: 08/03/2016

Legend

MSW	Municipal Solid Waste
C & D	Construction and Demolition

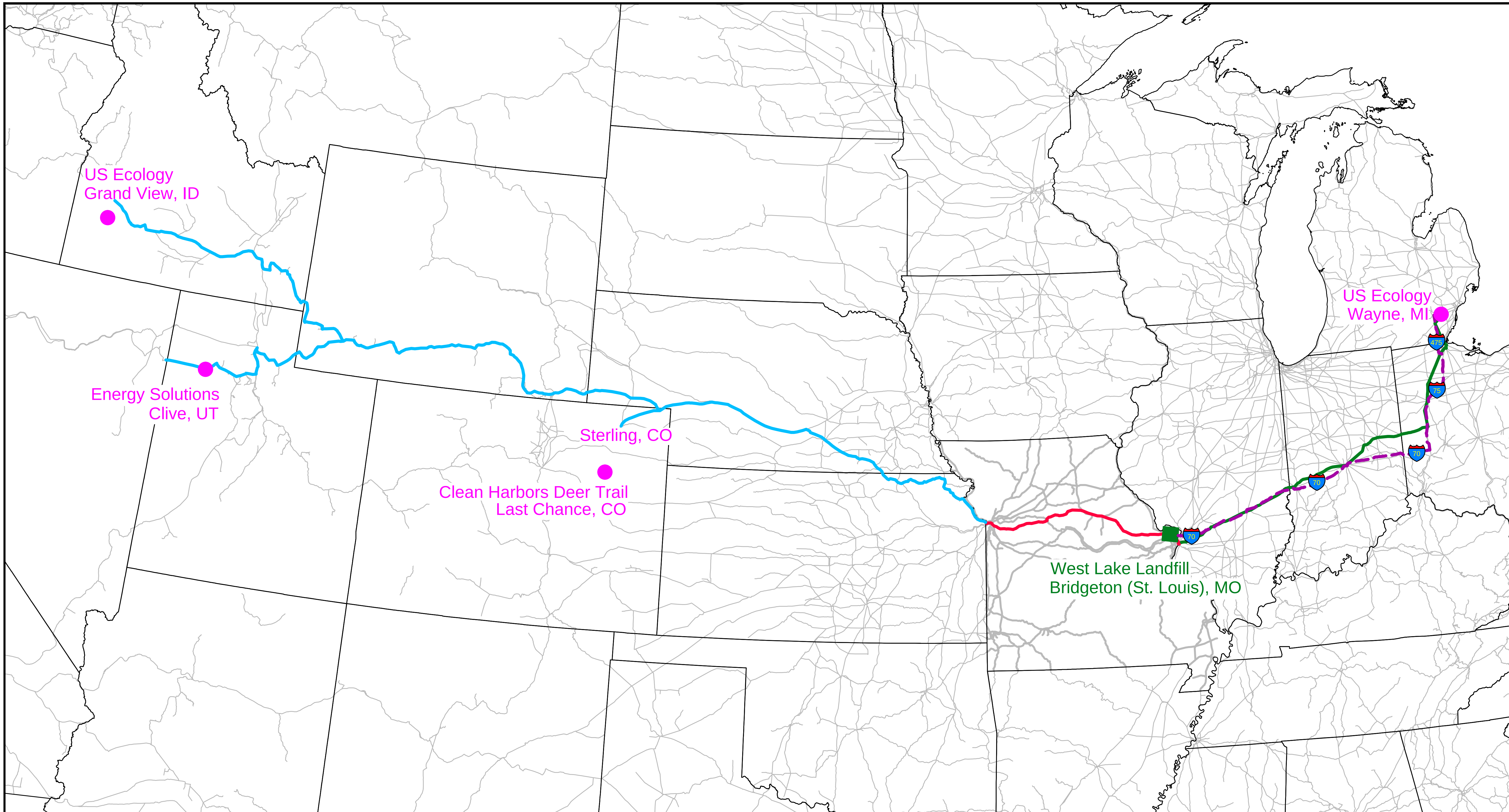
NOT TO SCALE

Figure 4-2

Waste Volume/Size Reduction and Separation Equipment

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.



Legend

- Disposal Facility
- Railroad Line
- Norfolk Southern or BNSF Railroad
- Union Pacific Railroad
- CSX Railroad
- Interstate Truck Route

0 60 120
APPROXIMATE SCALE IN MILES

Figure 4-3
Locations of Potential Off-Site Disposal Facilities and Rail Points
West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

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GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING COMMENTS
No Action	See Figure 4-2 in FS (EMSI, 2006)					
Institutional Controls	See Figure 4-2 in FS (EMSI, 2006)					
Monitoring	Long-term performance monitoring	Groundwater, surface water, sediment, landfill gas, and radon gas monitoring	Effective at determining whether there is any migration of contamination from soil or landfilled areas to groundwater, surface water, and sediment as well as verifying if any remedy is performing as required.	Easily implemented; resources are readily available.	Low capital and low to moderate O&M costs.	Would be implemented under monitoring program.
	Short-term monitoring during construction	Perimeter environmental media air monitoring	For airborne particulates, volatile organics, and radon, effective at documenting background conditions prior to, during, and after remedy implementation. Multiple monitoring stations may be required.	Easily implemented; resources are readily available.	Relatively high capital costs to establish power at monitoring station. Can be high O&M costs depending on parameters requiring analyses in off-site laboratory.	Would be implemented under monitoring program.
		Work zone monitoring	Effective at monitoring exposures of workers to radionuclides and contaminants that may be in airborne particulates.	Easily implemented using various portable, hand-held, passive and breathing zone monitoring devices and equipment. Worker participation in medical monitoring program may be required.	Low capital for dosimeter badges. Most other equipment can be rented.	Would be implemented under monitoring program.
		Excavation guidance/ clearance monitoring	For radionuclides and indirectly for volatile organics, effective for assessing presence of, location/extent, and relative concentration of waste materials. Provides real-time information for decisions during waste excavation projects. Monitoring for metals and semi-volatile organics would require analysis at off-site laboratory and delay excavation.	Easily implemented. Real-time monitoring and sampling equipment and supplies are readily available.	High capital costs for some portable radionuclide survey equipment and on-site laboratory, if needed. Low O&M costs.	Would be implemented under monitoring program.

MATCH A

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Figure 4-4

Evaluation of Remediation Technologies and Process Options

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

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GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING COMMENTS
		MATCH A				
	Short-term monitoring during construction	Waste acceptance monitoring	Effective at assessing whether a container of waste meets off-site disposal facility acceptance criteria before waste material is shipped off-site. Results of field monitoring devices may need to be verified with samples analyzed in off-site laboratory.	Easily implemented with standard, readily-available equipment. Will require profile sampling and preparation/signature of waste manifests prior to shipment.	Low capital and O&M costs (unless laboratory confirmation required).	Would be implemented under monitoring program.
		Post cover construction radon flux monitoring	Effective at measuring radon flux of the cover surface of tailings piles and landfills.	Easily implemented with Large Area Activated Charcoal Canisters (LAACCs).	No capital and low O&M. LAACCs are rented from the analytical laboratory.	Would be implemented under monitoring program.
Containment	See Figure 4-2 in FS (EMSI, 2006) for Surface Controls/Diversions, Surface Water/Sediment Control/Barriers, and Dust Controls					
	Capping and Covers[1,2]	Soil, clay, and vegetation; asphalt or concrete; synthetic membrane material; and multilayer, multimedia material	Caps and covers can effectively limit airborne emissions (including radon) and external gamma radiation, and they can also reduce precipitation-enhanced percolation and leaching.	Can be easily implemented with conventional equipment and procedures. Resources are readily available. Consideration must be given to settlement of filled materials in OU-1 after a cover is placed. Surface depressions must be filled-in.	Moderate to high capital costs, depending on type of cover. Low maintenance and monitoring costs.	Soil, clay and vegetation layer covers retained. Asphalt or concrete covers screened-out because of potential settlement concerns if a cover were to be placed over Areas 1 and 2. Synthetic membrane and multilayer/multimedia material covers screened out because they are inconsistent with the existing landfill cover requirements.
	Land Encapsulation[2]	Off-site Licensed Facility[2]	Can effectively remove the source of contamination to limit contaminant mobility and volume at the affected area and reduce related exposures.	Difficult to implement; potentially only three facilities in U.S. will accept wastes. Will require construction of an on-site rail spur or truck-to-railcar transfer facility. Will require transportation of radiologically-impacted materials by truck and railroad and the attendant risks.	High	Associated with Excavation and Transportation.

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Figure 4-4

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GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING COMMENTS
Physical/Chemical Treatment	Solidification/ Stabilization[2]	Cement Solidification/ Stabilization[2]	Effective at reducing mobility of hazardous and radioactive contaminants.	Cement solidification/stabilization is best suited to highly porous, coarse-grained, permeable soils. Would be difficult to implement in-situ because of the nature of the matrix of landfilled refuse, debris and fill materials, soil, and quarry spoils. Easily implemented ex-situ at permitted off-site disposal facility prior to disposal of hazardous or mixed wastes if hazardous wastes encountered during excavation of RIM in Areas 1 and 2.	Moderate capital costs.	Would only be relevant if hazardous wastes were encountered during surface regrading or excavation of RIM in Areas 1 and 2.
		Chemical Solidification/ Stabilization[2]	Effective at reducing mobility of hazardous and radioactive contaminants.	Chemical solidification/stabilization best suited to fine-grained soil with small pores. Macroencapsulation is used for immobilizing low-level radioactive and mixed debris waste with dimensions greater than or equal to 2.5 inches while microencapsulation used to solidify wastes with smaller particles. Would be difficult to implement in-situ because of the nature of the matrix of landfilled refuse, debris and fill materials, soil, and quarry spoils. Easily implemented ex-situ at permitted off-site disposal facility prior to disposal of hazardous or mixed wastes if hazardous wastes encountered during excavation of RIM in Areas 1 and 2.	Moderate capital costs.	Would only be relevant if hazardous wastes were encountered during surface regrading or excavation of RIM in Areas 1 and 2.

MATCH C

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Figure 4-4

Evaluation of Remediation Technologies and Process Options

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

MATCH C

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING COMMENTS
Physical/Chemical Treatment	Physical Separation[2]	Dry Soil Separation[2]	Could potentially be effective at reducing volume of RIM by separating the soil materials containing radionuclides from the overall matrix of landfilled refuse, debris and fill materials, and unimpacted soil and quarry spoils if full-scale pilot-testing indicates that radionuclide concentrations in samples of the non-soil fraction of RIM that is discharged from the screening process would allow for unrestricted use of the non-soil fraction. If soil materials containing radionuclides remain adhered to the segregated refuse because of moisture content or other reasons, a separation process would not be effective. The effectiveness and degree of separation that may be achieved is uncertain until pilot-testing results are obtained. RIM matrix may require drying to improve separation effectiveness.	Pilot-testing using representative material from Areas 1 and/or 2 would be needed to determine the site-specific implementability. Equipment is readily available. Shear shredding pretreatment step prior to separation screening would be required. In maintaining the separation screening equipment, workers would be exposed to increased radiation emitted by RIM that adheres to the screen. Inclusion of a solids separation step as part of a process used for excavation and disposal of the RIM could become a factor relative to the daily production rates and project duration. Use of separation equipment could extend the overall project schedule and increase the potential or amounts of stormwater accumulation, airborne (dust) emissions, and bird or other vector impacts due to a possible increase in the overall schedule.	High capital cost. High operating costs.	Full-scale pilot-testing using representative material from Areas 1 and/or 2 would need to be conducted as a pre-design study early in the Remedial Design schedule.
Removal	Excavation	Backhoe, bulldozer, scraper and front-end loader	Can effectively remove the source of contamination to limit contaminant mobility and volume at the affected area and reduce related exposures.	Can be implemented with conventional equipment and procedures, and resources are available. Consideration must be given to type and composition of material to be excavated and excavations at depths greater than 25 feet, as special excavation equipment may be required.	Cost dependent on material properties. Moderate if shallow. High if deep.	None.
	Physical Separation	Dry Soil Separation	Would potentially be effective at reducing volume of RIM if pilot testing shows that the activity of the separated non-soil MSW would be less than the activity criteria for the respective complete rad removal or partial excavation alternative.	Interstitial soil materials need to be separated from MSW using solids separation process (handpicking, magnetic and eddy current separation, air classification, screens).	Moderate to high capital costs, high operating costs.	Pilot testing of various methods needed during remedial design.

MATCH D

MATCH D

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Figure 4-4

Evaluation of Remediation Technologies and Process Options

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

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MATCH D

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING COMMENTS
Removal	Physical Separation	Rotating Screen - Trommel	Would potentially be effective at reducing volume of RIM if pilot testing shows that the activity of the separated non-soil MSW would be less than the activity criteria for the respective complete rad removal or partial excavation alternative.	Shredding pretreatment needed prior to rotating screen to reduce size of larger materials. Materials such as rebar and plastics can jamb or clog rotating screen requiring workers to enter screen to remove, which would interrupt production. Full scale pilot testing using representative materials excavated from West Lake OU-1 required.	High capital and operating costs.	Air borne dust would be generated during shredding and screening activities if excavated materials are dry. Increased worker exposure when removing materials from clogged screen. Pilot testing needed during remedial design.
		Radiological Segregation/ Separation	Would potentially be effective at reducing volume of RIM if pilot testing shows that the activity of the separated non-soil MSW would be less than the activity criteria for the respective complete rad removal or partial excavation alternative. Effective for gamma emitting radionuclides only.	Materials greater than 1.5 inches would need to be hand-picked out, screened-out or crushed. Optimal soil moisture content of between 5 and 15% needed. Limited to analysis of 2 radionuclides at a time.	High capital and operating costs.	Likely not applicable for 7.9 pCi/g complete rad removal and 52.9 pCi/g partial excavation alternatives, may be applicable for 1,000 pCi/g partial excavation alternative. Pilot testing needed during remedial design.
	Transportation (hauling of waste material)	Truck	With the numerous types of trucks available, effective for hauling of waste materials over all types of terrain and distances.	Easily implemented. Can be mobilized quickly. Depending on the characteristics of the waste material, truck beds may require lining or the waste may need to be transported in special containers. Federal, State, and local laws limit weight that can be carried on roads (depending on type of truck and characteristics of road).	Relatively cost-effective, plenty of competition available. Truck hauling is typically the only option to haul materials short distances. Not cost-effective for hauling large volumes/weights of materials long distances.	Except for maybe the US Ecology - Michigan location, eliminated for hauling of radiologically-impacted materials to off-site disposal facilities because of long distances.

MATCH E

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Figure 4-4

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MATCH E (General Response Action) — MATCH E (Remedial Technology)

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING COMMENTS
Removal	Transportation (hauling of waste material)	Rail	Effective for hauling of waste materials over long distances or heavy volumes locally.	Difficult to implement. Would require truck-to-rail transfer and lease of nearby rail spur or extension of a rail spur onto the Site. Construction of new spur on-site would require land purchase or lease and coordination with local agencies and the railroad. Rate of waste transport via rail would be dependent on length of rail spur, number of switches provided by the railroad per week, and availability of specialty railcars for waste transport.	Cost-effective for hauling large volumes/weights long distances.	None.
Removal	Disposal	Off-site disposal in a licensed facility	Can effectively remove the source of contamination to limit contaminant mobility and volume at the affected area and reduce related exposures.	Logistically more difficult to implement if a rail spur is not on-site. Will require construction of an on-site rail spur and crossing across St. Charles Rock Rd or a truck-to-rail transloading facility at a nearby rented rail spur. Depending on disposal facility selected, RIM may need to be staged and blending prior to loading into trucks or railcars.	High costs.	Risk of accidents associated with truck and rail transportation. Significant amount of greenhouse gases emitted during transportation to disposal facility.
Removal	Storm Water Management	Implement Best Management Practices to route runon around working areas.	Effective in the short-term and long-term.	Easily implementable. Relies on use of conventional construction equipment and materials.	Low capital and O&M cost.	Would be implemented as part of RA and O&M.
Removal	Storm Water Management	Implement Best Management Practices to minimize waste exposure to direct precipitation.	Would be effective during excavation if the RIM was being removed.	Easily implementable. Relies on use of conventional construction equipment and materials.	Moderate O&M cost.	Would be implemented as part of RA.
Removal	Storm Water Management	Implement Best Management Practices to collect, detain, treat, and release runoff.	Effective during excavation while the RIM is being removed.	Easily implementable. Relies on use of conventional construction equipment and materials.	Moderate capital and O&M cost.	Would be implemented as part of RA.

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Figure 4-4

Evaluation of Remediation Technologies and Process Options

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

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GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING COMMENTS
Nuisance Control Technologies	Bird Nuisance Mitigation	Implement Best Management Practices	Effective means to minimize waste exposure opportunity for birds.	Can be implemented as part of an excavation program.	Low-moderate cost, depending on size of waste area to be covered.	Potentually effective.
		Erect wire or monofilament grids over exposed refuse.	May be effective deterrent with adequate grid spacing and pole placement.	Can be implemented with parallel spacings of between 10 and 50 feet. Line height can be 10-15 feet above the starting grade for Areas 1 and 2 if scrapers are used to strip overburden. Line length depends on strength of the wire/filament used and available space for poles and pole anchors. Should be able to implement with conventional wire, poles, construction equipment, and labor.	Cost dependent on wire/monofilament used, grid spacing, and height. Moderate capital cost if parallel spacings >15 feet and pole height <15 feet.	More effective if combined with visual and/or auditory deterrents.
		Use of visual deterrents such as predator birds or effigies of predator birds	May be effective short-term in one position, but long-term (greater than several months) effectiveness will require frequent repositioning.	Can be implemented with commercially-available effigies of predator birds mounted on poles and/or onsite buildings.	Low capital and O&M cost.	More effective if combined with auditory deterrents and/or overhead wire grid.
		Use of auditory "frightening" devices such as pyrotechnics, screamer whistles, and bird distress calls.	May be effective short-term in one position, but long-term (greater than several months) effectiveness will require frequent repositioning and altering of timing of activation.	Can be implemented with commercially-available sound devices that can be mobilized to new locations.	Low capital and O&M cost.	More effective if combined with visual deterrents and/or overhead wire grid.
	Fugitive Dust/Odor Control	Implement Best Management Practices	Effective for minimizing dust on exposed surfaces, but little effect with respect to odor.	Easily implementable using conventional materials, but depending on construction schedule requirements, may be difficult to constantly move tarps to minimize exposed surfaces.	Low to moderate cost, depending on size of waste area to be covered.	Would be implemented in areas where MSD is exposed.

MATCH G

MATCH G

[1] Indicates that General Response Action or remedial technology is component of presumptive remedy for CERCLA municipal landfill sites (USEPA, 1993)

[2] Treatment technology or remedial technology specified in Technology Reference Guide for Radioactively Contaminated Media, EPA 402-R-07-004, October 2007.

Figure 4-4

Evaluation of Remediation Technologies and Process Options

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

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GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING COMMENTS
MATCH G	MATCH G					
Nuisance Control Technologies	Fugitive Dust/Odor Control	Water spray/mist, foam, or other agents	Water effective for fugitive dust, particularly on roads, little effectiveness for odor. Foam would be effective for minimizing dust and odor on excavated surfaces and staged waste.	Sprayed water or mist could runoff sloped excavation.	Water: low cost. Foam: moderate cost.	Foam covering of exposed waste in excavation and staged material would assist with bird mitigation. For alternatives where recently-filled materials from the North Quarry portion of the Bridgeton Landfill in the southeast area of Area 1 need to be excavated and stockpiled to access RIM, foaming of surfaces of open excavations and stockpiles might be desirable to address odors.
		Enclose waste sorting/ loading within temporary structure	Effective for addressing fugitive dust and odor associated with excavated RIM staged for off-site disposal, not effective for open excavations.	Easily implemented with standard construction equipment and personnel. Would require an approximate 4-acre open area on the West Lake Landfill Site that is not located on fill. Long lead time from placement of order to delivery on-site. Would require ventilation exhaust air treatment for odor control.	Very high capital and O&M costs.	Would eliminate precipitation on as well as odor to the public from excavated RIM staged for off-site disposal and eliminate bird nuisance concerns associated with staged RIM.

[1] Indicates that General Response Action or remedial technology is component of presumptive remedy for CERCLA municipal landfill sites (USEPA, 1993)

[2] Treatment technology or remedial technology specified in Technology Reference Guide for Radioactively Contaminated Media, EPA 402-R-07-004, October 2007.

Figure 4-4

Evaluation of Remediation Technologies and Process Options

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

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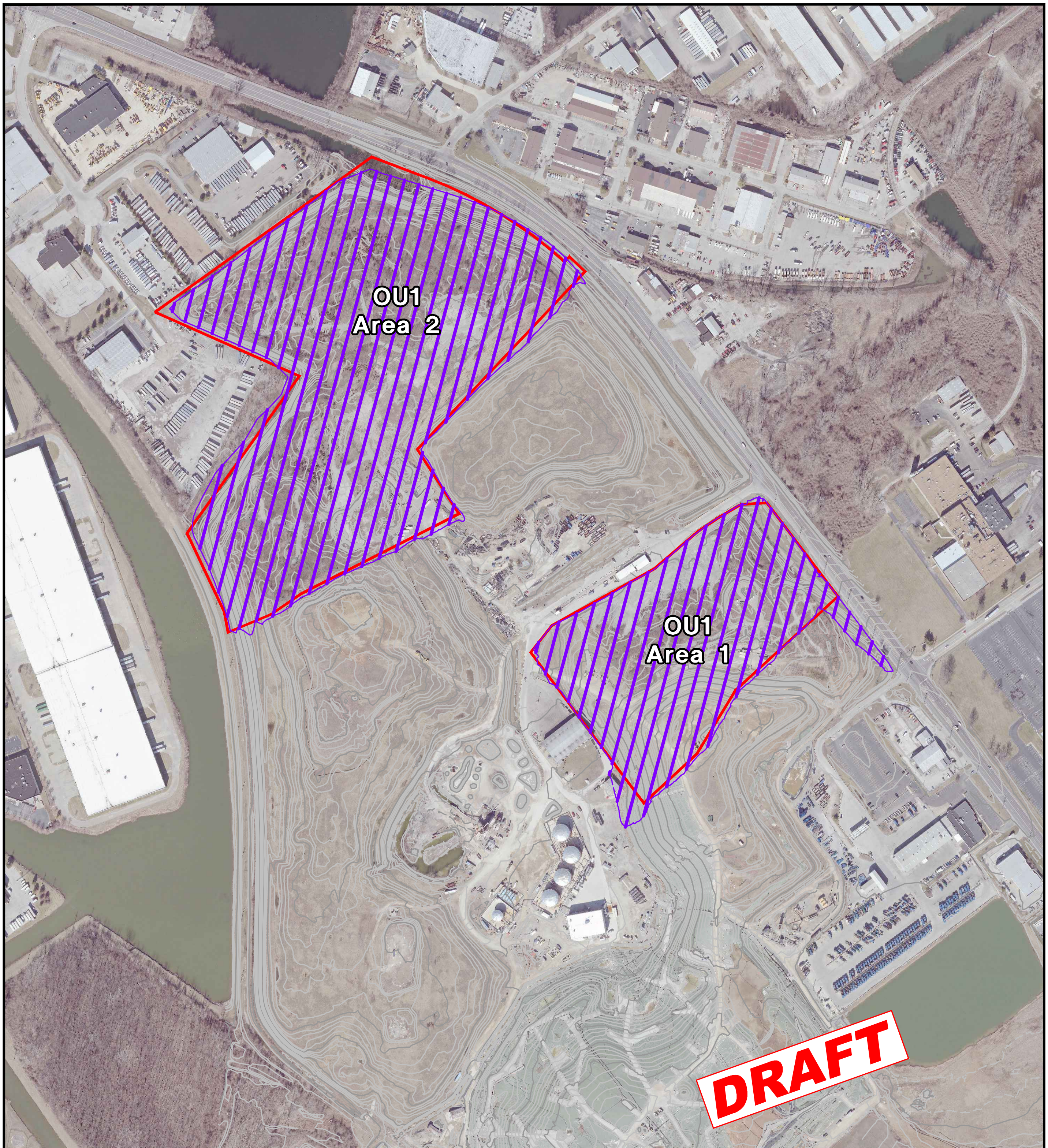


LEGEND

OU-1 AREA BOUNDARY

Extent of Cover

N

0 600

SCALE IN FEET

FROM FEEZER ENGINEERING 2011

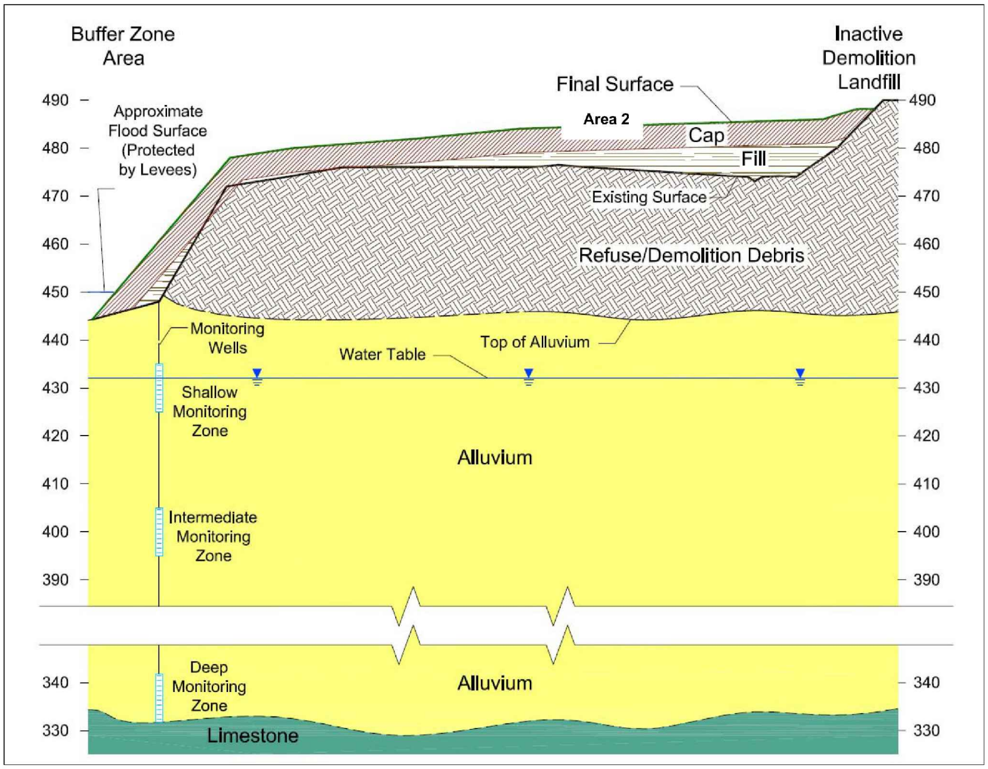
Figure 5-1

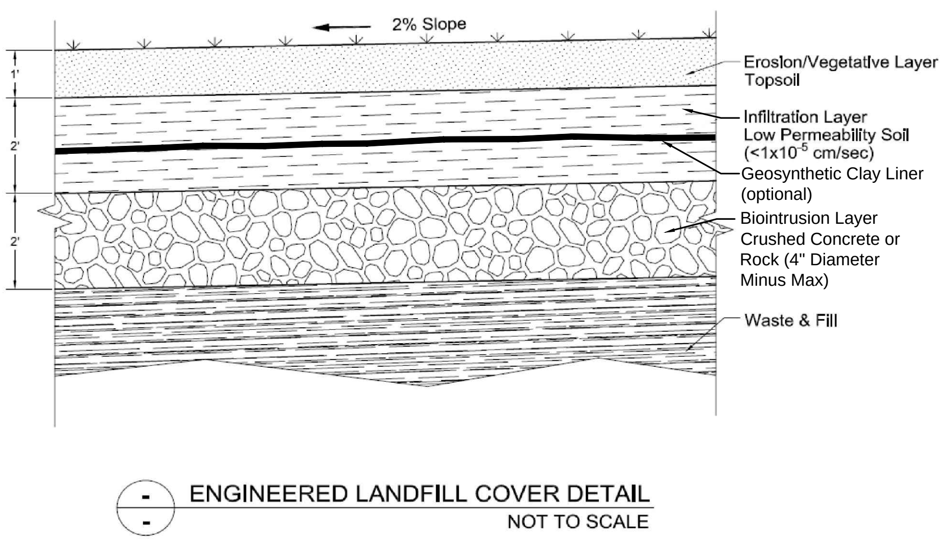
Extent of ROD - Selected Remedy Landfill Cover

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

M:\clients\EMSI\westlake\2016\Final-FS\Section-5\WL-Fig-5-1-Extent-ROD.dwg 4/14/2015





DRAFT

Figure 5-2
Conceptual Cross-Section of the ROD Remedy
West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

M:\clients\EMSI\westlake\2016\Final-FS\Section-5\WL-Fig-5-2-Concept-Xsec.dwg plotted: 12/15/2016

Figure 5-3

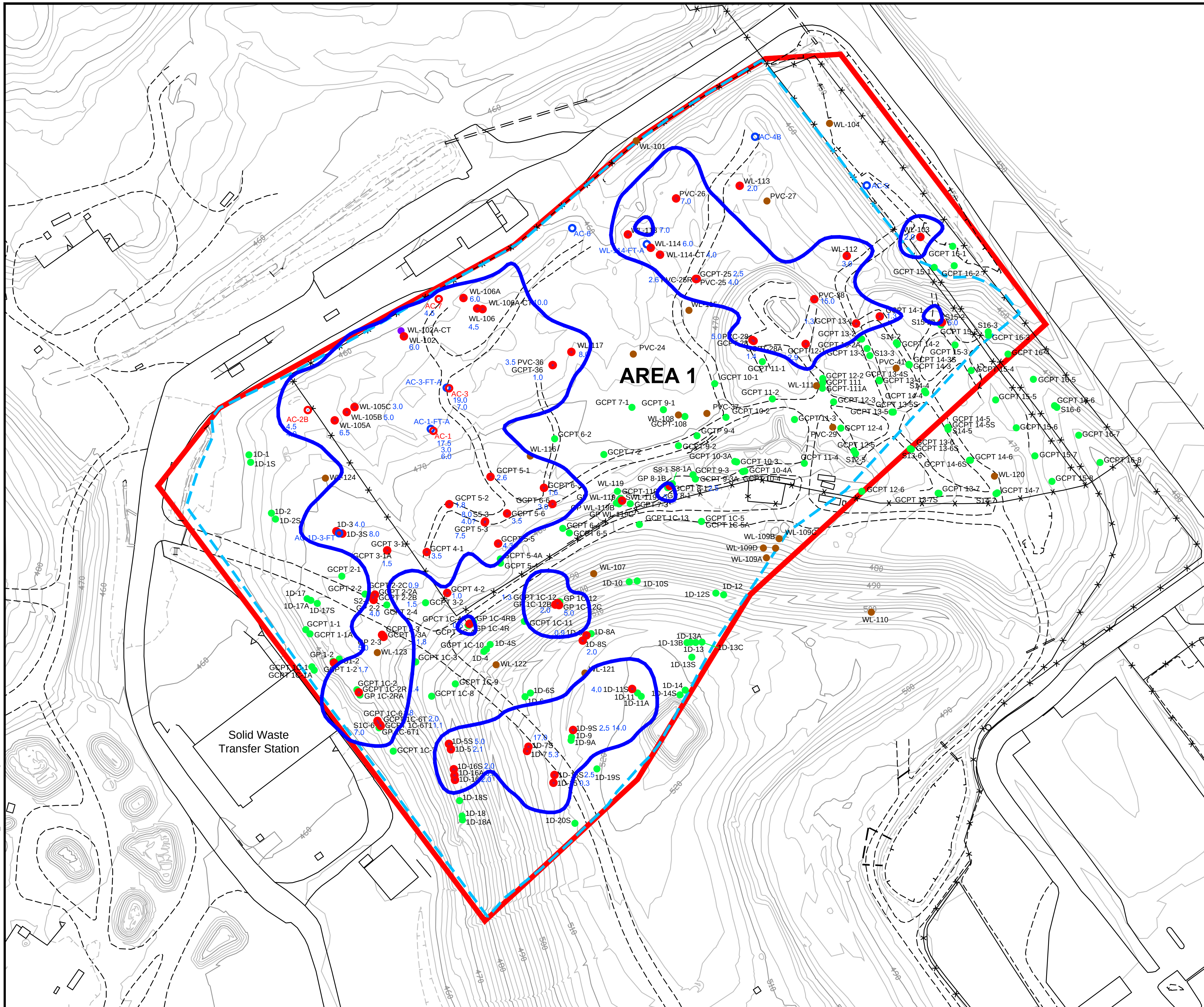
Potential Material Stockpile Areas

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

FROM FEEZER ENGINEERING 2011

M:\clients\EMSI\westlake\2016\Final-FS\Section-5\WL-Fig-5-3-Pot-Stkpile-areas.dwg 4/14/2015



LEGEND

- OU-1 AREA 1 BOUNDARY
- APPROXIMATE EDGE OF REFUSE
- RI SOIL BORING
- PHASE 1 SOIL BORING
- COTTER SOIL BORING
- ADDITIONAL SOIL BORING
- PRESENCE OF RIM
- 5.0 THICKNESS OF RIM (IN FEET)
- GEOSTATISTICAL-BASED ESTIMATE OF RIM EXTENT

150 0 150
SCALE IN FEET

NOTES:

- AERIAL TOPOGRAPHY PROVIDED BY COOPER AERIAL SURVEYS CO. AND IS DATED FEBRUARY 27, 2016
- ALL ELEVATIONS ARE ABOVE MEAN SEA LEVEL (AMSL)

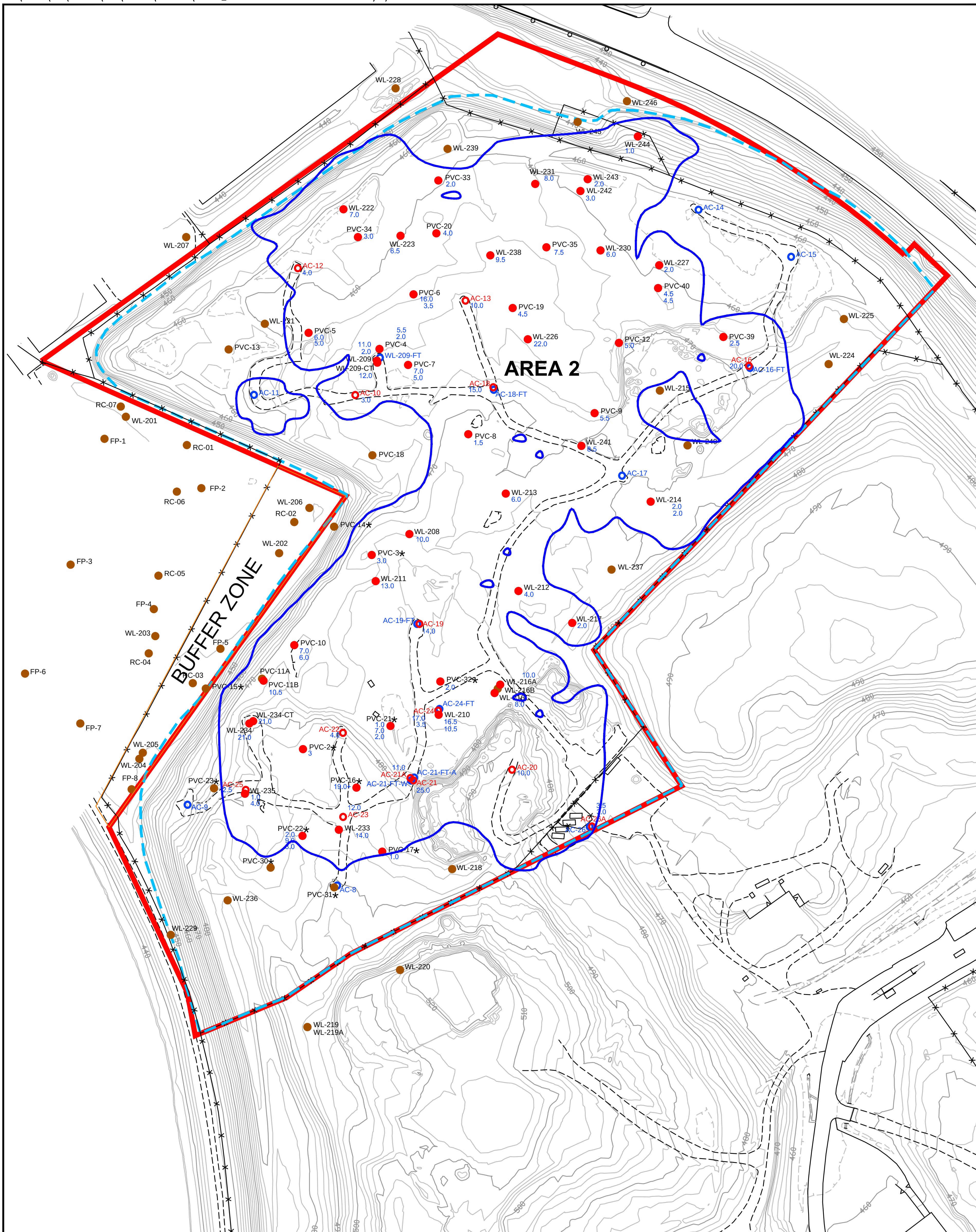
Figure 5-4

Approximate Extent of RIM-Area 1
"Complete rad removal" Alternative

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

M:\clients\EMSI\westlake\2016\Final-FS\Section-5\FIG-5-4_5-5-Extent-RIM.dwg



LEGEND

- OU-1 AREA 2 BOUNDARY
- APPROXIMATE EDGE OF REFUSE
- ★ LOCATION APPROXIMATE-NO SURVEY DATA AVAILABLE
- ● RI SOIL BORING
- ● COTTER SOIL BORING
- ○ ADDITIONAL SOIL BORING
- ● PRESENCE OF RIM
- 5.0 THICKNESS OF RIM (IN FEET)
- GEOSTATISTICAL-BASED ESTIMATE OF RIM EXTENT

DRAFT

NOTES:

- AERIAL TOPOGRAPHY PROVIDED BY COOPER AERIAL SURVEYS CO. AND IS DATED FEBRUARY 27, 2016
- ALL ELEVATIONS ARE ABOVE MEAN SEA LEVEL (AMSL)

N

200 0 200

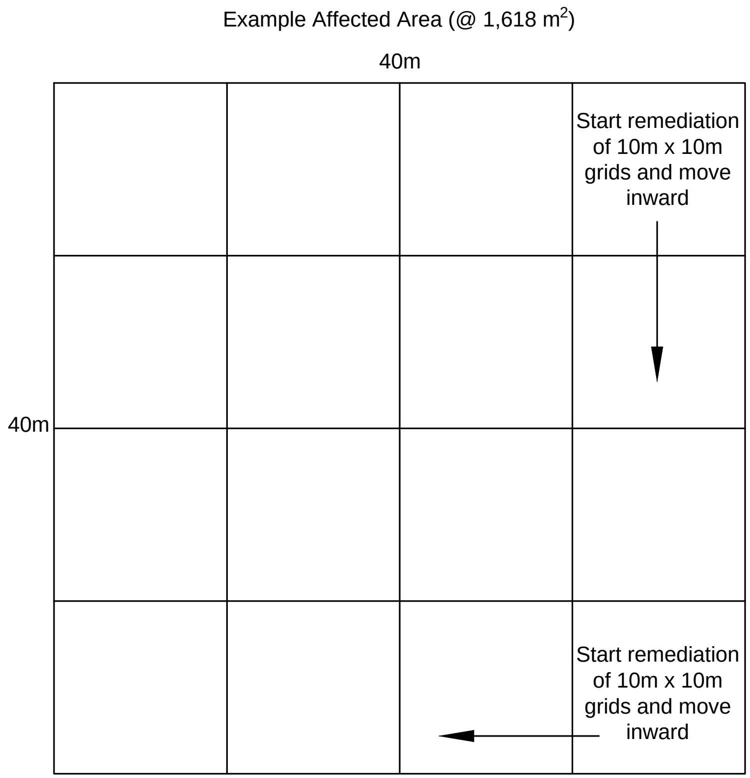
SCALE IN FEET

Figure 5-5

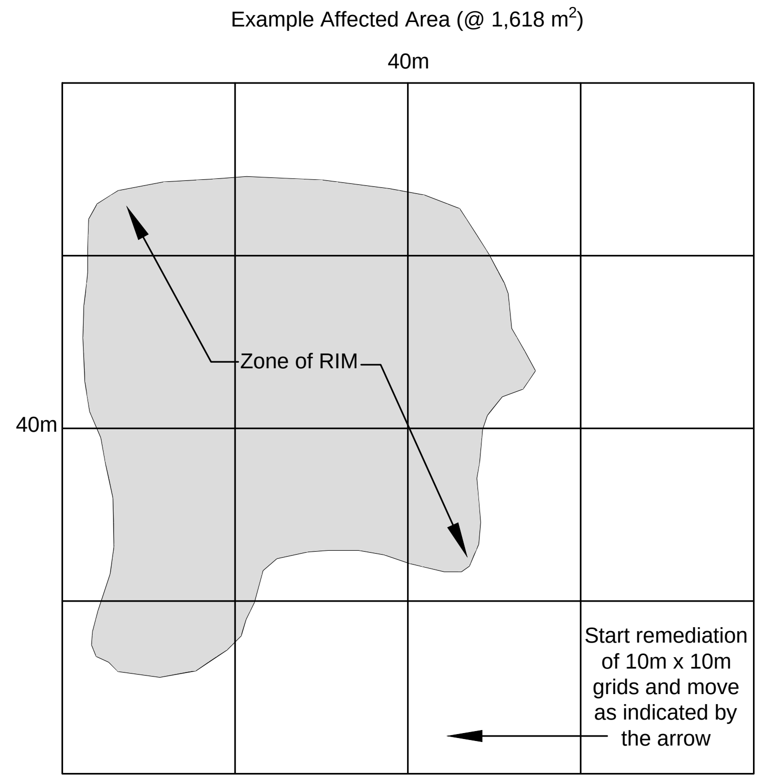
Approximate Extent of RIM-Area 2 "Complete rad removal" Alternative

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.



The soil would be excavated from the boundary inward, allowing movement of the hauling equipment closer to the excavator to try to increase efficiency and prevent the spread of contamination.



<u>Example of Excavation Plan Logistics</u>

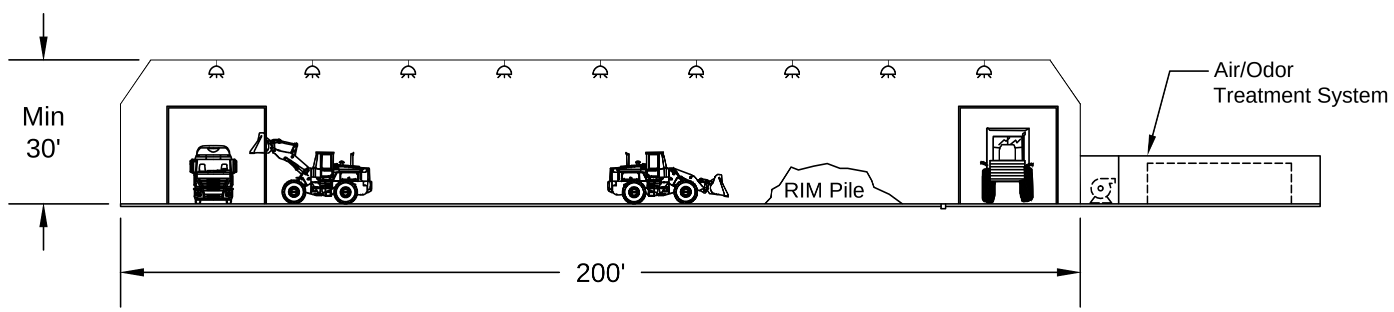
<u>Continue Excavation Along Edges of RIM</u>

Figure 5-6

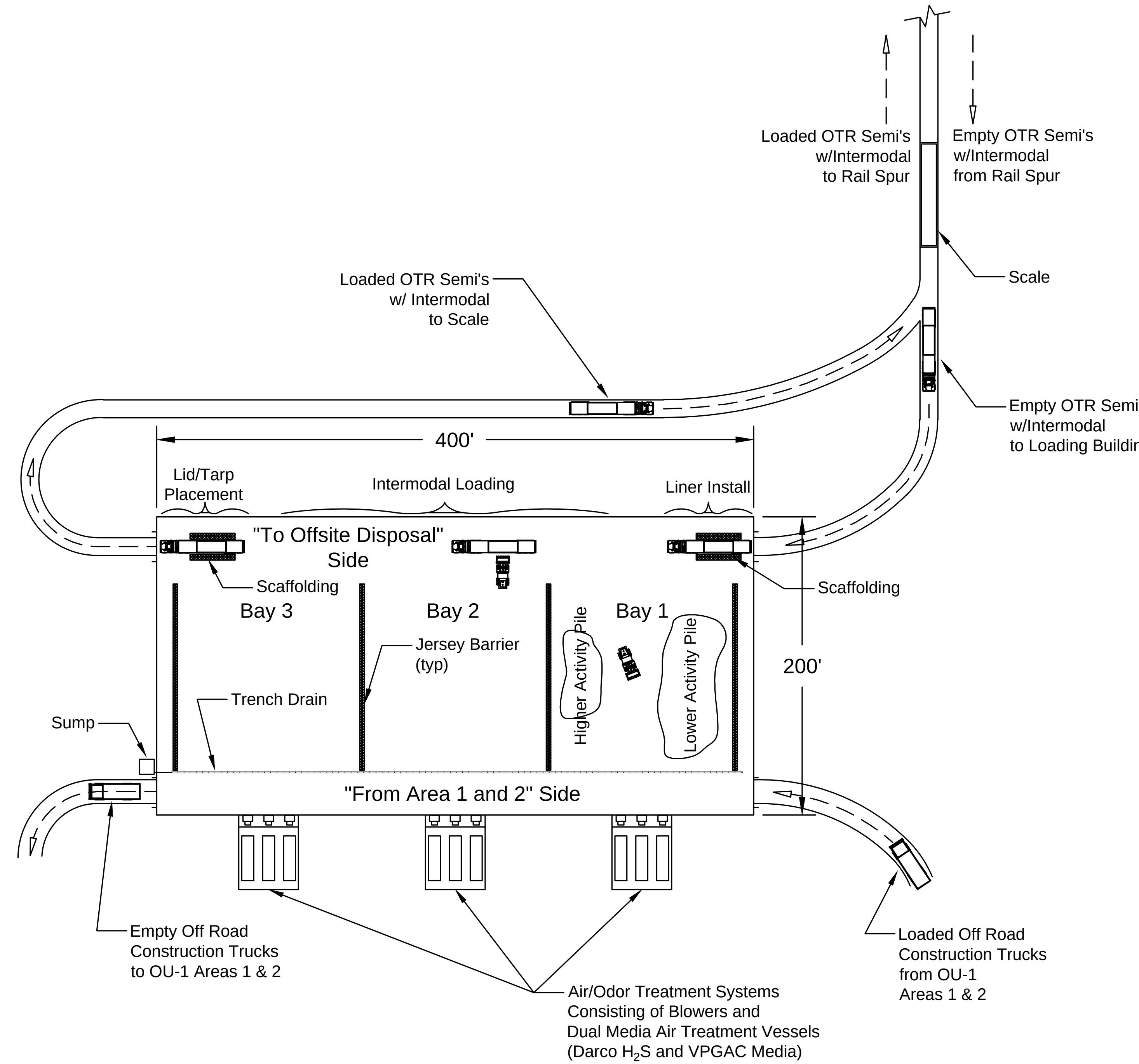
RIM Excavation Sequencing

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.



END VIEW
(End Wall Removed for Clarity)
N.T.S.



PLAN VIEW
N.T.S.

DRAFT

Figure 5-7

RIM Staging and
Loading Building Layout

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

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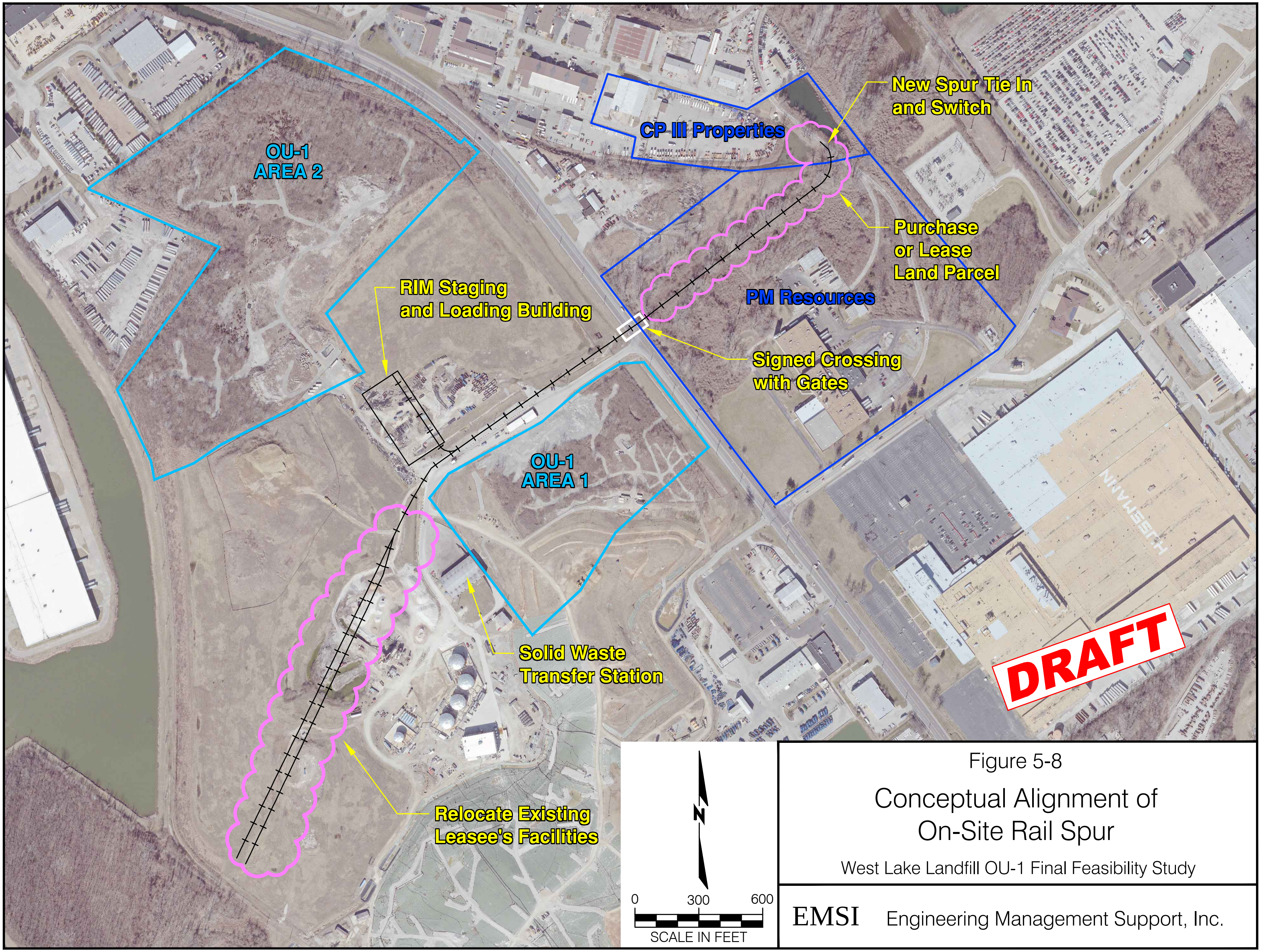
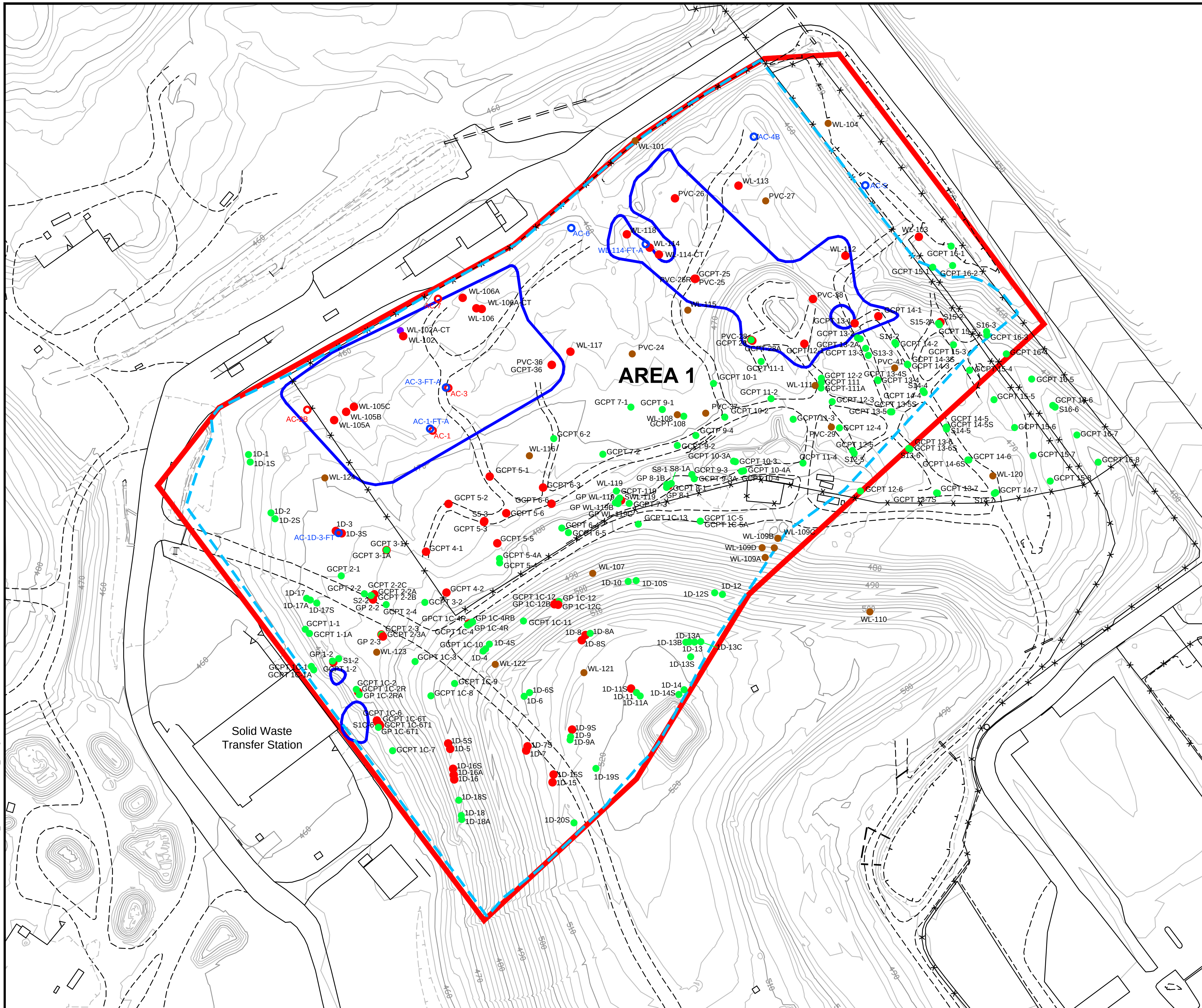


Figure 5-8

Conceptual Alignment of
On-Site Rail Spur

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.



LEGEND

- OU-1 AREA 1 BOUNDARY
- APPROXIMATE EDGE OF REFUSE
- RI SOIL BORING
- PHASE 1 SOIL BORING
- COTTER SOIL BORING
- ADDITIONAL SOIL BORING
- PRESENCE OF RIM
- GEOSTATISTICAL-BASED ESTIMATE OF RIM EXTENT

150 0 150
SCALE IN FEET

NOTES:
- AERIAL TOPOGRAPHY PROVIDED BY COOPER AERIAL SURVEYS CO. AND IS DATED FEBRUARY 27, 2016
- ALL ELEVATIONS ARE ABOVE MEAN SEA LEVEL (AMSL)

Figure 5-9

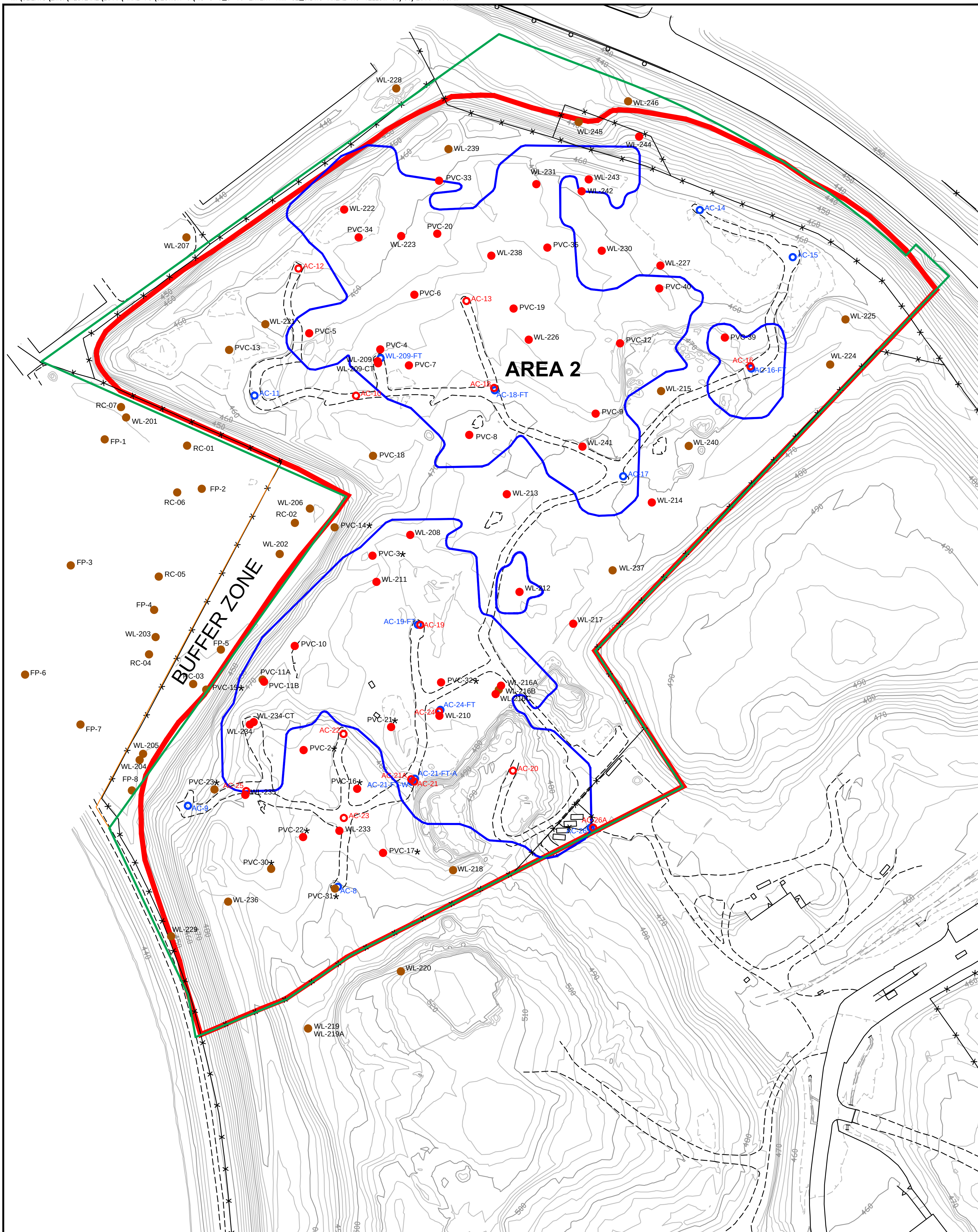
Approximate Extent of RIM-Area 1 52.9 pCi/g Partial Excavation Alternative

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

M:\clients\EMSI\westlake\2016\Final-FS\Section-5\FIG-5-9_5-10-Extent-RIM-52_9.dwg

M:\CLIENTS\EMSI\WESTLAKE\2016\FINAL-FS\SECTION-5\FIG-5-9_5-10-EXTENT-RIM-52_9.DWG-AREA2 NO-YELLOW 09/30/2016 4:50PM



LEGEND

- OU-1 AREA 2 BOUNDARY
- APPROXIMATE EDGE OF REFUSE
- LOCATION APPROXIMATE-NO SURVEY DATA AVAILABLE
- RI SOIL BORING
- COTTER SOIL BORING
- ADDITIONAL SOIL BORING
- PRESENCE OF RIM
- GEOSTATISTICAL-BASED ESTIMATE OF RIM EXTENT

DRAFT

NOTES:
- AERIAL TOPOGRAPHY PROVIDED BY COOPER AERIAL SURVEYS CO. AND IS DATED FEBRUARY 27, 2016
- ALL ELEVATIONS ARE ABOVE MEAN SEA LEVEL (AMSL)

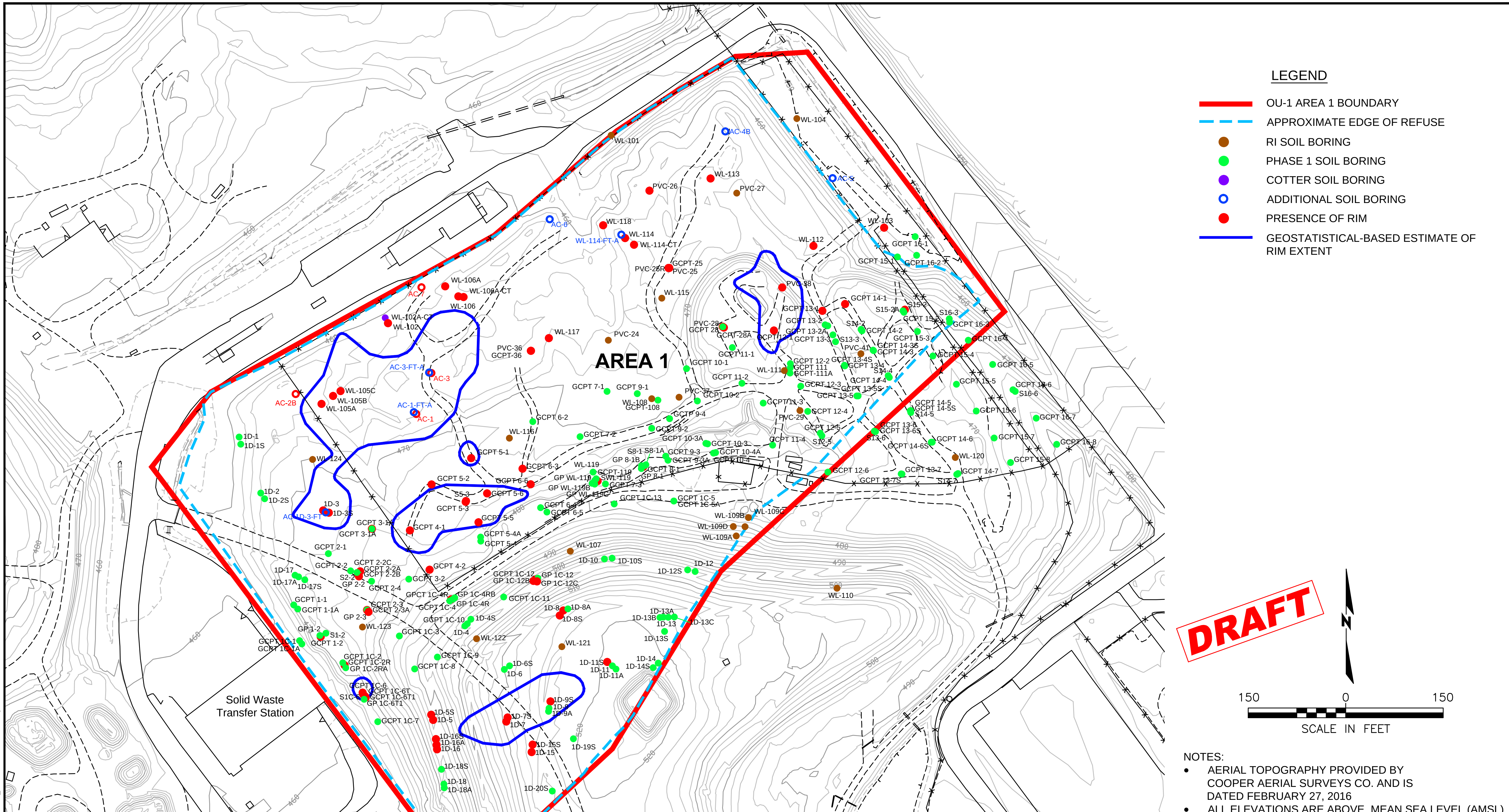
N

200 0 200
SCALE IN FEET

Figure 5-10
Approximate Extent of RIM-Area 2
52.9 pCi/g Partial
Excavation Alternative

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.



NOTES:

- AERIAL TOPOGRAPHY PROVIDED BY COOPER AERIAL SURVEYS CO. AND IS DATED FEBRUARY 27, 2016
- ALL ELEVATIONS ARE ABOVE MEAN SEA LEVEL (AMSL)

Figure 5-11

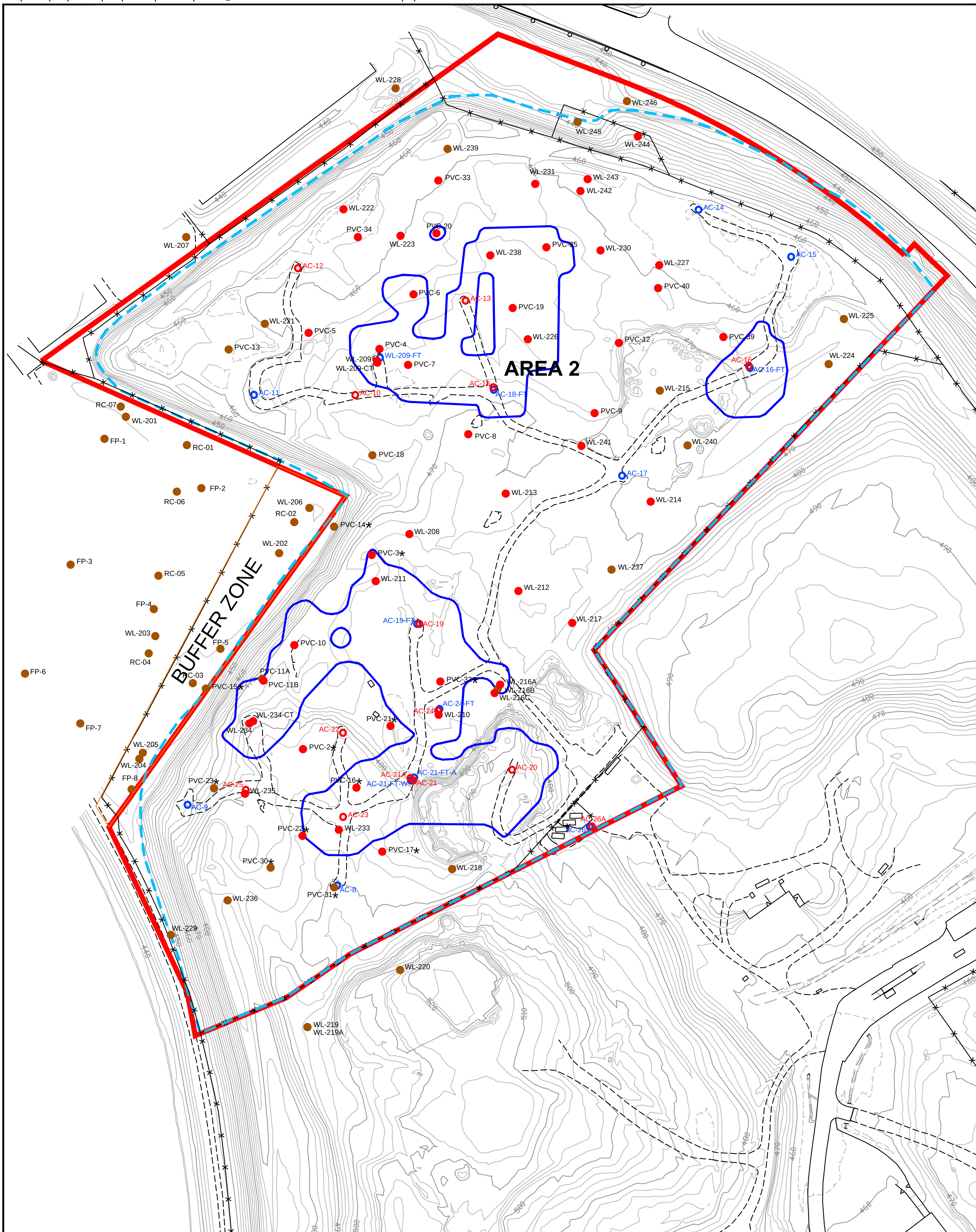
Approximate Extent of RIM-Area 1 1,000 pCi/g Partial Excavation Alternative

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

M:\clients\EMSI\westlake\2016\Final-FS\Section-5\FIG-5-11_5-12-Extent-RIM-1000.dwg

M:\CLIENTS\EMSI\WESTLAKE\2016\FINAL-FS\SECTION-5\FIG-5-11_5-12-EXTENT-RIM-1000.DWG-AREA2 NO-YELLOW 09/30/2016 4:52PM



LEGEND

- OU-1 AREA 2 BOUNDARY
- APPROXIMATE EDGE OF REFUSE
- LOCATION APPROXIMATE-NO SURVEY DATA AVAILABLE
- RI SOIL BORING
- COTTER SOIL BORING
- ADDITIONAL SOIL BORING
- PRESENCE OF RIM
- GEOSTATISTICAL-BASED ESTIMATE OF RIM EXTENT

DRAFT

NOTES:
- AERIAL TOPOGRAPHY PROVIDED BY COOPER AERIAL SURVEYS CO. AND IS DATED FEBRUARY 27, 2016
- ALL ELEVATIONS ARE ABOVE MEAN SEA LEVEL (AMSL)

N

200 0 200

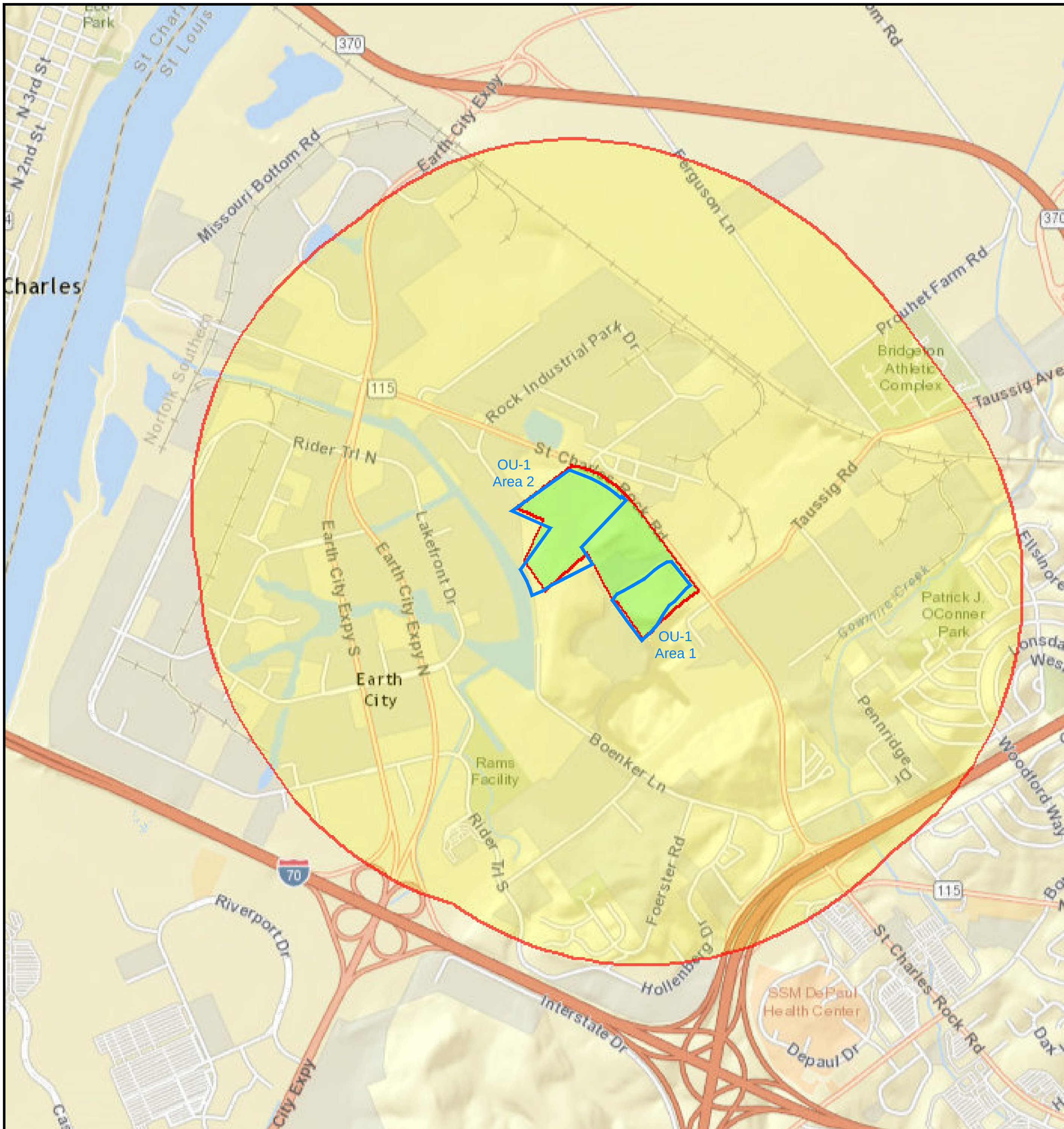
SCALE IN FEET

Figure 5-12

Approximate Extent of RIM-Area 2 1,000 pCi/g Partial Excavation Alternative

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.



August 13, 2016

Digitized Polygon

Buffer Area

DRAFT

1:36,112

0 0.3 0.6 1.2 mi

0 0.5 1 2 km

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Figure 6-1

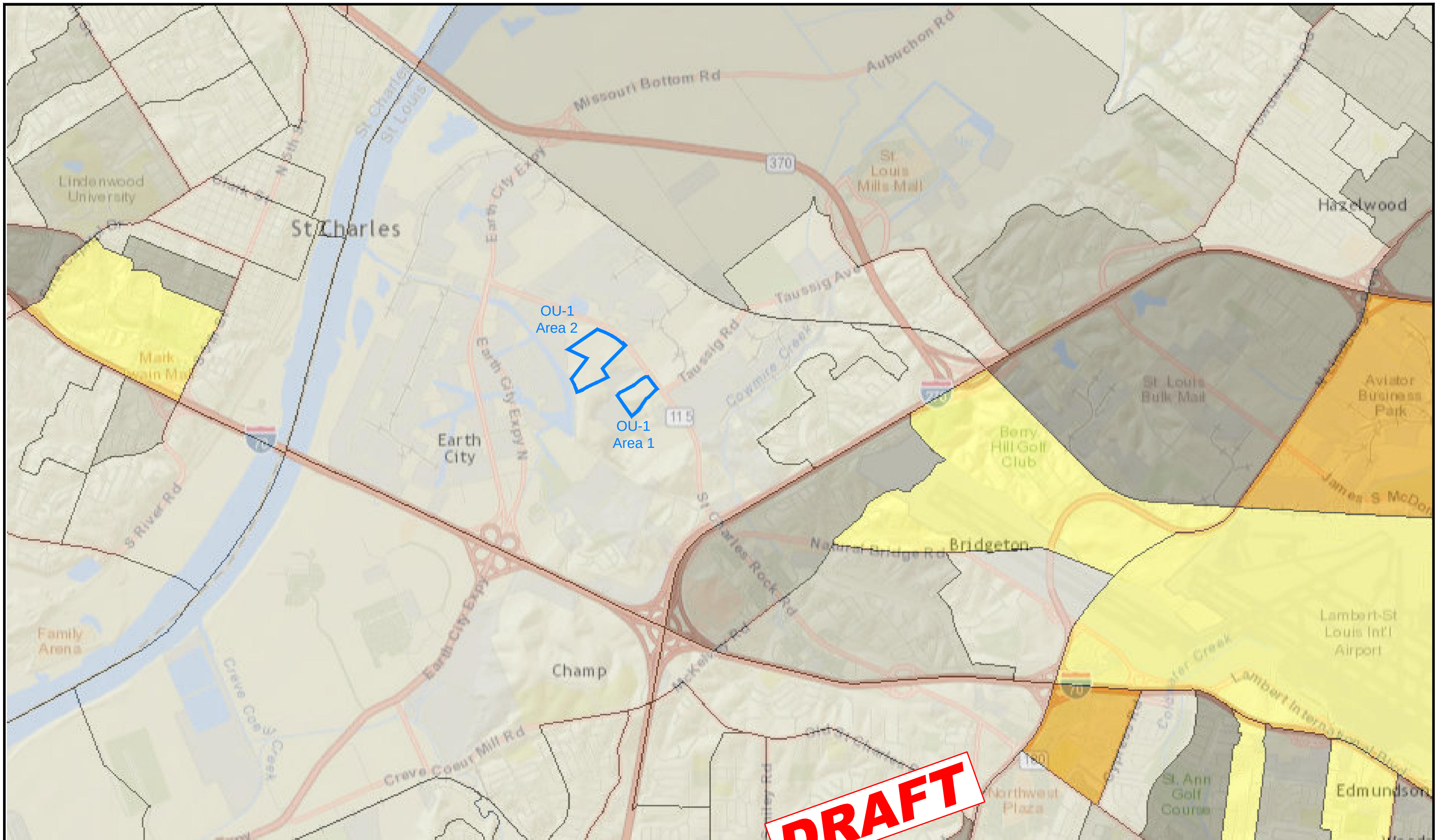
1 Mile Radius
Buffer

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

M:\clients\EMSI\westlake\2016\Final-FS\Section-6\FIG-6-1_1mile-Radius.dwg

M:\clients\EMSI\westlake\2016\Final-FS\Section-6\FIG-6-2_Demographic-Index.dwg



August 13, 2016

EJSCREEN_Indexes

- Data not available
- Less than 50 percentile
- 50 -60 percentile
- 60 -70 percentile
- 70 -80 percentile
- 80 - 90 percentile
- 90 - 95 percentile
- 95 - 100 percentile

1:72,224

0 0.5 1 2 mi

0 1 2 4 km

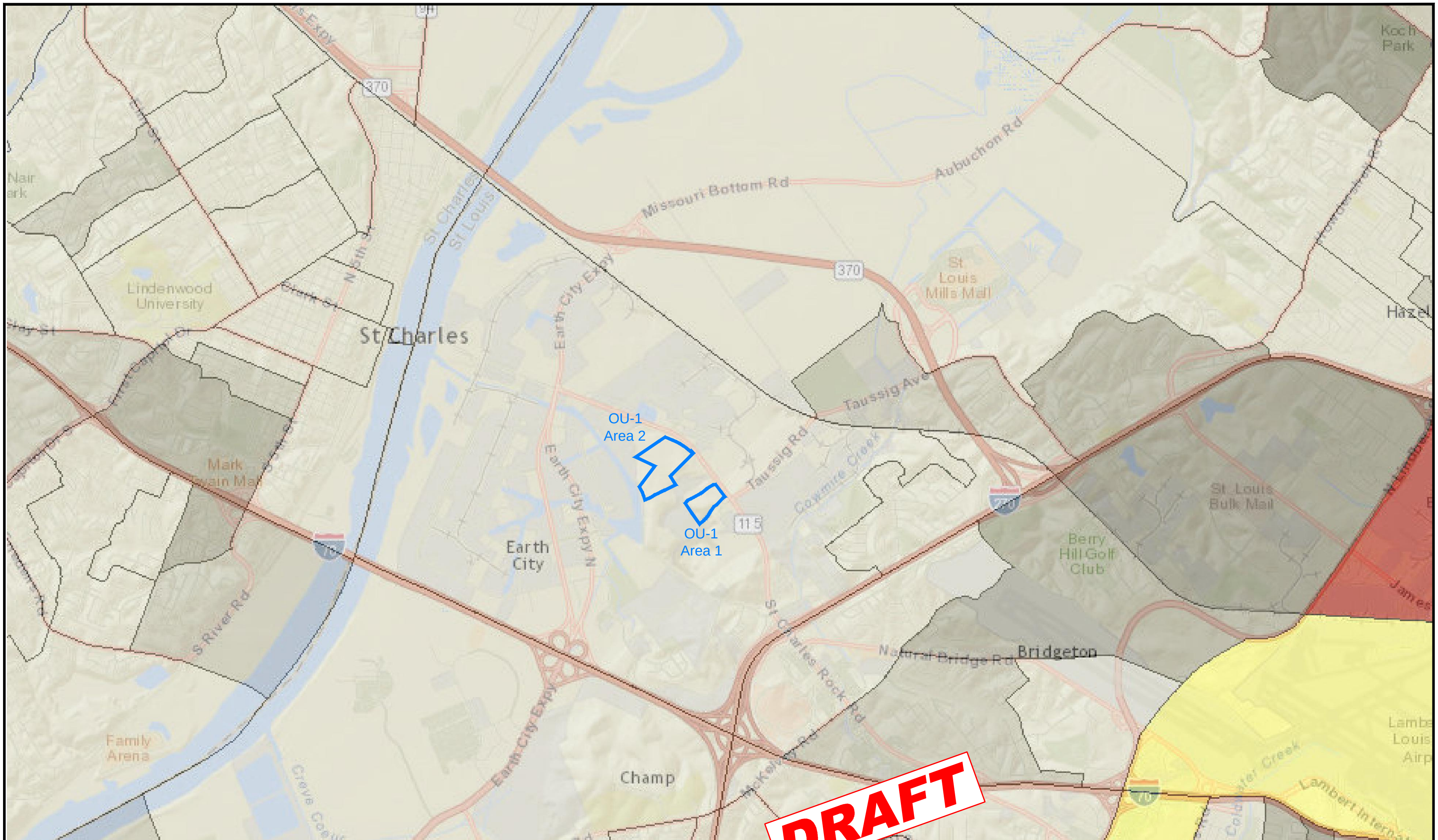
Figure 6-2

Demographic Index

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), M:\clients\EMSI\westlake\2016\Final-FS\Section-6\FIG-6-3_Minority.dwg



August 13, 2016

EJSCREEN_Indexes

- Data not available
- Less than 50 percentile
- 50 -60 percentile
- 60 -70 percentile
- 70 -80 percentile
- 80 - 90 percentile
- 90 - 95 percentile
- 95 - 100 percentile

1:72,224

0 0.5 1 2 mi

0 1 2 4 km

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

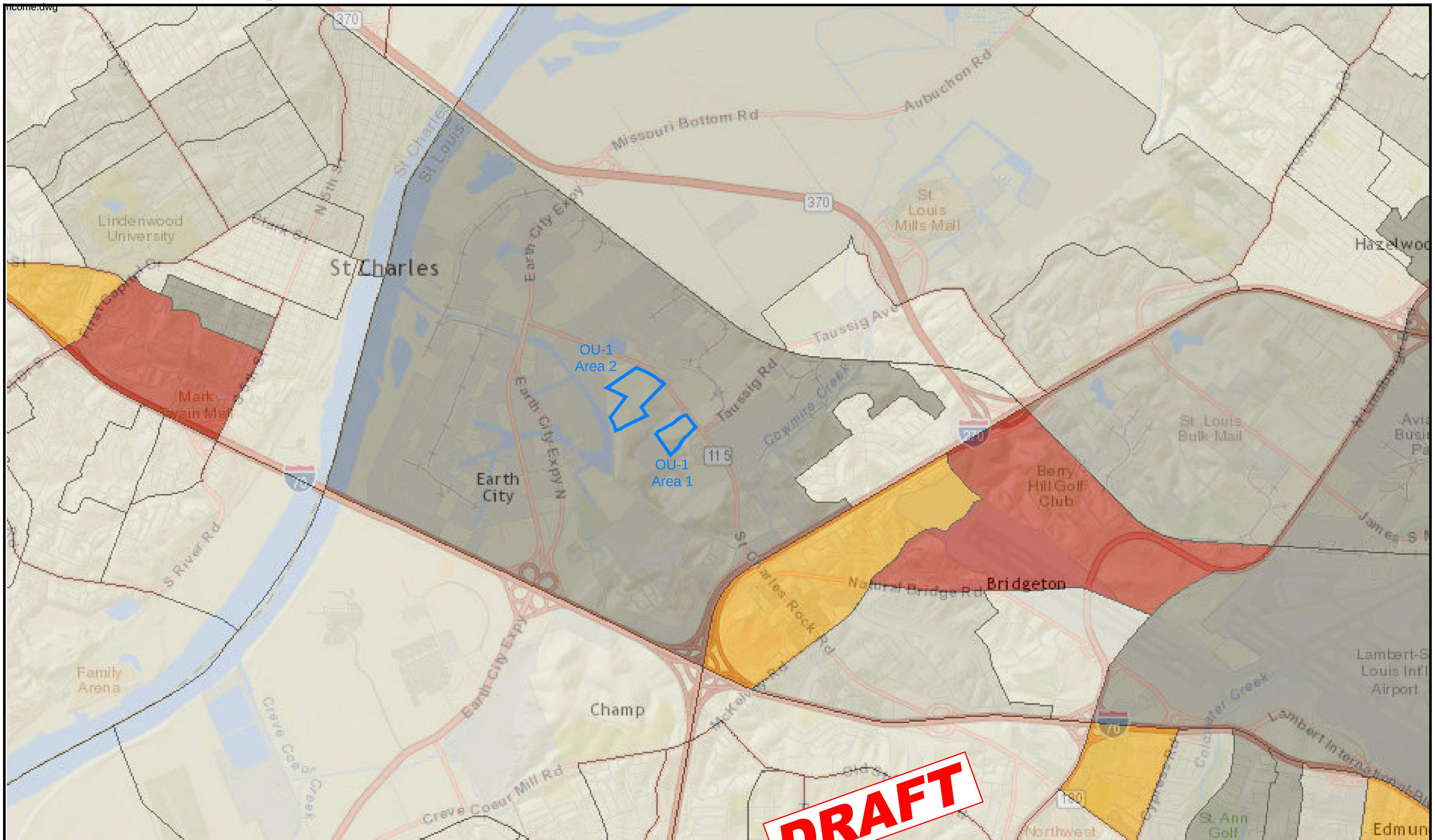
Figure 6-3

Minority
Population

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

M:\clients\EMSI\westlake\2016\Final-FS\Section-6\FIG-6-4_Low Income.dwg



August 13, 2016

EJSCREEN_Indexes

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Less than 50 percentile	60 -70 percentile
	70 -80 percentile
	80 - 90 percentile
	90 - 95 percentile
	95 - 100 percentile

1:72,224

0 0.5 1 2 mi

0 1 2 4 km

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

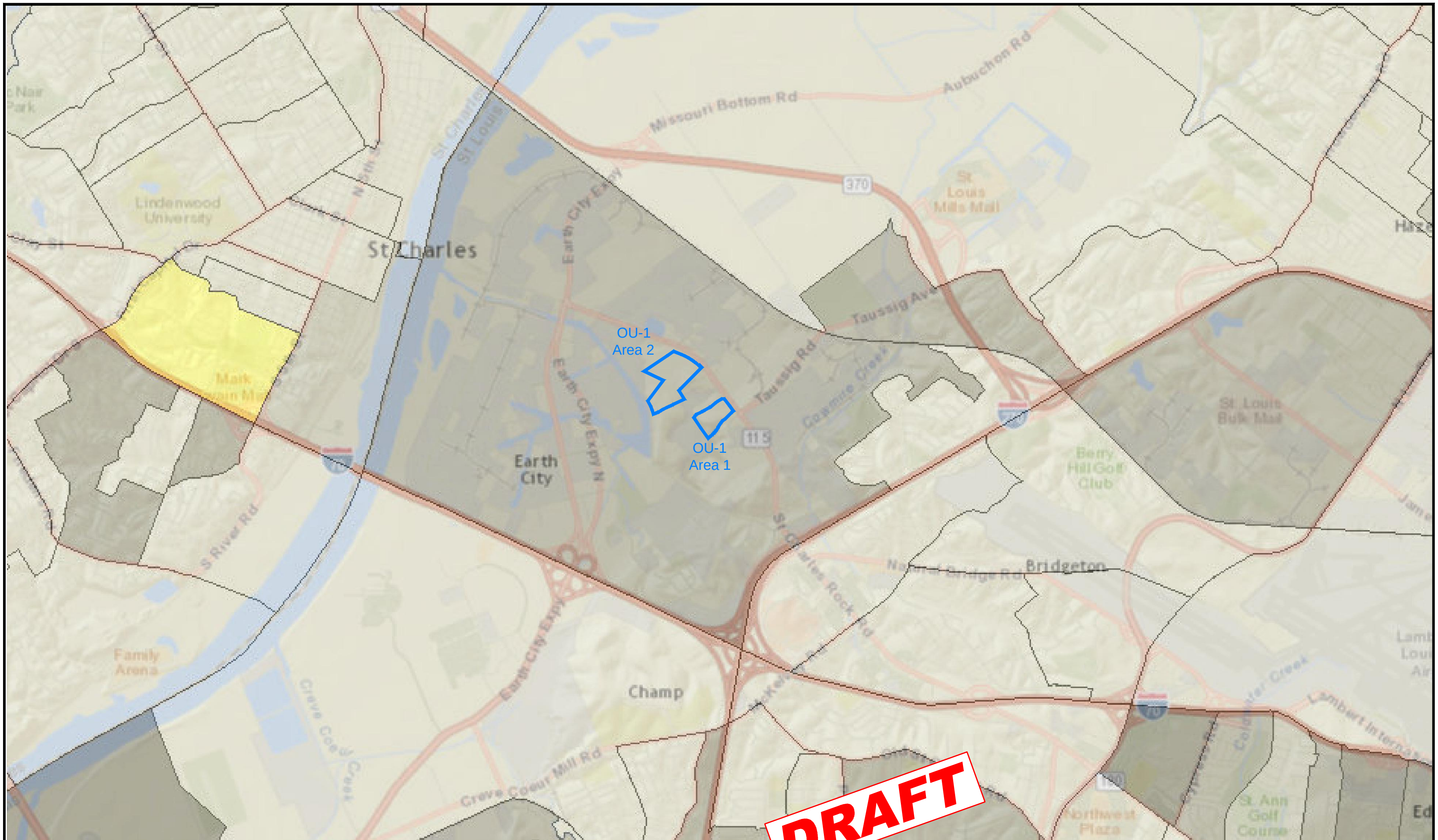
Figure 6-4

Low Income

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

M:\clients\EMSI\westlake\2016\Final-FS\Section-6\FIG-6-5_Linguistically-Isolated.dwg



August 13, 2016

EJSCREEN_Indexes

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- Less than 50 percentile
- 50 -60 percentile
- 60 -70 percentile
- 70 -80 percentile
- 80 - 90 percentile
- 90 - 95 percentile
- 95 - 100 percentile

1:72,224

0 0.5 1 2 mi

0 1 2 4 km

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

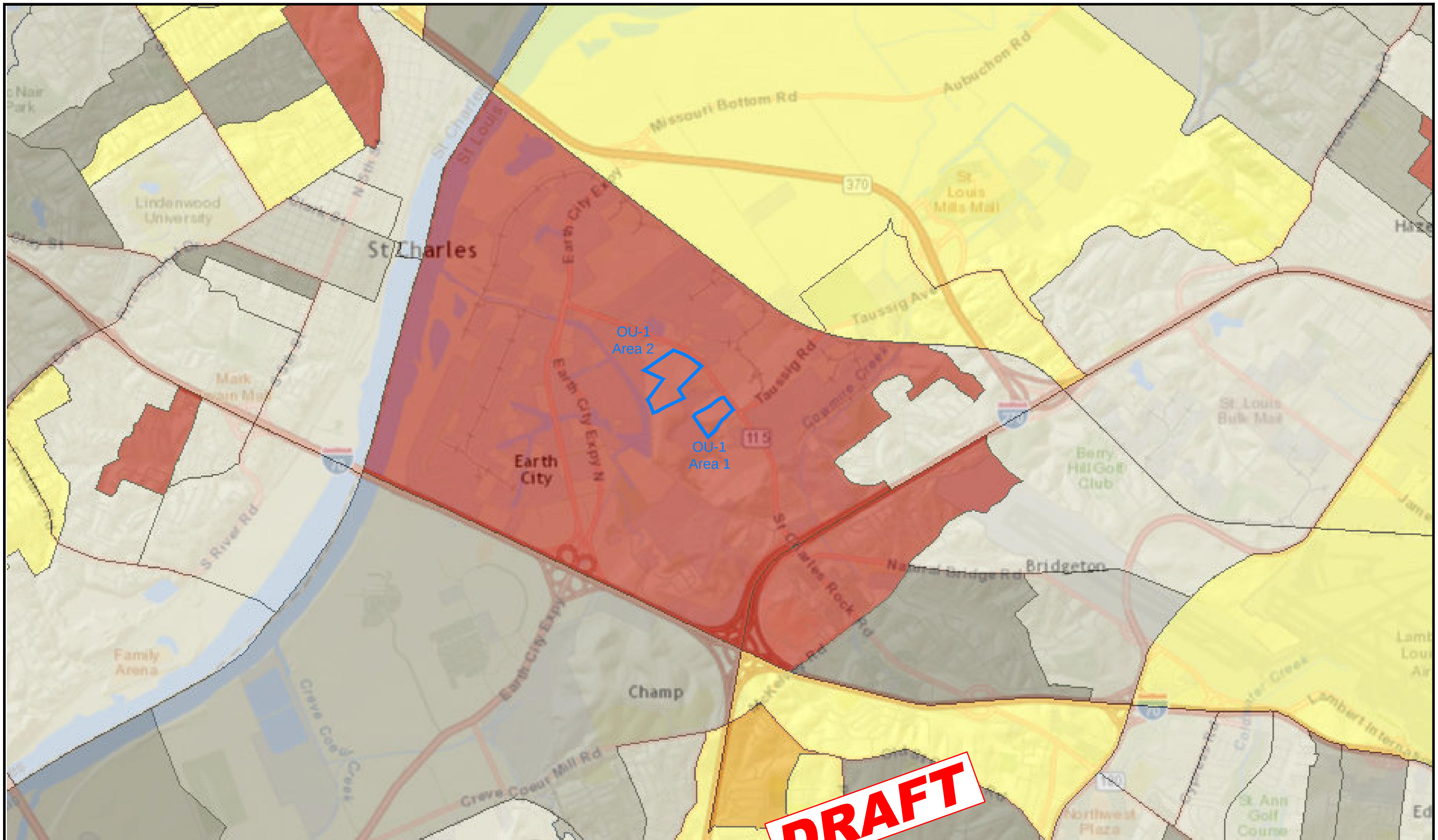
Figure 6-5

Linguistically Isolated

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

M:\clients\EMSI\westlake\2016\Final-FS\Section-6\FIG-6-6_Over-64.dwg



August 13, 2016

EJSCREEN_Indexes

- Data not available
- Less than 50 percentile
- 50 -60 percentile
- 60 -70 percentile
- 70 -80 percentile
- 80 - 90 percentile
- 90 - 95 percentile
- 95 - 100 percentile

1:72,224

0 0.5 1 2 mi

0 1 2 4 km

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

Figure 6-6

Over 64

West Lake Landfill OU-1 Final Feasibility Study

EMSI Engineering Management Support, Inc.

APPENDICES

APPENDIX A:

A-1: Existing Institutional Controls

A-2: City of St. Louis - Negative Easement and Restrictive Covenants on West Lake Landfill

A-3: Federal Aviation Administration
Record of Decision
Memorandum of Understanding
Advisory Circulars

A-4: Meeting Notes
September 7, 2010 Meeting with
St. Louis Airport Authority

A-5: St. Louis Airport Authority
September 20, 2010 Letter

Appendix A-1:

Existing Institutional Controls

MICHAEL D. HOCKLEY
DIRECT DIAL (816) 292-8233
mdh@spencerfane.com

File No. 2741000/1

July 30, 1997

David A. Hoefer, Esq.
Assistant Regional Counsel
Office of Regional Counsel
U.S. Environmental Protection Agency
Region VII
726 Minnesota Avenue
Kansas City, Kansas 66101

Re: West Lake Landfill Site, Declaration of Covenants and Restrictions

Dear David:

With this letter I enclose copies of the following documents:

1. Declaration of Covenants and Restrictions executed by West Lake Quarry and Material Company, recorded with the St. Louis County Recorder of Deeds on June 30, 1997 at Book 11208, Page 2499;

2. Declaration of Covenants and Restrictions executed by Rock Road Industries, Inc., recorded with the St. Louis County Recorder of Deeds on June 30, 19997 at Book 11208, Page 2508;

3. Declaration of Covenants and Restrictions executed by Laidlaw Waste Systems (Bridgeton) Inc., recorded with the St. Louis County Recorder of Deeds on June 30, 1997 at Book 11208, Page 2515.

By recording these Declarations of Covenants and Restrictions, future use of the area encompassed by the West Lake Superfund Site has been limited and cannot include residential use. To change such use, the Environmental Protection Agency, the Missouri Department of Natural Resources, and the owner of the affected premises would have to agree to such changes. Therefore, the West

212540.1

Lake Landfill Site Respondents believe that the only reasonable future use that should be considered for risk assessment purposes is a non-residential use.

Sincerely,

Michael D. Hockley

MDH:nrl

cc: Mr. Doug Borro
William R. Werner, Esq.
Charlotte L. Neitzel, Esq.
Mr. James W. Wagoner II
Mr. Paul V. Rosasco, P.E.
(All via mail, w/enclosure)

BP11208/2499

[redacted]

1997063000829

DANIEL T. O'LEARY
RECORDER OF DEEDS
ST. LOUIS COUNTY MISSOURI
41 SOUTH CENTRAL
CLAYTON, MO 63105

RECORDER OF DEEDS DOCUMENT IDENTIFICATION & CERTIFICATION SHEET

TYPE OF INSTRUMENT	GRANTOR	TO	GRANTEE
RESTR	WEST LAKE QUARRY AND MATERIAL CO ETAL		

PROPERTY DESCRIPTION: YOSTI PARTITION LOT PT 1 2 3 & 4

Lien Number	Notation	Document Number	Locator
		829	

STATE OF MISSOURI)
SS.
COUNTY OF ST. LOUIS)

I, the undersigned Recorder of Deeds for said County and State, do hereby certify that the following and annexed instrument of writing, which consists of 8 pages, (this page inclusive), was filed for record in my office on the 30 day of June 1997 at 02:30 PM and is truly recorded in the book and at the page shown at the top and/or bottom of this page.

In witness whereof I have hereunto set my hand and official seal the day, month and year aforesaid.

SEAL OF THE RECORDER OF DEEDS FOR ST. LOUIS COUNTY, MO

Daniel T. O'Leary
Recorder of Deeds
St. Louis County, Missouri

J. Allen
Deputy Recorder

RECORDING FEE $36.32

7

DECLARATION OF COVENANTS AND RESTRICTIONS

WEST LAKE QUARRY AND MATERIAL COMPANY

West Lake Quarry and Material Company, a Missouri corporation ("Declarant"), hereby (a) imposes the provisions of this Declaration upon the Premises (as defined below), (b) publishes and declares that the following terms, conditions, restrictions and obligations shall (i) affect and encumber the Premises, (ii) run with and be a burden upon and a benefit to the Premises, and (iii) be fully binding upon Declarant and all other persons or entities acquiring the Premises or any part thereof or interest therein whether by descent, devise, purchase or otherwise, and (c) declares that any person or entity, by the acceptance of title to the Premises or any part thereof or interest therein, shall thereby agree and covenant to abide by and be bound by the following terms, conditions, restrictions and obligations.

RECITALS

A. Declarant is the owner of certain real property (located in the City of Bridgeton, County of St. Louis, State of Missouri), legally described on Exhibit A, attached hereto and incorporated herein by this reference, which real property is herein referred to as the "Premises".

B. The Premises and nearly all real property in the immediate vicinity of the Premises have been used exclusively for more than 40 years for non-residential uses, primarily for commercial and industrial uses and in some cases, for agricultural uses.

C. Such uses have included, but have not been limited to, quarrying operations, demolition and sanitary landfill operations, asphalt and concrete batch plant operations, and vehicle maintenance, repair and body shop operations.

D. Such uses, and the character and nature of the land uses in the vicinity of the Premises, make the Premises unsuitable for any future residential use.

E. The United States Environmental Protection Agency ("EPA") has entered into an Administrative Order on Consent (the "Consent Order") with Cotter Corporation (N.S.L.), Laidlaw Waste Systems (Bridgeton) Inc., Rock Road Industries, Inc., and the United States Department of Energy.

F. The Consent Order, among other things, (i) provides for the investigation of the nature and extent of contamination and any threat to the public health, welfare, or the environment caused by the release or threatened release of hazardous substances at or from two isolated areas either on or in the vicinity of the Premises and which have been designated as Radiological Areas 1 and 2 in the Consent Order, and which contain low-level radioactive waste materials, and (ii) has been filed with the Regional Hearing Clerk, EPA, Region VII, 726 Minnesota Avenue, Kansas City, Kansas, Docket No. VII-93-F-0005.

G. Declarant desires to prohibit the present and future use of the Premises for any residential purpose in accordance with the terms and provisions of this Declaration.

DECLARATION

Declarant hereby states and declares as follows:

1. Neither the Premises, nor any portion thereof, shall be used now or hereafter for any residential purpose, or for any day care, preschool or other educational use.

2. This Declaration shall not unlawfully restrict and shall not be used to violate any federal law, rule, or regulation regarding the use of real estate, including, but not limited to, the Fair Housing Act.

3. No water well for drinking water use shall be installed on the Premises.

4. This Declaration shall be recorded in the office of the Recorder of Deeds for the County of St. Louis, State of Missouri.

5. Any deed or other instrument of conveyance for the Premises or any portion thereof shall be subject to this Declaration.

6. Each of EPA (or its successor), the Missouri Department of Natural Resources ("MDNR") (or its successor) and the owner of any portion of the Premises shall have the right to sue for and obtain an injunction, prohibitive or mandatory, to prevent the breach, or to enforce the observance, of this Declaration. This right shall be in addition to any other action available at law or in equity. The failure to enforce any covenant or restriction herein at the time of its violation shall not constitute a waiver of the right to do so later.

7. The provisions of this Declaration shall continue in full force and effect until the fiftieth anniversary of the date of this Declaration and thereafter for successive twenty-year periods unless, prior to the expiration of the then current term, a written notice of termination of this Declaration, executed by each of the then owners of the Premises and by authorized representatives of EPA (or its successor) and MDNR (or its successor), has been filed with the office of the Recorder of Deeds for St. Louis County, State of Missouri. A notice of termination of this Declaration may be filed at any time after the effective date of this Declaration, and the Declaration shall terminate on the date the notice of termination is filed with the Recorder of Deeds.

IN WITNESS WHEREOF, West Lake Quarry and Material Company has caused this instrument to be executed this 27th day of May, 1997.

WEST LAKE QUARRY AND MATERIAL COMPANY
a Missouri corporation

By: ______________________
William E. Whitaker
President

ACKNOWLEDGEMENT

STATE OF MISSOURI)
) ss
County OF ST. LOUIS)

On this 27th day of May, 1997, before me, a notary public, personally appeared William E. Whitaker, to me known, who, being by me duly sworn, did say that he is the President of West Lake Quarry and Material Company, a Missouri corporation, and that said instrument was signed on behalf of said corporation by authority of its Board of Directors, and said person acknowledged said instrument to be the free act and deed of said corporation.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal in the County and State aforesaid, the day and year first above written.

Margaret G. Cusumano
Notary Public

My Commission Expires:

November 5, 1998

MARGARET G CUSUMANO
NOTARY PUBLIC STATE OF MISSOURI
ST. LOUIS COUNTY
MY COMMISSION EXP. NOV. 5,1998

MARGARET G. CUSUMANO NOTARY PUBLIC NOTARY SEAL STATE OF

GRANTOR'S PROPERTY

A tract of land in part of Lots 1,2,3, and 4 of the Yosti Partition in U.S. Survey 131, part of Lot 21, of the St. Charles Ferry Company Tract in U.S. Survey 47 and 1934, part of U.S. Survey 131, and part of U.S. Survey 47 in Townships 46 and 47 North, Range 5 East of the 5th Principal Meridian, St. Louis County Missouri, described as follows:

Beginning at the most easterly corner of Lot 1 of the Yosti Partition in U.S. Survey 131, being a point in the centerline of Taussig Avenue; thence South 43 degrees 34 minutes 53 seconds East, along the northeasterly line of Lot 4 of the Yosti Partition, a distance of 99.92; thence South 6 degrees 41 minutes 15 seconds West, a distance of 68.96 feet; thence South 23 degrees 21 minutes 55 seconds West, a distance of 154.73 feet; thence South 26 degrees 49 minutes 07 East, a distance of 55.27 feet; thence South 14 degrees 32 minutes 36 seconds West, a distance of 143.63 feet; thence South 34 degrees 03 minutes 12 seconds West, a distance of 220.86 feet; thence North 55 degrees 41 minutes 34 seconds West, a distance of 127.00 feet; thence South 88 degrees 59 minutes 19 seconds West, a distance of 62.24 feet; thence South 54 degrees 43 minutes 18 seconds West, a distance of 240.50 feet; thence South 26 degrees 44 minutes 32 seconds West, a distance of 450.91 feet; thence South 8 degrees 25 minutes 49 seconds West, a distance of 224.01 feet; thence South 17 degrees 14 minutes 43 seconds East, a distance of 28.63 feet; thence South 47 degrees 09 minutes 44 seconds East, a distance of 61.27 feet; thence South 24 degrees 34 minutes 10 seconds East, a distance of 73.64 feet; thence South 0 degrees 07 minutes 21 seconds West, a distance of 107.37 feet to the northeasterly right of way line of the St. Charles Rock Road, 60 foot wide; thence North 61 degrees 07 minutes 11 seconds West, along said right of way line, a distance of 99.72 feet to the centerline of Taussig Avenue; thence North 28 degrees 07 minutes 01 seconds East, along said centerline, a distance of 100.00 feet to the intersection of said centerline and the southeasterly prolongation of the northeasterly line of a tract of land conveyed to American Telephone and Telegraph Company of Missouri by deed recorded in Book 1719 on Page 170; thence North 61 degrees 07 minutes 11 seconds West, along said line, a distance of 120.00 feet to the most northerly corner of said tract; thence South 28 degrees 07 minutes 01 seconds West, along the northwesterly line of said tract and its southwesterly extension, a distance of 130.00 feet to the centerline of the St. Charles Rock Road; thence North 61 degrees 07 minutes 11 seconds West, along said centerline a distance of 252.27 feet; thence North 51 degrees 56 minutes 32 seconds East, a distance of 311.60 feet; thence North 26 degrees 44 minutes 32 seconds East, a distance of 644.89 feet; thence North 56 degrees 34 minutes 13 seconds West, a distance of 296.04 feet; thence North 49 degrees 02 minutes 55 seconds West, a distance of 174.81 feet; thence North 7 degrees 43 minutes 38 seconds West, a distance of 65.61 feet; thence South 82 degrees 16 minutes 22 seconds West, a distance of 106.78 feet; thence around a curve to the right, having a radius of 150.00 feet and a chord bearing North 47 degrees 50 minutes 16 seconds West, a chord distance of 229.44 feet to a point of compound curve; thence around a curve to the right, having a radius of 450.00 feet and a chord bearing North 30 degrees 29 minutes 30 seconds East, a chord distance of 428.61 feet to its point of tangency; thence North 58 degrees 55 minutes 53 seconds East, a distance of 277.03 feet; thence North 2 degrees 03 minutes 23 seconds West, a distance of 332.12 feet; thence North 43 degrees 55 minutes 12 seconds West, a distance of 444.12 feet; thence North 39 degrees 22 minutes 26 seconds East, a distance of 463.83 feet; thence North 53 degrees 20 minutes 34 second East, a distance of 126.98 feet; thence South 50 degrees 18 minutes 12 seconds East, a distance of 205.86 feet; thence North 75 degrees 52 minutes 00 seconds East, a distance of 426.11 feet; thence North 51 degrees 12 minutes 40 seconds East, a distance of 277.46 feet to the southwesterly right of way line of Highway 40; also known as St. Charles Rock Road; thence South 43 degrees 53 minutes 31 seconds East, along said right of way line, a distance of 137.18 feet; thence leaving said right of way, South 51 degrees 12 minutes 40 seconds West, a distance of 1023.23 feet; thence South 25 degrees 58 minutes 41 seconds West, a distance of 181.33 feet to the northeasterly line of Lot 1 of the Yosti Partition of U.S. Survey 131; thence South 43 degrees 34 minutes 53 seconds East, along said northeasterly line, a distance of 971.20 feet to the Point of Beginning.

Excepting from the above the following:

A tract of land being part of Lots 1, 3, and 4 of the "Yosti Partition in U.S. Survey 131, townships 46 and 47 north, range 5 east of the Fifth Principal Meridian, St. Louis County, Missouri, more particularly described as follows:

Commencing at the intersection of the northwesterly line of U.S. Survey 131 and the southwesterly right of way line of Highway 40, also known as "St. Charles Rock Road;" thence South 37 degrees 11 minutes 39 seconds East, along said south right of way line, 209.98 feet; thence exiting said right of way line, South 57 degrees 54 minutes 32 seconds West, 1023.23 feet; thence South degrees 40 minutes 33 seconds West, 181.33 feet to the northeasterly line of said lot 1; thence South 36 degrees 53 minutes 01 seconds East, along said northeasterly line of lot 1, a distance of 591.05 feet to the point of beginning of the tract described herein; thence continuing along the northeasterly line of said lot 1 and along the northeasterly line of said lot 4, South 36 degrees 53 minutes 01 seconds East, 480.07 feet; thence exiting said northeasterly line, South 13 degrees 23 minutes 07 seconds West, 68.96 feet; thence South 30 degrees 03 minutes 47 seconds West, 154.73 feet; thence South 20 degrees 07 minutes 14 seconds East; 55.27 feet; thence South 21 degrees 14 minutes 28 seconds West, 143.63 feet; thence South 40 degrees 45 minutes 05 seconds West, 220.86 feet; thence North 48 degrees 59 minutes 42 seconds West, 127.00 feet; thence North 84 degrees 18 minutes 49 seconds West, 62.24 feet; thence South 61 degrees 25 minutes 10 seconds West, 240.50 feet; thence South 33 degrees 26 minutes 24 seconds West, 450.91 feet; thence South 15 degrees 07 minutes 41 seconds West, 224.01 feet; thence South 10 degrees 32 minutes 51 seconds East, 28.63 feet; thence South 40 degrees 27 minutes 52 seconds East, 61.27 feet; thence South 17 degrees 52 minutes 18 seconds East, 73.64 feet; thence South 06 degrees 49 minutes 13 seconds West, 107.37 feet to the north right of way line of "Old St. Charles Rock Road;" thence North 54 degrees 25 minutes 19 seconds West, along said right of way line, 99.72 feet; thence North 34 degrees 48 minutes 53 seconds East, 100.00 feet; thence exiting said west line, North 54 degrees 25 minutes 19 seconds West, 120.00 feet; thence North 21 degrees 27 minutes 09 seconds East, 153.52 feet; thence North 00 degrees 02 minutes 46 seconds West, 37.43 feet; thence North 56 degrees 33 minutes 36 seconds West, 70.00 feet; thence North 33 degrees 26 minutes 24 seconds East, 624.89 feet; thence South 49 degrees 52 minutes 21 seconds East, 56.85 feet; thence North 67 degrees 30 minutes 55 seconds East, 06.05 feet; thence North 08 degrees 48 minutes 44 seconds East, 158.15 feet; thence South 59 degrees 03 minutes 26 seconds East, 82.21 feet; thence North 33 degrees 28 minutes 55 seconds East, 321.44 feet; thence North 55 degrees 02 minutes 11 seconds West, 158.34 feet; thence North 01 degrees 10 minutes 17 seconds East, 342.38 feet to the point of beginning.

[redacted]

BP 11208/2507

1997063000830

DANIEL T. O'LEARY
RECORDER OF DEEDS
ST. LOUIS COUNTY MISSOURI
41 SOUTH CENTRAL
CLAYTON, MO 63105

RECORDER OF DEEDS DOCUMENT IDENTIFICATION & CERTIFICATION SHEET

TYPE OF INSTRUMENT	GRANTOR	TO	GRANTEE
RESTR	ROCK ROAD INDUSTRIES INC ETAL		

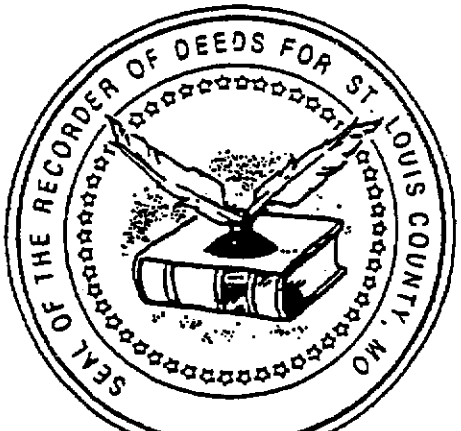
PROPERTY DESCRIPTION: SUR 131 T 47 R 5 W/O/P

Lien Number	Notation	Document Number	Locator
		830	

STATE OF MISSOURI)
SS.
COUNTY OF ST. LOUIS)

I, the undersigned Recorder of Deeds for said County and State, do hereby certify that the following and annexed instrument of writing, which consists of 7 pages, (this page inclusive), was filed for record in my office on the 30 day of June 1997 at 02:30 PM and is truly recorded in the book and at the page shown at the top and/or bottom of this page.

In witness whereof I have hereunto set my hand and official seal the day, month and year aforesaid.



Recorder of Deeds
St. Louis County, Missouri

Deputy Recorder

RECORDING FEE $33.32

(Paid at the time of Recording)

V

DECLARATION OF COVENANTS AND RESTRICTIONS

ROCK ROAD INDUSTRIES, INC.

Rock Road Industries, Inc., a Missouri corporation ("Declarant"), hereby (a) imposes the provisions of this Declaration upon the Premises (as defined below), (b) publishes and declares that the following terms, conditions, restrictions and obligations shall (i) affect and encumber the Premises, (ii) run with and be a burden upon and a benefit to the Premises, and (iii) be fully binding upon Declarant and all other persons or entities acquiring the Premises or any part thereof or interest therein whether by descent, devise, purchase or otherwise, and (c) declares that any person or entity, by the acceptance of title to the Premises or any part thereof or interest therein, shall thereby agree and covenant to abide by and be bound by the following terms, conditions, restrictions and obligations.

RECITALS

A. Declarant is the owner of certain real property (located in the City of Bridgeton, County of St. Louis, State of Missouri), legally described on Exhibit A, attached hereto and incorporated herein by this reference, which real property is herein referred to as the "Premises".

B. The Premises and nearly all real property in the immediate vicinity of the Premises have been used exclusively for more than 40 years for non-residential uses, primarily for commercial and industrial uses and in some cases, for agricultural uses.

C. Such uses have included, but have not been limited to, quarrying operations, demolition and sanitary landfill operations, asphalt and concrete batch plant operations, and vehicle maintenance, repair and body shop operations.

D. Such uses, and the character and nature of the land uses in the vicinity of the Premises, make the Premises unsuitable for any future residential use.

E. The United States Environmental Protection Agency ("EPA") has entered into an Administrative Order on Consent (the "Consent Order") with Cotter Corporation (N.S.L.), Declarant, Laidlaw Waste Systems (Bridgeton) Inc., and the United States Department of Energy.

F. The Consent Order, among other things, (i) provides for the investigation of the nature and extent of contamination and any threat to the public health, welfare, or the environment caused by the release or threatened release of hazardous substances at or from two isolated areas either on or in the vicinity of the Premises and which have been designated as Radiological Areas 1 and 2 in the Consent Order, and which contain low-level radioactive waste materials, and (ii) has been filed with the Regional Hearing Clerk, EPA, Region VII, 726 Minnesota Avenue, Kansas City, Kansas, Docket No. VII-93-F-0005.

G. Declarant desires to prohibit the present and future use of the Premises for any residential purpose in accordance with the terms and provisions of this Declaration.

DECLARATION

Declarant hereby states and declares as follows:

1. Neither the Premises, nor any portion thereof, shall be used now or hereafter for any residential purpose, or for any day care, preschool or other educational use.

2. This Declaration shall not unlawfully restrict and shall not be used to violate any federal law, rule, or regulation regarding the use of real estate, including, but not limited to, the Fair Housing Act.

3. No water well for drinking water use shall be installed on the Premises.

4. This Declaration shall be recorded in the office of the Recorder of Deeds for the County of St. Louis, State of Missouri.

5. Any deed or other instrument of conveyance for the Premises or any portion thereof shall be subject to this Declaration.

6. Each of EPA (or its successor), the Missouri Department of Natural Resources ("MDNR") (or its successor) and the owner of any portion of the Premises shall have the right to sue for and obtain an injunction, prohibitive or mandatory, to prevent the breach, or to enforce the observance, of this Declaration. This right shall be in addition to any other action available at law or in equity. The failure to enforce any covenant or restriction herein at the time of its violation shall not constitute a waiver of the right to do so later.

7. The provisions of this Declaration shall continue in full force and effect until the fiftieth anniversary of the date of this Declaration and thereafter for successive twenty-year periods unless, prior to the expiration of the then current term, a written notice of termination of this Declaration, executed by each of the then owners of the Premises and by authorized representatives of EPA (or its successor) and MDNR (or its successor), has been filed with the office of the Recorder of Deeds for St. Louis County, State of Missouri. A notice of termination of this Declaration may be filed at any time after the effective date of this Declaration, and the Declaration shall terminate on the date the notice of termination is filed with the Recorder of Deeds.

IN WITNESS WHEREOF, Rock Road Industries, Inc. has caused this instrument to be executed this 27th day of May, 1997.

ROCK ROAD INDUSTRIES, INC.
a Missouri corporation

By: __________________
William E. Whitaker
President

ACKNOWLEDGEMENT

STATE OF MISSOURI)
) ss
County OF ST. LOUIS)

On this 27th day of May, 1997, before me, a notary public, personally appeared William E. Whitaker, to me known, who, being by me duly sworn, did say that he is the President of Rock Road Industries, Inc., a Missouri corporation, and that said instrument was signed on behalf of said corporation by authority of its Board of Directors, and said person acknowledged said instrument to be the free act and deed of said corporation.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal in the County and State aforesaid, the day and year first above written.

Margaret G. Cusumano
Notary Public

My Commission Expires:

November 5, 1998

MARGARET G CUSUMANO
NOTARY PUBLIC STATE OF MISSOURI
ST. LOUIS COUNTY
MY COMMISSION EXP. NOV. 5,1998

MARGARET G. CUSUMANO NOTARY PUBLIC NOTARY SEAL STATE

EXHIBIT "A"

AREA 1

A tract of land in part of U.S. Survey 131, Township 47 North, Range 5 East of the 5th Principal Meridian, St. Louis County, Missouri, described as follows:

Commencing at the intersection of the northwesterly line, of U.S. Survey 131 and the southwesterly right of way line of Highway 40, also known as St. Charles Rock Road; thence South 43 degrees 53 minutes 31 seconds East, along said right of way line, a distance of 729.68 feet; thence South 40 degrees 49 minutes 32 seconds West, a distance of 92.54 feet to the Point of Beginning of the following described tract; thence continuing South 40 degrees 49 minutes 32 seconds West, a distance of 288.61 feet; thence South 89 degrees 29 minutes 50 seconds West, a distance of 241.41 feet; thence North 79 degrees 05 minutes 44 seconds West, a distance of 390.43 feet; thence North 29 degrees 48 minutes 55 seconds East, a distance of 499.73 feet; thence North 84 degrees 45 minutes 59 seconds East, a distance of 248.68 feet; thence South 32 degrees 24 minutes 17 seconds East, a distance of 201.28 feet;thence South 56 degrees 18 minutes 22 seconds East, a distance of 251.78 feet to the Point of Beginning.

AREA 2

A tract of land in part of Lot 20, of the St. Charles Ferry Company Tract in U.S. Survey 47 and 1934 and in part of U.S. Survey 47 Township 47 North, Range 5 East of the 5th Principal Meridian, St. Louis County, Missouri, described as follows:

Commencing at the intersection of the centerline of St. Charles Rock Road and the northwesterly line of Lot 20 of the St. Charles Ferry Company Tract; thence North 28 degrees 53 minutes 11 seconds East, along said northwesterly line, a distance of 148.48 feet of the Point of Beginning of the following described tract; thence continuing North 28 degrees 53 minutes 11 seconds East, along said line, a distance of 676.08 feet to the northwest corner of said Lot 20; thence North 72 degrees 46 minutes 42 seconds West, along the northerly line of Lot 19 of the St. Charles Ferry Company tract, a distance of 674.79 feet;thence North 47 degrees 43 minutes 02 seconds East, a distance of 906.64 feet; thence South 64 degrees 46 minutes 52 seconds East, a distance of 389.58 feet; thence South 76 degrees 30 minutes 26 seconds East, a distance of 245.51 feet; thence South 60 degrees 07 minutes 01 seconds East, a distance of 283.36 feet; thence South 31 degrees 26 minutes 39 seconds West, a distance of 1136.42 feet; thence South 33 degrees 08 minutes 25 seconds West, a distance of 109.40 feet; thence South 34 degrees 54 minutes 38 seconds East, a distance of 149.81 feet; thence South 44 degrees 29 minutes 33 seconds West, a distance of 267.70 feet; thence North 78 degrees 25 minutes 41 seconds West, a distance of 241.02 feet; thence North 34 degrees 31 minutes 30 seconds West, a distance of 351.19 feet to the Point of Beginning.

DI 11200/ L317

[redacted]

1997063000831

DANIEL T. O'LEARY
RECORDER OF DEEDS
ST. LOUIS COUNTY MISSOURI
41 SOUTH CENTRAL
CLAYTON, MO 63105

RECORDER OF DEEDS DOCUMENT IDENTIFICATION & CERTIFICATION SHEET

TYPE OF INSTRUMENT	GRANTOR	TO	GRANTEE
RESTR	LAIDLAW WASTE SYSTEMS BRIDGETON INC ETAL		

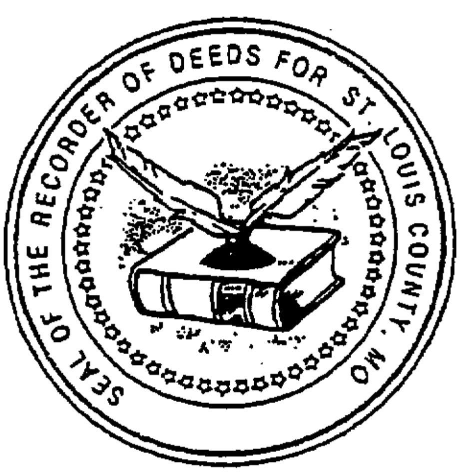
PROPERTY DESCRIPTION: YOSTI PARTITION LOT PT 1 2 & 3

Lien Number	Notation	Document Number	Locator
		831	

STATE OF MISSOURI)
SS.
COUNTY OF ST. LOUIS)

I, the undersigned Recorder of Deeds for said County and State, do hereby certify that the following and annexed instrument of writing, which consists of 10 pages, (this page inclusive), was filed for record in my office on the 30 day of June 1997 at 02:30 PM and is truly recorded in the book and at the page shown at the top and/or bottom of this page.

In witness whereof I have hereunto set my hand and official seal the day, month and year aforesaid.



Daniel T. O'Leary
Recorder of Deeds
St. Louis County, Missouri

J. Allen
Deputy Recorder

RECORDING FEE $42.32

(Paid at the time of Recording)

9

DECLARATION OF COVENANTS AND RESTRICTIONS
LAIDLAW WASTE SYSTEMS (BRIDGETON) INC.

Laidlaw Waste Systems (Bridgeton) Inc. f/k/a/ West Lake Landfill, Inc., a Missouri corporation ("Declarant"), hereby (a) imposes the provisions of this Declaration upon the Premises (as defined below), (b) publishes and declares that the following terms, conditions, restrictions and obligations shall (i) affect and encumber the Premises, (ii) run with and be a burden upon and a benefit to the Premises, and (iii) be fully binding upon Declarant and all persons or entities acquiring the Premises or any part thereof or interest therein whether by descent, devise, purchase or otherwise, and (c) declares that any person or entity, by the acceptance of title to the Premises or any part thereof or interest therein, shall thereby agree and covenant to abide by and be bound by the following terms, conditions, restrictions and obligations.

RECITALS

A. Declarant is the owner of certain real property (located in the City of Bridgeton, County of St. Louis, State of Missouri), legally described on Exhibit 1, attached hereto and incorporated herein by this reference, which real property is herein referred to as the "Premises".

B. The Premises and nearly all real property in the immediate vicinity of the Premises have been used exclusively for more than 40 years for non-residential uses, primarily for commercial and industrial uses and in some cases, for agricultural uses.

C. Such uses have included, but have not been limited to, quarrying operations, demolition and sanitary landfill operations, asphalt and concrete batch plant operations, and vehicle maintenance, repair and body shop operations.

D. Such uses, and the character and nature of the land uses in the vicinity of the Premises, make the Premises unsuitable for any future residential use.

E. The United States Environmental Protection Agency ("EPA") has entered into an Administrative Order on Consent (the "Consent Order") with Cotter Corporation (N.S.L.), Declarant, Rock Road Industries, Inc., and the United States Department of Energy.

F. The Consent Order, among other things, (i) provides for the investigation of the nature and extent of contamination and any threat to the public health, welfare, or the environment caused by the release or threatened release of hazardous substances at or from two isolated areas either on or in the vicinity of the Premises, which have been designated as Radiological Areas 1 and 2 in the Consent Order, and which contain low-level radioactive waste materials, and (ii) has been filed with the Regional Hearing Clerk, EPA, Region VII, 726 Minnesota Avenue, Kansas City, Kansas, Docket No. VII-93-F-0005.

G. The EPA and Declarant have entered into an additional Administrative Order on Consent, which has been filed with the Regional Hearing Clerk, EPA, Region VII, 726 Minnesota Avenue, Kansas City, Kansas, Docket No. VII-94-F-0025, to investigate the nature and extent of any potential contamination at the Premises (other than Radiological Areas 1 and 2) relating to the historical use of the Premises.

H. Declarant desires to prohibit the present and future use of the Premises for any residential purpose in accordance with the terms and provisions of this Declaration.

DECLARATION

Declarant hereby states and declares as follows:

1. Neither the Premises, nor any portion thereof, shall be used now or hereafter for any residential purpose, or for any day care, preschool, or other educational use.

2. This Declaration shall not unlawfully restrict and shall not be used to violate any federal law, rule, or regulation regarding the use of real estate, including, but not limited to, the Fair Housing Act.

3. No water well for drinking water use shall be installed on the Premises.

4. This Declaration shall be recorded in the office of the Recorder of Deeds for the County of St. Louis, State of Missouri.

5. Any deed or other instrument of conveyance for the Premises or any portion therefor shall be subject to this Declaration.

6. Each of EPA (or its successor), the Missouri Department of Natural Resources ("MDNR") (or its successor), and the owner of any portion of the Premises shall have the right to sue for and

obtain an injunction, prohibitive or mandatory, to prevent the breach, or to enforce the observance, of this Declaration. This right shall be in addition to any other action available at law or in equity. The failure to enforce any covenant or restriction herein at the time of its violation shall not constitute a waiver of the right to do so later.

7. The provisions of this Declaration shall continue in full force and effect until the fiftieth anniversary of the date of this Declaration and thereafter for successive twenty-year periods unless, prior to the expiration of the then current term, a written notice of termination of this Declaration, executed by each of the then owners of the Premises and by authorized representatives of EPA (or its successor) and MDNR (or its successor), has been filed with the office of the Recorder of Deeds for St. Louis County, State of Missouri. A notice of termination of this Declaration may be filed at any time after the effective date of this Declaration, and the Declaration shall terminate on the date the notice of termination is filed with the Recorder of Deeds.

IN WITNESS WHEREOF, Laidlaw Waste Systems (Bridgeton) Inc. has caused this instrument to be executed this 9th day of June, 1997.

LAIDLAW WASTE SYSTEMS
(BRIDGETON) INC.

By ______________________

ACKNOWLEDGMENT

STATE OF Arizona)
) SS.
COUNTY OF Maricopa)

On this 9th day of June, 1997, before me, a notary public, personally appeared Steven Helm, to me known, who, being by me duly sworn, did say that he is the Vice President of Laidlaw Waste Systems (Bridgeton) Inc., a Missouri corporation, and that said instrument was signed on behalf of said corporation by authority of its Board of Directors, and said person acknowledged said instrument to be the free act and deed of said corporation.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal in the County and State aforesaid, the day and year first above written.

Mary Deborah Stoup
Notary Public

My commission expires:
5/16/99

MARY DEBORAH STOUP NOTARY PUBLIC MARICOPA COUNTY, AZ

EXHIBIT "1"

Landfill Area

Tract 1

tract of land in part of Lots 1,2, and 3 of the Yosti Partition in U.S. Survey 131, part of Lots 20,21, and 22 of the St. Charles Ferry Company Tract in U.S. Survey 47 and 1934, part of U.S. Survey 131, and part of U.S. Survey 47 in Townships 46 and 47 North, Range 5 East of the 5th Principal Meridian, St. Louis County Missouri, described as follows:

Beginning at the intersection of the northwesterly line of U.S. Survey 131 and the southwesterly right of way line of Highway 40, also known as St. Charles Rock Road; thence South 43 degrees 53 minutes 31 seconds East, along said right of way line, a distance of 72.80 feet; thence South 51 degrees 12 minutes 40 seconds West, a distance of 277.46 feet; thence South 75 degrees 52 minutes 00 seconds West, a distance of 426.11 feet; thence North 50 degrees 18 minutes 12 seconds West, a distance of 205.86 feet; thence South 53 degrees 20 minutes 34 seconds West, a distance of 126.98 feet; thence South 39 degrees 22 minutes 26 seconds West, a distance of 463.83 feet; thence South 43 degrees 55 minutes 12 seconds East, a distance of 444.12 feet; thence South 2 degrees 03 minutes 23 seconds East, a distance of 332.12 feet; thence South 58 degrees 55 minutes 53 seconds West, a distance of 277.03 feet; thence around a curve to the left, having a radius of 450.00 feet and a chord bearing South 30 degrees 29 minutes 30 seconds West, a chord distance of 428.61 feet to a point of compound curve; thence around a curve to the left, having a radius of 150.00 feet and a chord bearing South 47 degrees) minutes 16 seconds East, a chord distance of 229.44 feet to its point of tangency; thence North 82 degrees 16 minutes 22 seconds East, a distance of 106.78 feet; thence South 7 degrees 43 minutes 38 seconds East, a distance of 65.61 feet; thence South 49 degrees 02 minutes 55 seconds East, a distance of 174.81 feet; thence South 56 degrees 34 minutes 13 seconds East, a distance of 296.04 feet; thence South 26 degrees 44 minutes 32 seconds West, a distance of 644.89 feet; thence South 51 degrees 56 minutes 32 seconds West, a distance of 311.60 feet to the centerline of St. Charles Rock Road; thence along said centerline the following courses and distances: North 61 degrees 07 minutes 11 seconds West, a distance of 739.36 feet; North 5 degrees 58 minutes 11 seconds West, a distance of 997.50 feet; North 11 degrees 22 minutes 11 seconds West, a distance of 477.70 feet; North 17 degrees 07 minutes 11 seconds West, a distance of 348.30 feet; North 31 degrees 34 minutes 11 seconds West, a distance of 349.50 feet; North 38 degrees 50 minutes 11 seconds West, a distance of 22.38 feet to the northwest line of Lot 20 of the St. Charles Ferry Company Tract; thence North 28 degrees 53 minutes 11 seconds East, along said Northwest line, a distance of 824.56 feet to the Northwest corner of said Lot 20; thence North 72 degrees 46 minutes 42 seconds West, along the North line of Lot 19 of the St. Charles Ferry Company Tract, a distance of 674.79 feet; thence North 47 degrees 43 minutes 02 seconds East, a distance of 1137.84 feet to the Southwesterly right of way line of Highway 40 also known as St. Charles Rock Road; thence along said right of way line the following courses and distances; thence South 75 degrees 56 minutes 31 seconds East, a distance of 260.00 feet; thence around a curve to the right, having a radius of 1825.08 feet and a chord bearing South 65 degrees 11 minutes 52 seconds East, a chord distance of 680.49 feet; thence

North 35 degrees 32 minutes 48 seconds East, a distance of 30.00 feet; thence around a curve to the right, having a radius of 1855.08 feet and a chord bearing South 49 degrees 10 minutes 22 seconds East, chord distance of 341.47 feet; thence South 43 degrees 53 minutes 31 seconds East, a distance of 47.91 feet; thence South 46 degress 06 minutes 29 seconds West, a distance of 15.00 feet; thence South 43 degrees 53 minutes 31 seconds East, a distance of 34.28 feet; thence South 55 degrees 55 minutes 28 seconds East, a distance of 95.94 feet; thence South 43 degrees 53 minutes 31 seconds East, a distance of 602.78 feet to the Point of Beginning and containing 111.80 Acres.

Tract 2

A tract of land in part of Lots 1,3, and 4 of the Yosti Partition in U.S. Survey 131, and part of U.S. Survey 131, in Townships 46 and 47 North, Range 5 East of the 5th Principal Meridian, St. Louis County, Missouri, described as follows:

Beginning at the most easterly corner of Lot 1 of the Yosti Partition in U.S. Survey 131, being a point in the centerline of Taussig Avenue; thence South 43 degrees 34 minutes 53 seconds East, along the northeasterly line of Lot 4 of the Yosti Partition, a distance of 99.92 feet; thence South 6 degrees 41 minutes 15 seconds West, a distance of 68.96 feet; thence South 23 degrees 21 minutes 55 seconds West, a distance of 154.73 feet; thence South 26 degrees 49 minutes 07 seconds East, a distance of 55.27 feet; thence South 14 degrees 32 minutes 36 seconds West, a distance of 143.63 feet; thence South 34 degrees 03 minutes 12 seconds West, a distance of 220.86 feet; thence North 55 degrees 41 minutes 34 seconds West, a distance of 127.00 feet; thence South 88 degrees 59 minutes 19 seconds West, a distance of 62.24 feet; thence South 54 degrees 43 minutes 18 seconds West, a distance of 240.50 feet; thence South 26 degrees 44 minutes 32 seconds West, a distance of 450.91 feet; thence South 8 degrees 25 minutes 49 seconds West, a distance of 224.01 feet; thence South 17 degrees 14 minutes 43 seconds East, a distance of 28.63 feet; thence South 47 degrees 09 minutes 44 seconds East, a distance of 61.27 feet; thence South 24 degrees 34 minutes 10 seconds East, a distance of 73.64 feet; thence South 0 degrees 07 minutes 21 seconds West, a distance of 107.37 feet to the northeasterly right of way line of the St. Charles Rock Road, 60 foot wide; thence South 61 degrees 07 minutes 11 seconds East, along said right of way line, a distance of 758.45 feet to the most southerly corner of Lot 4 of said Yosti Partition; thence North 39 degrees 17 minutes 12 seconds East, along the southeasterly line of said Lot 4, a distance of 1349.58 feet to the most easterly corner thereof; thence North 43 degrees 34 minutes 53 seconds West, along the northeasterly line of said lot 4, a distance of 779.68 feet to a point 50.00 feet southeasterly of the most southerly corner of a tract of land conveyed to John Guerra and wife by deed recorded in Book 1642 on Page 263; thence North 46 degrees 24 minutes 31 seconds East, parallel with the southeasterly line of said Guerra tract, a distance of 437.11 feet; thence North 43 degrees 34 minutes 53 seconds West, parallel with the northeasterly line of said Guerra tract, a distance of 486.26 feet to the centerline of Taussig Avenue; thence North 41 degrees 52 minutes 29 seconds East, along said centerline, a distance of 68.21 feet; thence North 47 degrees 48 minutes 29 seconds East, along said centerline, a distance of 340.00 feet; thence North 42 degrees 11 minutes 31 seconds West, a distance of 30.00 feet to the northwesterly right of way line of said Taussig Avenue; thence North 47 degrees 48 minutes

29 seconds East, along said right of way a distance of 312.95 feet; thence North 5 degrees 09 minutes 06 seconds West, continuing along said right of way, a distance of 57.50 feet to the southwesterly right of way of Highway 40, also known as St. Charles Rock Road; thence North 43 degrees 53 minutes 31 seconds West, along said southwesterly right of way line, a distance of 877.45 feet; thence South 51 degrees 12 minutes 40 seconds West, a distance of 1023.23 feet; thence South 25 degrees 58 minutes 41 seconds West, a distance of 181.33 feet, to the northeasterly line of Lot 1 of the Yosti Partition of U.S. Survey 131; thence South 43 degrees 34 minutes 53 seconds East, along said northeasterly line, a distance of 971.20 feet to the Point of Beginning.

Tract 3

A tract of land being part of Lots 1, 3, and 4 of the "Yosti Partition in U.S. Survey 131, townships 46 and 47 north, range 5 east of the Fifth Principal Meridian, St. Louis County, Missouri, more particularly described as follows:

Commencing at the intersection of the northwesterly line of U.S. Survey 131 and the southwesterly right of way line of Highway 40, also known as "St. Charles Rock Road;" thence South 37 degrees 11 minutes 39 seconds East, along said south right of way line, 209.98 feet; thence exiting said right of way line, South 57 degrees 54 minutes 32 seconds West, 1023.23 feet; thence South 32 degrees 40 minutes 33 seconds West, 181.33 feet to the northeasterly line of said lot 1; thence South 36 degrees 53 minutes 01 seconds East, along said northeasterly line of lot 1, a distance of 591.05 feet to the point of beginning of the tract described herein; thence continuing along the northeasterly line of said lot 1 and along the northeasterly line of said lot 4, South 36 degrees 53 minutes 01 seconds East, 480.07 feet; thence exiting said northeasterly line, South 13 degrees 23 minutes 07 seconds West, 68.96 feet; thence South 30 degrees 03 minutes 47 seconds West, 154.73 feet; thence South 20 degrees 07 minutes 14 seconds East, 55.27 feet; thence South 21 degrees 14 minutes 28 seconds West, 143.63 feet; thence South 40 degrees 45 minutes 05 seconds West, 220.86 feet; thence North 48 degrees 59 minutes 42 seconds West, 127.00 feet; thence North 84 degrees 18 minutes 49 seconds West, 62.24 feet; thence South 61 degrees 25 minutes 10 seconds West, 240.50 feet; thence South 33 degrees 26 minutes 24 seconds West, 450.91 feet; thence South 15 degrees 07 minutes 41 seconds West, 224.01 feet; thence South 10 degrees 32 minutes 51 seconds East, 28.63 feet; thence South 40 degrees 27 minutes 52 seconds East, 61.27 feet; thence South 17 degrees 52 minutes 18 seconds East, 73.64 feet; thence South 06 degrees 49 minutes 13 seconds West, 107.37 feet to the north right of way line of "Old St. Charles Rock Road;" thence North 54 degrees 25 minutes 19 seconds West, along said right of way line, 99.72 feet; thence North 34 degrees 48 minutes 53 seconds East, 100.00 feet; thence exiting said west line, North 54 degrees 25 minutes 19 seconds West, 120.00 feet; thence North 21 degrees 27 minutes 09 seconds East, 153.52 feet; thence North 00 degrees 02 minutes 46 seconds West, 37.43 feet; thence North 56 degrees 33 minutes 36 seconds West, 70.00 feet; thence North 33 degrees 26 minutes 24 seconds East, 624.89 feet; thence South 49 degrees 52 minutes 21 seconds East, 56.85 feet; thence North 67 degrees 30 minutes 55 seconds East, _6.05 feet; thence North 08 degrees 48 minutes 44 seconds East, 158.15 feet; thence South 59 degrees 03 minutes 26 seconds East, 82.21 feet; thence North 3_ degrees 28 minutes 55 seconds East, 321.44 feet; thence North 55 degrees 02 minutes 11 seconds West, 158.34 feet; thence North 01 degrees 10 minutes 17 seconds East, 342.38 feet to the point of beginning.

Excluding from the above tracts the real property sometimes referred to as Area 1 and Area 2, and more particularly described as follows:

AREA 1

A tract of land in part of U.S. Survey 131, Township 47 North, Range 5 East of the 5th Principal Meridian, St. Louis County, Missouri, described as follows:

Commencing at the intersection of the northwesterly line, of U.S. Survey 131 and the southwesterly right of way line of Highway 40, also known as St. Charles Rock Road; thence South 43 degrees 53 minutes 31 seconds East, along said right of way line, a distance of 729.68 feet; thence South 40 degrees 49 minutes 32 seconds West, a distance of 92.54 feet to the Point of Beginning of the following described tract; thence continuing South 40 degrees 49 minutes 32 seconds West, a distance of 288.61 feet; thence South 89 degrees 29 minutes 50 seconds West, a distance of 241.41 feet; thence North 79 degrees 05 minutes 44 seconds West, a distance of 390.43 feet; thence North 29 degrees 48 minutes 55 seconds East, a distance of 499.73 feet; thence North 84 degrees 45 minutes 59 seconds East, a distance of 248.68 feet; thence South 32 degrees 24 minutes 17 seconds East, a distance of 201.28 feet;thence South 56 degrees 18 minutes 22 seconds East, a distance of 251.78 feet to the Point of Beginning.

AREA 2

A tract of land in part of Lot 20, of the St. Charles Ferry Company Tract in U.S. Survey 47 and 1934 and in part of U.S. Survey 47 Township 47 North, Range 5 East of the 5th Principal Meridian, St. Louis County, Missouri, described as follows:

Commencing at the intersection of the centerline of St. Charles Rock Road and the northwesterly line of Lot 20 of the St. Charles Ferry Company Tract; thence North 28 degrees 53 minutes 11 seconds East, along said northwesterly line, a distance of 148.48 feet of the Point of Beginning of the following described tract; thence continuing North 28 degrees 53 minutes 11 seconds East, along said line, a distance of 676.08 feet to the northwest corner of said Lot 20; thence North 72 degrees 46 minutes 42 seconds West, along the northerly line of Lot 19 of the St. Charles Ferry Company tract, a distance of 674.79 feet;thence North 47 degrees 43 minutes 02 seconds East, a distance of 906.64 feet; thence South 64 degrees 46 minutes 52 seconds East, a distance of 389.58 feet; thence South 76 degrees 30 minutes 26 seconds East, a distance of 245.51 feet; thence South 60 degrees 07 minutes 01 seconds East, a distance of 283.36 feet; thence South 31 degrees 26 minutes 39 seconds West, a distance of 1136.42 feet; thence South 33 degrees 08 minutes 25 seconds West, a distance of 109.40 feet; thence South 34 degrees 54 minutes 38 seconds East, a distance of 149.81 feet; thence South 44 degrees 29 minutes 33 seconds West, a distance of 267.70 feet; thence North 78 degrees 25 minutes 41 seconds West, a distance of 241.02 feet; thence North 34 degrees 31 minutes 30 seconds West, a distance of 351.19 feet to the Point of Beginning.

THE STOLAR PARTNERSHIP
ATTORNEYS AT LAW
THE LAMMERT BUILDING
911 WASHINGTON AVENUE
ST. LOUIS, MISSOURI 63101-1290
(314) 231-2800

TELEFAX: (314) 436-8400

WILLIAM R. WERNER
Email: WRW@TSPSTL.COM

H.M. STOLAR
(RETIRED 1984)

February 5, 1998

David A. Hoefer, Esq.
Office of Regional Counsel
U.S. Environmental Protection
Agency - Region VII
726 Minnesota Ave.
Kansas City, KS 66101

RE: West Lake Landfill Site - Supplemental Declaration of Covenants and Restrictions

Dear David;

Attached for your file is a copy of the Supplemental Declaration of Covenants and Restrictions which was executed on behalf of Rock Road Industries, Inc. subsequent to your review. The Declaration has been recorded with the St. Louis County Recorder of Deeds at the Book and Page number shown on the enclosed copy.

Very truly yours,

William R. Werner

WRW:jvb
Enclosure
cc(w/enc): John Frazier
Angela Foster
Michael Hockley
Charlotte Neitzel
Paul Rosasco
James Wagoner II

[redacted]

199801200 1106

DANIEL T. O'LEARY
RECORDER OF DEEDS
ST. LOUIS COUNTY MISSOURI
41 SOUTH CENTRAL
CLAYTON, MO 63105

RECORDER OF DEEDS DOCUMENT IDENTIFICATION & CERTIFICATION SHEET

TYPE OF INSTRUMENT	GRANTOR	TO	GRANTEE
RESTR	**ROCK ROAD INDUSTRIES INC**		

PROPERTY DESCRIPTION: **SUR 131 T 47 R 5 W/O/P**

Lien Number	Notation	Document Number	Locator
		1,106	

STATE OF MISSOURI)
SS.
COUNTY OF ST. LOUIS)

I, the undersigned Recorder of Deeds for said County and State, do hereby certify that the following and annexed instrument of writing, which consists of 6 pages, (this page inclusive), was filed for record in my office on the 20 day of January 1998 at 04:27 PM and is truly recorded in the book and at the page shown at the top and/or bottom of this page.

In witness whereof I have hereunto set my hand and official seal the day, month and year aforesaid.

ʖ

SUPPLEMENTAL DECLARATION OF COVENANTS AND RESTRICTIONS

ROCK ROAD INDUSTRIES, INC.

Rock Road Industries, Inc., a Missouri corporation ("Declarant"), hereby (a) imposes the provisions of this Supplemental Declaration upon the Premises (as defined below), (b) publishes and declares that the following terms, conditions, restrictions and obligations shall (i) affect and encumber the Premises, (ii) run with and be a burden upon and a benefit to the Premises, and (iii) be fully binding upon Declarant and all other persons or entities acquiring the Premises or any part thereof or interest therein whether by descent, devise, purchase or otherwise, and (c) declares that any person or entity, by the acceptance of title to the Premises or any part thereof or interest therein, shall thereby agree and covenant to abide by and be bound by the following terms, conditions, restrictions and obligations.

RECITALS

A. Declarant is the owner of certain real property (located in the City of Bridgeton, County of St. Louis, State of Missouri), legally described on Exhibit A, attached hereto and incorporated herein by this reference, which real property is herein referred to as the "Premises".

B. The United States Environmental Protection Agency ("EPA") has entered into an Administrative Order on Consent (the "Consent Order") with Cotter Corporation (N.S.L.), Declarant, Laidlaw Waste Systems (Bridgeton) Inc., and the United States Department of Energy for a Remedial Investigation and Feasibility Study.

C. The Consent Order, among other things, (i) provides for the investigation of the nature and extent of contamination and any threat to the public health, welfare, or the environment caused by the release or threatened release of hazardous substances at or from two isolated areas either on or in the vicinity of the Premises and which have been designated as Radiological Areas 1 and 2 in the Consent Order, and which contain low-level radioactive waste materials (the "Environmental Condition"), and (ii) has been filed with the Regional Hearing Clerk, EPA, Region VII, 726 Minnesota Avenue, Kansas City, Kansas, Docket No. VII-93-F-0005.

D. The Premises is subject to a Declaration of Covenants and Restrictions dated May 27, 1997, which is recorded in Book 11208 Page 2507 in the St. Louis County Recorder of Deeds Office (the "May 1997 Declaration").

E. In addition to the restrictions contained in the May 1997 Declaration, Declarant desires to prohibit in perpetuity (i) the construction or placement upon the Premises of any building for any purpose, and (ii) the installation of underground utilities, pipes and/or excavation upon the Premises, except as set forth herein.

DECLARATION

Declarant hereby states and declares as follows:

1. No building of any kind or nature for any purpose shall be constructed or placed on the Premises, now or at any time in the future, in perpetuity. In addition, no underground utilities or pipes shall be installed at the Premises and no excavation work shall be performed on the Premises, now or at any time in the future, in perpetuity, except such utilities, pipes and/or excavation work, if any, which (a) are approved by EPA in connection with a plan selected by EPA to remediate the Environmental Condition and are performed in accordance with safety regulations applicable to such remedial plan or otherwise required by EPA as a condition of such approval, or (b) are any part of a landfill gas control, leachate collection, or surface water management system installed and operated pursuant to a plan approved by all

applicable Federal, State and/or local authorities exercising jurisdiction over inactive landfill conditions on the Premises or active or inactive landfill operations conducted adjacent to the Premises.

2. This Supplemental Declaration shall not unlawfully restrict and shall not be used to violate any Federal law, rule, or regulation regarding the use of real estate, including, but not limited to, the Fair Housing Act.

3. This Supplemental Declaration shall be recorded in the office of the Recorder of Deeds for the County of St. Louis, State of Missouri.

4. Any deed or other instrument of conveyance for the Premises or any portion thereof shall be subject to this Supplemental Declaration.

5. Each of EPA (or its successor), the Missouri Department of Natural Resources ("MDNR") (or its successor) and the owner of any portion of the Premises shall have the right to sue for and obtain an injunction, prohibitive or mandatory, to prevent the breach, or to enforce the observance, of this Supplemental Declaration. This right shall be in addition to any other action available at law or in equity. The failure to enforce any covenant or restriction herein at the time of its violation shall not constitute a waiver of the right to do so later.

6. The provisions of this Supplemental Declaration shall continue in full force and effect until the fiftieth anniversary of the date of this Supplemental Declaration and thereafter for successive twenty-year periods unless, prior to the expiration of the then current term, a written notice of termination of this Supplemental Declaration, executed by each of the then owners of the Premises and by authorized representatives of EPA (or its successor) and MDNR (or its successor), has been filed with the office of the Recorder of Deeds for St. Louis County, State of Missouri. A notice of termination of this Supplemental Declaration may be filed at any

time after the effective date of this Supplemental Declaration, and this Supplemental Declaration shall terminate on the date the notice of termination is filed with the Recorder of Deeds.

7. The May 1997 Declaration remains in full force and effect, and shall be deemed supplemented, but not amended, by this Supplemental Declaration.

IN WITNESS WHEREOF, Rock Road Industries, Inc. has caused this instrument to be executed this 16th day of January, 1998.

ROCK ROAD INDUSTRIES, INC., a Missouri corporation

By: ____________________
William E. Whitaker
President

ACKNOWLEDGEMENT

STATE OF MISSOURI)
) ss
County OF ST. LOUIS)

On this 16th day of January, 1998, before me, a notary public, personally appeared William E. Whitaker, to me known, who, being by me duly sworn, did say that he is the President of Rock Road Industries, Inc., a Missouri corporation, and that said instrument was signed on behalf of said corporation by authority of its Board of Directors, and said person acknowledged said instrument to be the free act and deed of said corporation.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal in the County and State aforesaid, the day and year first above written.

Margaret G. Cusumano
Notary Public

My Commission Expires:

MARGARET G CUSUMANO
NOTARY PUBLIC STATE OF MISSOURI
ST. LOUIS COUNTY
MY COMMISSION EXP. NOV. 5,1998

EXHIBIT A

AREA 1

A tract of land in part of U.S. Survey 131, Township 47 North, Range 5 East of the 5th Principal Meridian, St. Louis County, Missouri, described as follows:

Commencing at the intersection of the northwesterly line, of U.S. Survey 131 and the southwesterly right of way line of Highway 40, also known as St. Charles Rock Road; thence South 43 degrees 53 minutes 31 seconds East, along said right of way line, a distance of 729.68 feet; thence South 40 degrees 49 minutes 32 seconds West, a distance of 92.54 feet to the Point of Beginning of the following described tract; thence continuing South 40 degrees 49 minutes 32 seconds West, a distance of 288.61 feet; thence South 89 degrees 29 minutes 50 seconds West, a distance of 241.41 feet; thence North 79 degrees 05 minutes 44 seconds West, a distance of 390.43 feet; thence North 29 degrees 48 minutes 55 seconds East, a distance of 499.73 feet; thence North 84 degrees 45 minutes 59 seconds East, a distance of 248.68 feet; thence South 32 degrees 24 minutes 17 seconds East, a distance of 201.28 feet; thence South 56 degrees 18 minutes 22 seconds East, a distance of 251.78 feet to the Point of Beginning.

AREA 2

A tract of land in part of Lot 20, of the St. Charles Ferry Company Tract in U.S. Survey 47 and 1934 and in part of U.S. Survey 47 Township 47 North, Range 5 East of the 5th Principal Meridian, St. Louis County, Missouri, described as follows:

Commencing at the intersection of the centerline of St. Charles Rock Road and the northwesterly line of Lot 20 of the St. Charles Ferry Company Tract; thence North 28 degrees 53 minutes 11 seconds East, along said northwesterly line, a distance of 148.48 feet of the Point of Beginning of the following described tract; thence continuing North 28 degrees 53 minutes 11 seconds East, along said line, a distance of 676.08 feet to the northwest corner of said Lot 20; thence North 72 degrees 46 minutes 42 seconds West, along the northerly line of Lot 19 of the St. Charles Ferry Company tract, a distance of 674.79 feet; thence North 47 degrees 43 minutes 02 seconds East, a distance of 906.64 feet; thence South 64 degrees 46 minutes 52 seconds East, a distance of 389.58 feet; thence South 76 degrees 30 minutes 26 seconds East, a distance of 245.51 feet; thence South 60 degrees 07 minutes 01 seconds East, a distance of 283.36 feet; thence South 31 degrees 26 minutes 39 seconds West, a distance of 1136.42 feet; thence South 33 degrees 08 minutes 25 seconds West, a distance of 109.40 feet; thence South 34 degrees 54 minutes 38 seconds East, a distance of 149.81 feet; thence South 44 degrees 29 minutes 33 seconds West, a distance of 267.70 feet; thence North 78 degrees 25 minutes 41 seconds West, a distance of 241.02 feet; thence North 34 degrees 31 minutes 30 seconds West, a distance of 351.19 feet to the Point of Beginning.

[redacted]

2016103100626

GERALD E. SMITH, RECORDER OF DEEDS
ST. LOUIS COUNTY MISSOURI
41 SOUTH CENTRAL, CLAYTON, MO 63105

TYPE OF INSTRUMENT	GRANTOR	TO	GRANTEE
RESTR	**ROCK ROAD INDUSTRIES INC**		

PROPERTY DESCRIPTION: **ST CHARLES FERRY CO PT LOT 19**

Lien Number	Notation	Locator

NOTE: I, the undersigned Recorder of Deeds, do hereby certify that the information shown on this Certification Sheet as to **TYPE OF INSTRUMENT, the NAMES of the GRANTOR and GRANTEE as well as the DESCRIPTION of the REAL PROPERTY affected** is furnished merely as a convenience only, and in the case of any discrepancy of such information between this Certification Sheet and the attached Document, **the ATTACHED DOCUMENT governs.** Only the DOCUMENT NUMBER, the DATE and TIME of filing for record, and the **BOOK** and **PAGE** of the recorded Document is taken from this CERTIFICATION SHEET.

RECORDER OF DEEDS DOCUMENT CERTIFICATION

STATE OF MISSOURI)
SS.
COUNTY OF ST. LOUIS)

Document Number
00626

I, the undersigned Recorder of Deeds for said County and State, do hereby certify that the following and annexed instrument of writing, which consists of **67** pages, (this page inclusive), was filed for record in my office on the **31** day of **October** **2016** at **02:07PM** and is truly recorded in the book and at the page number printed above.

In witness whereof I have hereunto set my hand and official seal the day, month and year aforesaid.

CF
Deputy Recorder

SEAL OF THE RECORDER OF DEEDS FOR ST. LOUIS COUNTY, MO

Gerald E. Smith
Recorder of Deeds
St. Louis County, Missouri

Mail to:

Lathrop & Gage, LLP - St. Louis
7701 Forsyth Blvd., Suite 500
St. Louis, MO 63105

Destination code: **4002**

RECORDING FEE **219.00**
(Paid at the time of Recording)

DECLARATION OF COVENANTS AND RESTRICTIONS

ROCK ROAD INDUSTRIES, INC.

Rock Road Industries, Inc., a Missouri corporation ("Declarant"), hereby (a) imposes the provisions of this Declaration upon the Premises (as defined below); (b) publishes and declares that the following terms, conditions, restrictions, and obligations shall (i) affect and encumber the Premises; (ii) run with and be a burden upon and a benefit to the Premises; and (iii) be fully binding upon Declarant and all other persons or entities acquiring the Premises or any part thereof or interest therein, whether by descent, devise, purchase or otherwise; and (c) declares that any person or entity, by the acceptance of title to the Premises or any part thereof or interest therein, shall thereby agree and covenant to abide by and be bound by the following terms, conditions, restrictions, and obligations.

RECITALS

A. Declarant is the owner of certain legal property, located in the City of Bridgeton, County of St. Louis, State of Missouri, legally described on **Exhibit A-1** and described by survey on **Exhibit A-2**, both of which are attached hereto and incorporated herein by this reference, which real property is herein referred to as "the Premises."

B. The Premises and nearly all real property in the immediate vicinity of the Premises have been used exclusively for more than forty (40) years for non-residential uses – primarily for commercial and industrial uses, but in some cases, for agricultural uses.

C. Such uses have included, but have not been limited to, quarrying operations, demolition and sanitary landfill operations, asphalt and concrete batch plant operations, trailer storage operations, and vehicle maintenance, repair, and body shop operations.

D. Such uses, and the nature and character of the land in the vicinity of the Premises, make the Premises unsuitable for any future residential use.

E. The United States Environmental Protection Agency ("EPA") has entered into an Administrative Order on Consent (the "Consent Order") with Cotter Corporation (N.S.L.), Declarant, Bridgeton Landfill, LLC (f/k/a Laidlaw Waste Systems (Bridgeton) Inc.), and the United States Department of Energy, dated March 3, 1993, as amended from time to time thereafter, and as is attached hereto as **Exhibit B**.

F. The Consent Order, among other things, provides for the investigation of the nature and extent of contamination and any threat to the public health, welfare, or the environment caused by the release or threatened release of hazardous substances at or from isolated areas either on or in the vicinity of the Premises.

G. Declarant desires to prohibit in perpetuity (i) the use of the Premises for residential purposes; (ii) the construction or placement upon the Premises of any building or habitable structure for any purpose; (iii) the use of the Premises for commercial and industrial purposes, including (but not limited to) use of the property as a storage yard; (iv) the installation of underground utilities, pipes and/or excavation upon the Premises, and (v) the installation on the Premises of water wells for drinking water use, except as set forth herein.

DECLARATION

Declarant hereby states and declares as follows:

1. Neither the Premises, nor any portion thereof, shall be used now or hereafter for any residential purpose, or for any day care, preschool, or any other educational use.

2. The Premises shall not be used for commercial or industrial purposes, now or at any time in the future, in perpetuity.

3. No building or habitable structure of any kind, and for any purpose, shall be constructed or placed upon the Premises, now or at any time in the future, in perpetuity.

4. The Premises shall not be used as a storage yard (whether temporarily or permanently), now or at any time in the future, in perpetuity.

5. No underground utilities or pipes shall be installed at, on, or under the Premises, and no excavation work shall be performed on the Premises, now or at any time in the future, in perpetuity, except for such utilities, pipes, and/or excavation work, if any, which are approved by EPA in connection with a plan selected by EPA to remediate hazardous substances on the Premises and that are performed in accordance with environmental and safety regulations applicable to such a remedial plan or are otherwise required by EPA as a condition of such approval.

6. No water wells for drinking water use shall be installed on the Premises.

7. This Declaration shall not unlawfully restrict and shall not be used to violate any federal law, rule, or regulation regarding the use of real estate, including, but not limited to, the Fair Housing Act.

8. This Declaration shall be recorded in the office of the Recorder of Deeds for the County of St. Louis, State of Missouri.

9. Any deed or other instrument of conveyance for the Premises or any portion thereof shall be subject to this Declaration.

10. Each of EPA (or its successor), the Missouri Department of Natural Resources ("MNDR") (or its successor), and the owner of any portion of the Premises shall have the right to sue for and obtain an injunction, prohibitive or mandatory, to prevent the breach, or to enforce the observance, of this Declaration. This right shall be in addition to any other action available

at law or in equity. The failure to enforce any covenant or restriction herein at the time of its violation shall not constitute a waiver of the right to do so later.

11. The provisions of this Declaration shall continue in full force and effect until the fiftieth (50^{th}) anniversary of the date of this Declaration and thereafter for successive twenty (20) year periods unless, prior to the expiration of the then-current term, a written notice of termination of this Declaration, executed by each of the then-owners of the Premises and by authorized representatives of EPA (or its successor) and MDNR (or its successor), has been filed with the office of the Recorder of Deeds for St. Louis County, State of Missouri. A notice of termination of this Declaration may be filed at any time after the effective date of this Declaration, and the Declaration shall terminate on the date the notice of termination is filed with the Recorder of Deeds.

[Signature Page Follows]

IN WITNESS WHEREOF, Rock Road Industries, Inc. has caused this instrument to be executed this 14th day of October, 2016.

ROCK ROAD INDUSTRIES INC.
A Missouri corporation

By: ______________________
Tim M. Benter, Vice President and Assistant Secretary

ACKNOWLEDGEMENT

STATE OF ARIZONA)
) ss
County of Maricopa)

On this 14th day of October, 2016, before me, a notary public, personally appeared Tim M. Benter, to me known, who, being by me duly sworn, did say that he is the Vice President and Assistant Secretary of Rock Road Industries, Inc., a Missouri corporation, and that said instrument was signed on behalf of said corporation by authority of its Board of Directors, and said person acknowledged said instrument to be the free act and deed of said corporation.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal in the County and State aforesaid, the day and year first above written.

Andrea Wing
Notary Public

My commission expires:

11/11/18

Notary Public State of Arizona
Maricopa County
Andrea Wing
My Commission Expires 11/11/2018

EXHIBIT A-1

Legal Description

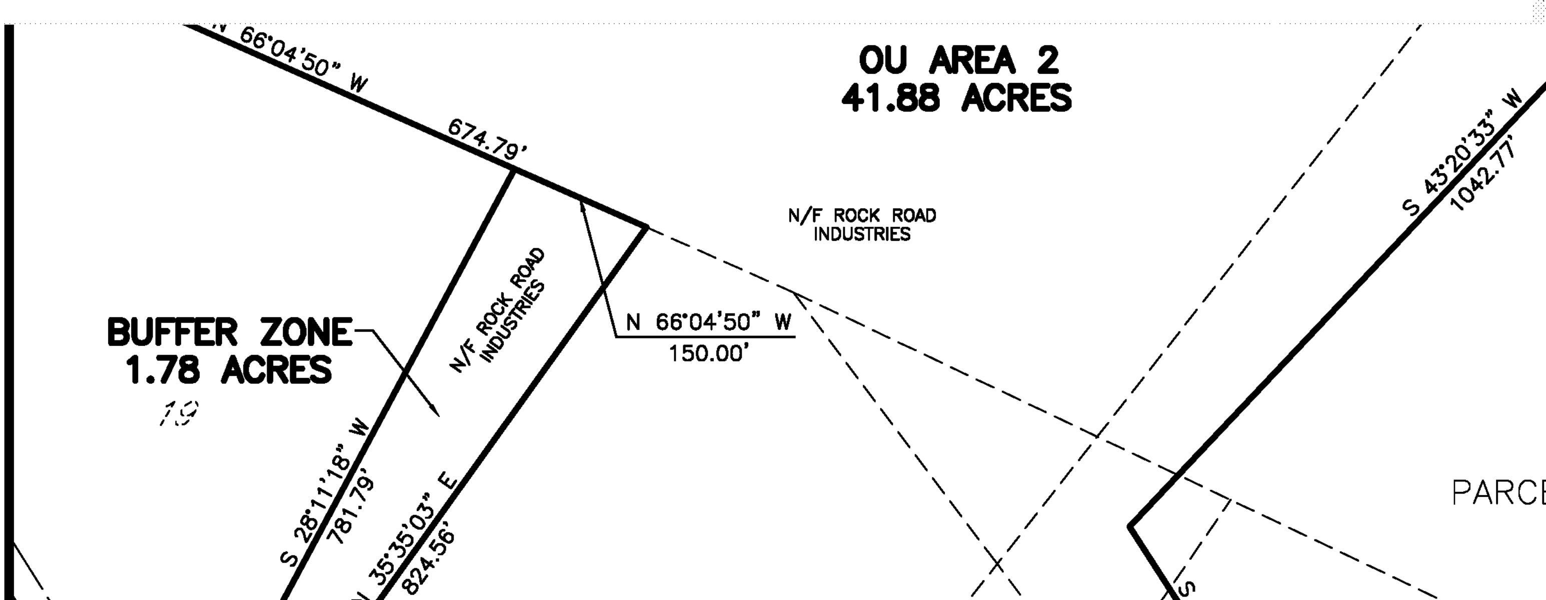
Part of Lot 19 of St. Charles Ferry Co. Tracts in U.S. Surveys 47 and 1934 Township 47 North; Range 5 East of the Fifth Principal Meridian, St. Louis, MO being more particularly described as follows:

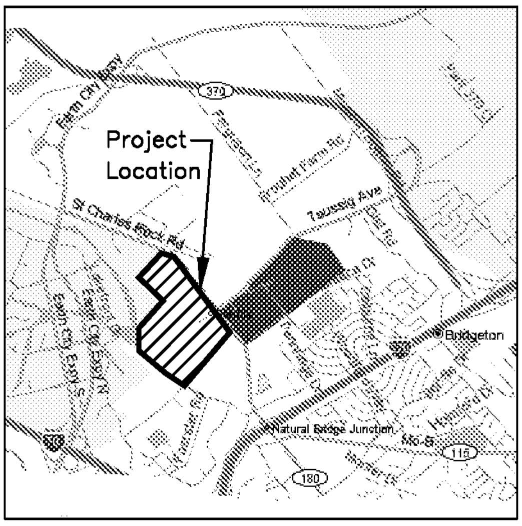
Beginning at a point of intersection of the Centerline of the Old St. Charles Rock Road with the Easterly line of Lot 19 of St. Charles Ferry Co. Tracts; thence North 35 degrees 35 minutes 03 seconds East along the easterly line of lot 19 a distance of 824.56 feet to the Northeast corner of said Lot 19; thence North 66 degrees 04 minutes 50 seconds West along the northerly line of lot 19 a distance of 150.00 feet; thence South 28 degrees 11 minutes 18 seconds West a distance of 781.79 feet to the aforementioned Center line of the Old St. Charles Rock Road; thence South 32 degrees 08 minutes 19 seconds East along said centerline a distance of 50.00 feet to the point of beginning and containing 1.78 acres.

EXHIBIT A-2

Survey

[See attached]





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NOTE:

1. THIS PLAT WAS PREPARED BY USE OF PREVIOUS SURVEY INFORMATION, SURVEY PLATS, COUNTY RECORDS RESEARCH, AND OTHER MISCELLANEOUS INFORMATION. HOWEVER THIS MAP IS NOT TO BE USED AS OR CONSIDERED A CURRENT BOUNDARY SURVEY OF THE LANDFILL PROPERTY. A COMPLETE TITLE SEARCH AND REPORT SHOULD BE DONE TO DETERMINE CURRENT PARCEL OWNERSHIPS.

2. BASIS OF BEARINGS AND COORDINATES OBTAINED BY FIELD SURVEY OF LOCAL STATE PLANE COORDINATE MONUMENTATION PRIOR TO THE MOST RECENT STATE PLANE COORDINATE SYSTEMS ADJUSTMENTS. SAID MONUMENTATION HAS SINCE BEEN DESTROYED.

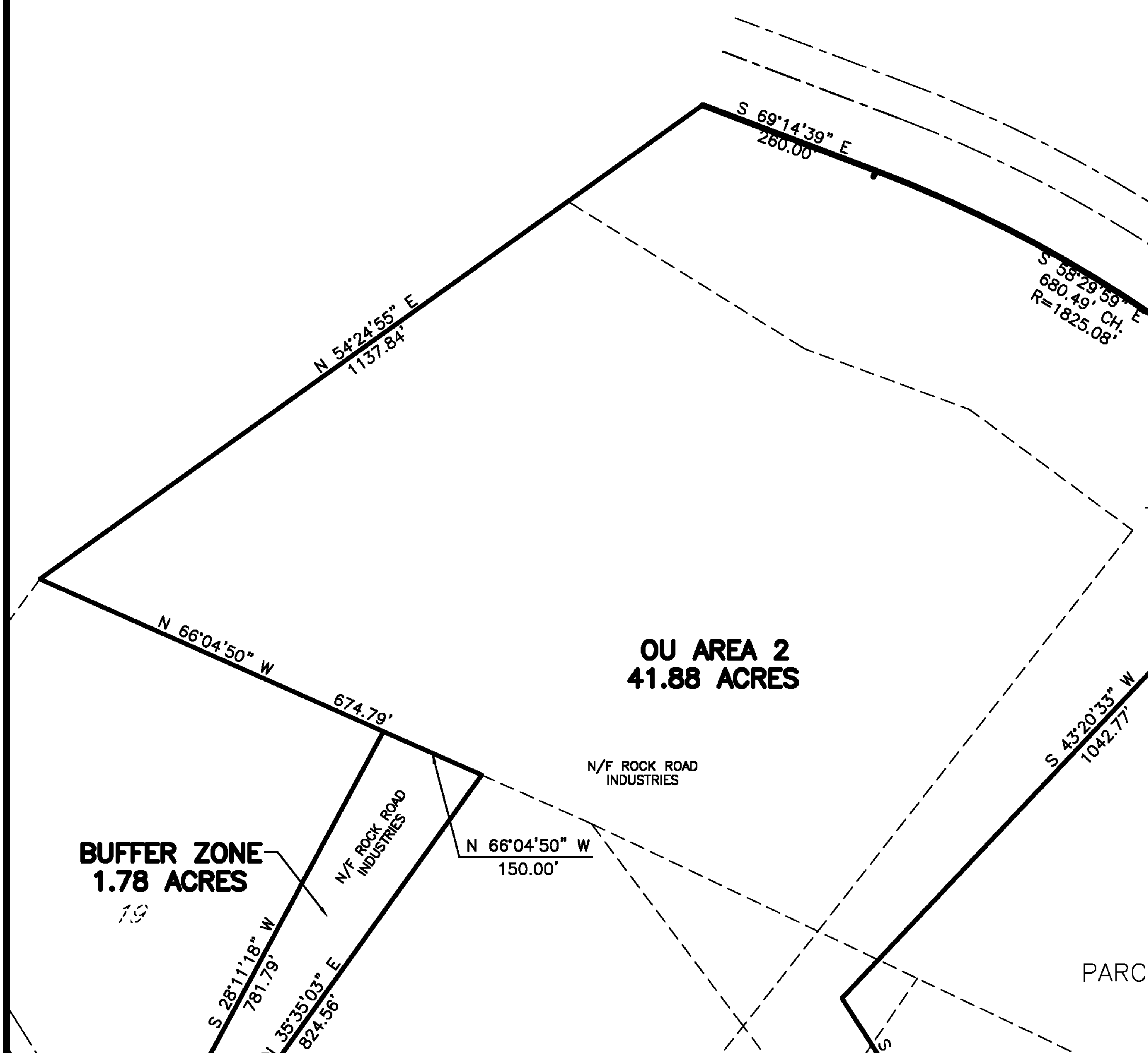


EXHIBIT B

Consent Order

[See attached]

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VII
726 MINNESOTA AVENUE
KANSAS CITY, KANSAS 66101

IN THE MATTER OF: COTTER CORPORATION (N.S.L.), and LAIDLAW WASTE SYSTEMS (BRIDGETON), INC., and ROCK ROAD INDUSTRIES, INC., and UNITED STATES DEPARTMENT OF ENERGY, RESPONDENTS. Proceeding Under Sections 104, 122(a), and 122(d)(3) of the Comprehensive Environmental Response, Compensation, and Liability Act as amended 42 U.S.C §§ 9604, 9622(a), 9622(d)(3).	Docket No. VII-93-F-0005

ADMINISTRATIVE ORDER ON CONSENT
FOR REMEDIAL INVESTIGATION/FEASIBILITY STUDY

TABLE OF CONTENTS

I. INTRODUCTION

1. This Administrative Order on Consent ("Consent Order") is entered into voluntarily by the United States Environmental Protection Agency ("EPA"), Cotter Corporation (N.S.L.) ("Cotter"), Laidlaw Waste Systems (Bridgeton), Inc. ("Laidlaw"), Rock Road Industries, Inc. ("Rock Road"), and the United States Department of Energy ("DOE") (Cotter, Laidlaw, Rock Road, and DOE are collectively referred to herein as "Respondents"). This Consent Order concerns the preparation of, performance of, and reimbursement of all costs incurred by EPA in connection with a remedial investigation and feasibility study ("RI/FS") at the West Lake Landfill NPL Site located at Bridgeton, Missouri (hereinafter referred to as "West Lake" or "Site").

II. JURISDICTION

2. This Consent Order is issued pursuant to the authority vested in the President of the United States by Sections 104, 122(a), and 122(d)(3) of the Comprehensive Environmental Response, Compensation, and Liability Act, as amended, 42 U.S.C. §§ 9604, 9622(a), and 9622(d)(3) ("CERCLA"). This authority was delegated to the Administrator of EPA by Executive Order 12580 of January 23, 1987, 52 Fed. Reg. 2923, and was further delegated to EPA's Regional Administrators on September 13, 1987 by EPA Delegation No. 14-14-C. This authority has been redelegated by the Regional Administrator of EPA Region VII to the Director of the Waste Management Division of EPA Region VII by Delegation R7-14-14C dated May 16, 1988.

3. Respondents agree to undertake all actions required by the terms and conditions of this Consent Order. In any action by EPA or the United States to enforce the terms of this Consent Order, Respondents consent to and agree not to contest the authority or jurisdiction of EPA to issue or enforce this Consent Order, and agree not to contest the validity of this Consent Order or its terms.

III. PARTIES BOUND

4. This Consent Order shall apply to and be binding upon EPA and Respondents and their respective agents, successors, and assigns, and upon all persons, including contractors and consultants, acting under or on behalf of Respondents or EPA with regard to the Site. Respondents' participation in this Consent Order, however, shall not be construed as an admission of liability or of EPA's findings of fact or conclusions of law and determinations contained in this Consent Order. The signatories to this Consent Order certify that they are authorized to execute and legally bind the parties they represent to this Consent Order. No change in the ownership or corporate status of Respondents, or of the ownership of the Site, shall alter Respondents' responsibilities under this Consent Order.

5. Respondents shall provide a copy of this Consent Order to any subsequent owners or successors before all or substantially all of the stock or assets are transferred in a corporate acquisition. Respondents shall provide a copy of this Consent Order to all contractors, subcontractors, laboratories, and consultants which

are retained to conduct any work performed under this Consent Order within fourteen (14) days after the effective date hereof or the date of retaining their services, whichever is later. Respondents shall condition any such contracts upon satisfactory compliance with all applicable terms of this Consent Order. Notwithstanding the terms of any contract, each Respondent is responsible for compliance with this Consent Order and shall use its best efforts to ensure that its subsidiaries, employees, contractors, consultants, subcontractors, and agents comply with all applicable terms of this Consent Order.

IV. STATEMENT OF PURPOSE

6. In entering into this Consent Order, the objectives of EPA and Respondents are: (a) to determine the nature and extent of contamination and any threat to the public health, welfare, or the environment caused by the release or threatened release of hazardous substances, pollutants, or contaminants at or from Radiological Areas 1 and 2, as defined in Paragraph 12, herein, at the Site by conducting a remedial investigation; (b) to determine and evaluate alternatives for remedial action (if any) to prevent, mitigate, or otherwise respond to or remedy any release or threatened release of hazardous substances, pollutants, or contaminants at or from Radiological Areas 1 and 2 at the Site, by conducting a feasibility study; and (c) to recover all response and oversight costs incurred by EPA with respect to this Consent Order in accordance with the procedures set forth in Section XXII (Reimbursement of Response and Oversight Costs).

7. The activities conducted under this Consent Order are subject to approval by EPA and shall provide all appropriate and necessary information for the RI/FS, and for a Record of Decision ("ROD") that is consistent with CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan ("NCP"), 40 C.F.R. Part 300. The activities conducted under this Consent Order shall be conducted in compliance with all applicable EPA guidances, policies, and procedures, which EPA will identify in writing in advance. Activities conducted in compliance with this Consent Order shall be deemed in compliance with the NCP.

V. EPA'S FINDINGS OF FACT

EPA makes the following Findings of Fact (contained in Paragraphs 8-31), which Respondents do not admit:

8. The Landfill is comprised of approximately 200 acres located at 13570 St. Charles Rock Road, Bridgeton, St. Louis County, Missouri, and is approximately 4 miles west of St. Louis' Lambert Field International Airport, near the intersection of Highways I-70 and I-270. Limestone was quarried at the Landfill from 1939 to the present. Since 1962 portions of the quarried property have been used for landfilling municipal refuse, industrial solid and liquid wastes, and construction demolition debris.

9. In 1966, the Atomic Energy Commission ("AEC") sold 8,700 tons of leached barium sulfate, together with other radioactive residues, to Continental Mining and Milling Company ("Continental Mining"). The radioactive residues were generated as by-products

of uranium processing performed by the AEC's contractor. These processing residues were stored at the AEC's St. Louis Airport Storage Site ("SLAPSS").

10. Continental Mining removed the radioactive residues to its facility at 9200 Latty Avenue in Hazelwood, Missouri. Eventually, Cotter purchased the radioactive residues and shipped all but the 8,700 tons of leached barium sulfate to its processing facility in Colorado.

11. In 1973 approximately 8,700 tons of radioactively contaminated leached barium sulfate residues were mixed with approximately 39,000 tons of soil, and the entire amount was disposed of in Radiological Areas 1 and 2, which are described in Paragraph 12, at the Landfill. This material resulted from decontamination efforts undertaken by Cotter at 9200 Latty Avenue, St. Louis, Missouri, where the residues had been stored.

12. In 1978, an aerial survey sponsored by the Nuclear Regulatory Commission ("NRC") revealed two areas within the Landfill where gamma radiation levels indicated radioactive material had been deposited. In 1980-81, Radiation Management Corporation ("RMC") of Chicago, Illinois, performed a detailed radiological survey of the Landfill under contract to the NRC. This survey was performed to determine the extent of radiological contamination. This survey indicated that the radioactive contaminants were located in two areas of the Landfill. The northern area of radioactive contamination ("Radiological Area 2") is comprised of approximately 13 acres. The radioactive debris in

this area forms a layer 2 to 15 feet thick, with radioactive debris exposed on the surface of the Landfill and along the berm on the northwest face of the Landfill. The southern area of radioactive contamination ("Radiological Area 1") is comprised of approximately 3 acres with most of the contaminated soil buried under approximately 3 feet of soil and fill.

13. The RMC survey indicated that the radioactivity emanates from uranium-238 ("U-238") and uranium-235 ("U-235") series with thorium-230 ("Th-230") and radium-226 ("Ra-226"). The survey data indicate that the average Ra-226 concentration in the radioactive wastes is approximately 90 picocuries per gram ("pCi/g"), with the average Th-230 concentration estimated to be approximately 9,000 pCi/g. Since Ra-226 has been depleted with respect to its parent Th-230, Ra-226 activity will increase in time (for example, over the next 200 years, Ra-226 activity will increase ninefold over the present level).

14. In addition to RMC's radiological survey, the NRC through Oak Ridge Associated Universities ("ORAU") contracted with the University of Missouri-Columbia Department of Civil Engineering to describe the environmental characteristics of the Site, conduct an engineering evaluation, and propose possible remedial actions for dealing with the radioactive materials at the Site. In March of 1984 a radiological survey along a section of a berm bounding the Landfill was performed by ORAU.

15. Measurements of direct radiation levels and radionuclide concentrations in soil and the physical condition of the berm area

indicated that erosion was occurring and that there were elevated concentrations of Ra-226 and Th-230 at the base of the berm and extending into the adjacent field. A sample from the mound of soil at the base of the berm contained 185 pCi/g of Ra-226 and 6,270 pCi/g of Th-230. Samples collected in the adjacent field contained 4.29-4.47 pCi/g of Ra-226 and 132-178 pCi/g of Th-230. In May 1986, ORAU sampled water wells on and close to the Landfill to determine if radioactive contamination had migrated into the groundwater. The sampling consisted of 18 monitoring wells which are located in various locations around the Landfill and are screened in the shallow, intermediate, and deep parts of the aquifer. Two sampling rounds were evaluated. Round 1 occurred from December 11-15, 1985 and Round 2 from May 19-21, 1986. All samples were analyzed for priority pollutants listed under 40 C.F.R. Part 122, Appendix D. This list includes volatile organics, acid and base/neutral extractables, pesticides, polyclorinated biphenyls ("PCBs"), total phenols, total cyanide, and metals. Four wells sampled during Round 1 were also analyzed for gross alpha and beta radiation.

16. Chemical results indicated that samples from certain wells contained detectable levels of several constituents. Chemicals found during Round 1 included methylene chloride (2-83 micrograms per liter ("ug/l"), bis-2-ethyhexyl phthalate (4-477 ug/l), phenol (7-19 ug/l), total cyanide (1-6 ug/l), sodium (5-175 milligrams per liter), iron (20-14,380 ug/l), lead (13 ug/l), and zinc (2-1,240 ug/l). Trace amounts of several pesticides also were

detected such as lindane, chlordane, dieldrin, endrin, 4,4'DDD, 4,4' DDE, 4,4' DDT, and hexachlorobenzene. The four wells sampled for gross alpha and beta radiation during Round 1 contained values for gross alpha ranging from 2-270 picocuries per liter ("pCi/l") and values for gross beta ranging from 11-171 pCi/l. Round 2 chemical results indicated the presence of methylene chloride (6-10 ug/l), bis-2-ethyhexyl phthalate (10 ug/l), total cyanide (7 ug/l), zinc (2-2,000 ug/l), and arsenic (4-9 ug/l). Compounds such as antimony, nickel, and thallium also were found.

17. In May 1986, 32 wells at the Site were sampled and analyzed for gross alpha and beta by ORAU. Isotopic analyses were performed on many of the samples to determine radium levels. The radionuclide concentrations were found to be gross alpha (0.9-8.4 pCi/l), gross beta (1.9-22 pCi/l), Ra-226 (0.2-0.7 pCi/l), Ra-228 (0.2-5.8 pCi/l), U-total (1.6-25 pCi/l), Th-228 (0.2-1.7 pCi/l), Th-230 (0.1-12 pCi/l), and Th-232 (0.2-4.0 pCi/l). The concentrations for gross alpha, Ra-226, and Ra-228 are below the permissible maximum contaminant levels for community water systems set forth in 40 C.F.R. § 141.

18. Direct contact with, and air transport of, radiological contamination would primarily affect persons working in and around the Site. Surface water runoff from the Landfill primarily flows to a drainage ditch along the north side of the Landfill and the south side of St. Charles Rock Road. This ditch may occasionally be recharged by groundwater. This surface water either recharges the groundwater or discharges through a drainage ditch to the

Missouri River. A pond along this ditch is located on the north side of the Landfill and is known to contain fish. Surface water runoff to the south and southwest flows across relatively flat agricultural fields. This runoff joins the small intermittent ditches which traverse the area. Groundwater contamination could affect persons using groundwater downgradient of the Landfill before it discharges to the Missouri River.

19. In a report entitled "Hydrogeological Investigation, West Lake Landfill, Primary Phase Report" prepared by Burns & McDonnell in October 1986, it was stated that the predominant groundwater flow direction in the alluvial aquifer in the vicinity of the Site is northwestward toward the Missouri River. The water table generally slopes toward the Missouri River, although changes in gradient direction apparently occur at some times during the year in response to changes in the stage of the Missouri River. The alluvial aquifer consists of a continuous sequence of sand deposits with some gravel zones. The alluvium at shallow depths is primarily fine to medium sand, with only traces of gravel. The alluvium in the deeper part of the aquifer is coarser grained, consisting primarily of coarse sand and gravel.

20. Uranium, thorium, radium, protactinium, and actinium are all known human carcinogens. Methylene chloride and lead are both probable human carcinogens. Phenol is a suspected carcinogen and mutagen.

21. The following pesticides were detected in analyses of groundwater samples taken at the Site: gamma BH (Lindane),

chlordane, dieldrin, endrin, 4,4' DDD, 4,4' DDE, 4,4' DDT, and hexachlorobenzene. These highly-chlorinated pesticides are probable carcinogens. They are toxic to humans via ingestion and dermal contact. Some are reproductive toxins.

22. U-238, U-235, Th-230, and Ra-226, the pesticides identified in Paragraph 21, above, methylene chloride, phenol, and lead are hazardous substances as defined in CERCLA Section 101(14), 42 U.S.C. § 9601(14).

23. Pursuant to Section 105 of CERCLA, 42 U.S.C. § 9605, EPA placed the Site on the National Priorities List, set forth at 40 C.F.R. Part 300, Appendix B, by publication in the Federal Register on August 30, 1990, 55 Fed. Reg. 35502.

24. Cotter Corporation (N.S.L.) is a corporation organized and existing pursuant to the laws of the State of New Mexico.

25. Laidlaw Waste Systems (Bridgeton), Inc. is a corporation organized and existing pursuant to the laws of the State of Missouri.

26. Rock Road Industries, Inc. is a corporation organized and existing pursuant to the laws of the State of Missouri.

27. The United States Department of Energy is a department of the United States Government and is a successor to the Atomic Energy Commission.

28. Cotter, by contract, agreement, or otherwise arranged for the disposal, or arranged with a transporter for transport for disposal, hazardous substances owned or possessed by it at the Site.

29. At the time of disposal of hazardous substances at the Site, West Lake Landfill, Inc. (now known as Laidlaw Waste Systems (Bridgeton), Inc., and referred to herein as Laidlaw) was an owner or operator of the Site.

30. DOE, by contract, agreement, or otherwise arranged for the disposal, or arranged with a transporter for transport for disposal, hazardous substances owned or possessed by it at the Site.

31. Rock Road is a current owner of the Site.

VI. EPA'S CONCLUSIONS OF LAW AND DETERMINATIONS

EPA makes the following Conclusions of Law and Determinations, which Respondents do not admit:

32. The Site is a "facility" as defined in Section 101(9) of CERCLA, 42 U.S.C. § 9601(9).

33. There has been a "release" or threat of a release of a "hazardous substance" at the Site as defined in Section 101(22) and 101(14) of CERCLA, 42 U.S.C. §§ 9601(22) and 9601(14).

34. Respondents are each a "person" as defined in Section 101(21) of CERCLA, 42 U.S.C. § 9601(21).

35. Respondents are each a responsible party pursuant to Sections 104, 107, and 122 of CERCLA, 42 U.S.C. §§ 9604, 9607, and 9622.

36. The actions required by this Consent Order are necessary to protect the public health, welfare, or environment, are practicable and in the public interest, are consistent with CERCLA and the NCP, and will expedite effective remedial action and

minimize litigation, all in accordance with Sections 104 and 122 of CERCLA, 42 U.S.C. §§ 9604 and 9622.

VII. NOTICE TO THE STATE

37. By providing a copy of this Consent Order to the State of Missouri, EPA is notifying the State of Missouri that this Consent Order is being issued and that EPA is the lead agency for coordinating, overseeing, and enforcing the activities required hereunder.

VIII. WORK TO BE PERFORMED

38. All activities performed pursuant to this Consent Order (the "Work") shall be under the direction and supervision of qualified personnel. Within thirty (30) days of the effective date of this Consent Order, and before the Work outlined below begins, Respondents shall notify EPA in writing of the names, titles, and qualifications of the principal personnel, including contractors, subcontractors, consultants, and laboratories, to be used in carrying out the Work. The qualifications of the principal persons responsible for undertaking the Work for Respondents shall be subject to EPA's review, for verification that such persons meet minimum technical background and experience requirements. This Consent Order is contingent on Respondents' demonstration to EPA's satisfaction that Respondents are qualified to perform properly and promptly the actions set forth in this Consent Order. If EPA disapproves of the technical qualifications of any person, Respondents shall notify EPA of the identity and qualifications of a replacement within thirty (30) days of receipt of EPA's

disapproval. If EPA disapproves of the replacement, EPA reserves the right to terminate this Consent Order and to conduct the Work itself, to seek reimbursement from Respondents, and/or to seek any other appropriate relief as provided herein. During the course of the performance of the Work, Respondents shall notify EPA in writing of any changes or additions in the principal personnel used to carry out the Work, including their names, titles, and qualifications. EPA shall have the same right to approve changes and additions to principal personnel as it has hereunder regarding the initial notification.

39. Respondents shall conduct activities and submit deliverables as provided by this Consent Order and the attached RI/FS Statement of Work ("SOW"), which is incorporated herein by reference, and Section IV (Statement of Purpose). All such work shall be conducted in accordance with CERCLA, the NCP, and EPA guidance including, but not limited to, the "Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (OSWER Directive 9355.3-01), guidances referenced therein, and guidances referenced in the SOW, as may be amended or modified by EPA. The general activities that Respondents are required to perform are identified below. The tasks that Respondents must perform are described more fully in the SOW and guidances. The activities and deliverables identified below shall be developed as provided in the RI/FS Work Plan and Sampling and Analysis Plan, and shall be submitted to EPA as provided. All work performed under this Consent Order shall be in accordance with the

schedules herein, and in full accordance with the standards, specifications, and other requirements of the RI/FS Work Plan and Sampling and Analysis Plan, as approved by EPA, and as may be amended or modified by EPA.

a. **Task I - Scoping**. EPA determines the Site-specific objectives of the RI/FS and devises a general management approach for the Site, as stated in the attached SOW. Respondents shall conduct the remaining scoping activities as described in the SOW and referenced guidances. At the conclusion of the project planning phase, Respondents shall submit the following deliverables to EPA:

(1) RI/FS Work Plan. Within sixty (60) days of the effective date of this Consent Order, Respondents shall submit to EPA a complete RI/FS Work Plan in accordance with the SOW. If EPA disapproves of or requires revisions to the RI/FS Work Plan, in whole or in part, Respondents shall amend and submit to EPA a revised RI/FS Work Plan which is responsive to all of EPA's comments, within forty-five (45) days of receiving EPA's comments.

(2) Sampling and Analysis Plan. Within sixty (60) days of the effective date of this Consent Order, Respondents shall submit to EPA a Sampling and Analysis Plan in accordance with the schedule set forth in the EPA approved RI/FS Work Plan. This Sampling and Analysis Plan shall consist of a Field Sampling Plan ("FSP") and a Quality Assurance Project Plan ("QAPP") as described in the SOW and guidances. If EPA

disapproves of or requires revisions to the Sampling and Analysis Plan, in whole or in part, Respondents shall amend and submit to EPA a revised Sampling and Analysis Plan which is responsive to all of EPA's comments, within forty-five (45) days of receiving EPA's comments.

(3) Site Health and Safety Plan. Within sixty (60) days of the effective date of this Consent Order, Respondents shall submit to EPA a Site Health and Safety Plan.

b. **Task II - Community Relations**. EPA will prepare a Community Relations Plan, in accordance with EPA guidance and the NCP. Respondents shall provide information supporting EPA's community relations programs.

c. **Task III - Site Characterization**. Following EPA approval or modification of the RI/FS Work Plan and Sampling and Analysis Plan, Respondents shall implement the provisions of these Plans to characterize the Site. Respondents shall complete Site characterization in accordance with the schedule set forth in the EPA approved RI/FS Work Plan. Respondents shall provide EPA with validated analytical data generated pursuant to this Consent Order in a form showing the location, medium, and results. As used herein, "validated analytical data" refers to data that has been quality assured pursuant to the QAPP and the supporting empirical data, including instrument printouts, used to determine such quality assured data. Respondents shall require validation of all sampling results within sixty (60) days of receipt from the laboratory. This information shall be submitted to EPA with the subsequent monthly progress report as described in Section XIII (Progress Reports), herein. Within seven (7) days of completion of field activities, Respondents shall notify EPA in writing. During Site characterization, Respondents shall provide EPA with the following deliverables, as described in the SOW and RI/FS Work Plan:

(1) Technical Memorandum on Modeling of Site Characteristics. Where Respondents propose that modeling is appropriate, Respondents shall submit a technical memorandum on modeling of Site characteristics in accordance with the schedule set forth in the approved RI/FS Work Plan. If EPA disapproves of, or requires revisions to, the technical memorandum on modeling of Site characteristics, in whole or in part, Respondents shall amend and submit to EPA a revised technical memorandum on modeling of Site characteristics which is responsive to all of EPA's comments, within forty-five (45) days of receiving EPA's comments.

(2) Site Characterization Summary Report. Respondents shall submit a Site Characterization Summary Report to EPA in accordance with the schedule set forth in the approved RI/FS Work Plan.

(3) Remedial Investigation Report. Within sixty (60) days of receipt from EPA of the Baseline Risk Assessment described in Section IX (EPA's Baseline Risk Assessment), Respondents shall submit to EPA a Remedial Investigation Report consistent with the SOW, RI/FS Work Plan, and Sampling

and Analysis Plan. If EPA disapproves of or requires revisions to the Remedial Investigation Report, in whole or in part, Respondents shall amend and submit to EPA a revised Remedial Investigation Report which is responsive to all of EPA's comments, within forty-five (45) days of receiving EPA's comments.

d. **<u>Task IV - Treatability Studies</u>**. Respondents shall submit to EPA a memorandum analyzing whether treatability studies are needed based on the information developed during the conduct of the Remedial Investigation and the basis therefor. EPA will then determine whether Respondents shall conduct treatability studies and notify Respondents of its decision in writing. If required, major components of the treatability studies include determination of the need for and scope of studies, the design of the studies, and the completion of the studies as described in the SOW. During treatability studies, Respondents shall provide EPA with the following deliverables:

(1) <u>Identification of Candidate Technologies Memorandum</u>. This memorandum shall be submitted in accordance with the schedule set forth in the EPA approved RI/FS Work Plan. If EPA disapproves of, or requires revisions to, the technical memorandum identifying candidate technologies, in whole or in part, Respondents shall amend and submit to EPA a revised technical memorandum identifying candidate technologies which is responsive to all of EPA's comments within forty-five (45) days of receiving EPA's comments.

(2) <u>Treatability Testing Work Plan</u>. Respondents shall submit a Treatability Testing Work Plan or a proposed amendment to the RI/FS Work Plan, including a schedule, in accordance with the schedule set forth in the approved RI/FS Work Plan. If EPA disapproves of, or requires revisions to, the Treatability Testing Work Plan or the proposed amendment to the RI/FS Work Plan, in whole or in part, Respondents shall amend and submit to EPA a revised Treatability Testing Work Plan or proposed amendment to the RI/FS Work Plan, which is responsive to all of EPA's comments, within forty-five (45) days of receiving EPA's comments.

(3) <u>Treatability Study Sampling and Analysis Plan</u>. Upon the identification of the need for a separate or amended QAPP or FSP, Respondents shall submit a Treatability Study Sampling and Analysis Plan or a proposed amendment to the original QAPP or FSP, in accordance with the schedule set forth in the approved RI/FS Work Plan. If EPA disapproves of, or requires revisions to, the Treatability Study Sampling and Analysis Plan or the proposed amendment to the original QAPP or FSP, in whole or in part, Respondents shall amend and submit to EPA a revised Treatability Study Sampling and Analysis Plan or proposed amendment to the original QAPP or FSP, which is responsive to all of EPA's comments, within forty-five (45) days of receiving EPA's comments.

(4) <u>Treatability Study Site Health and Safety Plan</u>. Upon the identification of the need for a separate or amended

Health and Safety Plan, Respondents shall submit a Treatability Study Site Health and Safety Plan or a proposed amendment to the original Site Health and Safety Plan, in accordance with the schedule set forth in the approved RI/FS Work Plan.

(6) Treatability Study Evaluation Report. Respondents shall submit a Treatability Study Evaluation Report as provided in the SOW and RI/FS Work Plan in accordance with the schedule set forth in the approved RI/FS Work Plan. If EPA disapproves of, or requires revisions to, the Treatability Study Evaluation Report, in whole or in part, Respondents shall amend and submit to EPA a revised Treatability Study Evaluation Report which is responsive to all of EPA's comments within forty-five (45) days of receiving EPA's comments.

e. **Task V - Development and Screening of Remedial Alternatives**. Respondents shall develop an appropriate range of waste management options that will be evaluated through the development and screening of alternatives as provided in the SOW and RI/FS Work Plan. During the development and screening of alternatives, Respondents shall provide EPA with the following deliverables:

(1) Memorandum on Remedial Action Objectives. Within sixty (60) days of receipt of the Baseline Risk Assessment, Respondents shall submit a memorandum on remedial action objectives.

(2) Report on Development and Screening of Remedial Alternatives. Respondents shall submit a report summarizing the development and screening of remedial alternatives including an alternatives array document as described in the SOW in accordance with the schedule set forth in the approved RI/FS Work Plan.

f. **Task VI - Detailed Analysis of Remedial Alternatives**. Respondents shall conduct a detailed analysis of remedial alternatives as described in the SOW and RI/FS Work Plan. During the detailed analysis of alternatives, Respondents shall provide EPA with the following deliverables and presentation:

(1) Comparative Analysis Technical Memorandum and Presentation to EPA. Respondents shall submit a technical memorandum to EPA summarizing the results of the comparative analysis performed between the remedial alternatives in accordance with the schedule set forth in the approved RI/FS Work Plan. If EPA disapproves of, or requires revisions to, the comparative analysis technical memorandum, Respondents shall amend and submit to EPA a revised comparative analysis technical memorandum which is responsive to all of EPA's comments within forty-five (45) days of receiving EPA's comments. Upon EPA's request, Respondents shall make a presentation to EPA during which Respondents shall summarize the findings of the remedial investigation and remedial action objectives, and present the results of the nine criteria evaluation and comparative analysis as described in the SOW,

in accordance with the schedule set forth in the approved RI/FS Work Plan.

(2) Feasibility Study Report. Respondents shall submit a draft Feasibility Study Report which reflects the findings in the Baseline Risk Assessment in accordance with the schedule set forth in the approved RI/FS Work Plan. Respondents shall refer to Table 6-5 of the RI/FS Guidance for report content and format. If EPA disapproves of, or requires revisions to, the draft Feasibility Study Report, in whole or in part, Respondents shall amend and submit to EPA a revised Feasibility Study Report which is responsive to all of EPA's comments, within forty-five (45) days of receiving EPA's comments. The report, as amended, and the Administrative Record shall provide the basis for the Proposed Plan under CERCLA §§ 113(k) and 117(a), 42 U.S.C. §§ 6913(k) and 6917(a), by EPA and shall document the development and analysis of remedial alternatives.

40. For all deliverables, EPA will approve, disapprove, or return the deliverable to Respondents with comments or requests for modifications. In subsequent or resubmitted deliverables, Respondents shall respond to the specified deficiencies and address the information and comments from EPA. If EPA disapproves of a deliverable, EPA will state with specificity the grounds for disapproval.

41. Respondents shall not proceed further with any subsequent activities or tasks until receiving EPA approval for the following

deliverables: RI/FS Work Plan, Sampling and Analysis Plan, draft Remedial Investigation Report, Treatability Testing Work Plan, Treatability Study Sampling and Analysis Plan, and the draft Feasibility Study Report. While awaiting EPA approval on these deliverables, Respondents shall proceed with all other tasks and activities which may be conducted independently of these deliverables, in accordance with the schedule set forth in this Consent Order or the approved RI/FS Work Plan.

42. For all remaining deliverables not enumerated in the preceding Paragraph, Respondents may proceed with all subsequent tasks, activities and deliverables without awaiting EPA approval. If Respondents have not complied with an approved Work Plan or this Consent Order, or at any time EPA deems necessary to protect public health, welfare, or the environment, however, EPA reserves the right to disapprove Respondents' implementation of such tasks and may require that Respondents' cease the implementation of such tasks, either temporarily or permanently, at any point during the RI/FS.

43. In the event that Respondents amend or revise a report, plan, or other submittal upon receipt of EPA comments, if EPA subsequently disapproves of the revised submittal, or if subsequent submittals do not fully reflect EPA's directions for changes, EPA retains the right to seek stipulated or statutory penalties, perform its own studies, complete the RI/FS (or any portion of the RI/FS) pursuant to CERCLA and the NCP, and seek reimbursement from the Respondents for its costs and/or seek any other appropriate

relief. In the event EPA refuses to approve a deliverable unless Respondents change or modify it in a manner which Respondents deem inconsistent with Respondents' best professional judgment, Respondents reserve the right to seek Dispute Resolution in accordance with Section XIX (Dispute Resolutions) or pursue any other rights they may have.

44. In the event that EPA takes over some of the tasks but not the preparation of the RI/FS, Respondents shall incorporate and integrate information supplied by EPA into the final RI/FS report.

45. Neither the failure of EPA to expressly approve or disapprove of Respondents' submissions within a specified time period nor the absence of comments, shall be construed as approval by EPA. EPA will make it a goal to approve, disapprove, or comment on all deliverables within sixty (60) days of receipt of the deliverable.

IX. EPA'S BASELINE RISK ASSESSMENT

46. EPA will perform the Baseline Risk Assessment. Respondents shall support EPA in the effort by providing various information to EPA as outlined above. The major components of the Baseline Risk Assessment include contaminant identification, exposure assessment, toxicology assessment, and human health and ecological risk characterization.

47. EPA will provide, after review of Respondents' Site Characterization Summary, sufficient information concerning the baseline risks such that the Respondents can begin drafting the

Feasibility Study Report and the Memorandum on Remedial Action Objectives.

48. EPA will prepare a Baseline Risk Assessment report based on data collected by the Respondents during Site characterization. EPA will release the final report to the public at the same time it releases the final RI Report. Both reports will be put into the Administrative Record for the Site.

X. MODIFICATION OF THE RI/FS WORK PLAN

49. Respondents shall have the right to gather any additional data not specified or required under this Consent Order. If, at any time during the performance of the Work required under this Consent Order, Respondents identify a need for additional data to complete the Work which shall require a modification or extension of any part of the schedule, Respondents shall submit a memorandum to the EPA Project Coordinator explaining the need for and the nature of the requested modification or extension. If EPA does not approve or disapprove of the request for modification or extension within fourteen (14) days of receipt of the request, Respondents may proceed to gather such additional data and submit it to EPA for inclusion in the administrative record. However, any schedule modification or extension may be accomplished only in conformity with Section XXVII (Effective Date and Subsequent Modification) of this Consent Order.

50. In the event conditions posing an immediate threat to human health, welfare, or the environment become known to them, Respondents shall notify EPA and the State of Missouri no later

than twenty-four (24) hours of discovery. In the event of material unanticipated or changed circumstances at the Site, Respondents shall notify the EPA Project Coordinator by telephone within forty-eight (48) hours of discovery of such unanticipated or changed circumstances. In addition to the authorities in the NCP, in the event that EPA determines that the immediate threat or the material unanticipated or changed circumstances warrant changes in the RI/FS Work Plan, EPA may modify or amend the RI/FS Work Plan in writing accordingly. If Respondents dispute EPA's modifications or amendments to the RI/FS Work Plan, they shall submit such issue to Dispute Resolution pursuant to Section XIX. Otherwise, Respondents shall perform the RI/FS Work Plan as modified or amended.

51. EPA may determine that in addition to tasks defined in the initially approved RI/FS Work Plan, other additional work may be necessary to accomplish the objectives of the RI/FS as set forth in the SOW and the Statement of Purpose set forth in Section IV, herein. EPA may request that Respondents perform such other work in addition to the work required by the initially approved RI/FS Work Plan including any approved modifications if it determines that such actions are necessary for a complete RI/FS and is consistent with the Statement of Purpose set forth in Section IV, herein. Respondents shall confirm their willingness to perform the additional work in writing to EPA within seven (7) days of receipt of the EPA request or Respondents shall invoke Dispute Resolution. Subject to resolution of any dispute pursuant to the provisions of Section XIX (Dispute Resolution), Respondents shall implement the

additional tasks which EPA determines are necessary. The additional work shall be completed according to the standards, specifications, and schedules set forth or approved by EPA in a written modification to the RI/FS Work Plan. In the event Respondents do not agree to perform the additional work and the modification is not the subject of Dispute Resolution, EPA reserves the right to conduct the additional work itself, to seek reimbursement from Respondents, and/or to seek other appropriate relief.

XI. QUALITY ASSURANCE

52. Respondents shall assure that work performed, samples taken, and analyses conducted pursuant to this Consent Order conform to the requirements of the SOW, the QAPP, and all guidances identified herein. Respondents shall assure that field personnel used by Respondents are properly trained in the use of field equipment and in chain of custody procedures.

XII. FINAL RI/FS; PROPOSED PLAN; PUBLIC COMMENT; RECORD OF DECISION; ADMINISTRATIVE RECORD

53. EPA retains the responsibility for the release to the public of the RI/FS Reports. EPA retains responsibility for the preparation and release to the public of the Proposed Plan and ROD in accordance with CERCLA and the NCP.

54. EPA will determine the contents of the administrative record file for selection of the remedial action. Respondents will submit to EPA documents developed during the course of the RI/FS upon which selection of the response action may be based. Respondents shall provide copies of plans, task memoranda

(including documentation of field modifications, if any), recommendations for further action, quality assurance memoranda and audits, raw data, field notes, laboratory analytical reports, and other reports. To the extent not in EPA's possession at Region VII or in the possession of MDNR, Respondents must additionally submit copies of any previous studies in their possession or under their control conducted under state, local, or other federal authorities relating to selection of a response action for Radiological Areas 1 and 2, and copies of all written communications between Respondents and state, local, or other federal authorities concerning selection of a response action for Radiological Areas 1 and 2. At their discretion, Respondents may establish a community information repository at, or near, the Site to house a copy of the administrative record.

XIII. <u>PROGRESS REPORTS</u>

55. Respondents shall make presentations at and participate in meetings at the request of EPA during the initiation, conduct, and completion of the Work. In addition to discussion of the technical aspects of the Work, topics will include anticipated problems or new issues. Meetings will be scheduled at EPA's discretion. When practicable, EPA will give Respondents five (5) days advance written notice of any such meeting or presentation.

56. In addition to the deliverables set forth in this Consent Order, Respondents shall provide to EPA monthly progress reports by the 10th day of each following month. These progress reports shall include: (1) a description of the actions which have been taken to

comply with this Consent Order during that month; (2) all validated analytical data and all other validated data received by Respondents during that month; (3) a description of the work planned for the next two months with schedules relating such work to the overall project schedule; and (4) a description of all material problems encountered and any anticipated material problems, any actual or anticipated material delays, and solutions developed and implemented to address any actual or anticipated material problems or delays.

XIV. SAMPLING AND DATA ANALYSIS

57. All validated analytical data, including results of sampling, tests, modeling, or other data generated by Respondents or on Respondents' behalf, pursuant to the requirements of this Consent Order shall be submitted to EPA in the subsequent monthly progress report as described in Section XIII (Progress Reports) of this Consent Order. EPA will make available to Respondents validated data generated by EPA unless it is exempt from disclosure by any federal or state law or regulation.

58. Respondents orally will notify EPA at least fourteen (14) days prior to conducting significant field events as described in the SOW, RI/FS Work Plan, or Sampling and Analysis Plan. Upon EPA's request, Respondents shall allow EPA or its authorized representatives to take a reasonable number of split or duplicate samples of samples collected by Respondents in implementing this Consent Order.

59. Respondents may assert a business confidentiality claim covering part or all of the information submitted to EPA pursuant to the terms of this Consent Order to the extent permitted by and in accordance with Section 104(e)(7) of CERCLA, 42 U.S.C. § 9607(e)(7), and 40 C.F.R. § 2.203(b). This claim shall be asserted in the manner described by 40 C.F.R. § 2.203(b) and substantiated at the time the claim is made. Information determined to be confidential by EPA will be given the protection specified in 40 C.F.R. Part 2, Subpart B. If no such claim accompanies the information when it is submitted to EPA, it may be made available to the public without further notice to Respondents. Respondents agree not to assert confidentiality claims with respect to any data related to Site conditions, sampling, or monitoring.

60. By entering into this Consent Order, Respondents waive any objections to the validity of any data gathered, generated, or evaluated by EPA, the State of Missouri, or Respondents in the performance or oversight of the Work that has been verified according to the approved quality assurance/quality control ("QA/QC") procedures required by the Consent Order. If Respondents object to data relating to the Work, Respondents shall submit to EPA a report that identifies and explains its objections, describes the acceptable uses of the data, if any, and identifies any limitations to the use of the data. Such report must be submitted to EPA within fifteen (15) days of the monthly progress report containing the data.

61. To the extent practicable, EPA orally will notify Respondents at least five (5) days prior to conducting any independent field activities relating to the Site during the course of the performance of the Work. At Respondents' oral or written request, EPA will permit Respondents' representative to be present during any such activities and shall allow split or duplicate samples to be taken by Respondents of any samples collected by EPA relating to the Site. All samples taken by EPA will be taken, handled, and analyzed in accordance with the procedures specified in the FSP, to the extent applicable, and the QAPP. EPA will assure that field personnel used by EPA are properly trained in the use of field equipment, in chain of custody procedures, and as required by the Health and Safety Plan.

XV. ACCESS

62. Commencing upon the effective date of this Consent Order, Respondents agree to provide EPA and its representatives, including its contractors, access at all times to the Site and any other property to which access is required for the implementation of this Consent Order, to the extent access to the property is controlled by Respondents, for the purposes of conducting any activity related to this Consent Order including, but not limited to:

a. Monitoring the Work;

b. Verifying any data or information submitted to EPA;

c. Conducting investigations relating to contamination at or near the Site;

d. Obtaining samples;

e. Assessing the need for, planning, or implementing additional response actions at or near the Site;

f. Inspecting and copying records, operating logs, contracts, or other documents maintained or generated by Respondents or their agents; and

g. Assessing Respondents' compliance with this Consent Order.

63. Prior to entering the Site, EPA will provide, when practicable, Respondents' Project Coordinator with the credentials or other written notice of all EPA personnel and representatives authorized to enter the Site pursuant to this Section.

64. EPA and its representatives shall comply with the Site Health and Safety Plan while on Site.

65. To the extent that the Site or any other property to which access is required for the implementation of this Consent Order is owned or controlled by persons other than Respondents, Respondents shall use best efforts to secure from such persons access for Respondents, as well as for EPA and its representatives, including, but not limited to, its contractors, as necessary to effectuate this Consent Order. If any access required to complete the Work is not obtained within thirty (30) days of the effective date of this Consent Order, or within thirty (30) days of the date EPA notifies Respondents in writing that additional access beyond that previously secured is necessary, Respondents shall promptly notify EPA, and shall include in that notification a summary of the steps Respondents have taken to attempt to obtain access. EPA may, as it deems appropriate, assist Respondents in obtaining access.

Respondents shall reimburse EPA, in accordance with the procedures in Section XXII (Reimbursement of Response and Oversight Costs), for all costs incurred by EPA in obtaining access.

66. Notwithstanding any provision of this Consent Order, EPA retains all of its access authorities and rights, including enforcement authorities related thereto, under CERCLA, the Resource Conservation and Recovery Act, 42 U.S.C. §§ 6901-6992k, and any other applicable statutes or regulations.

XVI. PROJECT COORDINATORS

67. All documents and correspondence which must be submitted pursuant to this Consent Order shall be sent by certified mail, return receipt requested, by overnight delivery service, or hand-delivered to the following addressees or to any other addressees which Respondents and EPA designate in writing:

a. Documents to be submitted to EPA shall be sent in triplicate to:

Diana L. Newman
U.S. Environmental Protection Agency
Region VII
WSTM/SAFE
726 Minnesota Avenue
Kansas City, Kansas 66101

b. Documents to be submitted to Respondents should be sent to:

Jerome T. Wolf
Michael D. Hockley
Spencer Fane Britt & Browne
1400 Commerce Bank Building
1000 Walnut Street
Kansas City, Missouri 64106

with cc by mail to:

James F. Gunn
Sandra L. Oberkfell
The Stolar Partnership
911 Washington Avenue
St. Louis, Missouri 63101

Charlotte Neitzel
Holme Roberts & Owen
1700 Lincoln, Suite 4100
Denver, Colorado 80203

James W. Wagoner II
Director, Division of Offsite Programs
Office of Eastern Area Programs
Office of Environmental Restoration
U.S. Department of Energy
12800 Middlebrook Road
Germantown, Maryland 20874

Unless otherwise specified, any notices or submissions required by this Consent Order shall be deemed delivered on the date placed in the United States Mail, delivered to an overnight service, or hand-delivered. If response deadlines are triggered by receipt of a notice, then such notice, for purposes of calculating the affected deadline, shall be deemed received upon actual receipt.

68. On or before the effective date of this Consent Order, EPA and Respondents shall each designate their own Project Coordinator. Each Project Coordinator shall be responsible for overseeing the implementation of this Consent Order. To the maximum extent possible, communications between Respondents and EPA shall be directed between the Project Coordinators as specified in Section XVI (Project Coordinators), herein, by mail with copies to such other persons as EPA and Respondents may respectively designate. Communications include, but are not limited to, all

documents, reports, approvals, and other correspondence submitted under this Consent Order.

69. EPA and Respondents each have the right to change their respective Project Coordinator. The other party must be notified in writing at least ten (10) days prior to any such change.

70. EPA's Project Coordinator shall have the authority lawfully vested in a Remedial Project Manager ("RPM") and On-Scene Coordinator ("OSC") by the NCP. In addition, EPA's Project Coordinator shall have authority consistent with the NCP to halt any work required by this Consent Order and to take any necessary response action when EPA determines that conditions at the Site may present an immediate endangerment to public health or welfare or the environment. The absence of the EPA Project Coordinator from the Site shall not be cause for the stoppage or delay of work.

XVII. OTHER APPLICABLE LAWS

71. Respondents shall comply with all applicable laws when performing the activities pursuant to this Consent Order. No federal, state, or local permits are required for on-Site response actions conducted pursuant to CERCLA Sections 104, 121, or 122. The term "on-Site" means the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of activities pursuant to this Consent Order.

XVIII. RECORD PRESERVATION

72. One complete set of all records and documents in Respondents' possession that relate to this Consent Order shall be

preserved during the conduct of this Consent Order and for a minimum of six (6) years after commencement of construction of any remedial action. Respondents shall acquire and retain one complete copy of all non-privileged documents that relate to this Consent Order that are in the possession of their employees, agents, accountants, contractors, or attorneys. At the conclusion of this six (6) year period, Respondents shall notify EPA at least ninety (90) days prior to the destruction of any such records or documents, and, upon EPA's request, Respondents shall deliver any such records or documents to EPA.

XIX. DISPUTE RESOLUTION

73. The provisions of this Dispute Resolution section apply to all deliverables required by the Consent Order and all matters for which Dispute Resolution has been expressly provided. Any disputes concerning activities or deliverables required under this Consent Order for which Dispute Resolution is applicable shall be resolved as follows: If Respondents object to any EPA notice of disapproval or requirement made pursuant to this Consent Order, Respondents shall notify EPA's Project Coordinator in writing of their objections within fourteen (14) days of receipt of the disapproval notice or requirement. Respondents' written objections shall define the dispute, state the basis of Respondents' objections, and be sent certified mail, return receipt requested. EPA will, within fourteen (14) days of receipt of Respondents' objections, respond to Respondents in writing, specifically addressing the points raised by Respondents and identifying points

of agreement and disagreement. EPA and Respondents then have an additional fourteen (14) days to reach agreement.

74. If agreement is not reached within the fourteen (14) day period referenced above, Respondents and EPA will communicate their respective position in writing to the Division Director of EPA Region VII's Waste Management Division, who shall resolve the dispute and provide a written statement of his decision to Respondent. The Division Director's determination is EPA's final decision. Respondents shall proceed in accordance with EPA's final decision regarding the matter in dispute regardless of whether Respondents agree with the decision. If the Respondents do not agree to perform, or do not perform the work in accordance with EPA's final decision, EPA reserves the right in its sole discretion to conduct the work itself, to seek reimbursement from the Respondents, to seek enforcement of the decision, to seek stipulated penalties, and/or to seek any other appropriate relief. No action, decision, or directive made by EPA, including without limitation the Division Director of EPA Region VII's Waste Management Division pursuant to this Consent Order shall constitute a final agency action giving rise to any rights to judicial review prior to EPA's initiation of judicial action to compel Respondents' compliance with this Consent Order. Respondents reserve any rights that they may have to seek any appropriate relief to the extent available by applicable law.

75. Respondents are not relieved of their obligations to perform and conduct activities and submit deliverables on the

schedule set forth in the RI/FS Work Plan while a matter is pending in Dispute Resolution. The invocation of Dispute Resolution does not stay stipulated penalties under this Consent Order. If, however, Respondents prevail in the dispute, deadlines directly affected by the matters in dispute shall be extended for a period of time equal to the time taken to resolve the dispute under the procedures of this Section, plus reasonable time for remobilization, as determined by EPA.

XX. DELAY IN PERFORMANCE/STIPULATED PENALTIES

76. Respondents (excluding DOE) shall be liable for stipulated penalties in the amounts set forth in Paragraphs 77 and 78 to the EPA for failure to comply with the requirements of this Consent Order specified below, unless excused pursuant to Section XXI (Force Majeure). In the event that EPA determines that DOE has failed to comply with any provision which would otherwise give rise to stipulated penalties, DOE understands that this Consent Order, as it applies to DOE, will be deemed null and void, and the rights and protections afforded DOE under the Consent Order will be terminated. "Compliance" by Respondents shall include completion of the activities under this Consent Order or any work plan or other plan approved under this Consent Order identified below in accordance with all applicable requirements of law, this Consent Order, the SOW, and any plans or other documents approved by EPA pursuant to this Consent Order and within the specified time schedules established by and approved under this Consent Order.

77. If Respondents do not submit the deliverable items listed below by the deadlines stated in the SOW, or do not perform the tasks listed below in accordance with the schedules listed in the RI/FS Work Plan, the following stipulated penalties shall be payable per day by Respondents:

Penalty Per Violation Per Day	Period of Noncompliance
$ 500	1st through 7th day
$ 1,000	8th through 30th day
$ 2,500	31st day and beyond.

The penalties in this Paragraph shall apply to the following deliverable items:

a. The draft and any revised work plan.

b. The draft and any revised sampling and analysis plan.

c. The draft and any revised Remedial Investigation Report.

d. The draft and any revised Feasibility Study Report.

78. If Respondents do not submit the deliverable items listed below by the deadlines stated in the RI/FS Work Plan, or do not perform the tasks listed below in accordance with the schedules listed in the RI/FS Work Plan, the following stipulated penalties shall be payable per day by Respondents:

Penalty Per Violation Per Day	Period of Noncompliance
$ 250.00	1st through 7th day
$ 500.00	8th through 30th day
$ 1,000.00	31st day and beyond.

The penalties in this Paragraph shall apply to the following deliverable items as well as any other deliverables not specifically listed in this Section:

a. Site Health and Safety Plan.

b. Technical memorandum on modeling of Site characteristics.

c. Site Characterization Summary.

d. Evaluation of Need for Treatability Studies technical memorandum.

e. Treatability Study Site Health and Safety Plan.

f. Treatability Study Evaluation Report.

g. Technical memorandum entitled Refined Remedial Action Objectives.

h. Report entitled Development and Screening of Remedial Alternatives.

i. Comparative analysis technical memorandum.

j. Monthly progress reports.

79. Except as otherwise provided herein, all penalties shall begin to accrue on the day after complete performance is due or the day a violation occurs, and shall continue to accrue through the final day of the correction of the noncompliance or completion of the activity. Nothing herein shall prevent the simultaneous accrual of separate penalties for separate violations of this Consent Order. For violations not based on timeliness, stipulated penalties shall not begin to accrue until after Respondents have had the opportunity to revise the submission to respond to EPA's written comments. If any revised submission fails to respond to

EPA's comments and/or remedy the specified deficiencies and EPA deems such failure to constitute a violation, then EPA will provide Respondents with written notice of such violation. In such case, the stipulated penalties shall accrue from the date of receipt of such notice by Respondents.

80. Following EPA's determination that Respondents have failed to comply with a requirement of this Consent Order, EPA will provide Respondents with written notification of same and describe the noncompliance. This notice also will indicate the amount of penalties due and whether the penalties continue to accrue. Except for violations not based on timeliness, penalties shall accrue as provided in the preceding Paragraph regardless of whether EPA has notified the Respondents of a violation.

81. All penalties owed to the EPA under this Section shall be due and payable within thirty (30) days of the Respondents' receipt from EPA of a notification of noncompliance, unless Respondents invoke the Dispute Resolution procedures set forth in Section XIX (Dispute Resolution) of this Consent Order. Respondents shall pay interest on the unpaid balance, which shall begin to accrue at the end of the thirty (30) day period at the rate established by the Department of Treasury pursuant to 31 U.S.C. § 3717 and 4 C.F.R. § 102.13. Respondents shall further pay a handling charge of one percent (1%), to be assessed at the end of each thirty-day period, and a six percent (6%) per annum penalty charge, to be assessed if the penalty is not paid in full within ninety (90) days after it is due. All payments under this Section shall be paid by certified

check made payable to "EPA Hazardous Substance Superfund," shall be mailed to:

Mellon Bank
Attn: Superfund Accounting
EPA Region VII
(Comptroller Branch)
Post Office Box 360748M
Pittsburgh, PA 15251

82. Copies of check(s) paid pursuant to this Section, and any accompanying transmittal letter(s), shall be sent to EPA's Project Coordinator as set forth in Section XVI (Project Coordinators) of this Consent Order.

83. Neither the filing of a request to resolve a dispute nor the payment of penalties shall alter in any way Respondents' obligation to complete the performance required hereunder.

84. Respondents may dispute the applicability of stipulated penalties and EPA's right to the stated amount of penalties by invoking the Dispute Resolution procedures set forth in Section XIX (Dispute Resolution) of this Consent Order. Penalties shall accrue but need not be paid during the Dispute Resolution period.

85. If Respondents fail to pay stipulated penalties when due, EPA may institute proceedings to collect the penalties, as well as late charges and interest. Respondents shall pay interest on the unpaid balance, which shall begin to accrue at the end of the forty-five day period at the rate established pursuant to 31 U.S.C. § 3717 and 4 C.F.R. § 102.13. The stipulated penalties provisions do not prohibit, alter, or in any way limit EPA's ability to seek any other remedies or sanctions available by virtue of Respondents' violation of this Consent Order or of the statutes and regulations

upon which it is based. Provided, however, EPA will be precluded from seeking other judicial or administrative penalties for those violations specified in this Section unless Respondents fail to pay penalties assessed pursuant to this Section.

XXI. FORCE MAJEURE

86. Respondents shall perform the requirements of this Consent Order within the time limits set forth herein, unless the performance is prevented or delayed by events which constitute a force majeure or excusable delay. A force majeure or excusable delay is defined as any event arising from causes not foreseeable and beyond the reasonable control of Respondents, including its consultants and contractors, which could not be overcome by Respondents' best efforts and which delays or prevents performance by a date required by this Consent Order. Such events do not include unanticipated or increased costs of performance or changed economic circumstances. To the extent Respondents (excluding DOE pursuant to Paragraph 76 herein) are subject to stipulated penalties as a result of a delay caused by an act or omission of DOE, EPA, at its discretion, may consider such delay excusable for the purposes of assessment of stipulated penalties.

87. Respondents shall notify EPA orally within forty-eight (48) hours of when they first knew or should have known that a delay might occur. Within ten (10) business days thereafter, Respondents shall submit to EPA a written statement setting forth the reasons for the delay; the anticipated duration of the delay; all actions taken or to be taken to prevent or minimize the delay;

a schedule for implementation of any measures to be taken to mitigate the effect of the delay; and a statement as to whether, in the opinion of Respondents, such event may cause or contribute to an endangerment to public health, welfare, or the environment. Respondents shall adopt all reasonable measures to avoid and minimize the delay. Failure to comply with the notice provision of this Section shall constitute a waiver of Respondent's right to assert a force majeure or that the delay is excusable.

88. If EPA determines that the delay has been or will be caused by force majeure or that the delay is otherwise excusable, the time for performance for that element of work, and other tasks the completion of which is dependent upon that element of work, may be extended, upon EPA approval, for a period of equal to the delay resulting from such circumstances. All such modifications of the schedule caused by a force majeure or excusable delay shall be made in accordance with Section XXVII (Effective Date and Subsequent Modification) of this Consent Order. The schedule for those tasks which are not altered by these modifications remains unchanged unless altered in accordance with Section XXVII (Effective Date and Subsequent Modification). In the event EPA and Respondents cannot agree that any delay or failure has been or will be caused by a force majeure or that the delay is otherwise excusable, or if there is no agreement on the length of the extension, this dispute shall be resolved in accordance with the Dispute Resolution provisions of Section XIX (Dispute Resolution) of this Consent Order.

XXII. REIMBURSEMENT OF RESPONSE AND OVERSIGHT COSTS

89. Following the effective date of this Consent Order, EPA periodically will submit to the Respondents an accounting of all response costs including oversight costs incurred by EPA with respect to this Consent Order. Response costs may include, but are not limited to, costs incurred by EPA in overseeing Respondents' implementation of the requirements of this Consent Order and activities performed by EPA relating to the Consent Order and any costs incurred while assisting Respondents in obtaining access. Costs shall include all direct and indirect costs including, but not limited to, time and travel costs of EPA personnel and associated indirect costs, contractor costs, cooperative agreement costs, compliance monitoring, including the collection and analysis of split samples, inspection of activities required by this Consent Order, Site visits, discussions regarding disputes that may arise as a result of this Consent Order, review and approval or disapproval of reports, and costs of redoing any of Respondents' tasks. Any necessary summaries including, but not limited to, EPA's certified Agency Financial Management System summary data ("SPUR Reports"), or such other summary as certified by EPA, shall serve as a basis for payment demands.

90. Respondents (excluding DOE) shall, within sixty (60) days of receipt of each accounting, remit a certified or cashier's check for the amount of those costs. Interest shall accrue from the later of the date payment of a specified amount demanded in writing is due, or the date of the expenditure. The interest rate is the

rate of interest on investments for the Hazardous Substances Superfund in Section 107(a) of CERCLA, 42 U.S.C. § 9607(a).

91. All payments to EPA under this Section shall be made by certified or cashier's check made payable to "EPA Hazardous Substance Superfund" and shall include the Site name, the EPA Site identification number 514, and the EPA Docket Number assigned to this matter, and shall be remitted to:

Mellon Bank
Attn: Superfund Accounting
EPA Region VII
(Comptroller Branch)
Post Office Box 360748M
Pittsburgh, PA 15251

92. A copy of the check shall be sent simultaneously to the EPA Project Coordinator.

93. Respondents agree to limit any disputes concerning costs to accounting errors, the inclusion of costs outside the scope of this Consent Order, or costs that are inconsistent with the NCP. Respondents shall identify any contested costs and the basis of their objection. All undisputed costs shall be remitted in accordance with the time frame set forth above. Disputed costs shall be paid into an escrow account while the dispute is pending. Respondents bear the burden of establishing an EPA accounting error, the inclusion of costs outside the scope of this Consent Order, or costs inconsistent with the NCP.

XXIII. <u>RESERVATION OF RIGHTS</u>

94. Any requirement for the payment or obligation of funds by DOE established by the terms of this Consent Order shall be subject to the availability of funds appropriated for that purpose, and no

provision herein shall be interpreted to require the obligation or payment of funds in violation of the Anti-Deficiency Act, 31 U.S.C. § 1341.

95. EPA reserves the right to bring an action against the Respondents pursuant to Section 107 of CERCLA, 42 U.S.C. § 9607, for the recovery of all response costs including oversight costs incurred by EPA at the Site that are not reimbursed by the Respondents, any costs incurred in the event that EPA performs the RI/FS or any part thereof, and any future costs incurred by EPA in connection with response activities conducted under CERCLA at the Site. Respondents reserve all rights they may have to oppose and defend against such claims and actions and to assert any and all claims they may have against EPA or any person or government agency.

96. EPA reserves the right to bring an action against Respondents to enforce the requirements of this Consent Order, and to seek penalties and punitive damages pursuant to CERCLA.

97. Except as expressly provided in this Consent Order, each party reserves all rights and defenses it may have. Nothing in this Consent Order shall affect EPA's removal authority or EPA's response or enforcement authorities including, but not limited to, the right to seek injunctive relief, statutory penalties, and/or punitive damages. To the extent stipulated penalties apply to violations of a particular requirement of this Consent Order, however, EPA will not seek statutory penalties for such violations unless Respondents fail or refuse to pay stipulated penalties

assessed for such a violation. Respondents reserve any and all rights they may have to oppose and defend against such claims and actions and to assert any and all claims they may have against EPA or any person or government agency. Respondents reserve any rights they may have to bring any action otherwise available against any "person" as defined in Section 101(21) of CERCLA, 42 U.S.C. § 9601(21).

98. Following satisfaction of the requirements of this Consent Order, Respondents shall have resolved their liability to EPA for the work performed by Respondents pursuant to this Consent Order. Respondents are not released from liability, if any, for any response actions taken beyond the scope of this Consent Order regarding removals or activities arising pursuant to Section 121(c) of CERCLA, 42 U.S.C. § 9612(c).

XXIV. DISCLAIMER

99. By signing this Consent Order and taking actions under this Consent Order, Respondents do not admit EPA's Findings of Fact and Conclusions of Law. Furthermore, the participation of Respondents in this Consent Order shall not be considered an admission of liability and is not admissible in evidence against Respondents in any judicial or administrative proceeding other than a proceeding by the United States on behalf of EPA to enforce this Consent Order or a judgment relating to it. Each Respondent retains its rights to assert claims against the other Respondents and other potentially responsible parties at the Site. Respondents agree, however, not to contest the validity or terms of this

Consent Order or the procedures underlying or relating to it in any action brought by the United States on behalf of EPA to enforce its terms.

XXV. OTHER CLAIMS

100. In entering into this Consent Order, Respondents waive any right to seek reimbursement pursuant to Section 106(b) of CERCLA, 42 U.S.C. § 9606(b). Respondents also waive any right to present a claim under Section 111 or 112 of CERCLA, 42 U.S.C. §§ 9611 and 9612. This Consent Order does not constitute any decision on preauthorization of funds under Section 111(a)(2) of CERCLA, 42 U.S.C. § 9611(a)(2). Injuries or damages resulting from acts or omissions of the EPA, its agents, employees or other persons acting on its behalf on property owned or operated by Respondents shall be subject to the procedures of the Federal Tort Claims Act of 1949, as amended, 28 U.S.C. § 2671, et seq. (FTCA). Except for claims subject to the procedures of the FTCA, Respondents waive all other statutory and common law claims against EPA relating to or arising out of conduct of the RI/FS under this Consent Order.

101. Nothing in this Consent Order shall constitute or be construed as a release from any claim, cause of action, or demand in law or equity against any party not a signatory to this Consent Order for any liability it may have arising out of or relating in any way to the generation, storage, treatment, handling, transportation, releases or disposal of any hazardous substances, pollutants, or contaminants found at, taken to, or taken from the Site.

102. Respondents shall each bear their own costs and attorneys fees.

XXVI. FINANCIAL ASSURANCE AND INDEMNIFICATION

103. Within thirty (30) days of the effective date of this Consent Order, Respondents (excluding DOE) shall obtain a Letter of Credit in the amount of $1,050,000, naming EPA as the Beneficiary, and provide a copy of such letter to EPA within forty-five (45) days of the effective date of this Consent Order.

104. Respondents (excluding DOE) agree to indemnify and hold the EPA, its agents, and its employees harmless from any and all claims or causes of action arising from or on account of acts or omissions of Respondents, its employees, agents, servants, receivers, successors, or assignees, or any persons including, but not limited to, firms, corporations, subsidiaries and contractors in carrying out activities under this Consent Order. Except for contracts entered into by DOE, the United States Government or any agency or authorized representative thereof shall not be held as a party to any contract entered into by Respondents in carrying out activities under this Consent Order. Respondents shall be under no duty, however, to indemnify the EPA for claims or causes of action arising from or on account of negligent, willful, or intentional acts or omissions of the EPA, its officers, agents, employees or any other person acting on its behalf. Nothing herein is intended to or shall be construed as extending the liability of the EPA beyond that provided for under federal law.

XXVII. EFFECTIVE DATE AND SUBSEQUENT MODIFICATION

105. The effective date of this Consent Order shall be the date that it is signed by EPA.

106. This Consent Order may be amended by mutual agreement of EPA and Respondents. Amendments shall be in writing and shall be effective when signed by EPA.

107. No informal advice, guidance, suggestions, or comments by EPA regarding reports, plans, specifications, schedules and any other writing submitted by the Respondents will be construed as relieving the Respondents of its obligation to obtain such formal approval as may be required by this Consent Order. Any deliverables, plans, technical memoranda, reports (other than progress reports), specifications, schedules and attachments required by this Consent Order are, upon approval by EPA, incorporated into this Consent Order.

XXVIII. TERMINATION AND SATISFACTION

108. This Consent Order shall terminate when Respondents demonstrate in writing and certify to the satisfaction of EPA that all activities required under this Consent Order including any additional work, payment of response and oversight costs, and any stipulated penalties demanded by EPA have been performed and EPA has approved the certification. EPA will make it a goal to notify Respondents within sixty (60) days of receipt of such certification whether it has approved or disapproved the certification. In the event EPA disapproves the certification, it will specify in writing the reasons therefore. If EPA disapproves the certification or

fails to respond to the certification within sixty (60) days, Respondents may invoke the provisions of Section XIX (Dispute Resolution). This notice shall not, however, terminate Respondents' obligation to comply with Sections XVII (Other Applicable Laws), XVIII (Record Preservation), XXII (Reimbursement of Response and Oversight Costs), and XXIII (Reservation of Rights) of this Consent Order.

109. The certification shall be signed by a responsible official representing each Respondent. Each representative shall make the following attestation: "I certify that the information contained in or accompanying this certification is true, accurate, and complete." For purposes of this Consent Order, a responsible official is a corporate official who is in charge of a principal business function.

FOR RESPONDENTS:

COTTER CORPORATION (N.S.L.),
a ~~New Mexico corporation~~

[signature]

Exec. Vice-President

LAIDLAW WASTE SYSTEMS (BRIDGETON), INC.,
a Missouri corporation

Miles H. Stotts

MILES H. STOTTS

REGIONAL ENVIRONMENTAL MANAGER

ROCK ROAD INDUSTRIES, INC.,
a Missouri corporation

W.E. WHITAKER - PRESIDENT

WEST LAKE LANDFILL AOC
SUMMARY OF DEADLINES

Task	Deadline[1]	Comment
Provide EPA Name/ Qualifications of Consultant.	30 Days (April 2).	¶ 38, Order.
Offsite Access Agreement.	30 Days (April 2).	¶ 65, Order. Order requires Respondents to notify EPA if access not obtained within 30 days of effective date of Order.
Obtain letter of credit.	30 Days (April 2).	¶ 103, Order.
Provide EPA copy of LOC.	45 Days (April 19).[2]	
RI/FS Work Plan.	60 Days (May 3)[3].	¶ 39a(1), Order.
Sampling and Analysis Plan.	60 Days (May 3).	¶ 39a(2), Order.
Health and Safety Plan.	60 Days (May 3).	¶ 39a(3), Order.
Monthly Progress Reports.	10th Day of following month.	¶ 56, Order.
Validation of Sampling Results.	60 Days after receipt of result from laboratory.	¶ 39c, Order.
Notify EPA of completion of field activities.	7 Days after completion of field activities.	¶ 39c, Order.
Remedial Investigation Report.	60 Days after receipt of baseline risk assessment.	¶ 39c(3), Order.

[1]Deadlines are triggered by effective date of the Order, March 3, 1993.

[2]Due date falls on Saturday, April 17. Next business day is Monday, April 19.

[3]The schedule for most deliverables required under the Order will be negotiated in the Work Plan.

Memorandum on Remedial Action Objectives.	60 Days after receipt of baseline risk assessment.	¶ 39e(1), Order.
Notice to EPA of Significant Field Events.	14 Days prior to conducting significant field events.	May be oral notice, ¶ 58, Order.
Notice of Force majeure.	48 Hours after learn of event (oral); 10 business days thereafter (written).	¶ 87, Order.
Payment of oversight costs.	60 Days after receipt of EPA accounting of response costs.	¶ 90, Order.

[redacted]

2016103100650

GERALD E. SMITH, RECORDER OF DEEDS
ST. LOUIS COUNTY MISSOURI
41 SOUTH CENTRAL, CLAYTON, MO 63105

TYPE OF INSTRUMENT	GRANTOR	TO	GRANTEE
RESTR	**ROCK ROAD INDUSTRIES INC ETAL**		

PROPERTY DESCRIPTION: **US SUR 131 T47N R5E WOP**

Lien Number	Notation	Locator

NOTE: I, the undersigned Recorder of Deeds, do hereby certify that the information shown on this Certification Sheet as to **TYPE OF INSTRUMENT, the NAMES of the GRANTOR and GRANTEE as well as the DESCRIPTION of the REAL PROPERTY affected** is furnished merely as a convenience only, and in the case of any discrepancy of such information between this Certification Sheet and the attached Document, **the ATTACHED DOCUMENT governs.** Only the DOCUMENT NUMBER, the DATE and TIME of filing for record, and the **BOOK** and **PAGE** of the recorded Document is taken from this CERTIFICATION SHEET.

RECORDER OF DEEDS DOCUMENT CERTIFICATION

STATE OF MISSOURI)
SS.
COUNTY OF ST. LOUIS)

Document Number
00650

I, the undersigned Recorder of Deeds for said County and State, do hereby certify that the following and annexed instrument of writing, which consists of **72** pages, (this page inclusive), was filed for record in my office on the **31** day of **October** **2016** at **02:14PM** and is truly recorded in the book and at the page number printed above.

In witness whereof I have hereunto set my hand and official seal the day, month and year aforesaid.

CF
Deputy Recorder

Gerald E. Smith
Recorder of Deeds
St. Louis County, Missouri

SEAL OF THE RECORDER OF DEEDS FOR ST. LOUIS COUNTY, MO

Mail to:

Lathrop & Gage, LLP - St. Louis
7701 Forsyth Blvd., Suite 500
St. Louis, MO 63105

Destination code: **4002**

RECORDING FEE **234.00**
(Paid at the time of Recording)

SUPPLEMENTAL AND PARTIALLY RESTATED DECLARATION OF COVENANTS AND RESTRICTIONS ROCK ROAD INDUSTRIES, INC. BRIDGETON LANDFILL, LLC

Rock Road Industries, Inc., a Missouri corporation ("Rock Road"), and Bridgeton Landfill, LLC, a Missouri corporation ("Bridgeton Landfill") (f/k/a Laidlaw Waste Systems (Bridgeton) Inc. and successor in interest to West Lake Quarry and Material Company, a Missouri corporation) (Rock Road and Bridgeton Landfill are collectively referred to hereinafter as "Declarants"), hereby (a) impose the provisions of this Supplemental and Partially Restated Declaration of Covenants and Restrictions (the "Supplemental Declaration") upon the Premises (as defined below); (b) publish and declare that the following terms, conditions, restrictions and obligations shall (i) affect and encumber the Premises; (ii) run with and be a burden upon and a benefit to the Premises, and (iii) be fully binding upon Declarants and all other persons or entities acquiring the Premises or any part thereof or interest therein, whether by descent, devise, purchase or otherwise; and (c) declare that any person or entity, by acceptance of title to the Premises or any part thereof or interest therein, shall thereby agree and covenant to abide by and be bound by the following terms, conditions, restrictions, and obligations.

RECITALS

A. Declarants are the owners of certain real property (located in the City of Bridgeton, County of St. Louis, State of Missouri), which is described more particularly on **Exhibit A**, attached hereto.

B. Certain portions of Declarants' real property are located within the areas legally described on **Exhibit B-1** and described by survey on **Exhibit B-2**, both of which are attached hereto and incorporated herein by this reference, as "OU Area 1" and "OU Area 2". The portions of Declarants' real property located within OU Area 1 and OU Area 2 shall be collectively referred to herein as the "Premises."

C. The United States Environmental Protection Agency ("EPA") has entered into an Administrative Order on Consent ("AOC") with Cotter Corporation (N.S.L.), Declarants and the United States Department of Energy, dated March 3, 1993, as amended from time to time thereafter, and as is attached hereto as **Exhibit C.**

D. The AOC, among other things, provides for the investigation of the nature and extent of contamination and any threat to the public health, welfare, or the environment caused by the release or threatened release of hazardous substances at or from the Premises.

E. The entire portion of the Premises owned by Rock Road is subject to a Declaration of Covenants and Restrictions filed by Rock Road dated May 27, 1997, which was recorded June 30, 1997 in Book 11208 Page 2507 in the St. Louis County Recorder of Deeds Office (the "Land Records"), and the entire portion of the Premises owned by Bridgeton Landfill is subject to a Declaration of Covenants and Restrictions filed by Bridgeton Landfill dated June 9, 1997, which was recorded June 30, 1997 in Book 11208 Page 2514 in the Land Records (collectively, the "1997 Declarations").

F. The 1997 Declarations restrict the Premises as follows: (i) neither the Premises, nor any part thereof, shall be used for any residential purpose, or for any day care, preschool or other educational use, and (ii) no water well for drinking water use shall be installed on the Premises.

G. The entire portion of the Premises owned by Rock Road is further subject to a Supplemental Declaration of Covenants and Restrictions filed by Rock Road dated

January 16, 1998, which was recorded January 20, 1998 in Book 11427 Page 1633 in the Land Records (the "1998 Declarations").

H. The 1998 Declarations restrict the portions of the Premises owned by Rock Road as follows: (i) no building of any kind or nature for any propose shall be constructed or placed on the portions of the Premises owned by Rock Road, now or at any time in the future, in perpetuity, and (ii) no underground utilities or pipes shall be installed at the portions of the Premises owned by Rock Road, and no excavation work shall be performed on the portions of the Premises owned by Rock Road, now or at any time in the future, in perpetuity, except such utilities, pipes, and/or excavation work, if any, which (a) are approved by EPA in connection with a plan selected by EPA to remediate hazardous substances on the Premises and that are performed in accordance with environmental and safety regulations applicable to such a remedial plan or are otherwise required by EPA as a condition of such approval; or (b) are a part of a landfill gas control, leachate collection, or surface water management system installed and operated pursuant to a plan approved by all applicable federal, state, or local authorities exercising jurisdiction over inactive landfill conditions on the portions of the Premises owned by Rock Road or active or inactive landfill operations conducted adjacent to the portions of the Premises owned by Rock Road.

I. All of the Premises in OU Area 1 and a portion of the Premises in OU Area 2 are further subject to a Negative Easement and Declaration of Restrictive Covenants Agreement, dated April 6, 2005, and which is recorded April 11, 2005 at Book 16465 Page 1141 in the Land Records (the "April 2005 Negative Easement").

J. The April 2005 Negative Easement restricts all of the Premises in OU Area 1 and the portion of the Premises in OU Area 2 as follows: there shall be no new or additional depositing or dumping of municipal waste, organic waste, and/or putrescible waste above, upon, on or under such portions of the Premises beginning as of August 1, 2005 and continuing in perpetuity, unless and until such time as the April 2005 Negative Easement is terminated or cancelled by the City of St. Louis, Missouri in accordance with the terms set forth in the April 2005 Negative Easement.

K. Declarants desire to subject the entirety of the Premises (i.e., all of OU Area 1 and OU Area 2) to the restrictions set forth in the 1998 Declarations and, for avoidance of confusion caused by the varying ownership of such parcels and the varying applicability of such restrictions, Declarants desire to restate or extend the restrictions set forth in the 1997 Restrictions and the 1998 Restrictions against the entirety of the Premises, as the case may be.

L. In addition to the restrictions contained in the 1997 Declaration, the 1998 Declaration and the April 2005 Negative Easement, Declarants desire to prohibit in perpetuity (i) the use of the Premises for commercial and industrial purposes, including (but not limited to) use of the Premises as a storage yard, and (ii) placement upon the Premises of water wells for agricultural purposes, except as set forth herein.

DECLARATION

Declarant hereby states and declares the following:

1. Neither the Premises, nor any portion thereof, shall be used now or hereafter for any residential purpose, or for any day care, preschool, or any other educational use.

2. No building or habitable structure of any kind or nature for any purpose shall be constructed or placed on the Premises, now or at any time in the future, in perpetuity.

3. No underground utilities or pipes shall be installed at, on or under the Premises and no excavation work shall be performed on the Premises, now or at any time in the future, in

perpetuity, except such utilities, pipes, and/or excavation work, if any, which (a) are approved by EPA in connection with a plan selected by EPA to remediate hazardous substances on the Premises and that are performed in accordance with environmental and safety regulations applicable to such a remedial plan or are otherwise required by EPA as a condition of such approval; or (b) are a part of a landfill gas control, leachate collection, or surface water management system installed and operated pursuant to a plan approved by all applicable federal, state, or local authorities exercising jurisdiction over inactive landfill conditions on the Premises or active or inactive landfill operations conducted adjacent to the Premises.

4. The Premises shall not be used for commercial or industrial purposes, now or at any time in the future, in perpetuity.

5. The Premises shall not be used as a storage yard (whether temporarily or permanently), now or at any time in the future, in perpetuity.

6. No water wells for drinking water or agricultural use shall be installed on the Premises.

7. This Supplemental Declaration shall not unlawfully restrict and shall not be used to violate any federal or state law, rule, or regulation regarding the use of real property, including (but not limited to) the Fair Housing Act.

8. This Supplemental Declaration shall be recorded in the Office of the Recorder of Deeds for the County of St. Louis, State of Missouri.

9. Any deed or other instrument of conveyance for the Premises or any portion thereof shall be subject to this Supplemental Declaration.

10. Each of EPA (or its successor), the Missouri Department of Natural Resources ("MDNR") (or its successor), and the owner of any portion of the Premises shall have the right to

sue for and obtain an injunction, prohibitive or mandatory, to prevent the breach, or to enforce the observance, of this Supplemental Declaration. This right shall be in addition to any other action available at law or in equity. The failure to enforce any covenant or restriction herein at the time of its violation shall not constitute a waiver of the right to do so at a later time.

11. The provisions of this Supplemental Declaration shall continue in full force and effect until the fiftieth (50th) anniversary of the date of this Supplemental Declaration and thereafter for successive twenty (20) year periods, unless, prior to the expiration of the then-current term, a written notice of termination of this Supplemental Declaration, executed by each of the then-owners of the Premises, authorized representatives of EPA (or its successor), and the MDNR (or its successor) has been filed with the Office of the Recorder of Deeds for St. Louis County, State of Missouri (the "Notice of Termination"). Any Notice of Termination not so executed shall not be valid and shall have no binding effect on the terms and conditions of this Supplemental Declaration. The Notice of Termination may be filed at any time after the Effective Date of this Supplemental Declaration, and this Supplemental Declaration shall terminate on the date that the Notice of Termination is filed with the Recorder of Deeds.

12. The 1997 Declaration, the 1998 Declaration and the April 2005 Negative Easement each remain in full force and effect, and each shall be deemed supplemented and where applicable restated, but not amended, by this Supplemental Declaration.

IN WITNESS WHEREOF, Rock Road Industries, Inc. and Bridgeton Landfill, LLC have caused this instrument to be executed this 4th day of October 2016.

[Signature Pages Follow]

ROCK ROAD INDUSTRIES, INC.,
a Missouri corporation

By: ______________________________
Tim M. Benter, Vice President and Assistant Secretary

ACKNOWLEDGEMENT

STATE OF ARIZONA)
) ss
COUNTY OF MARICOPA)

On this 4th day of October, 2016, before me, a notary public, personally appeared Tim M. Benter, to me known, who, being by me duly sworn, did say that he is the Vice President and Assistant Secretary of Rock Road Industries, Inc., a Missouri corporation, and that said instrument was signed on behalf of said corporation by authority of its Board of Directors, and said person acknowledged said instrument to be the free act and deed of said corporation.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal in the County and State aforesaid, the day and year first above written.

Andrea Wing
Notary Public

My commission expires:

11/11/18

Notary Public State of Arizona
Maricopa County
Andrea Wing
My Commission Expires 11/11/2018

BRIDGETON LANDFILL, LLC, a Missouri corporation

By: ______________________
Tim M. Benter, Vice President and Assistant Secretary

ACKNOWLEDGEMENT

STATE OF ARIZONA)
) ss
COUNTY OF MARICOPA)

On this 4th day of October, 2016, before me, a notary public, personally appeared Tim M. Benter, to me known, who, being by me duly sworn, did say that he is the Vice President and Assistant Secretary of Bridgeton Landfill, LLC, a Missouri corporation, and that said instrument was signed on behalf of said corporation by authority of its Board of Directors, and said person acknowledged said instrument to be the free act and deed of said corporation.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal in the County and State aforesaid, the day and year first above written.

____
Notary Public

My commission expires:

11/11/16

Notary Public State of Arizona
Maricopa County
Andrea Wing
My Commission Expires 11/11/2016

EXHIBIT A

Parcels Owned by Rock Road Industries, Inc.

1. Parcel Locator No. 10O640061, 13004 St. Charles Rock Road, St. Louis County, Missouri

2. Parcel Locator No. 09O220025, 12999 Boenker Lane, St. Louis County, Missouri

3. Parcel Locator No. 10O540051, 13155 Boenker Lane, St. Louis County, Missouri

Parcels Owned by Bridgeton Landfill, LLC

1. Parcel Locator No. 10O610152, 13323 Boenker Lane, St. Louis County, Missouri

2. Parcel Locator No. 10O620085, 13002 St. Charles Rock Road, St. Louis County, Missouri

3. Parcel Locator No. 09O310060, 13570 St. Charles Rock Road, St. Louis County, Missouri

EXHIBIT B-1

Legal Description of OU Area 1 and OU Area 2

OU Area 1:

A tract of land in part of U.S. Survey 131 in Township 47 North; Range 5 East of the Fifth Principal Meridian St. Louis, Mo. being more particularly described as follows:

Commencing at a point being the intersection of the Northwesterly line of U.S. Survey 131 with the Southwesterly right of way line at St. Charles Rock Road- (Highway 40); thence South 37 degrees 11 minutes 39 seconds East along said right of way line a distance of 228.33 feet to the point of beginning at the tract described herein; thence South 37 degrees 11 minutes 39 seconds East continuing along said right of way line a distance of 501.34 feet; thence South 47 degrees 31 minutes 24 seconds West a distance of 591.78 feet; thence South 31 degrees 22 minutes 15 seconds West a distance of 320.47 feet; thence South 47 degrees 08 minutes 46 seconds West a distance of 307.43 feet; thence North 36 degrees 53 minutes 01 seconds West a distance of 804.43 feet; thence North 38 degrees 16 minutes 06 seconds East a distance of 146.84 feet; thence North 64 degrees 14 minutes 08 seconds East a distance of 113.07 feet; thence North 60 degrees 07 minutes 22 seconds East a distance of 384.20 feet; thence North 49 degrees 33 minutes 57 seconds East a distance of 249.05 feet; thence North 56 degrees 17 minutes 00 seconds East a distance of 112.57 feet; thence North 59 degrees 38 minutes 15 seconds East a distance of 102.59 feet; thence North 86 degrees 35 minutes 54 seconds East a distance of 110.98 feet to the point of beginning and containing 18.51 acres.

OU Area 2:

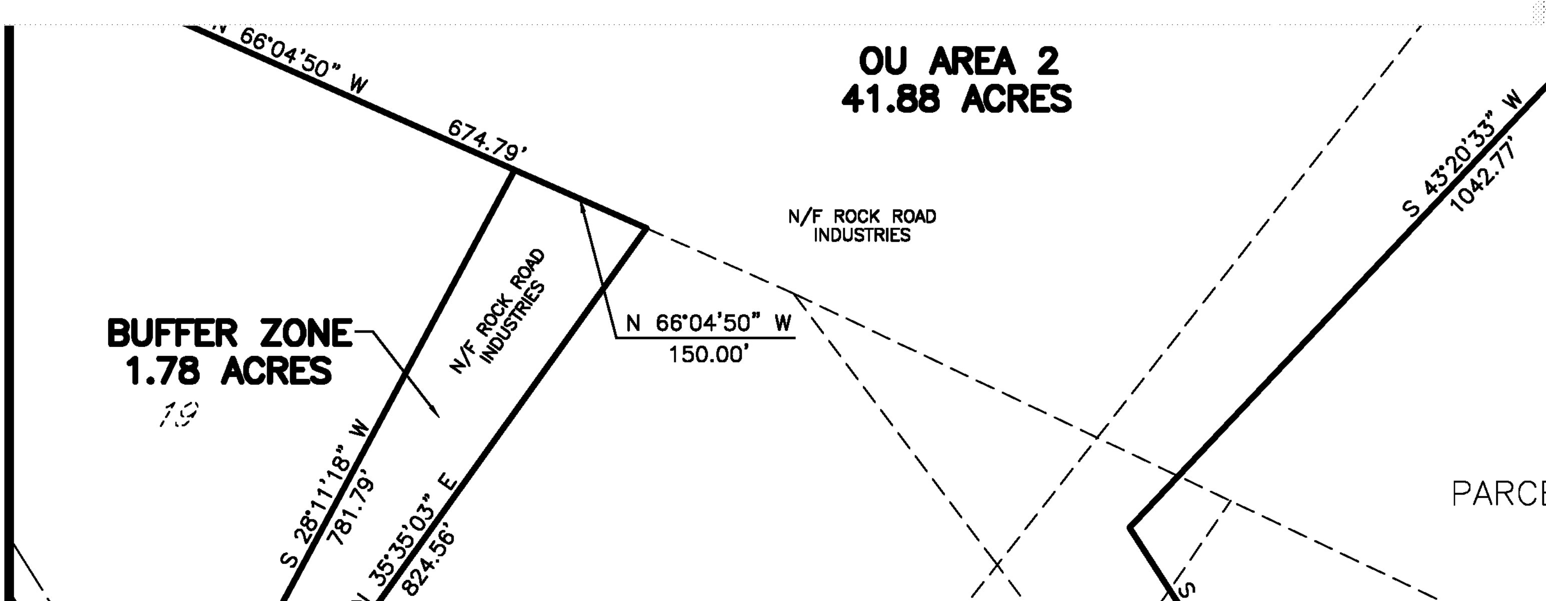
A tract of land being part of lots 20 and 21 of St. Charles Ferry Co. Tracts in U.S. Survey 47 and 1934 and part of U.S. Survey 47 all in township 47 North Range 5 East of the Fifth Principal Meridian St. Louis County, Mo. being more particularly described as follows:

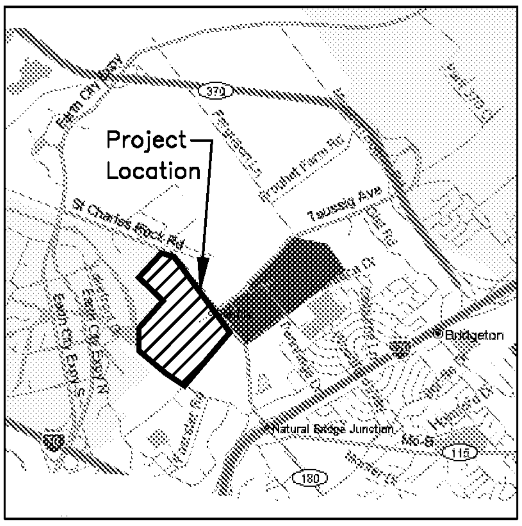
Commencing at a point being the intersection of the Southwesterly right of way line at St. Charles Rock Road with the dividing line between U.S. Survey 47 and U.S. Survey 131; thence North 37 degrees 11 minutes 39 seconds West along said right of way line a distance of 602.78 feet; thence North 49 degrees 13 minutes 36 seconds West continuing along said right of way line a distance of 95.94 feet; thence North 37 degrees 11 minutes 39 seconds West continuing along said right of way line a distance of 35.28 feet; thence North 52 degrees 48 minutes 21 seconds East continuing along said right of way line a distance of 15.00 feet; thence North 37 degrees 11 minutes 39 seconds West continuing along said right of way line a distance of 47.91 feet; thence along said right of way line being a curve to the left having a radius of 1855.08 feet a chord bearing North 41 degrees 02 minutes 55 seconds West a chord distance of 249.41 feet to the point of beginning of the tract described herein; thence South 43 degrees 20 minutes 33 seconds West a distance of 1042.77 feet; thence South 32 degrees 48 minutes 22 seconds East a distance of 327.69 feet; thence South 63 degrees 07 minutes 00 seconds West a distance of 752.42 seconds; thence South 55 degrees 39 minutes 27 seconds West a distance of 158.01 feet; thence South 67 degrees 24 minutes 36 seconds West a distance of 199.34 feet to the centerline of the Old St. Charles Rock Road; thence North 10 degrees 25 minutes 19 seconds West along said centerline a distance of 88.10 feet; thence North 24 degrees 52 minutes 19 seconds West continuing along said centerline a distance of 349.50 feet; thence North 32 degrees 08 minutes 19 seconds West continuing along said centerline a distance of 22.38 feet to the Northwesterly line of Lot 20 of St. Charles Ferry Co. Tracts; thence North 35 degrees 35 minutes 03 seconds East along said lot line a distance of 824.56 feet to the Northwest corner of lot 20; thence North 66 degrees 04 minutes 50 seconds West a distance of 674.79 feet; thence North 54 degrees 24 minutes 55 seconds East a distance of 1137.84 feet to the aforementioned Southwesterly right of way line of St. Charles Rock Road- (Highway 40); thence South 69 degrees 14 minutes 39 seconds East along said right of way line a distance of 260.00 feet; thence continuing along said right of way line being a curve to the right having a radius of 1825.08 feet a chord bearing South 58 degrees 29 minutes 59 seconds East a chord distance of 680.49 feet; thence North 42 degrees 14 minutes 40 seconds East continuing along said right of way line a distance of 30.00 feet; thence continuing along said right of way line being a curve to the right having a radius of 1855.08 feet a chord bearing South 46 degrees 19 minutes 46 seconds East a chord distance of 92.34 feet to the point of beginning and containing 41.88 acres.

EXHIBIT B-2

Survey Showing OU Area 1 and OU Area 2

[See attached]





LAIDLA
BRIDGETO

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"WEST
SURVEY
RANGE

NOTE:

1. THIS PLAT WAS PREPARED BY USE OF PREVIOUS SURVEY INFORMATION, SURVEY PLATS, COUNTY RECORDS RESEARCH, AND OTHER MISCELLANEOUS INFORMATION. HOWEVER THIS MAP IS NOT TO BE USED AS OR CONSIDERED A CURRENT BOUNDARY SURVEY OF THE LANDFILL PROPERTY. A COMPLETE TITLE SEARCH AND REPORT SHOULD BE DONE TO DETERMINE CURRENT PARCEL OWNERSHIPS.

2. BASIS OF BEARINGS AND COORDINATES OBTAINED BY FIELD SURVEY OF LOCAL STATE PLANE COORDINATE MONUMENTATION PRIOR TO THE MOST RECENT STATE PLANE COORDINATE SYSTEMS ADJUSTMENTS. SAID MONUMENTATION HAS SINCE BEEN DESTROYED.

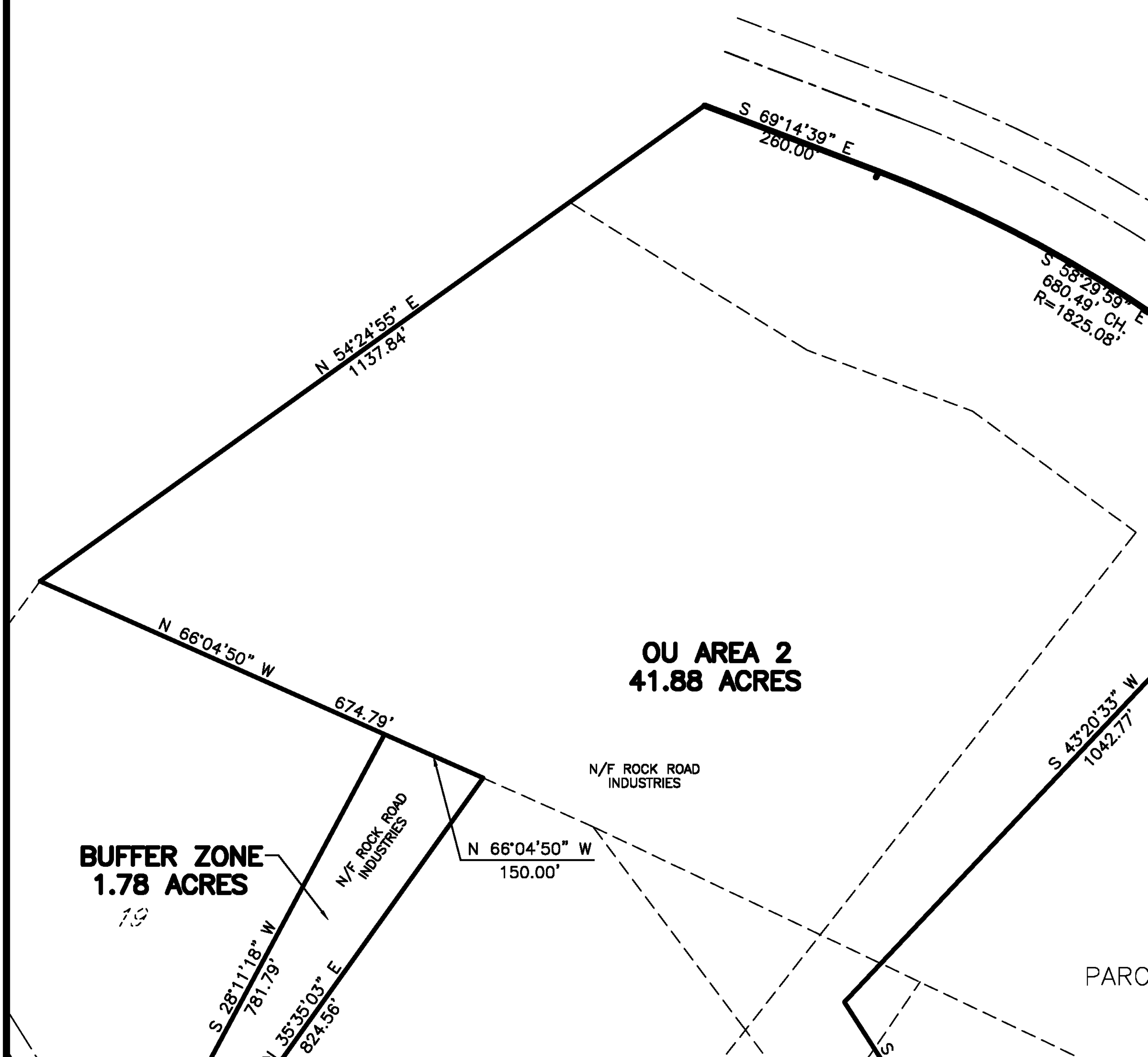

EXHIBIT C

Consent Order

[See Attached]

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VII
726 MINNESOTA AVENUE
KANSAS CITY, KANSAS 66101

IN THE MATTER OF: COTTER CORPORATION (N.S.L.), and LAIDLAW WASTE SYSTEMS (BRIDGETON), INC., and ROCK ROAD INDUSTRIES, INC., and UNITED STATES DEPARTMENT OF ENERGY, RESPONDENTS. Proceeding Under Sections 104, 122(a), and 122(d)(3) of the Comprehensive Environmental Response, Compensation, and Liability Act as amended 42 U.S.C §§ 9604, 9622(a), 9622(d)(3).	Docket No. VII-93-F-0005

ADMINISTRATIVE ORDER ON CONSENT
FOR REMEDIAL INVESTIGATION/FEASIBILITY STUDY

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I. INTRODUCTION

1. This Administrative Order on Consent ("Consent Order") is entered into voluntarily by the United States Environmental Protection Agency ("EPA"), Cotter Corporation (N.S.L.) ("Cotter"), Laidlaw Waste Systems (Bridgeton), Inc. ("Laidlaw"), Rock Road Industries, Inc. ("Rock Road"), and the United States Department of Energy ("DOE") (Cotter, Laidlaw, Rock Road, and DOE are collectively referred to herein as "Respondents"). This Consent Order concerns the preparation of, performance of, and reimbursement of all costs incurred by EPA in connection with a remedial investigation and feasibility study ("RI/FS") at the West Lake Landfill NPL Site located at Bridgeton, Missouri (hereinafter referred to as "West Lake" or "Site").

II. JURISDICTION

2. This Consent Order is issued pursuant to the authority vested in the President of the United States by Sections 104, 122(a), and 122(d)(3) of the Comprehensive Environmental Response, Compensation, and Liability Act, as amended, 42 U.S.C. §§ 9604, 9622(a), and 9622(d)(3) ("CERCLA"). This authority was delegated to the Administrator of EPA by Executive Order 12580 of January 23, 1987, 52 Fed. Reg. 2923, and was further delegated to EPA's Regional Administrators on September 13, 1987 by EPA Delegation No. 14-14-C. This authority has been redelegated by the Regional Administrator of EPA Region VII to the Director of the Waste Management Division of EPA Region VII by Delegation R7-14-14C dated May 16, 1988.

3. Respondents agree to undertake all actions required by the terms and conditions of this Consent Order. In any action by EPA or the United States to enforce the terms of this Consent Order, Respondents consent to and agree not to contest the authority or jurisdiction of EPA to issue or enforce this Consent Order, and agree not to contest the validity of this Consent Order or its terms.

III. PARTIES BOUND

4. This Consent Order shall apply to and be binding upon EPA and Respondents and their respective agents, successors, and assigns, and upon all persons, including contractors and consultants, acting under or on behalf of Respondents or EPA with regard to the Site. Respondents' participation in this Consent Order, however, shall not be construed as an admission of liability or of EPA's findings of fact or conclusions of law and determinations contained in this Consent Order. The signatories to this Consent Order certify that they are authorized to execute and legally bind the parties they represent to this Consent Order. No change in the ownership or corporate status of Respondents, or of the ownership of the Site, shall alter Respondents' responsibilities under this Consent Order.

5. Respondents shall provide a copy of this Consent Order to any subsequent owners or successors before all or substantially all of the stock or assets are transferred in a corporate acquisition. Respondents shall provide a copy of this Consent Order to all contractors, subcontractors, laboratories, and consultants which

are retained to conduct any work performed under this Consent Order within fourteen (14) days after the effective date hereof or the date of retaining their services, whichever is later. Respondents shall condition any such contracts upon satisfactory compliance with all applicable terms of this Consent Order. Notwithstanding the terms of any contract, each Respondent is responsible for compliance with this Consent Order and shall use its best efforts to ensure that its subsidiaries, employees, contractors, consultants, subcontractors, and agents comply with all applicable terms of this Consent Order.

IV. STATEMENT OF PURPOSE

6. In entering into this Consent Order, the objectives of EPA and Respondents are: (a) to determine the nature and extent of contamination and any threat to the public health, welfare, or the environment caused by the release or threatened release of hazardous substances, pollutants, or contaminants at or from Radiological Areas 1 and 2, as defined in Paragraph 12, herein, at the Site by conducting a remedial investigation; (b) to determine and evaluate alternatives for remedial action (if any) to prevent, mitigate, or otherwise respond to or remedy any release or threatened release of hazardous substances, pollutants, or contaminants at or from Radiological Areas 1 and 2 at the Site, by conducting a feasibility study; and (c) to recover all response and oversight costs incurred by EPA with respect to this Consent Order in accordance with the procedures set forth in Section XXII (Reimbursement of Response and Oversight Costs).

7. The activities conducted under this Consent Order are subject to approval by EPA and shall provide all appropriate and necessary information for the RI/FS, and for a Record of Decision ("ROD") that is consistent with CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan ("NCP"), 40 C.F.R. Part 300. The activities conducted under this Consent Order shall be conducted in compliance with all applicable EPA guidances, policies, and procedures, which EPA will identify in writing in advance. Activities conducted in compliance with this Consent Order shall be deemed in compliance with the NCP.

V. EPA'S FINDINGS OF FACT

EPA makes the following Findings of Fact (contained in Paragraphs 8-31), which Respondents do not admit:

8. The Landfill is comprised of approximately 200 acres located at 13570 St. Charles Rock Road, Bridgeton, St. Louis County, Missouri, and is approximately 4 miles west of St. Louis' Lambert Field International Airport, near the intersection of Highways I-70 and I-270. Limestone was quarried at the Landfill from 1939 to the present. Since 1962 portions of the quarried property have been used for landfilling municipal refuse, industrial solid and liquid wastes, and construction demolition debris.

9. In 1966, the Atomic Energy Commission ("AEC") sold 8,700 tons of leached barium sulfate, together with other radioactive residues, to Continental Mining and Milling Company ("Continental Mining"). The radioactive residues were generated as by-products

of uranium processing performed by the AEC's contractor. These processing residues were stored at the AEC's St. Louis Airport Storage Site ("SLAPSS").

10. Continental Mining removed the radioactive residues to its facility at 9200 Latty Avenue in Hazelwood, Missouri. Eventually, Cotter purchased the radioactive residues and shipped all but the 8,700 tons of leached barium sulfate to its processing facility in Colorado.

11. In 1973 approximately 8,700 tons of radioactively contaminated leached barium sulfate residues were mixed with approximately 39,000 tons of soil, and the entire amount was disposed of in Radiological Areas 1 and 2, which are described in Paragraph 12, at the Landfill. This material resulted from decontamination efforts undertaken by Cotter at 9200 Latty Avenue, St. Louis, Missouri, where the residues had been stored.

12. In 1978, an aerial survey sponsored by the Nuclear Regulatory Commission ("NRC") revealed two areas within the Landfill where gamma radiation levels indicated radioactive material had been deposited. In 1980-81, Radiation Management Corporation ("RMC") of Chicago, Illinois, performed a detailed radiological survey of the Landfill under contract to the NRC. This survey was performed to determine the extent of radiological contamination. This survey indicated that the radioactive contaminants were located in two areas of the Landfill. The northern area of radioactive contamination ("Radiological Area 2") is comprised of approximately 13 acres. The radioactive debris in

this area forms a layer 2 to 15 feet thick, with radioactive debris exposed on the surface of the Landfill and along the berm on the northwest face of the Landfill. The southern area of radioactive contamination ("Radiological Area 1") is comprised of approximately 3 acres with most of the contaminated soil buried under approximately 3 feet of soil and fill.

13. The RMC survey indicated that the radioactivity emanates from uranium-238 ("U-238") and uranium-235 ("U-235") series with thorium-230 ("Th-230") and radium-226 ("Ra-226"). The survey data indicate that the average Ra-226 concentration in the radioactive wastes is approximately 90 picocuries per gram ("pCi/g"), with the average Th-230 concentration estimated to be approximately 9,000 pCi/g. Since Ra-226 has been depleted with respect to its parent Th-230, Ra-226 activity will increase in time (for example, over the next 200 years, Ra-226 activity will increase ninefold over the present level).

14. In addition to RMC's radiological survey, the NRC through Oak Ridge Associated Universities ("ORAU") contracted with the University of Missouri-Columbia Department of Civil Engineering to describe the environmental characteristics of the Site, conduct an engineering evaluation, and propose possible remedial actions for dealing with the radioactive materials at the Site. In March of 1984 a radiological survey along a section of a berm bounding the Landfill was performed by ORAU.

15. Measurements of direct radiation levels and radionuclide concentrations in soil and the physical condition of the berm area

indicated that erosion was occurring and that there were elevated concentrations of Ra-226 and Th-230 at the base of the berm and extending into the adjacent field. A sample from the mound of soil at the base of the berm contained 185 pCi/g of Ra-226 and 6,270 pCi/g of Th-230. Samples collected in the adjacent field contained 4.29-4.47 pCi/g of Ra-226 and 132-178 pCi/g of Th-230. In May 1986, ORAU sampled water wells on and close to the Landfill to determine if radioactive contamination had migrated into the groundwater. The sampling consisted of 18 monitoring wells which are located in various locations around the Landfill and are screened in the shallow, intermediate, and deep parts of the aquifer. Two sampling rounds were evaluated. Round 1 occurred from December 11-15, 1985 and Round 2 from May 19-21, 1986. All samples were analyzed for priority pollutants listed under 40 C.F.R. Part 122, Appendix D. This list includes volatile organics, acid and base/neutral extractables, pesticides, polyclorinated biphenyls ("PCBs"), total phenols, total cyanide, and metals. Four wells sampled during Round 1 were also analyzed for gross alpha and beta radiation.

16. Chemical results indicated that samples from certain wells contained detectable levels of several constituents. Chemicals found during Round 1 included methylene chloride (2-83 micrograms per liter ("ug/l"), bis-2-ethyhexyl phthalate (4-477 ug/l), phenol (7-19 ug/l), total cyanide (1-6 ug/l), sodium (5-175 milligrams per liter), iron (20-14,380 ug/l), lead (13 ug/l), and zinc (2-1,240 ug/l). Trace amounts of several pesticides also were

detected such as lindane, chlordane, dieldrin, endrin, 4,4'DDD, 4,4' DDE, 4,4' DDT, and hexachlorobenzene. The four wells sampled for gross alpha and beta radiation during Round 1 contained values for gross alpha ranging from 2-270 picocuries per liter ("pCi/l") and values for gross beta ranging from 11-171 pCi/l. Round 2 chemical results indicated the presence of methylene chloride (6-10 ug/l), bis-2-ethyhexyl phthalate (10 ug/l), total cyanide (7 ug/l), zinc (2-2,000 ug/l), and arsenic (4-9 ug/l). Compounds such as antimony, nickel, and thallium also were found.

17. In May 1986, 32 wells at the Site were sampled and analyzed for gross alpha and beta by ORAU. Isotopic analyses were performed on many of the samples to determine radium levels. The radionuclide concentrations were found to be gross alpha (0.9-8.4 pCi/l), gross beta (1.9-22 pCi/l), Ra-226 (0.2-0.7 pCi/l), Ra-228 (0.2-5.8 pCi/l), U-total (1.6-25 pCi/l), Th-228 (0.2-1.7 pCi/l), Th-230 (0.1-12 pCi/l), and Th-232 (0.2-4.0 pCi/l). The concentrations for gross alpha, Ra-226, and Ra-228 are below the permissible maximum contaminant levels for community water systems set forth in 40 C.F.R. § 141.

18. Direct contact with, and air transport of, radiological contamination would primarily affect persons working in and around the Site. Surface water runoff from the Landfill primarily flows to a drainage ditch along the north side of the Landfill and the south side of St. Charles Rock Road. This ditch may occasionally be recharged by groundwater. This surface water either recharges the groundwater or discharges through a drainage ditch to the

Missouri River. A pond along this ditch is located on the north side of the Landfill and is known to contain fish. Surface water runoff to the south and southwest flows across relatively flat agricultural fields. This runoff joins the small intermittent ditches which traverse the area. Groundwater contamination could affect persons using groundwater downgradient of the Landfill before it discharges to the Missouri River.

19. In a report entitled "Hydrogeological Investigation, West Lake Landfill, Primary Phase Report" prepared by Burns & McDonnell in October 1986, it was stated that the predominant groundwater flow direction in the alluvial aquifer in the vicinity of the Site is northwestward toward the Missouri River. The water table generally slopes toward the Missouri River, although changes in gradient direction apparently occur at some times during the year in response to changes in the stage of the Missouri River. The alluvial aquifer consists of a continuous sequence of sand deposits with some gravel zones. The alluvium at shallow depths is primarily fine to medium sand, with only traces of gravel. The alluvium in the deeper part of the aquifer is coarser grained, consisting primarily of coarse sand and gravel.

20. Uranium, thorium, radium, protactinium, and actinium are all known human carcinogens. Methylene chloride and lead are both probable human carcinogens. Phenol is a suspected carcinogen and mutagen.

21. The following pesticides were detected in analyses of groundwater samples taken at the Site: gamma BH (Lindane),

chlordane, dieldrin, endrin, 4,4' DDD, 4,4' DDE, 4,4' DDT, and hexachlorobenzene. These highly-chlorinated pesticides are probable carcinogens. They are toxic to humans via ingestion and dermal contact. Some are reproductive toxins.

22. U-238, U-235, Th-230, and Ra-226, the pesticides identified in Paragraph 21, above, methylene chloride, phenol, and lead are hazardous substances as defined in CERCLA Section 101(14), 42 U.S.C. § 9601(14).

23. Pursuant to Section 105 of CERCLA, 42 U.S.C. § 9605, EPA placed the Site on the National Priorities List, set forth at 40 C.F.R. Part 300, Appendix B, by publication in the Federal Register on August 30, 1990, 55 Fed. Reg. 35502.

24. Cotter Corporation (N.S.L.) is a corporation organized and existing pursuant to the laws of the State of New Mexico.

25. Laidlaw Waste Systems (Bridgeton), Inc. is a corporation organized and existing pursuant to the laws of the State of Missouri.

26. Rock Road Industries, Inc. is a corporation organized and existing pursuant to the laws of the State of Missouri.

27. The United States Department of Energy is a department of the United States Government and is a successor to the Atomic Energy Commission.

28. Cotter, by contract, agreement, or otherwise arranged for the disposal, or arranged with a transporter for transport for disposal, hazardous substances owned or possessed by it at the Site.

29. At the time of disposal of hazardous substances at the Site, West Lake Landfill, Inc. (now known as Laidlaw Waste Systems (Bridgeton), Inc., and referred to herein as Laidlaw) was an owner or operator of the Site.

30. DOE, by contract, agreement, or otherwise arranged for the disposal, or arranged with a transporter for transport for disposal, hazardous substances owned or possessed by it at the Site.

31. Rock Road is a current owner of the Site.

VI. EPA'S CONCLUSIONS OF LAW AND DETERMINATIONS

EPA makes the following Conclusions of Law and Determinations, which Respondents do not admit:

32. The Site is a "facility" as defined in Section 101(9) of CERCLA, 42 U.S.C. § 9601(9).

33. There has been a "release" or threat of a release of a "hazardous substance" at the Site as defined in Section 101(22) and 101(14) of CERCLA, 42 U.S.C. §§ 9601(22) and 9601(14).

34. Respondents are each a "person" as defined in Section 101(21) of CERCLA, 42 U.S.C. § 9601(21).

35. Respondents are each a responsible party pursuant to Sections 104, 107, and 122 of CERCLA, 42 U.S.C. §§ 9604, 9607, and 9622.

36. The actions required by this Consent Order are necessary to protect the public health, welfare, or environment, are practicable and in the public interest, are consistent with CERCLA and the NCP, and will expedite effective remedial action and

minimize litigation, all in accordance with Sections 104 and 122 of CERCLA, 42 U.S.C. §§ 9604 and 9622.

VII. NOTICE TO THE STATE

37. By providing a copy of this Consent Order to the State of Missouri, EPA is notifying the State of Missouri that this Consent Order is being issued and that EPA is the lead agency for coordinating, overseeing, and enforcing the activities required hereunder.

VIII. WORK TO BE PERFORMED

38. All activities performed pursuant to this Consent Order (the "Work") shall be under the direction and supervision of qualified personnel. Within thirty (30) days of the effective date of this Consent Order, and before the Work outlined below begins, Respondents shall notify EPA in writing of the names, titles, and qualifications of the principal personnel, including contractors, subcontractors, consultants, and laboratories, to be used in carrying out the Work. The qualifications of the principal persons responsible for undertaking the Work for Respondents shall be subject to EPA's review, for verification that such persons meet minimum technical background and experience requirements. This Consent Order is contingent on Respondents' demonstration to EPA's satisfaction that Respondents are qualified to perform properly and promptly the actions set forth in this Consent Order. If EPA disapproves of the technical qualifications of any person, Respondents shall notify EPA of the identity and qualifications of a replacement within thirty (30) days of receipt of EPA's

disapproval. If EPA disapproves of the replacement, EPA reserves the right to terminate this Consent Order and to conduct the Work itself, to seek reimbursement from Respondents, and/or to seek any other appropriate relief as provided herein. During the course of the performance of the Work, Respondents shall notify EPA in writing of any changes or additions in the principal personnel used to carry out the Work, including their names, titles, and qualifications. EPA shall have the same right to approve changes and additions to principal personnel as it has hereunder regarding the initial notification.

39. Respondents shall conduct activities and submit deliverables as provided by this Consent Order and the attached RI/FS Statement of Work ("SOW"), which is incorporated herein by reference, and Section IV (Statement of Purpose). All such work shall be conducted in accordance with CERCLA, the NCP, and EPA guidance including, but not limited to, the "Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (OSWER Directive 9355.3-01), guidances referenced therein, and guidances referenced in the SOW, as may be amended or modified by EPA. The general activities that Respondents are required to perform are identified below. The tasks that Respondents must perform are described more fully in the SOW and guidances. The activities and deliverables identified below shall be developed as provided in the RI/FS Work Plan and Sampling and Analysis Plan, and shall be submitted to EPA as provided. All work performed under this Consent Order shall be in accordance with the

schedules herein, and in full accordance with the standards, specifications, and other requirements of the RI/FS Work Plan and Sampling and Analysis Plan, as approved by EPA, and as may be amended or modified by EPA.

a. **Task I - Scoping**. EPA determines the Site-specific objectives of the RI/FS and devises a general management approach for the Site, as stated in the attached SOW. Respondents shall conduct the remaining scoping activities as described in the SOW and referenced guidances. At the conclusion of the project planning phase, Respondents shall submit the following deliverables to EPA:

(1) RI/FS Work Plan. Within sixty (60) days of the effective date of this Consent Order, Respondents shall submit to EPA a complete RI/FS Work Plan in accordance with the SOW. If EPA disapproves of or requires revisions to the RI/FS Work Plan, in whole or in part, Respondents shall amend and submit to EPA a revised RI/FS Work Plan which is responsive to all of EPA's comments, within forty-five (45) days of receiving EPA's comments.

(2) Sampling and Analysis Plan. Within sixty (60) days of the effective date of this Consent Order, Respondents shall submit to EPA a Sampling and Analysis Plan in accordance with the schedule set forth in the EPA approved RI/FS Work Plan. This Sampling and Analysis Plan shall consist of a Field Sampling Plan ("FSP") and a Quality Assurance Project Plan ("QAPP") as described in the SOW and guidances. If EPA

disapproves of or requires revisions to the Sampling and Analysis Plan, in whole or in part, Respondents shall amend and submit to EPA a revised Sampling and Analysis Plan which is responsive to all of EPA's comments, within forty-five (45) days of receiving EPA's comments.

(3) Site Health and Safety Plan. Within sixty (60) days of the effective date of this Consent Order, Respondents shall submit to EPA a Site Health and Safety Plan.

b. **Task II - Community Relations**. EPA will prepare a Community Relations Plan, in accordance with EPA guidance and the NCP. Respondents shall provide information supporting EPA's community relations programs.

c. **Task III - Site Characterization**. Following EPA approval or modification of the RI/FS Work Plan and Sampling and Analysis Plan, Respondents shall implement the provisions of these Plans to characterize the Site. Respondents shall complete Site characterization in accordance with the schedule set forth in the EPA approved RI/FS Work Plan. Respondents shall provide EPA with validated analytical data generated pursuant to this Consent Order in a form showing the location, medium, and results. As used herein, "validated analytical data" refers to data that has been quality assured pursuant to the QAPP and the supporting empirical data, including instrument printouts, used to determine such quality assured data. Respondents shall require validation of all sampling results within sixty (60) days of receipt from the laboratory. This information shall be submitted to EPA with the subsequent monthly progress report as described in Section XIII (Progress Reports), herein. Within seven (7) days of completion of field activities, Respondents shall notify EPA in writing. During Site characterization, Respondents shall provide EPA with the following deliverables, as described in the SOW and RI/FS Work Plan:

(1) Technical Memorandum on Modeling of Site Characteristics. Where Respondents propose that modeling is appropriate, Respondents shall submit a technical memorandum on modeling of Site characteristics in accordance with the schedule set forth in the approved RI/FS Work Plan. If EPA disapproves of, or requires revisions to, the technical memorandum on modeling of Site characteristics, in whole or in part, Respondents shall amend and submit to EPA a revised technical memorandum on modeling of Site characteristics which is responsive to all of EPA's comments, within forty-five (45) days of receiving EPA's comments.

(2) Site Characterization Summary Report. Respondents shall submit a Site Characterization Summary Report to EPA in accordance with the schedule set forth in the approved RI/FS Work Plan.

(3) Remedial Investigation Report. Within sixty (60) days of receipt from EPA of the Baseline Risk Assessment described in Section IX (EPA's Baseline Risk Assessment), Respondents shall submit to EPA a Remedial Investigation Report consistent with the SOW, RI/FS Work Plan, and Sampling

and Analysis Plan. If EPA disapproves of or requires revisions to the Remedial Investigation Report, in whole or in part, Respondents shall amend and submit to EPA a revised Remedial Investigation Report which is responsive to all of EPA's comments, within forty-five (45) days of receiving EPA's comments.

d. **<u>Task IV - Treatability Studies</u>**. Respondents shall submit to EPA a memorandum analyzing whether treatability studies are needed based on the information developed during the conduct of the Remedial Investigation and the basis therefor. EPA will then determine whether Respondents shall conduct treatability studies and notify Respondents of its decision in writing. If required, major components of the treatability studies include determination of the need for and scope of studies, the design of the studies, and the completion of the studies as described in the SOW. During treatability studies, Respondents shall provide EPA with the following deliverables:

(1) <u>Identification of Candidate Technologies Memorandum</u>. This memorandum shall be submitted in accordance with the schedule set forth in the EPA approved RI/FS Work Plan. If EPA disapproves of, or requires revisions to, the technical memorandum identifying candidate technologies, in whole or in part, Respondents shall amend and submit to EPA a revised technical memorandum identifying candidate technologies which is responsive to all of EPA's comments within forty-five (45) days of receiving EPA's comments.

(2) Treatability Testing Work Plan. Respondents shall submit a Treatability Testing Work Plan or a proposed amendment to the RI/FS Work Plan, including a schedule, in accordance with the schedule set forth in the approved RI/FS Work Plan. If EPA disapproves of, or requires revisions to, the Treatability Testing Work Plan or the proposed amendment to the RI/FS Work Plan, in whole or in part, Respondents shall amend and submit to EPA a revised Treatability Testing Work Plan or proposed amendment to the RI/FS Work Plan, which is responsive to all of EPA's comments, within forty-five (45) days of receiving EPA's comments.

(3) Treatability Study Sampling and Analysis Plan. Upon the identification of the need for a separate or amended QAPP or FSP, Respondents shall submit a Treatability Study Sampling and Analysis Plan or a proposed amendment to the original QAPP or FSP, in accordance with the schedule set forth in the approved RI/FS Work Plan. If EPA disapproves of, or requires revisions to, the Treatability Study Sampling and Analysis Plan or the proposed amendment to the original QAPP or FSP, in whole or in part, Respondents shall amend and submit to EPA a revised Treatability Study Sampling and Analysis Plan or proposed amendment to the original QAPP or FSP, which is responsive to all of EPA's comments, within forty-five (45) days of receiving EPA's comments.

(4) Treatability Study Site Health and Safety Plan. Upon the identification of the need for a separate or amended

Health and Safety Plan, Respondents shall submit a Treatability Study Site Health and Safety Plan or a proposed amendment to the original Site Health and Safety Plan, in accordance with the schedule set forth in the approved RI/FS Work Plan.

(6) Treatability Study Evaluation Report. Respondents shall submit a Treatability Study Evaluation Report as provided in the SOW and RI/FS Work Plan in accordance with the schedule set forth in the approved RI/FS Work Plan. If EPA disapproves of, or requires revisions to, the Treatability Study Evaluation Report, in whole or in part, Respondents shall amend and submit to EPA a revised Treatability Study Evaluation Report which is responsive to all of EPA's comments within forty-five (45) days of receiving EPA's comments.

e. **Task V - Development and Screening of Remedial Alternatives**. Respondents shall develop an appropriate range of waste management options that will be evaluated through the development and screening of alternatives as provided in the SOW and RI/FS Work Plan. During the development and screening of alternatives, Respondents shall provide EPA with the following deliverables:

(1) Memorandum on Remedial Action Objectives. Within sixty (60) days of receipt of the Baseline Risk Assessment, Respondents shall submit a memorandum on remedial action objectives.

(2) <u>Report on Development and Screening of Remedial Alternatives</u>. Respondents shall submit a report summarizing the development and screening of remedial alternatives including an alternatives array document as described in the SOW in accordance with the schedule set forth in the approved RI/FS Work Plan.

f. **<u>Task VI - Detailed Analysis of Remedial Alternatives</u>**. Respondents shall conduct a detailed analysis of remedial alternatives as described in the SOW and RI/FS Work Plan. During the detailed analysis of alternatives, Respondents shall provide EPA with the following deliverables and presentation:

(1) <u>Comparative Analysis Technical Memorandum and Presentation to EPA</u>. Respondents shall submit a technical memorandum to EPA summarizing the results of the comparative analysis performed between the remedial alternatives in accordance with the schedule set forth in the approved RI/FS Work Plan. If EPA disapproves of, or requires revisions to, the comparative analysis technical memorandum, Respondents shall amend and submit to EPA a revised comparative analysis technical memorandum which is responsive to all of EPA's comments within forty-five (45) days of receiving EPA's comments. Upon EPA's request, Respondents shall make a presentation to EPA during which Respondents shall summarize the findings of the remedial investigation and remedial action objectives, and present the results of the nine criteria evaluation and comparative analysis as described in the SOW,

in accordance with the schedule set forth in the approved RI/FS Work Plan.

(2) Feasibility Study Report. Respondents shall submit a draft Feasibility Study Report which reflects the findings in the Baseline Risk Assessment in accordance with the schedule set forth in the approved RI/FS Work Plan. Respondents shall refer to Table 6-5 of the RI/FS Guidance for report content and format. If EPA disapproves of, or requires revisions to, the draft Feasibility Study Report, in whole or in part, Respondents shall amend and submit to EPA a revised Feasibility Study Report which is responsive to all of EPA's comments, within forty-five (45) days of receiving EPA's comments. The report, as amended, and the Administrative Record shall provide the basis for the Proposed Plan under CERCLA §§ 113(k) and 117(a), 42 U.S.C. §§ 6913(k) and 6917(a), by EPA and shall document the development and analysis of remedial alternatives.

40. For all deliverables, EPA will approve, disapprove, or return the deliverable to Respondents with comments or requests for modifications. In subsequent or resubmitted deliverables, Respondents shall respond to the specified deficiencies and address the information and comments from EPA. If EPA disapproves of a deliverable, EPA will state with specificity the grounds for disapproval.

41. Respondents shall not proceed further with any subsequent activities or tasks until receiving EPA approval for the following

deliverables: RI/FS Work Plan, Sampling and Analysis Plan, draft Remedial Investigation Report, Treatability Testing Work Plan, Treatability Study Sampling and Analysis Plan, and the draft Feasibility Study Report. While awaiting EPA approval on these deliverables, Respondents shall proceed with all other tasks and activities which may be conducted independently of these deliverables, in accordance with the schedule set forth in this Consent Order or the approved RI/FS Work Plan.

42. For all remaining deliverables not enumerated in the preceding Paragraph, Respondents may proceed with all subsequent tasks, activities and deliverables without awaiting EPA approval. If Respondents have not complied with an approved Work Plan or this Consent Order, or at any time EPA deems necessary to protect public health, welfare, or the environment, however, EPA reserves the right to disapprove Respondents' implementation of such tasks and may require that Respondents' cease the implementation of such tasks, either temporarily or permanently, at any point during the RI/FS.

43. In the event that Respondents amend or revise a report, plan, or other submittal upon receipt of EPA comments, if EPA subsequently disapproves of the revised submittal, or if subsequent submittals do not fully reflect EPA's directions for changes, EPA retains the right to seek stipulated or statutory penalties, perform its own studies, complete the RI/FS (or any portion of the RI/FS) pursuant to CERCLA and the NCP, and seek reimbursement from the Respondents for its costs and/or seek any other appropriate

relief. In the event EPA refuses to approve a deliverable unless Respondents change or modify it in a manner which Respondents deem inconsistent with Respondents' best professional judgment, Respondents reserve the right to seek Dispute Resolution in accordance with Section XIX (Dispute Resolutions) or pursue any other rights they may have.

44. In the event that EPA takes over some of the tasks but not the preparation of the RI/FS, Respondents shall incorporate and integrate information supplied by EPA into the final RI/FS report.

45. Neither the failure of EPA to expressly approve or disapprove of Respondents' submissions within a specified time period nor the absence of comments, shall be construed as approval by EPA. EPA will make it a goal to approve, disapprove, or comment on all deliverables within sixty (60) days of receipt of the deliverable.

IX. EPA'S BASELINE RISK ASSESSMENT

46. EPA will perform the Baseline Risk Assessment. Respondents shall support EPA in the effort by providing various information to EPA as outlined above. The major components of the Baseline Risk Assessment include contaminant identification, exposure assessment, toxicology assessment, and human health and ecological risk characterization.

47. EPA will provide, after review of Respondents' Site Characterization Summary, sufficient information concerning the baseline risks such that the Respondents can begin drafting the

Feasibility Study Report and the Memorandum on Remedial Action Objectives.

48. EPA will prepare a Baseline Risk Assessment report based on data collected by the Respondents during Site characterization. EPA will release the final report to the public at the same time it releases the final RI Report. Both reports will be put into the Administrative Record for the Site.

X. MODIFICATION OF THE RI/FS WORK PLAN

49. Respondents shall have the right to gather any additional data not specified or required under this Consent Order. If, at any time during the performance of the Work required under this Consent Order, Respondents identify a need for additional data to complete the Work which shall require a modification or extension of any part of the schedule, Respondents shall submit a memorandum to the EPA Project Coordinator explaining the need for and the nature of the requested modification or extension. If EPA does not approve or disapprove of the request for modification or extension within fourteen (14) days of receipt of the request, Respondents may proceed to gather such additional data and submit it to EPA for inclusion in the administrative record. However, any schedule modification or extension may be accomplished only in conformity with Section XXVII (Effective Date and Subsequent Modification) of this Consent Order.

50. In the event conditions posing an immediate threat to human health, welfare, or the environment become known to them, Respondents shall notify EPA and the State of Missouri no later

than twenty-four (24) hours of discovery. In the event of material unanticipated or changed circumstances at the Site, Respondents shall notify the EPA Project Coordinator by telephone within forty-eight (48) hours of discovery of such unanticipated or changed circumstances. In addition to the authorities in the NCP, in the event that EPA determines that the immediate threat or the material unanticipated or changed circumstances warrant changes in the RI/FS Work Plan, EPA may modify or amend the RI/FS Work Plan in writing accordingly. If Respondents dispute EPA's modifications or amendments to the RI/FS Work Plan, they shall submit such issue to Dispute Resolution pursuant to Section XIX. Otherwise, Respondents shall perform the RI/FS Work Plan as modified or amended.

51. EPA may determine that in addition to tasks defined in the initially approved RI/FS Work Plan, other additional work may be necessary to accomplish the objectives of the RI/FS as set forth in the SOW and the Statement of Purpose set forth in Section IV, herein. EPA may request that Respondents perform such other work in addition to the work required by the initially approved RI/FS Work Plan including any approved modifications if it determines that such actions are necessary for a complete RI/FS and is consistent with the Statement of Purpose set forth in Section IV, herein. Respondents shall confirm their willingness to perform the additional work in writing to EPA within seven (7) days of receipt of the EPA request or Respondents shall invoke Dispute Resolution. Subject to resolution of any dispute pursuant to the provisions of Section XIX (Dispute Resolution), Respondents shall implement the

additional tasks which EPA determines are necessary. The additional work shall be completed according to the standards, specifications, and schedules set forth or approved by EPA in a written modification to the RI/FS Work Plan. In the event Respondents do not agree to perform the additional work and the modification is not the subject of Dispute Resolution, EPA reserves the right to conduct the additional work itself, to seek reimbursement from Respondents, and/or to seek other appropriate relief.

XI. QUALITY ASSURANCE

52. Respondents shall assure that work performed, samples taken, and analyses conducted pursuant to this Consent Order conform to the requirements of the SOW, the QAPP, and all guidances identified herein. Respondents shall assure that field personnel used by Respondents are properly trained in the use of field equipment and in chain of custody procedures.

XII. FINAL RI/FS; PROPOSED PLAN; PUBLIC COMMENT; RECORD OF DECISION; ADMINISTRATIVE RECORD

53. EPA retains the responsibility for the release to the public of the RI/FS Reports. EPA retains responsibility for the preparation and release to the public of the Proposed Plan and ROD in accordance with CERCLA and the NCP.

54. EPA will determine the contents of the administrative record file for selection of the remedial action. Respondents will submit to EPA documents developed during the course of the RI/FS upon which selection of the response action may be based. Respondents shall provide copies of plans, task memoranda

(including documentation of field modifications, if any), recommendations for further action, quality assurance memoranda and audits, raw data, field notes, laboratory analytical reports, and other reports. To the extent not in EPA's possession at Region VII or in the possession of MDNR, Respondents must additionally submit copies of any previous studies in their possession or under their control conducted under state, local, or other federal authorities relating to selection of a response action for Radiological Areas 1 and 2, and copies of all written communications between Respondents and state, local, or other federal authorities concerning selection of a response action for Radiological Areas 1 and 2. At their discretion, Respondents may establish a community information repository at, or near, the Site to house a copy of the administrative record.

XIII. PROGRESS REPORTS

55. Respondents shall make presentations at and participate in meetings at the request of EPA during the initiation, conduct, and completion of the Work. In addition to discussion of the technical aspects of the Work, topics will include anticipated problems or new issues. Meetings will be scheduled at EPA's discretion. When practicable, EPA will give Respondents five (5) days advance written notice of any such meeting or presentation.

56. In addition to the deliverables set forth in this Consent Order, Respondents shall provide to EPA monthly progress reports by the 10th day of each following month. These progress reports shall include: (1) a description of the actions which have been taken to

comply with this Consent Order during that month; (2) all validated analytical data and all other validated data received by Respondents during that month; (3) a description of the work planned for the next two months with schedules relating such work to the overall project schedule; and (4) a description of all material problems encountered and any anticipated material problems, any actual or anticipated material delays, and solutions developed and implemented to address any actual or anticipated material problems or delays.

XIV. SAMPLING AND DATA ANALYSIS

57. All validated analytical data, including results of sampling, tests, modeling, or other data generated by Respondents or on Respondents' behalf, pursuant to the requirements of this Consent Order shall be submitted to EPA in the subsequent monthly progress report as described in Section XIII (Progress Reports) of this Consent Order. EPA will make available to Respondents validated data generated by EPA unless it is exempt from disclosure by any federal or state law or regulation.

58. Respondents orally will notify EPA at least fourteen (14) days prior to conducting significant field events as described in the SOW, RI/FS Work Plan, or Sampling and Analysis Plan. Upon EPA's request, Respondents shall allow EPA or its authorized representatives to take a reasonable number of split or duplicate samples of samples collected by Respondents in implementing this Consent Order.

59. Respondents may assert a business confidentiality claim covering part or all of the information submitted to EPA pursuant to the terms of this Consent Order to the extent permitted by and in accordance with Section 104(e)(7) of CERCLA, 42 U.S.C. § 9607(e)(7), and 40 C.F.R. § 2.203(b). This claim shall be asserted in the manner described by 40 C.F.R. § 2.203(b) and substantiated at the time the claim is made. Information determined to be confidential by EPA will be given the protection specified in 40 C.F.R. Part 2, Subpart B. If no such claim accompanies the information when it is submitted to EPA, it may be made available to the public without further notice to Respondents. Respondents agree not to assert confidentiality claims with respect to any data related to Site conditions, sampling, or monitoring.

60. By entering into this Consent Order, Respondents waive any objections to the validity of any data gathered, generated, or evaluated by EPA, the State of Missouri, or Respondents in the performance or oversight of the Work that has been verified according to the approved quality assurance/quality control ("QA/QC") procedures required by the Consent Order. If Respondents object to data relating to the Work, Respondents shall submit to EPA a report that identifies and explains its objections, describes the acceptable uses of the data, if any, and identifies any limitations to the use of the data. Such report must be submitted to EPA within fifteen (15) days of the monthly progress report containing the data.

61. To the extent practicable, EPA orally will notify Respondents at least five (5) days prior to conducting any independent field activities relating to the Site during the course of the performance of the Work. At Respondents' oral or written request, EPA will permit Respondents' representative to be present during any such activities and shall allow split or duplicate samples to be taken by Respondents of any samples collected by EPA relating to the Site. All samples taken by EPA will be taken, handled, and analyzed in accordance with the procedures specified in the FSP, to the extent applicable, and the QAPP. EPA will assure that field personnel used by EPA are properly trained in the use of field equipment, in chain of custody procedures, and as required by the Health and Safety Plan.

XV. ACCESS

62. Commencing upon the effective date of this Consent Order, Respondents agree to provide EPA and its representatives, including its contractors, access at all times to the Site and any other property to which access is required for the implementation of this Consent Order, to the extent access to the property is controlled by Respondents, for the purposes of conducting any activity related to this Consent Order including, but not limited to:

a. Monitoring the Work;

b. Verifying any data or information submitted to EPA;

c. Conducting investigations relating to contamination at or near the Site;

d. Obtaining samples;

e. Assessing the need for, planning, or implementing additional response actions at or near the Site;

f. Inspecting and copying records, operating logs, contracts, or other documents maintained or generated by Respondents or their agents; and

g. Assessing Respondents' compliance with this Consent Order.

63. Prior to entering the Site, EPA will provide, when practicable, Respondents' Project Coordinator with the credentials or other written notice of all EPA personnel and representatives authorized to enter the Site pursuant to this Section.

64. EPA and its representatives shall comply with the Site Health and Safety Plan while on Site.

65. To the extent that the Site or any other property to which access is required for the implementation of this Consent Order is owned or controlled by persons other than Respondents, Respondents shall use best efforts to secure from such persons access for Respondents, as well as for EPA and its representatives, including, but not limited to, its contractors, as necessary to effectuate this Consent Order. If any access required to complete the Work is not obtained within thirty (30) days of the effective date of this Consent Order, or within thirty (30) days of the date EPA notifies Respondents in writing that additional access beyond that previously secured is necessary, Respondents shall promptly notify EPA, and shall include in that notification a summary of the steps Respondents have taken to attempt to obtain access. EPA may, as it deems appropriate, assist Respondents in obtaining access.

Respondents shall reimburse EPA, in accordance with the procedures in Section XXII (Reimbursement of Response and Oversight Costs), for all costs incurred by EPA in obtaining access.

66. Notwithstanding any provision of this Consent Order, EPA retains all of its access authorities and rights, including enforcement authorities related thereto, under CERCLA, the Resource Conservation and Recovery Act, 42 U.S.C. §§ 6901-6992k, and any other applicable statutes or regulations.

XVI. PROJECT COORDINATORS

67. All documents and correspondence which must be submitted pursuant to this Consent Order shall be sent by certified mail, return receipt requested, by overnight delivery service, or hand-delivered to the following addressees or to any other addressees which Respondents and EPA designate in writing:

a. Documents to be submitted to EPA shall be sent in triplicate to:

Diana L. Newman
U.S. Environmental Protection Agency
Region VII
WSTM/SAFE
726 Minnesota Avenue
Kansas City, Kansas 66101

b. Documents to be submitted to Respondents should be sent to:

Jerome T. Wolf
Michael D. Hockley
Spencer Fane Britt & Browne
1400 Commerce Bank Building
1000 Walnut Street
Kansas City, Missouri 64106

with cc by mail to:

James F. Gunn
Sandra L. Oberkfell
The Stolar Partnership
911 Washington Avenue
St. Louis, Missouri 63101

Charlotte Neitzel
Holme Roberts & Owen
1700 Lincoln, Suite 4100
Denver, Colorado 80203

James W. Wagoner II
Director, Division of Offsite Programs
Office of Eastern Area Programs
Office of Environmental Restoration
U.S. Department of Energy
12800 Middlebrook Road
Germantown, Maryland 20874

Unless otherwise specified, any notices or submissions required by this Consent Order shall be deemed delivered on the date placed in the United States Mail, delivered to an overnight service, or hand-delivered. If response deadlines are triggered by receipt of a notice, then such notice, for purposes of calculating the affected deadline, shall be deemed received upon actual receipt.

68. On or before the effective date of this Consent Order, EPA and Respondents shall each designate their own Project Coordinator. Each Project Coordinator shall be responsible for overseeing the implementation of this Consent Order. To the maximum extent possible, communications between Respondents and EPA shall be directed between the Project Coordinators as specified in Section XVI (Project Coordinators), herein, by mail with copies to such other persons as EPA and Respondents may respectively designate. Communications include, but are not limited to, all

documents, reports, approvals, and other correspondence submitted under this Consent Order.

69. EPA and Respondents each have the right to change their respective Project Coordinator. The other party must be notified in writing at least ten (10) days prior to any such change.

70. EPA's Project Coordinator shall have the authority lawfully vested in a Remedial Project Manager ("RPM") and On-Scene Coordinator ("OSC") by the NCP. In addition, EPA's Project Coordinator shall have authority consistent with the NCP to halt any work required by this Consent Order and to take any necessary response action when EPA determines that conditions at the Site may present an immediate endangerment to public health or welfare or the environment. The absence of the EPA Project Coordinator from the Site shall not be cause for the stoppage or delay of work.

XVII. OTHER APPLICABLE LAWS

71. Respondents shall comply with all applicable laws when performing the activities pursuant to this Consent Order. No federal, state, or local permits are required for on-Site response actions conducted pursuant to CERCLA Sections 104, 121, or 122. The term "on-Site" means the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of activities pursuant to this Consent Order.

XVIII. RECORD PRESERVATION

72. One complete set of all records and documents in Respondents' possession that relate to this Consent Order shall be

preserved during the conduct of this Consent Order and for a minimum of six (6) years after commencement of construction of any remedial action. Respondents shall acquire and retain one complete copy of all non-privileged documents that relate to this Consent Order that are in the possession of their employees, agents, accountants, contractors, or attorneys. At the conclusion of this six (6) year period, Respondents shall notify EPA at least ninety (90) days prior to the destruction of any such records or documents, and, upon EPA's request, Respondents shall deliver any such records or documents to EPA.

XIX. DISPUTE RESOLUTION

73. The provisions of this Dispute Resolution section apply to all deliverables required by the Consent Order and all matters for which Dispute Resolution has been expressly provided. Any disputes concerning activities or deliverables required under this Consent Order for which Dispute Resolution is applicable shall be resolved as follows: If Respondents object to any EPA notice of disapproval or requirement made pursuant to this Consent Order, Respondents shall notify EPA's Project Coordinator in writing of their objections within fourteen (14) days of receipt of the disapproval notice or requirement. Respondents' written objections shall define the dispute, state the basis of Respondents' objections, and be sent certified mail, return receipt requested. EPA will, within fourteen (14) days of receipt of Respondents' objections, respond to Respondents in writing, specifically addressing the points raised by Respondents and identifying points

of agreement and disagreement. EPA and Respondents then have an additional fourteen (14) days to reach agreement.

74. If agreement is not reached within the fourteen (14) day period referenced above, Respondents and EPA will communicate their respective position in writing to the Division Director of EPA Region VII's Waste Management Division, who shall resolve the dispute and provide a written statement of his decision to Respondent. The Division Director's determination is EPA's final decision. Respondents shall proceed in accordance with EPA's final decision regarding the matter in dispute regardless of whether Respondents agree with the decision. If the Respondents do not agree to perform, or do not perform the work in accordance with EPA's final decision, EPA reserves the right in its sole discretion to conduct the work itself, to seek reimbursement from the Respondents, to seek enforcement of the decision, to seek stipulated penalties, and/or to seek any other appropriate relief. No action, decision, or directive made by EPA, including without limitation the Division Director of EPA Region VII's Waste Management Division pursuant to this Consent Order shall constitute a final agency action giving rise to any rights to judicial review prior to EPA's initiation of judicial action to compel Respondents' compliance with this Consent Order. Respondents reserve any rights that they may have to seek any appropriate relief to the extent available by applicable law.

75. Respondents are not relieved of their obligations to perform and conduct activities and submit deliverables on the

schedule set forth in the RI/FS Work Plan while a matter is pending in Dispute Resolution. The invocation of Dispute Resolution does not stay stipulated penalties under this Consent Order. If, however, Respondents prevail in the dispute, deadlines directly affected by the matters in dispute shall be extended for a period of time equal to the time taken to resolve the dispute under the procedures of this Section, plus reasonable time for remobilization, as determined by EPA.

XX. DELAY IN PERFORMANCE/STIPULATED PENALTIES

76. Respondents (excluding DOE) shall be liable for stipulated penalties in the amounts set forth in Paragraphs 77 and 78 to the EPA for failure to comply with the requirements of this Consent Order specified below, unless excused pursuant to Section XXI (Force Majeure). In the event that EPA determines that DOE has failed to comply with any provision which would otherwise give rise to stipulated penalties, DOE understands that this Consent Order, as it applies to DOE, will be deemed null and void, and the rights and protections afforded DOE under the Consent Order will be terminated. "Compliance" by Respondents shall include completion of the activities under this Consent Order or any work plan or other plan approved under this Consent Order identified below in accordance with all applicable requirements of law, this Consent Order, the SOW, and any plans or other documents approved by EPA pursuant to this Consent Order and within the specified time schedules established by and approved under this Consent Order.

77. If Respondents do not submit the deliverable items listed below by the deadlines stated in the SOW, or do not perform the tasks listed below in accordance with the schedules listed in the RI/FS Work Plan, the following stipulated penalties shall be payable per day by Respondents:

Penalty Per Violation Per Day	Period of Noncompliance
$ 500	1st through 7th day
$ 1,000	8th through 30th day
$ 2,500	31st day and beyond.

The penalties in this Paragraph shall apply to the following deliverable items:

a. The draft and any revised work plan.

b. The draft and any revised sampling and analysis plan.

c. The draft and any revised Remedial Investigation Report.

d. The draft and any revised Feasibility Study Report.

78. If Respondents do not submit the deliverable items listed below by the deadlines stated in the RI/FS Work Plan, or do not perform the tasks listed below in accordance with the schedules listed in the RI/FS Work Plan, the following stipulated penalties shall be payable per day by Respondents:

Penalty Per Violation Per Day	Period of Noncompliance
$ 250.00	1st through 7th day
$ 500.00	8th through 30th day
$ 1,000.00	31st day and beyond.

The penalties in this Paragraph shall apply to the following deliverable items as well as any other deliverables not specifically listed in this Section:

a. Site Health and Safety Plan.

b. Technical memorandum on modeling of Site characteristics.

c. Site Characterization Summary.

d. Evaluation of Need for Treatability Studies technical memorandum.

e. Treatability Study Site Health and Safety Plan.

f. Treatability Study Evaluation Report.

g. Technical memorandum entitled Refined Remedial Action Objectives.

h. Report entitled Development and Screening of Remedial Alternatives.

i. Comparative analysis technical memorandum.

j. Monthly progress reports.

79. Except as otherwise provided herein, all penalties shall begin to accrue on the day after complete performance is due or the day a violation occurs, and shall continue to accrue through the final day of the correction of the noncompliance or completion of the activity. Nothing herein shall prevent the simultaneous accrual of separate penalties for separate violations of this Consent Order. For violations not based on timeliness, stipulated penalties shall not begin to accrue until after Respondents have had the opportunity to revise the submission to respond to EPA's written comments. If any revised submission fails to respond to

EPA's comments and/or remedy the specified deficiencies and EPA deems such failure to constitute a violation, then EPA will provide Respondents with written notice of such violation. In such case, the stipulated penalties shall accrue from the date of receipt of such notice by Respondents.

80. Following EPA's determination that Respondents have failed to comply with a requirement of this Consent Order, EPA will provide Respondents with written notification of same and describe the noncompliance. This notice also will indicate the amount of penalties due and whether the penalties continue to accrue. Except for violations not based on timeliness, penalties shall accrue as provided in the preceding Paragraph regardless of whether EPA has notified the Respondents of a violation.

81. All penalties owed to the EPA under this Section shall be due and payable within thirty (30) days of the Respondents' receipt from EPA of a notification of noncompliance, unless Respondents invoke the Dispute Resolution procedures set forth in Section XIX (Dispute Resolution) of this Consent Order. Respondents shall pay interest on the unpaid balance, which shall begin to accrue at the end of the thirty (30) day period at the rate established by the Department of Treasury pursuant to 31 U.S.C. § 3717 and 4 C.F.R. § 102.13. Respondents shall further pay a handling charge of one percent (1%), to be assessed at the end of each thirty-day period, and a six percent (6%) per annum penalty charge, to be assessed if the penalty is not paid in full within ninety (90) days after it is due. All payments under this Section shall be paid by certified

check made payable to "EPA Hazardous Substance Superfund," shall be mailed to:

Mellon Bank
Attn: Superfund Accounting
EPA Region VII
(Comptroller Branch)
Post Office Box 360748M
Pittsburgh, PA 15251

82. Copies of check(s) paid pursuant to this Section, and any accompanying transmittal letter(s), shall be sent to EPA's Project Coordinator as set forth in Section XVI (Project Coordinators) of this Consent Order.

83. Neither the filing of a request to resolve a dispute nor the payment of penalties shall alter in any way Respondents' obligation to complete the performance required hereunder.

84. Respondents may dispute the applicability of stipulated penalties and EPA's right to the stated amount of penalties by invoking the Dispute Resolution procedures set forth in Section XIX (Dispute Resolution) of this Consent Order. Penalties shall accrue but need not be paid during the Dispute Resolution period.

85. If Respondents fail to pay stipulated penalties when due, EPA may institute proceedings to collect the penalties, as well as late charges and interest. Respondents shall pay interest on the unpaid balance, which shall begin to accrue at the end of the forty-five day period at the rate established pursuant to 31 U.S.C. § 3717 and 4 C.F.R. § 102.13. The stipulated penalties provisions do not prohibit, alter, or in any way limit EPA's ability to seek any other remedies or sanctions available by virtue of Respondents' violation of this Consent Order or of the statutes and regulations

upon which it is based. Provided, however, EPA will be precluded from seeking other judicial or administrative penalties for those violations specified in this Section unless Respondents fail to pay penalties assessed pursuant to this Section.

XXI. FORCE MAJEURE

86. Respondents shall perform the requirements of this Consent Order within the time limits set forth herein, unless the performance is prevented or delayed by events which constitute a force majeure or excusable delay. A force majeure or excusable delay is defined as any event arising from causes not foreseeable and beyond the reasonable control of Respondents, including its consultants and contractors, which could not be overcome by Respondents' best efforts and which delays or prevents performance by a date required by this Consent Order. Such events do not include unanticipated or increased costs of performance or changed economic circumstances. To the extent Respondents (excluding DOE pursuant to Paragraph 76 herein) are subject to stipulated penalties as a result of a delay caused by an act or omission of DOE, EPA, at its discretion, may consider such delay excusable for the purposes of assessment of stipulated penalties.

87. Respondents shall notify EPA orally within forty-eight (48) hours of when they first knew or should have known that a delay might occur. Within ten (10) business days thereafter, Respondents shall submit to EPA a written statement setting forth the reasons for the delay; the anticipated duration of the delay; all actions taken or to be taken to prevent or minimize the delay;

a schedule for implementation of any measures to be taken to mitigate the effect of the delay; and a statement as to whether, in the opinion of Respondents, such event may cause or contribute to an endangerment to public health, welfare, or the environment. Respondents shall adopt all reasonable measures to avoid and minimize the delay. Failure to comply with the notice provision of this Section shall constitute a waiver of Respondent's right to assert a force majeure or that the delay is excusable.

88. If EPA determines that the delay has been or will be caused by force majeure or that the delay is otherwise excusable, the time for performance for that element of work, and other tasks the completion of which is dependent upon that element of work, may be extended, upon EPA approval, for a period of equal to the delay resulting from such circumstances. All such modifications of the schedule caused by a force majeure or excusable delay shall be made in accordance with Section XXVII (Effective Date and Subsequent Modification) of this Consent Order. The schedule for those tasks which are not altered by these modifications remains unchanged unless altered in accordance with Section XXVII (Effective Date and Subsequent Modification). In the event EPA and Respondents cannot agree that any delay or failure has been or will be caused by a force majeure or that the delay is otherwise excusable, or if there is no agreement on the length of the extension, this dispute shall be resolved in accordance with the Dispute Resolution provisions of Section XIX (Dispute Resolution) of this Consent Order.

XXII. REIMBURSEMENT OF RESPONSE AND OVERSIGHT COSTS

89. Following the effective date of this Consent Order, EPA periodically will submit to the Respondents an accounting of all response costs including oversight costs incurred by EPA with respect to this Consent Order. Response costs may include, but are not limited to, costs incurred by EPA in overseeing Respondents' implementation of the requirements of this Consent Order and activities performed by EPA relating to the Consent Order and any costs incurred while assisting Respondents in obtaining access. Costs shall include all direct and indirect costs including, but not limited to, time and travel costs of EPA personnel and associated indirect costs, contractor costs, cooperative agreement costs, compliance monitoring, including the collection and analysis of split samples, inspection of activities required by this Consent Order, Site visits, discussions regarding disputes that may arise as a result of this Consent Order, review and approval or disapproval of reports, and costs of redoing any of Respondents' tasks. Any necessary summaries including, but not limited to, EPA's certified Agency Financial Management System summary data ("SPUR Reports"), or such other summary as certified by EPA, shall serve as a basis for payment demands.

90. Respondents (excluding DOE) shall, within sixty (60) days of receipt of each accounting, remit a certified or cashier's check for the amount of those costs. Interest shall accrue from the later of the date payment of a specified amount demanded in writing is due, or the date of the expenditure. The interest rate is the

rate of interest on investments for the Hazardous Substances Superfund in Section 107(a) of CERCLA, 42 U.S.C. § 9607(a).

91. All payments to EPA under this Section shall be made by certified or cashier's check made payable to "EPA Hazardous Substance Superfund" and shall include the Site name, the EPA Site identification number 514, and the EPA Docket Number assigned to this matter, and shall be remitted to:

Mellon Bank
Attn: Superfund Accounting
EPA Region VII
(Comptroller Branch)
Post Office Box 360748M
Pittsburgh, PA 15251

92. A copy of the check shall be sent simultaneously to the EPA Project Coordinator.

93. Respondents agree to limit any disputes concerning costs to accounting errors, the inclusion of costs outside the scope of this Consent Order, or costs that are inconsistent with the NCP. Respondents shall identify any contested costs and the basis of their objection. All undisputed costs shall be remitted in accordance with the time frame set forth above. Disputed costs shall be paid into an escrow account while the dispute is pending. Respondents bear the burden of establishing an EPA accounting error, the inclusion of costs outside the scope of this Consent Order, or costs inconsistent with the NCP.

XXIII. RESERVATION OF RIGHTS

94. Any requirement for the payment or obligation of funds by DOE established by the terms of this Consent Order shall be subject to the availability of funds appropriated for that purpose, and no

provision herein shall be interpreted to require the obligation or payment of funds in violation of the Anti-Deficiency Act, 31 U.S.C. § 1341.

95. EPA reserves the right to bring an action against the Respondents pursuant to Section 107 of CERCLA, 42 U.S.C. § 9607, for the recovery of all response costs including oversight costs incurred by EPA at the Site that are not reimbursed by the Respondents, any costs incurred in the event that EPA performs the RI/FS or any part thereof, and any future costs incurred by EPA in connection with response activities conducted under CERCLA at the Site. Respondents reserve all rights they may have to oppose and defend against such claims and actions and to assert any and all claims they may have against EPA or any person or government agency.

96. EPA reserves the right to bring an action against Respondents to enforce the requirements of this Consent Order, and to seek penalties and punitive damages pursuant to CERCLA.

97. Except as expressly provided in this Consent Order, each party reserves all rights and defenses it may have. Nothing in this Consent Order shall affect EPA's removal authority or EPA's response or enforcement authorities including, but not limited to, the right to seek injunctive relief, statutory penalties, and/or punitive damages. To the extent stipulated penalties apply to violations of a particular requirement of this Consent Order, however, EPA will not seek statutory penalties for such violations unless Respondents fail or refuse to pay stipulated penalties

assessed for such a violation. Respondents reserve any and all rights they may have to oppose and defend against such claims and actions and to assert any and all claims they may have against EPA or any person or government agency. Respondents reserve any rights they may have to bring any action otherwise available against any "person" as defined in Section 101(21) of CERCLA, 42 U.S.C. § 9601(21).

98. Following satisfaction of the requirements of this Consent Order, Respondents shall have resolved their liability to EPA for the work performed by Respondents pursuant to this Consent Order. Respondents are not released from liability, if any, for any response actions taken beyond the scope of this Consent Order regarding removals or activities arising pursuant to Section 121(c) of CERCLA, 42 U.S.C. § 9612(c).

XXIV. DISCLAIMER

99. By signing this Consent Order and taking actions under this Consent Order, Respondents do not admit EPA's Findings of Fact and Conclusions of Law. Furthermore, the participation of Respondents in this Consent Order shall not be considered an admission of liability and is not admissible in evidence against Respondents in any judicial or administrative proceeding other than a proceeding by the United States on behalf of EPA to enforce this Consent Order or a judgment relating to it. Each Respondent retains its rights to assert claims against the other Respondents and other potentially responsible parties at the Site. Respondents agree, however, not to contest the validity or terms of this

Consent Order or the procedures underlying or relating to it in any action brought by the United States on behalf of EPA to enforce its terms.

XXV. OTHER CLAIMS

100. In entering into this Consent Order, Respondents waive any right to seek reimbursement pursuant to Section 106(b) of CERCLA, 42 U.S.C. § 9606(b). Respondents also waive any right to present a claim under Section 111 or 112 of CERCLA, 42 U.S.C. §§ 9611 and 9612. This Consent Order does not constitute any decision on preauthorization of funds under Section 111(a)(2) of CERCLA, 42 U.S.C. § 9611(a)(2). Injuries or damages resulting from acts or omissions of the EPA, its agents, employees or other persons acting on its behalf on property owned or operated by Respondents shall be subject to the procedures of the Federal Tort Claims Act of 1949, as amended, 28 U.S.C. § 2671, et seq. (FTCA). Except for claims subject to the procedures of the FTCA, Respondents waive all other statutory and common law claims against EPA relating to or arising out of conduct of the RI/FS under this Consent Order.

101. Nothing in this Consent Order shall constitute or be construed as a release from any claim, cause of action, or demand in law or equity against any party not a signatory to this Consent Order for any liability it may have arising out of or relating in any way to the generation, storage, treatment, handling, transportation, releases or disposal of any hazardous substances, pollutants, or contaminants found at, taken to, or taken from the Site.

102. Respondents shall each bear their own costs and attorneys fees.

XXVI. FINANCIAL ASSURANCE AND INDEMNIFICATION

103. Within thirty (30) days of the effective date of this Consent Order, Respondents (excluding DOE) shall obtain a Letter of Credit in the amount of $1,050,000, naming EPA as the Beneficiary, and provide a copy of such letter to EPA within forty-five (45) days of the effective date of this Consent Order.

104. Respondents (excluding DOE) agree to indemnify and hold the EPA, its agents, and its employees harmless from any and all claims or causes of action arising from or on account of acts or omissions of Respondents, its employees, agents, servants, receivers, successors, or assignees, or any persons including, but not limited to, firms, corporations, subsidiaries and contractors in carrying out activities under this Consent Order. Except for contracts entered into by DOE, the United States Government or any agency or authorized representative thereof shall not be held as a party to any contract entered into by Respondents in carrying out activities under this Consent Order. Respondents shall be under no duty, however, to indemnify the EPA for claims or causes of action arising from or on account of negligent, willful, or intentional acts or omissions of the EPA, its officers, agents, employees or any other person acting on its behalf. Nothing herein is intended to or shall be construed as extending the liability of the EPA beyond that provided for under federal law.

XXVII. EFFECTIVE DATE AND SUBSEQUENT MODIFICATION

105. The effective date of this Consent Order shall be the date that it is signed by EPA.

106. This Consent Order may be amended by mutual agreement of EPA and Respondents. Amendments shall be in writing and shall be effective when signed by EPA.

107. No informal advice, guidance, suggestions, or comments by EPA regarding reports, plans, specifications, schedules and any other writing submitted by the Respondents will be construed as relieving the Respondents of its obligation to obtain such formal approval as may be required by this Consent Order. Any deliverables, plans, technical memoranda, reports (other than progress reports), specifications, schedules and attachments required by this Consent Order are, upon approval by EPA, incorporated into this Consent Order.

XXVIII. TERMINATION AND SATISFACTION

108. This Consent Order shall terminate when Respondents demonstrate in writing and certify to the satisfaction of EPA that all activities required under this Consent Order including any additional work, payment of response and oversight costs, and any stipulated penalties demanded by EPA have been performed and EPA has approved the certification. EPA will make it a goal to notify Respondents within sixty (60) days of receipt of such certification whether it has approved or disapproved the certification. In the event EPA disapproves the certification, it will specify in writing the reasons therefore. If EPA disapproves the certification or

fails to respond to the certification within sixty (60) days, Respondents may invoke the provisions of Section XIX (Dispute Resolution). This notice shall not, however, terminate Respondents' obligation to comply with Sections XVII (Other Applicable Laws), XVIII (Record Preservation), XXII (Reimbursement of Response and Oversight Costs), and XXIII (Reservation of Rights) of this Consent Order.

109. The certification shall be signed by a responsible official representing each Respondent. Each representative shall make the following attestation: "I certify that the information contained in or accompanying this certification is true, accurate, and complete." For purposes of this Consent Order, a responsible official is a corporate official who is in charge of a principal business function.

FOR RESPONDENTS:

COTTER CORPORATION (N.S.L.),
a New ~~Mexico corporation~~

Rick D. [signature]

Exec. Vice-President

LAIDLAW WASTE SYSTEMS (BRIDGETON), INC.,
a Missouri corporation

Miles H Stotts

MILES H. STOTTS

REGIONAL ENVIRONMENTAL MANAGER

ROCK ROAD INDUSTRIES, INC.,
a Missouri corporation

W.E. WHITAKER - PRESIDENT

WEST LAKE LANDFILL AOC
SUMMARY OF DEADLINES

Task	Deadline[1]	Comment
Provide EPA Name/ Qualifications of Consultant.	30 Days (April 2).	¶ 38, Order.
Offsite Access Agreement. – Gunn working on this	30 Days (April 2).	¶ 65, Order. Order requires Respondents to notify EPA if access not obtained within 30 days of effective date of Order.
Obtain letter of credit.	30 Days (April 2).	¶ 103, Order.
Provide EPA copy of LOC.	45 Days (April 19).[2]	
RI/FS Work Plan.	60 Days (May 3)[3].	¶ 39a(1), Order.
Sampling and Analysis Plan.	60 Days (May 3).	¶ 39a(2), Order.
Health and Safety Plan.	60 Days (May 3).	¶ 39a(3), Order.
Monthly Progress Reports.	10th Day of following month.	¶ 56, Order.
Validation of Sampling Results.	60 Days after receipt of result from laboratory.	¶ 39c, Order.
Notify EPA of completion of field activities.	7 Days after completion of field activities.	¶ 39c, Order.
Remedial Investigation Report.	60 Days after receipt of baseline risk assessment.	¶ 39c(3), Order.

---

[1]Deadlines are triggered by effective date of the Order, March 3, 1993.

[2]Due date falls on Saturday, April 17. Next business day is Monday, April 19.

[3]The schedule for most deliverables required under the Order will be negotiated in the Work Plan.

Memorandum on Remedial Action Objectives.	60 Days after receipt of baseline risk assessment.	¶ 39e(1), Order.
Notice to EPA of Significant Field Events.	14 Days prior to conducting significant field events.	May be oral notice, ¶ 58, Order.
Notice of Force majeure.	48 Hours after learn of event (oral); 10 business days thereafter (written).	¶ 87, Order.
Payment of oversight costs.	60 Days after receipt of EPA accounting of response costs.	¶ 90, Order.

Appendix A-2:

City of St. Louis Negative Easement and Restrictive Covenants

[redacted]

BP16465/1140 BP16450/1140

2005041100245

JANICE M. HAMMONDS, RECORDER OF DEEDS
ST. LOUIS COUNTY MISSOURI
41 SOUTH CENTRAL, CLAYTON, MO 63105

TYPE OF INSTRUMENT	GRANTOR	TO	GRANTEE
AGRMT	BRIDGETON LANDFILL L L C ETAL		

PROPERTY DESCRIPTION: YOSTI PARTITION LOT 1 - 4 PB 3 PG 101 W/O/P

Lien Number	Notation	Locator

NOTE: I, the undersigned Recorder of Deeds, do hereby certify that the information shown on this Certication Sheet as to the **TYPE OF INSTRUMENT**, the **NAMES** of the **GRANTOR** and **GRANTEE** as well as the **DESCRIPTION** of the **REAL PROPERTY** affected is furnished merely as a convenience only, and in the case of any discrepancy of such information between this Certification Sheet and the attached Document, the **ATTACHED DOCUMENT** governs. Only the DOCUMENT NUMBER, the DATE and TIME of filing for record, and the **BOOK** and **PAGE** of the recorded Document is taken from this CERTIFICATION SHEET.

RECORDER OF DEEDS DOCUMENT CERTIFICATION

STATE OF MISSOURI)
SS.
COUNTY OF ST. LOUIS)

Document Number
245

I, the undersigned Recorder of Deeds for said County and State, do hereby certify that the following and annexed instrument of writing, which consists of ~~18~~ 19 pages, (this page inclusive), was filed for record in my office on the 11 day of April 2005 at 09:02 AM and is truly recorded in the book and at the page shown at the top and/or bottom of this page.

In witness whereof I have hereunto set my hand and official seal the day, month and year aforesaid.

JoAnn Reber CB
Deputy Recorder

Janice M. Hammonds
Recorder of Deeds
St. Louis County, Missouri

SEAL OF THE RECORDER OF DEEDS FOR ST LOUIS COUNTY, MO

____ N.P
____ N.P.C
____ N.N.C.
____ N.N.I.

RECORDING FEE $72.00
(Paid at the time of Recording

Mail to:

Destination code: 14 P

B-16465 P-1140/1158

THE CITY OF ST. LOUIS, MISSOURI

AT

LAMBERT-ST. LOUIS INTERNATIONAL AIRPORT®

NEGATIVE EASEMENT AND DECLARATION OF RESTRICTIVE COVENANTS AGREEMENT

THIS NEGATIVE EASEMENT AND DECLARATION OF RESTRICTIVE COVENANTS AGREEMENT, dated as of April 6, 2005 (the "**Agreement**"), is made and entered into by and among the grantors, whose names and addresses are listed below (collectively referred to herein as the "**Grantors**") and THE CITY OF ST. LOUIS, a municipal corporation of the State of Missouri, as the grantee ("**St. Louis**"), whose address is City Hall, Room 200, 1200 Market Street, St. Louis, Missouri 63103, acting by and through its Board of Estimate and Apportionment and its City Counselor.

GRANTORS' NAMES AND ADDRESSES:

Bridgeton Landfill LLC, a Delaware limited liability company
15880 N. Greenway-Hayden Loop, Ste.100
Scottsdale, AZ 85260

Rock Road Industries, Inc., a Missouri corporation
15880 N. Greenway-Hayden Loop, Ste.100
Scottsdale, AZ 85260

Bridgeton Transfer Station, LLC, a Delaware limited liability company
15880 N. Greenway-Hayden Loop, Ste.100
Scottsdale, AZ 85260

TIA 170270A-SC

WITNESSETH THAT:

WHEREAS, the Grantors are the fee simple owners of certain real property located in St. Louis County, Missouri that is more fully described in **EXHIBIT "A"**, which is attached hereto and incorporated herein (the "**Property**");

WHEREAS, St. Louis is the owner and operator of Lambert-St. Louis International Airport® ("**Airport**");

WHEREAS, St. Louis wishes to impose certain limitations and restrictions on the use and enjoyment of the Property in order to reduce or mitigate the potential harm to airport-related activities that could be caused by certain wildlife or birds on or from the Property. Such wildlife may include various species (birds, mammals, reptiles), including feral animals and domesticated animals not under control, that are associated with aircraft strike problems, are capable of causing structural damage to airport facilities, or act as attractants to other wildlife that pose a strike hazard to aircraft; and

WHEREAS, the Grantors and St. Louis recognize that the grant of a negative easement by Grantors to St. Louis, and the declaration of restrictive covenants by Grantors, will assist in reducing or mitigating the potential harm to airport-related activities that could be caused by said wildlife.

NOW, THEREFORE, stating their intention to be legally bound hereby and in consideration of the foregoing, and the promises, covenants, and agreements herein contained, and for other good and valuable consideration, including the sum of FOUR HUNDRED THOUSAND DOLLARS ($400,000.00) in hand paid by St. Louis to Grantors, the receipt and sufficiency of which are hereby acknowledged, Grantors do hereby grant and convey unto St. Louis, its successors in interest and assigns, a negative easement, as more particularly described below, upon, over, in, and to the Property.

The negative easement granted herein and described below shall constitute a binding servitude upon the Property. To that end, Grantors do hereby covenant on behalf of themselves and their heirs, successors in interest and assigns with St. Louis, its successors in interest and assigns, such covenants and provisions being deemed to run with the land as a binding servitude in perpetuity, as provided for below, to do and to refrain from doing upon the Property the following stipulations, which contribute to the public purpose in that they aid in the reduction or mitigation of said potential wildlife or bird hazards on or from the Property, and hereby declare and impose the following restrictions upon the use and enjoyment of the Property:

1. There shall be no new or additional depositing or dumping of municipal waste, organic waste, and/or putrescible waste (municipal waste, organic waste and putrescible waste hereinafter collectively referred to as "Putrescible Waste") above, upon, on, or under the Property beginning as of August 1, 2005 and continuing in perpetuity, unless and until such time as this Agreement is terminated or canceled by St. Louis in accordance with the terms set out in paragraph 4 below. The parties acknowledge and agree that the restriction described in the preceding sentence does not, and shall not, in any way prohibit solid waste transfer station activities or operations conducted on the

Transfer Station site as shown on the drawing attached hereto as Exhibit A (the "Site") as expanded to include any encroachments by solid waste transfer station buildings or improvement extending beyond the boundaries of the Site onto the Property at the time of the execution of this Agreement. For purposes of this Agreement, **"Putrescible Waste"** shall mean solid waste that contains organic matter capable of being decomposed by micro-organisms and of such a character and proportion as to be capable of attracting or providing food for birds. For purposes of this Agreement, **"Putrescible Waste"** shall not include solid waste that qualifies for disposal in a demolition landfill as defined in 10 CSR 8O-2.010(20).

2. At all times after the Effective Date (defined below), the Grantor shall comply with all applicable federal, state and local laws and regulations regarding proper landfill cover.

3. This Agreement shall become effective and binding on the date first written above upon the execution and delivery hereof by St. Louis and the Grantors (the **"Effective Date"**). This Agreement and any companion documents or instruments referred to herein may be executed in any number of counterparts, each of which shall be original, but all of which together shall constitute one document or instrument.

4. The term of this Agreement shall begin on the Effective Date and shall end only if and when St. Louis chooses in its sole and absolute discretion to abandon its negative easement granted herein by terminating or canceling this Agreement in writing and recording such writing with St. Louis County's Recorder of Deeds.

5. Except as provided for herein, Grantors reserve unto themselves all rights, privileges, powers, and immunities in and to the Property including, without limitation, the right of possession and the use and enjoyment of the Property.

6. Representatives and agents of St. Louis shall be permitted at reasonable times, which times shall be established in advance by St. Louis by three (3) days' written notice, to come upon the Property to inspect for violation of any of the promises, covenants, restrictions, or agreements herein (**"Inspections"**), except that if St. Louis has reasonable cause to believe that such violations are occurring or have occurred, St. Louis shall not be obligated to give said three (3) days' written notice or any other notice whatsoever to the Grantors. This right of Inspections is independent of any right-of-entry granted to the St. Louis under any separate agreement. Notwithstanding the foregoing, any representative or agent of St. Louis that comes upon the Property shall enter and exit the Property exclusively through the gate maintained by Grantors for such purpose and shall observe all customary formalities required by Grantors with respect to visitors including, but not limited to, immediately reporting their presence to Grantor's administrative personnel and signing in and signing out on appropriate security logs.

7. St. Louis shall promptly repair any damage it causes to the Property in the course of any Inspections, generally placing the Property and all points of entry in the same general condition as before the Inspections or entry, to the extent reasonably practical, ordinary wear and tear excepted, unless otherwise agreed to in writing by Grantors. All

Inspections, and all repairs to the Property arising from the Inspections, shall be at the sole cost of St. Louis. St. Louis and its representatives and agents shall use their best efforts to minimize damage to the Property and shall not substantially or materially disturb or interfere with the administration and/or operations of the Grantors when conducting its Inspections.

8. St. Louis, to the extent permitted by law, hereby agrees to indemnify, release and hold Grantors and their officers, employees, representatives and agents harmless from and against any and all losses, claims, judgments, actions, suits, cross-claims, counterclaims, third party actions, damages, liabilities, fines, penalties, including all reasonable costs for investigation and defense thereof (including, without limitation, attorneys' fees, court costs, expert fees and litigation expenses) and expenses in connection with loss of life, personal injury, bodily injury or damage to property, to the extent caused by or resulting from this Agreement (including activities conducted thereunder or relating thereto), the operations of the Airport in regard to aircraft bird strikes (provided that the Grantors are in compliance with the terms and provisions of this Agreement and the Right-Of-Entry Agreement dated April 6 2005 between St. Louis and the Grantors), the Inspections or the actions of St. Louis, its employees, contractors, representatives or agents in the course of the Inspections, except to the extent arising out of the negligence or intentional misconduct of the Grantors, or their officers, boards, commissions, employees, contractors, representatives, or agents. In case the Grantors or such other persons or entities shall be made a party to any action or proceeding commenced against St. Louis, to the extent provided in the preceding sentence, St. Louis shall protect and hold such parties harmless and pay all costs, expenses and reasonable attorneys' fees incurred or paid by such parties in connection with such action or proceeding. Grantors shall give to St. Louis reasonable notice of any such claims or actions. St. Louis shall use counsel reasonably acceptable to Grantors in carrying out their obligations hereunder. This indemnity provision shall survive the termination or cancellation of this Agreement, any and all sales or transfers of the Property or any portion thereof, or interest therein and shall be binding on St. Louis and its successors in interest and assigns and shall inure to the benefit of Grantors and their successors in interest and assigns.

9. In the event of a violation or default of any promise, covenant, restriction, stipulation, warranty, agreement, or provision (**"Provision"**) herein by either party, the non-defaulting party shall have all rights and remedies available in law or equity including, without limitation, the right to specific performance and injunctive relief, and the right to institute a suit to enjoin such violation. Notwithstanding the above sentence, Grantors hereby expressly stipulate and agree that Grantors and their heirs, successors in interest and assigns shall not have the right to terminate or cancel this Agreement under any circumstance whether with or without cause. In the event of any dispute regarding any Provision of this Agreement or the rights, obligations, and liabilities of the parties with regard to this Agreement, the prevailing party shall be entitled to recover from the non-prevailing party its reasonable attorneys' fees, court costs, and other litigation costs incurred in connection with such matter.

10. All notices, requests, information or other documents required or permitted hereunder or necessary or convenient in connection with this Agreement shall be in writing and shall be deemed duly given upon receipt if sent by certified mail or by overnight or express mail service, with a return receipt, postage prepaid, and addressed to the parties as set forth below. Notice shall be deemed received at the earlier of actual receipt or two (2) calendar days after deposit with one of the mail services described in this paragraph. Any party may change the person or address to which notices are to be sent to it by giving written notice of such change to the other party in the manner herein provided for giving notice.

If to the Grantors (individually or collectively) to:

Bridgeton Landfill LLC
15880 N. Greenway-Hayden Loop, Ste.100
Scottsdale, AZ 85260
Attn: Jo Lynn White

Rock Road Industries, Inc.
15880 N. Greenway-Hayden Loop, Ste.100
Scottsdale, AZ 85260
Attn: Jo Lynn White

Bridgeton Transfer Station, LLC
15880 N. Greenway-Hayden Loop, Ste.100
Scottsdale, AZ 85260
Attn: Jo Lynn White

with a copy to:

Spencer Fane Britt & Browne LLP
Attn: Michael Hockley
1000 Walnut Street, Suite 1400
Kansas City, MO 64106-2140

If to St. Louis to:

Director of Airports
Task Orders, Agreement and Facility Issues
Lambert-St. Louis International Airport®
10701 Lambert International Boulevard
P.O. Box 10212, Lambert Station
St. Louis, MO 63145
and
Mr. Gerard Slay
Deputy Director of Airports

Lambert-St. Louis International Airport®
Airport Operations
10701 Lambert International Boulevard
P.O. Box 10212, Lambert Station
St. Louis, MO 63145
(314) 426-8023
(314) 890-1844 FAX

with a copy to:

Mr. Donald L. Ruble, R.A.
Assistant Director of Planning and Development
Lambert-St. Louis International Airport®
Airport Planning and Development Office, 4th Floor
13723 Riverport Drive
Maryland Heights, MO 63043
(314) 551-5025
(314) 551-5013 FAX

11. No waiver of any breach of any Provision herein contained shall be deemed, or shall constitute, a waiver of any preceding or succeeding breach thereof of any Provision contained herein. No extension of time for performance of any obligation or act shall be deemed an extension of the time for performance of any other obligation or act. No waiver shall be binding unless executed in writing by the party granting the waiver.

12. The parties hereto covenant and warrant that they have the authority and power to enter into this Agreement, that this Agreement has been authorized by all necessary corporate and municipal actions, and that each party is authorized and empowered to consummate the transaction provided for herein. This Agreement constitutes a legal, binding, valid and enforceable obligation of the parties, and there are no claims or defenses, personal or otherwise, or offsets whatsoever to the enforceability or validity of this Agreement.

13. This Agreement constitutes the entire understanding between the parties hereto with respect to the subject matter hereof and supersedes all prior or contemporaneous agreements, whether verbal or written, between the parties in regard thereto. This Agreement shall not be altered or modified except by an agreement in writing signed by the authorized representatives of the parties hereto, which writing specifically shall refer to this Agreement. It is expressly understood by the parties hereto that the provisions of this Agreement shall in no way affect or impair the provisions or obligations of St. Louis or the Grantors in regard to any other existing, contemporaneous, or prior agreements between the parties.

14. The parties hereto affirm each has full knowledge of the Provisions and requirements contained in this Agreement. Each party hereto acknowledges that such party and its counsel, after negotiation and consultation, have reviewed and revised this

Agreement. As such, the Provisions of this Agreement shall be fairly construed, and the usual rule or construction, if applicable, to the effect that any ambiguities herein should be resolved against the drafting party, shall not be employed in the interpretation of this Agreement or any amendments modifications or exhibits thereto.

15. If for any reason one or more of the Provisions contained in this Agreement shall be held to be invalid, illegal, or unenforceable in any respect, such invalidity, illegality, or unenforceability shall not affect any other Provision of this Agreement and shall be construed as if such invalid, illegal, or unenforceable Provision never had been included in this Agreement, provided the invalidity of such Provision does not materially prejudice either St. Louis or the Grantors in their respective rights and obligations contained in the valid Provisions of this Agreement

16. When the consent, approval, waiver, or certification (**"Approval"**) of a party is required under the terms of this Agreement, such Approval must be in writing and signed by the party making the Approval. Whenever the Approval of St. Louis or the Director of Airports is required, the Approval must be from the Director of Airports or his/her authorized or designated representative. Whenever the Approval of the Grantors is required (individually or collectively), the Approval must be from all fee owners of the Property or any portion thereof or their authorized or designated representatives. St. Louis and the Grantors agree that an extension of time of performance may be made with the written mutual consent of St. Louis and Grantors. Whenever the approval of St. Louis, the Director of Airports or the Grantors is required or necessary herein, no such approval shall be unreasonably requested, withheld, conditioned, or delayed.

17. MISCELLANEOUS PROVISIONS:

A. Not An Agent: St. Louis and Grantors acknowledge and agree that nothing herein shall be interpreted or construed to mean that the parties hereto, or their respective officers, contractors, consultants, employees, representatives, or agents are employees or agents of the other party.

B. Dates and Non-Business Days: Whenever a number of days is referred to in this Agreement, days shall mean consecutive calendar days unless otherwise expressly provided. If the last day for giving of notice or for performance of any obligation or condition hereunder is a Saturday, Sunday or federal, state, or city holiday, then such last day shall be extended to the next succeeding business day thereafter. Whenever it is provided in this Agreement that days shall be counted, the first day to be counted shall be the day following the date on which the event causing the period to commence occurs.

C. Other Documents: St. Louis and Grantors agree that, at the request of the other, they will execute, acknowledge, certify, (if appropriate), and deliver whatever additional documents, affidavits, certifications, and records, and perform such other acts in good faith, as may be reasonably required in order to accomplish the intent and purposes of this Agreement.

D. <u>Gender and Number</u>: Whenever the sense of this Agreement so requires, the use of (i) the singular shall be deemed to include the plural, (ii) the masculine gender shall be deemed to include the feminine or neuter gender, and (iii) the neuter gender shall be deemed to include the masculine and feminine gender.

E. <u>Exhibits</u>: All exhibits described herein are fully incorporated into this Agreement by this reference as if fully set out herein. St. Louis and Grantors shall reasonably and in good faith finalize and attach all such exhibits to this Agreement, which may not have been in final form as of the Effective Date, or may require revisions. St. Louis hereby authorizes the Director of Airports to revise or approve said amendments or revisions to the exhibits on behalf of St. Louis.

F. <u>Compliance with Laws and Regulations</u>: This Agreement does not affect such other obligations as the Grantor may have under applicable federal, state, or local laws and regulations including, without limitation, 40 C.F.R 258.10.

TO HAVE AND TO HOLD unto St. Louis and unto its successors in interest and assigns forever. The Provisions of this Agreement and the parties' rights, commitments, and obligations within, shall be binding on the parties hereto, their respective heirs, successors in interest, and assigns. Every party acquiring or holding any interest or estate in any portion of the Property shall take or hold such interest or estate, or the security interest with respect thereto, with notice of this Agreement and of the Provisions of this Agreement. In accepting any interest or estate in, or any security interest with respect to any portion of the Property, such party shall be deemed to have assented to all of the Provisions hereof. The Provisions of this Agreement shall run with the land. To that end, this Agreement shall be deemed incorporated into all deeds and conveyances hereinafter made by Grantors and any heirs, successor in interest or assigns thereto. Grantors, for themselves, their heirs, successors in interest and assigns, hereby acknowledge, stipulate, and agree that the Provisions agreed to and the restrictions imposed, as aforesaid, shall be binding rights and privileges granted hereunder appertaining or belonging to St. Louis, its successors in interest and assigns, and shall continue as a servitude running in perpetuity with the Property, unless abandoned and terminated by St. Louis as provided for in paragraph 4 above.

[Signature pages to follow.]

IN WITNESS WHEREOF, the Grantors and St. Louis have entered into this Negative Easement and Declaration of Restrictive Covenants Agreement on the date first written above.

GRANTORS:

BRIDGETON LANDFILL, LLC

By: [signature]

Title: Vice President

STATE OF MISSOURI }
}
COUNTY OF ST. LOUIS }

On this 1st day of April 2005, before me appeared Rusty Walker VP, being by me duly sworn, and did state that he is a Vice President of Bridgeton Landfill, LLC, a Delaware limited liability company; that said instrument was signed and sealed on behalf of Bridgeton Landfill, LLC; and that he acknowledged said instrument to be the free act and deed of Bridgeton Landfill, LLC.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed my notarial seal at my office in the County of St. Louis.

NOTARY PUBLIC NOTARY SEAL STATE OF MISSOURI

BRAD R. GEURIN
My Commission Expires
September 21, 2008
St. Louis County

[signature: Brad R. Geurin]
Notary Public

My commission expires: 9/21/08.

165132.2

NAME OF GRANTOR:
ROCK ROAD INDUSTRIES, INC.

By: [signature]

Title: Vice President

STATE OF MISSOURI }
}
COUNTY OF ST. LOUIS }

On this 1st day of April 2005, before me appeared Rusty Waldrup, being by me duly sworn, and did state that he is a Vice President of Rock Road Industries, Inc, a Missouri corporation; that said instrument was signed and sealed on behalf of said corporation and that he acknowledged said instrument to be the free act and deed of Rock Road Industries, Inc.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed my notarial seal at my office in the County of St Louis.

NOTARY PUBLIC NOTARY SEAL STATE OF MISSOURI

BRAD R. GEURIN
My Commission Expires
September 21, 2008
St. Louis County

Brad R Geurin
Notary Public

My commission expires: 9/21/08.

165132.2

NAME OF GRANTOR:
BRIDGETON TRANSFER STATION, LLC

By: ______________________

Title: Vice President

STATE OF MISSOURI }
}
COUNTY OF ST. LOUIS }

On this 1st day of April 2005, before me appeared Rusty WALDRUP, being by me duly sworn, and did state that he is a Vice President of Bridgeton Transfer Station, LLC, a Delaware limited liability company; that said instrument was signed and sealed on behalf of Bridgeton Transfer Station, LLC and that he acknowledged said instrument to be the free act and deed of Bridgeton Transfer Station, LLC.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed my notarial seal at my office in the County of St Louis.

NOTARY PUBLIC NOTARY SEAL STATE OF MISSOURI

BRAD R. GEURIN
My Commission Expires
September 21, 2008
St. Louis County

Brad R. Geurin
Notary Public

My commission expires: 9/21/08.

165132.2

ST. LOUIS/GRANTEE:

THE CITY OF ST. LOUIS, MISSOURI, OWNER AND OPERATOR OF LAMBERT-ST. LOUIS INTERNATIONAL AIRPORT®

Pursuant to The City of St. Louis' Ordinance No. 64279, approved March 9, 1998, as amended.

The foregoing Negative Easement and Declaration of Restrictive Covenants Agreement was approved by the Board of Estimate and Apportionment at its meeting on March 16, 2005.

3/17/05

Secretary, Board of Estimate & Apportionment Date

APPROVED BY:

City Counselor, The City of St. Louis

COUNTERSIGNED BY:

3-22-05

Comptroller, The City of St. Louis Date

ATTESTED TO BY:

MAR 22 2005

Register, The City of St. Louis Date

COMPTROLLER'S OFFICE

DOCUMENT # 50337

STATE OF MISSOURI }

CITY OF ST. LOUIS }

On this 2d day of March 2005, before me appeared ~~Patricia A. Hageman~~ to me personally known, who being by me duly sworn, did say that she is the City Counselor of The City of St. Louis, Missouri, a municipal corporation, and that the seal affixed to the foregoing instrument is the corporate seal of The City of St. Louis and that said instrument was signed and sealed on behalf of The City of St. Louis pursuant to Ordinance No. 64279, approved March 9, 1998, as amended.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed my notarial seal at my office in the City of St. Louis, Missouri.

Notary Public

My commission expires: __________________.

PATRICIA A FLEMING
Notary Public - Notary Seal
STATE OF MISSOURI
ST. LOUIS CITY
MY COMMISSION EXP. AUG. 29,2006

1651322

STATE OF MISSOURI }
}
CITY OF ST. LOUIS }

On this 17th day of March 2005, before me appeared Yudora T. Mason to me personally known, who being by me duly sworn, did say that she is the Secretary for the Board of Estimate and Apportionment of The City of St. Louis, Missouri, a municipal corporation, and that the foregoing instrument was approved by the Board of Estimate and Apportionment on March 16, 2005, on behalf of The City of St. Louis pursuant to Ordinance No. 64279, approved March 9, 1998, as amended.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed my notarial seal at my office in the City of St. Louis, Missouri.

Karen Jackson
Notary Public

My commission expires: April 1, 2008.

Notary Public Notary Seal State of Missouri

KAREN JACKSON
St. Louis City
My Commission Expires
April 1, 2008

Exhibit A
Legal Description of Property
For Negative Easement and Declaration of
Restrictive Covenants Agreement

TRACT I
PROPERTY DESCRIPTION OF
ACTIVE LANDFILL MINUS TRANSFER STATION

A tract of land being part of U.S. Survey 131, all of Lots 1, 2, 3, and 4 of the Yosti Partition as recorded in Survey Record Book 3 Page 101 of the St. Louis City (former County) records, part of Lots 20 and 21 of the St. Charles Ferry Company tract as recorded in Plat Book 7 Pages 98 and 99 of the St. Louis City (former County) records, and being located in U.S. Surveys 131 and 1934, Townships 46 and 47 North, Range 5 East of the Fifth Principal Meridian, City of Bridgeton, St. Louis County, Missouri, and being more particularly described as follows:

Beginning at the most Westerly corner of Lot 3 of the Boundary Adjustment Plat of Lots 1 and 3 of West Lake Acres Plat Two, a subdivision according to the plat thereof recorded in Plat Book 348 Page 667 of the St. Louis County, Missouri Records; thence South 36 degrees 52 minutes 59 seconds East along the Southwesterly line of said Lot 3 and the Southwesterly line of Lot 4 of West Lake Acres Plat Two, a subdivision according to the plat thereof recorded in Plat Book 344 Page 261 of said records a distance of 486.26 feet to a point on the Northwesterly line of last said Lot 4; thence South 53 degrees 06 minutes 26 seconds West along said Northwesterly line 437.11 feet to a point on the Southwesterly line of last said Lot 4; thence South 36 degrees 52 minutes 59 seconds East along last said Southwesterly line 779.68 feet to a point on the Northwesterly line of Lot 13 of Foersters Subdivision, a subdivision according to the plat thereof recorded in Plat Book 10 Page 55 of the St. Louis City (former County) records, thence South 45 degrees 59 minutes 06 seconds West along said Northwesterly line of said Lot 13 and the Northwesterly line of Lot 12 of said Foersters Subdivision 1349.58 feet to the Northerly line of Old St. Charles Rock Road, 60 feet wide, also known as Boenker Lane; thence North 54 degrees 25 minutes 17 seconds West along said Northerly line 858.18 feet to a point on the centerline of Taussig Avenue, 40 feet wide (vacated); thence North 34 degrees 48 minutes 55 seconds East along said centerline 100.00 feet to a point on the Northeasterly line of a tract of land as conveyed to Laidlaw Waste Systems (Bridgeton), Inc. according to the instrument recorded in Book 11082 Page 319 of the St. Louis County Records; thence North 54 degrees 25 minutes 17 seconds West along said Northeasterly line 120.00 feet to a point on the Northwesterly line of above said Laidlaw Waste Systems (Bridgeton), Inc. tract; thence South 34 degrees 45 minutes 34 seconds West along said Northwesterly line 130.00 feet to a point on the centerline of above said Old St. Charles Rock Road (vacated); thence along said centerline the following courses and distances: North 54 degrees 25 minutes 17 seconds West 991.55 feet, North 00 degrees 43 minutes 42 seconds East 997.52 feet, North 04 degrees 40 minutes 18 seconds West 477.70 feet, North 10 degrees 25 minutes 18 seconds West 348.30 feet, North 24 degrees 52 minutes 18 seconds West 349.50 feet; thence North 32 degrees 08 minutes 18 seconds West 22.38 feet to a point on the Southeasterly line of a tract of land as conveyed to Rock Road Industries, Inc. according to the instrument recorded in Book 12868 Page 1159 of the St. Louis County Records; thence North 35 degrees 35 minutes 04 seconds East 824.56 feet to a point on the Southwesterly line of a tract of land as conveyed to Rock Road Industries, Inc. according to the instrument recorded in Book 8356 Page 1807 of said records, and being a point on the common line between U.S. Survey 47 and U.S Survey 1934, Township 47 North, Range 5 East; thence South 66 degrees 04 minutes 54 seconds East along said Southwesterly line and said common line 167.44 feet to a point on the Southwesterly line of said Rock Road Industries, Inc. tract; thence South 36 degrees 52 minutes 59 seconds East along last said Southwesterly line and the Southwesterly line of a tract of land as conveyed to West Lake Landfill, Inc. according to the instrument recorded in Book 5262 Page 311 of above said records, and departing above said common line South 36 degrees 52 minutes 59 seconds East 1221.43 feet to a point on the Southeasterly line of a tract of land as conveyed to above said West Lake Landfill, Inc. tract, and being a point on the common line between U.S. Survey 131 and U.S Survey 47, Township 47 North, Range 5 East; thence North 54 degrees 46 minutes 17 seconds East along said Southeasterly line and said common line 1188.94 feet to a point on the Southwesterly line of Highway 40, also known as St. Charles Rock Road, variable width; thence South 37 degrees 11 minutes 37 seconds East along said Southwesterly line 1087.25 feet; thence departing said Southwesterly line the following courses and distances: South 01 degrees 32 minutes 48 seconds West 57.51 feet, South 54 degrees 30 minutes 23 seconds West 312.95 feet and South 35 degrees 29 minutes 37 seconds East 30.00 feet to a point on the Northwesterly line of above said Lot 3 of the Boundary Adjustment Plat of Lots 1 and 3 of West Lake Acres Plat Two; thence South 54 degrees 30 minutes 23 seconds West along said Northwesterly line 340.00 feet and South 48 degrees 34 minutes 23 seconds West 68.21 feet to the POINT OF BEGINNING and containing 7,119,040 square feet or 163.43 acres more or less according to a survey by Stock & Associates Consulting Engineers, Inc. dated November 19, 2004, and most recently revised February 15, 2005.

AND EXCEPTING THEREFROM the following:

A tract of land being part of Lot 1 of the Yosti Partition as recorded in Survey Record Book 3 Page 101 of the St. Louis City (former County) Records and part of U.S. Survey 131 in Township 47 North, Range 5 East of the Fifth Principal Meridian, City of Bridgeton, St. Louis County, Missouri, and being the same property as described in Ordinance Number 03-26 approved by the City of Bridgeton on June 18, 2003, and being more particularly described as follows:

Commencing at a point on the Southwesterly line of Highway 40, also known as St. Charles Rock Road, variable width, with the intersection of the common line between U.S.

 BP16465/1156

Survey 131 and U.S. Survey 47, Township 47 North, Range 5 East; thence South 37 degrees 11 minutes 37 seconds West along said Southwesterly line 72.80 feet to the POINT OF BEGINNING of the herein described tract; thence continuing along said Southwesterly line South 37 degrees 11 minutes 37 seconds East 137.01 feet; thence departing said Southwesterly line the following courses and distances: South 57 degrees 54 minutes 34 seconds West 1023.24 feet, South 32 degrees 40 minutes 35 seconds West 181.33 feet, South 36 degrees 52 minutes 59 seconds East 771.12, South 53 degrees 07 minutes 01 seconds West 332.71 feet, North 10 degrees 28 minutes 16 seconds West 198.67 feet, North 20 degrees 00 minutes 51 seconds East 166.52 feet, North 30 degrees 50 minutes 21 seconds East 404.44 feet, North 04 degrees 38 minutes 30 seconds East 131.00 feet, North 37 degrees 13 minutes 19 seconds West 153.74 feet, and North 57 degrees 54 minutes 34 seconds East 1260.74 feet to the POINT OF BEGINNING and containing 347,048 square feet or 7.967 acres more or less according to a survey by Stock & Associates Consulting Engineers, Inc. dated November 19, 2004, and most recently revised February 15, 2005.

The above property (less exception) contains 6,771,992 square feet or 155.464 acres more or less according to a survey by Stock & Associates Consulting Engineers, Inc. dated November 19, 2004, most recently revised March 9, 2005 and on file with the City of St. Louis.

TRACT II

All of Lot 4 of West Lake Acres Plat II, according to the plat thereof recorded in Plat Book 344 Page 261 of the St. Louis County Records.

The above property is shown on as parcel 3 on a survey by Stock & Associates Consulting Engineers, Inc. dated November 19, 2004, most recently revised March 9, 2005 and on file with the City of St. Louis.

TRACT III

Part of Lots 12 and 13 of the "Foersters Subdivision" in U.S. Survey 131 in Township 46 North, Range 5 East of the Fifth Principal Meridian, St. Louis County, Missouri, said part being more particularly described as follows:

Beginning at the most southerly corner of Lot 4 of Yosti Partition, being the same as the most westerly corner of said Lot 12 of Foersters Subdivision; thence North 45 degrees 59 minutes 04 seconds East, along the northwesterly line of Lots 12 and 13 of Foersters Subdivision, being the same as the southeasterly line of Lot 4 of Yosti Partition, a distance of 1349.58 feet to a concrete monument which marks the most northerly corner of said Lot 13; thence South 36 degrees 53 minutes 01 seconds East, along the northeasterly line of said Lot 13, a distance of 151.17 feet to its intersection with a line which lies 150 feet southeasterly of and parallel to the northwesterly lines of said Lots 12 and 13 of the Foersters Subdivision; thence South 45 degrees 59 minutes 04 seconds West, along said parallel line, a distance of 1303.26 feet to the northerly right of way line of "Old St. Charles Rock Road"; thence North 54 degrees 25 minutes 19 seconds West, along said right of way line, a distance of 152.51 feet to the Point of Beginning.

The above property is shown on as parcel 4 on a survey by Stock & Associates Consulting Engineers, Inc. dated November 19, 2004, most recently revised March 9, 2005 and on file with the City of St. Louis.

TRACT IV

Lot 3 of the Boundary Adjustment Plat of Lots 1 and 3 of West Lake Acres Plat II, according to the plat thereof recorded in Plat Book 348 Page 657 of the St. Louis County Records.

The above property is shown on as parcel 6 on a survey by Stock & Associates Consulting Engineers, Inc. dated November 19, 2004, most recently revised March 9, 2005 and on file with the City of St. Louis.

TRACT V

All of Lot 5 of West Lake Acres Plat II, according to the plat thereof recorded in Plat Book 344 Page 261 of the St. Louis County Records.

The above property is shown on as parcel 7 on a survey by Stock & Associates Consulting Engineers, Inc. dated November 19, 2004, most recently revised March 9, 2005 and on file with the City of St. Louis.

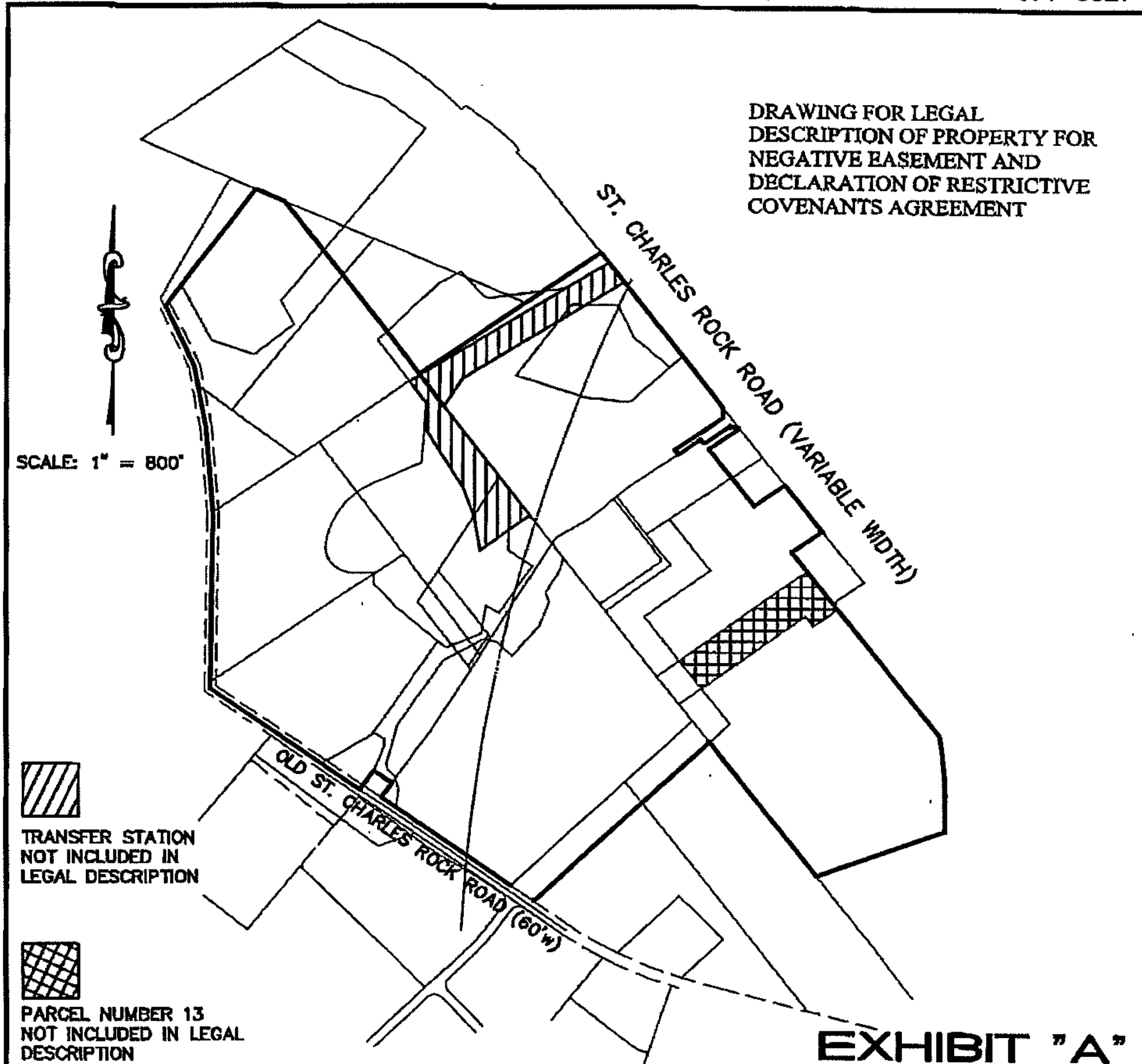
TRACT VI

Lot 6 of West Lake Acres Plat II, according to the plat thereof recorded in Plat Book 344 Page 261 of the St. Louis County Records.

The above property is shown on as parcel 8 on a survey by Stock & Associates Consulting Engineers, Inc. dated November 19, 2004, most recently revised March 9, 2005 and on file with the City of St. Louis.

DATE 3-9-05

JOB NO. 204-3327



A TRACT OF LAND BEING PART OF WEST LAKE ACRES PLAT II AS RECORDED IN PLAT BOOK 344 PAGE 261, PART OF THE BOUNDARY ADJUSTMENT PLAT OF LOTS 1 AND 3, OF WEST LAKE ACRES PLAT II AS RECORDED IN PLAT BOOK 348 PAGE 667 AND PART OF FOERSTERS SUBDIVISION AS RECORDED IN PLAT BOOK 342 PAGE 68, ALL OF THE ST. LOUIS COUNTY RECORDS; PART OF THE YOSTI PARTITION AS RECORDED IN SURVEY RECORD BOOK 3 PAGE 101 AND PART OF THE ST. CHARLES FERRY COMPANY TRACT AS RECORDED IN PLAT BOOK 7 PAGES 98 AND 99, ALL OF THE ST. LOUIS CITY (FORMER COUNTY) RECORDS AND PART OF US SURVEY 131 LOCATED IN U.S. SURVEYS 47, 131 AND 1934, TOWNSHIPS 46 & 47 NORTH, RANGE 5 EAST OF THE 5TH PRINCIPAL MERIDIAN, CITY OF BRIDGETON, ST. LOUIS COUNTY, MISSOURI

204-3327\SURVEY\3327EXHIBIT.DWG

Appendix A-3:

Federal Aviation Administration

Record of Decision

Memorandum of Understanding

Advisory Circulars

U.S. DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration
Central Region
Kansas City, MO

RECORD OF DECISION

For

Lambert-St. Louis International Airport
St. Louis, MO

September 30, 1998

The Federal Aviation Administration has approved Lambert-St. Louis International Airport's proposed airside and landside improvements, commonly known as Alternative W-1W. A Record of Decision (ROD) was signed on September 30, 1998, by FAA Central Region Administrator John E. Turner.

By October 14, 1998, official copies of the ROD may be viewed at the various locations (City Halls, Libraries, FAA and Lambert-St. Louis International Airport) identified in the September 30, 1998, press release *included at the end of this document.*

FEDERAL AVIATION ADMINISTRATION

Record of Decision

Lambert-St. Louis International Airport

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APPENDICES

1. FAA DECISION

This Record of Decision (ROD) provides final Federal Aviation Administration (FAA) approval for the Federal actions for proposed improvements at Lambert-St. Louis International Airport (Lambert), including construction and operation of a new air carrier length runway (12W/30W). The Federal actions and associated airport development are described in detail in the Final Environmental Impact Statement, Lambert-St. Louis International Airport, dated December 1997 (FEIS). The Federal actions are considered in Section 3, Agency Actions, of this ROD. The FAA's decision is based on the information contained in the FEIS and all other applicable documents available to the FAA and considered by it, which constitute the administrative record.

This ROD is issued in accordance with the requirements of the Council on Environmental Quality (CEQ), 40 CFR 1505.2. The principal features include:

- A statement of the agency's decision;
- An identification of all the alternatives considered by the FAA in reaching its decision, with a specification of the alternative or alternatives that are considered to be environmentally preferable; and
- The means adopted (mitigation measures) to avoid or minimize environmental harm from the alternative selected.

Based on a review of the administrative record and the FEIS approved on December 19, 1997, it is the FAA’s final determination that the revised Airport Layout Plan (ALP) for proposed improvements to Lambert, including a new air carrier-length runway, specifically described in Sections 2, 4 and 5 of this ROD, and identified in the FEIS as the "FAA’s Preferred Alternative” (Alternative W-1W), is approved. This runway is designated, for planning purposes, as 12W/30W. In addition, the runway is approved as eligible for Federal financial assistance and construction.

These approvals of the ALP and eligibility for Federal funding constitute final approval. The FAA notes that the airport-project sponsor, the St. Louis Airport Authority (STLAA), has agreed to the various conditions of approval, in particular, the conditions requiring mitigation measures.

In reaching this determination, careful consideration has been given to: (a) the needs of Lambert as a part of the national air transportation system and the airport capacity/delay reduction needs through the year 2015; (b) the aviation safety and operational objectives of the project in the light of the various aeronautical factors and judgments presented and (c) the anticipated environmental impacts of the project.

The FAA has carefully considered all reasonable alternatives to the proposed action. Although the “No-Action Alternative” had fewer developmental and environmental impacts than the preferred alternative and was the “environmentally preferred alternative,” it failed to achieve the purposes and needs for this project. The other reasonable development alternative, Alternative S-1, was examined in detail by the FAA and found to provide capacity and delay reduction benefits slightly higher than Alternative W-1W, at higher costs and with greater environmental impacts. Alternative W-1W is more protective than Alternative S-1 of natural resources protected under *49 U.S.C. 47016(c),* park and historic resources protected under Section 303 of the Department of Transportation Act (DOT Section 303, also referred to as Section 4(f)) and Section 6(f) of the Land and Water Conservation Fund Act, and wetlands. For the reasons summarized in this ROD, and supported by detailed discussion in the FEIS, the FAA has determined that the agency’s preferred alternative, Alternative W-1W, is the only possible, prudent and practicable alternative.

A discussion of the leading factors considered by the FAA in reaching this decision follows.

2. BACKGROUND

Over the past decade, the FAA has worked closely with local and regional officials and with the STLAA aviation planning staff to investigate ways to accommodate the increasing passenger and operational activity demands at Lambert. As documented in Section 1.0, Introduction, of the FEIS, the present airport runway configuration, with two closely spaced parallel air carrier runways (12L/30R and 12R/30L), is currently responsible for significant airside delays, particularly during poor weather conditions. It is forecast that this configuration will be responsible for increasing such delays in the future.

The FAA has prepared an FEIS to identify the potential environmental effects associated with the construction and operation of proposed improvements to Lambert. The City of St. Louis, the owner and operator of Lambert, has completed a Master Plan Supplement (MPS) that proposes a comprehensive development program for the expansion of Lambert. The STLAA has submitted an ALP to the FAA for approval and requested from the FAA the Federal environmental approval necessary to proceed with the processing of an application for Federal funds.

AIRPORT DESCRIPTION

Lambert is located 12 miles northwest of the St. Louis central business district. The primary area served by Lambert includes nine counties and the City of St. Louis. This area is referred to as the St. Louis Metropolitan Statistical Area and encompasses approximately 5,340 square miles. Five counties and 24 percent of the service area's population is in Illinois, while four counties, the City of St. Louis, and 76 percent of the service area's population is in Missouri.

Currently, Lambert has two parallel air carrier runways: 12L/30R and 12R/30L. In addition, Lambert has two crosswind runways, Runways 6/24 and 17/35, and Runway 13/31, which is a converted taxiway that is only used for small aircraft in visual daytime conditions. Runway 13/31 will be converted back to a taxiway after the new Runway 12W/30W is operational.

Runway 12R/30L, Lambert's longest runway, is 11,018 feet long, and the parallel Runway 12L/30R is 9,003 feet long. Runways 12R/30L and 12L/30R are separated by 1,300 feet. The airport is reduced to one precision instrument approach during adverse weather conditions because of the minimal separation of the parallel runways.

LAMBERT’S ROLE

Lambert is the primary commercial air carrier airport in the region and is one of the nation's major hub airports. It has consistently been ranked among the top 20 (Airport Council International) most active airports nationally, and in 1996, it ranked 14th in terms of total passengers (enplaned and deplaned) and 8th in total aircraft operations. In 1996, Lambert was served by nine scheduled air carriers, six cargo carriers and six commuter airlines.

Lambert serves as the primary connecting hub for TransWorld Airlines (TWA). In 1996, TWA offered direct service to over 70 cities. Approximately 60 percent of the enplaning passengers at Lambert were connecting passengers.

AIRPORT MASTER PLANNING PROCESS

Lambert-St. Louis International Airport Master Plan

Between the years 1987 and 1993, the STLAA prepared a comprehensive master plan study, the “Lambert-St. Louis International Airport Master Plan” (LAMP). The study developed forecasts of aviation demand through the year 2010 and proposed an airport development plan to enable Lambert to meet future projected demand levels.

The LAMP study culminated with the identification of a preferred airport development plan called Alternative F-4. This alternative proposed to rebuild the entire airfield while the airport continued to operate. Alternative F-4 would have reconfigured and expanded the airfield by rotating the alignment of the airport’s main runway system clockwise approximately 10 degrees. This configuration involved the construction of new runways resulting in four parallel Runways (14R/32L, 14L/32R, 13R/31L, and 13L/31R) and the retention of existing crosswind Runway 6/24.

In 1993, a more detailed review of the F-4 concept was accomplished by the STLAA. This review indicated that the costs to construct the proposed F-4 plan would be significantly greater than originally anticipated. There were several problems with this Alternative’s “constructability” (e.g., ability to phase and construct the alternative while maintaining continuous 24-hour operations, ability to maintain the hub at Lambert, and ability to operate the terminal and existing runways during construction). In particular, rotation of the airfield and the staging of its development would severely affect the ability of Lambert to operate as a hub for several years. The STLAA determined that it would be prudent to re-examine the development options at Lambert.

Master Plan Supplement

In 1994, the STLAA undertook a review and update to the master planning process at Lambert. This study, called the Master Plan Supplement (previously identified as MPS), re-examined the needs of Lambert. It resulted in the recommended course of development proposed by the STLAA and considered in the FEIS.

Aviation Demand Forecasts

During the development of the MPS, the City of St. Louis developed, refined, and updated aviation activity forecasts for Lambert, which considered the development and growth trends in the region, the aviation growth trends regionally and nationally, and changes in the airline industry. Before facility requirements were determined, the STLAA submitted forecasts representing unconstrained conditions to the FAA for its review and approval. The FAA approved the forecasts representing unconstrained conditions during the development of the MPS. Subsequently, the FAA issued FAA Safety Notice N7110.157, "Wake Turbulence." The Safety Notice has the effect of reducing airport capacity due to the recategorization of certain aircraft types and a resulting increase in separation standards. Taking into consideration the recently published guidelines, the FAA recognized that the unconstrained forecasts for the No-Action Alternative might not be achievable, given the configuration of the current runways. Therefore, the forecasts for the 2015 No-Action Alternative were adjusted to represent a constrained condition.

The MPS revised forecasts indicate that in the year 2015, Lambert has the potential to accommodate approximately 632,000 aircraft operations with the selected action, as compared to 595,000 aircraft operations without the proposed improvements. The FAA's revised 2015 No-Action constrained forecast for Lambert was 532,000 operations. The forecasts used in the FEIS and the FAA's Terminal Area Forecasts (TAF) are within the same range. Although the TAF are slightly higher than the FEIS forecasts, the differences are within a range that FAA considers to be insignificant and within the range of acceptable aviation forecasting.

Facility Requirements and Alternatives Analysis

A facility requirements analysis was accomplished to identify the shortfalls of the existing airport and to identify development items that would enable Lambert to effectively solve the shortfalls and meet projected demand levels. The analysis examined major components of the airport, including runways, airspace, terminals and ground transportation. This evaluation confirmed that Lambert needed an east-west parallel runway system capable of accommodating simultaneous independent Instrument Flight Rules (IFR) approaches.

The MPS included a comprehensive re-evaluation of possible development options, including an analysis of the alternatives studied as part of the previous LAMP. It was determined that the use of a Precision Runway Monitor (PRM) would enable consideration of runway development alternatives, which were rejected in previous studies. PRM is a system comprised of a rapid update radar, an enhanced color graphic monitor, and software package which aids the air traffic controller in more accurately monitoring the position of aircraft on final approach to a runway. PRM is the primary tool that has allowed the FAA to approve simultaneous independent instrument approaches to parallel runways spaced as little as 3,000 feet apart (3,400 feet for straight-in approaches). The PRM allows sufficient runway separation to allow simultaneous independent IFR approaches during marginal visual and instrument meteorological conditions. The alternatives analysis process considered operational, financial and environmental factors. From an initial list of more than 40 development concepts, the STLAA selected the airport development alternative, designated Alternative W-1W, as its preferred alternative.

THE PROPOSED IMPROVEMENTS TO LAMBERT

The STLAA has proposed airside and landside improvements to Lambert to enable the airport to meet projected levels of activity. The City's preferred development alternative, known as W-1W, includes a new parallel runway (12W/30W), 9,000 feet long by 150 feet wide, located at the southwestern side of Lambert in the City of Bridgeton. This runway will be located parallel to and 4,100 feet from existing runway 12L/30R with a staggered threshold of approximately 12,100 feet. This runway has been proposed to improve airfield capacity during both visual meteorological conditions (VMC) and instrument meteorological conditions (IMC).

The two parallel runways at Lambert, which are 1,300 feet apart, are too close together to allow simultaneous independent approaches. With the proposed improvements, the weighted hourly capacity at Lambert will be increased. With the use of a PRM, the separation of the new runway from the existing runways will be of sufficient distance to allow the airport to accommodate simultaneous independent approaches during IMC. Lambert does not currently have this capability. This feature will allow Lambert to reduce delay times, improve adverse weather capabilities, enhance capacity, and continue to accommodate hubbing operations such as the system TWA is now using at Lambert.

Other associated actions include property acquisition, terminal expansion, roadway improvements, and relocation of several airport tenant operations. A summary of the major components of the development plan and the proposed phasing is provided in Section 5, Alternatives Analysis, of this ROD.

EIS PROCESS

On August 17, 1995**,** the FAA began the public phase of the environmental process involving STLAA site-specific development proposals, which included a new runway for Lambert, by announcing in the Federal Register (60 Fed. Reg. 42938) its intent to prepare an Environmental Impact Statement (EIS), and by requesting scoping comments. Scoping meetings were held with the general public and with Federal, state and local agencies on September 6 and 7, 1995. See FEIS Section 7.0, regarding public involvement, and FEIS Appendix J, for a summary of scoping comments.

On October 4, 1996**,** a Notice of Availability of the Draft Environmental Impact Statement (DEIS) was published in the Federal Register (61 Fed. Reg. 51939). Public comments were taken on the DEIS from the date of its release until January 17, 1997. A public hearing was held on October 28, 1996. Appendix V of the FEIS contains a summary of comments and responses on the DEIS, which were received from the public and government agencies during the hearing as well as through the mail.

The FEIS was approved by the FAA on December 19, 1997, and released to the public on December 22, 1997. The FEIS addressed areas of public concern by way of modifications to the DEIS text and specific responses to public comments.

Pursuant to 40 CFR 1506.10, the U.S. Environmental Protection Agency (EPA) published a notice of the availability of the approved FEIS in the Federal Register on January 2, 1998 (63 Fed. Reg. 75). According to CEQ regulations, the FAA was required to wait a minimum of 30 days after the notice of availability of the approved FEIS before issuing its ROD. That 30-day waiting period has passed.

Although the FAA did not solicit public comment on the FEIS, several public agencies, community groups, and citizens submitted written comments for agency consideration. The FAA has to the extent practicable considered all comments received on the FEIS. Appendices A, B, C, D, E and G of the ROD respond to substantive agency and public comments on the FEIS and any new significant issues that have arisen.

3. AGENCY ACTIONS

The Federal actions are:

1. The approval of revisions to the ALP for construction and operation of proposed Runway 12W/30W and associated improvements, listed in full in Section 3.4.3 of the FEIS;

2. The Federal environmental approval necessary to proceed with processing of an application for Federal funding for those development items qualifying under the former Airport and Airway Improvement Act of 1982, as amended and recodified at *49 U.S.C. 47101 et seq.*; and

3. The approval of associated safety actions.

The City of St. Louis may also submit an amendment to its passenger facility charge (PFC) application to the FAA in order to use such PFC revenues for eligible portions of the proposed project. Although future projects other than Runway 12W/30W are depicted on the ALP, the City of St. Louis is requesting final environmental approval only for the runway and associated projects assessed as part of Phase I through the year 2000 and Phase II (2002-2015) in the FEIS. It is recognized that other projects may require additional environmental analysis when ripe for decision at a later date and will only be conditionally approved by the FAA on the ALP at this time.

The U.S. Army Corps of Engineers (COE), a cooperating agency for the FEIS, will be responsible for permitting processes under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. In addition, the U.S. Air Force (USAF) and the U.S. Navy (Navy) will be preparing separate RODs, when appropriate, for the relocation of their facilities. The necessary approval actions required by the Federal Highway Administration (FHWA) are included in Section 8, Cooperating Agencies, of this ROD.

The necessary FAA determinations and approvals are summarized below:

a. Determination of project eligibility for Federal grant-in-aid funds (*49 U.S.C. Section 47101*, *et. seq.*) and PFC funds (*49 U.S.C. Section 40117*), for land acquisition and relocation (49 CFR Part 24), site preparation, runway, taxiway, runway safety area, and other airfield construction, terminal and related landside development, navigational and landing aids, roadway improvements and environmental mitigation.

b. Determination regarding air quality conformance of the proposed facility with applicable air quality standards under the Clean Air Act, as amended (*42 U.S.C.*

Section 7506, Section 176 (c) (1), and 40 CFR Part 93). (The FAA issued a Final General Conformity Determination and published a notice in the *St. Louis Post Dispatch* on June 29, 1998.)

c. Approvals for establishment of new instrument landing systems (ILS) and associated approach lighting systems and navigational aids, including use of a PRM, as appropriate, for the new runway, the existing runways, and the airport as a whole (*49 U.S.C. Section 44502 (a) (1)*).

d. Decisions to develop air traffic control and airspace management procedures to effect the safe and efficient movement of air traffic to and from the proposed new runway. This includes the development of a system for the routing of arriving and departing traffic and the design, establishment, and publication of standardized flight operating procedures, including instrument approach procedures and standard instrument departure procedures (*49 U.S.C. Section 40103 (b)*).

e. Determinations, through the aeronautical study process, under 14 CFR Part 77, regarding obstructions to navigable airspace (*49 U.S.C. Section 40103 (b) and 40113*).

f. Determinations under 14 CFR Part 157 as to whether the FAA objects to the airport development proposal from an airspace perspective, based upon aeronautical studies (*49 U.S.C. Section 40113 (a)*).

g. Determinations under the *49 U.S.C. Sections 47106 and 47107* pertaining to FAA funding of airport development (including approval of a revised ALP, *49 U.S.C. Section 47107 (a) (16)*), environmental approval (*42 U.S.C. Sections 4321-4347*, and *40 CFR Section 1500-1508*), and approvals under various executive orders discussed in the ROD.

h. A certification that the proposed facility is reasonably necessary for use in air commerce or for the national defense (*49 U.S.C. Section 44502 (b)*).

i. FAA review and approval of amended Airport Certification Manual (14 CFR Part 139).

j. FAA determination that there would be no undue burden (unusual circumstances) barring the sponsor from obtaining a Section 404 permit for the filling of wetlands.

k. FAA determination that there would be no undue burden (unusual circumstances) barring the sponsor from obtaining a National Pollutant Discharge Elimination System (NPDES) permit for stormwater and wastewater discharges.

4. PURPOSE AND NEED

The identification of a proposed action's purpose and need is the primary foundation for the identification of reasonable alternatives and the evaluation of the impacts of the development. In exercising its authority and in the public interest, the FAA considers assigning, maintaining and enhancing safety and security as its highest priority (*49 U.S.C. 40101(d)*). This is the FAA's first consideration in evaluating the purpose and need for any proposed airport improvements.

The *purpose* of the proposed action is to:

1. Enable Lambert to effectively and safely accommodate projected levels of aviation activity at an acceptable level of delay by:

   – Increasing airfield capacity.

   – Improving visual flight rules (VFR) capacity.

   – Allowing dual simultaneous independent IFR arrival operations.

   – Decreasing delays.

2. Enhance the National Airspace System (NAS) by:

   – Reducing delays nationwide.

   – Increasing airfield capacity.

3. Recognize the importance of the economic benefits provided by Lambert and allow the local communities and the region to continue to reap those economic benefits.

4. Facilitate the airline hub at St. Louis, which is vital to alleviating projected shortfalls in capacity at Lambert and in the NAS. This is interrelated with all of the above purposes for the proposed project.

The proposed action is *needed* because:

1. The existing airport is severely constrained and it is projected that the airport will be unable to adequately meet projected levels of demand without incurring unacceptable operational delays;

2. As an important component of the NAS, Lambert cannot be allowed to become a “bottleneck,” because it would have detrimental ripple effects throughout the airspace system; and

3. The airport serves an important function in providing economic benefits important to the airport sponsor and the region.

INCREASED AIRFIELD CAPACITY

The 9,000-foot length of Runway 12W/30W will accommodate the operation of most of the aircraft types currently operating and projected to operate at Lambert. Both ends of Runway 12W/30W will be equipped with an ILS. In addition, the PRM, which is to be installed for the existing airfield, will be used for the new runway.

The increased airfield capacity provided by Runway 12W/30W will substantially reduce the existing and projected average annual delay time per aircraft operation. These estimated decreases in delay time will result in annual savings in aircraft delay costs. Conversely, estimated aircraft taxiing distances and time will slightly increase aircraft operating costs as a result of Runway 12W/30W. Taken together, there will be an estimated net savings in aircraft delay costs and taxiing costs of close to $100 million in the year 2005 and approaching $300 million in the year 2015.

PASSENGER HUB EFFICIENCY

The continued use of Lambert as an effective major airline hub will be constrained if the airport facilities are not expanded to accommodate future demand. One key airside feature associated with other hub airports that is absent from Lambert is simultaneous independent IFR arrival capability (including marginal VFR). The lack of independent IFR arrival capability greatly impacts the ability of a hub airline in St. Louis to effectively meet projected demand. Without an improvement in IFR and marginal VFR operating capability, the reliability of services at Lambert will be increasingly burdened during the periods of the year when IFR and marginal VFR weather conditions occur (approximately 14 percent of the year). Without terminal and airfield expansion capabilities, it will be difficult for Lambert to continue as an effective hub airport. This lack of facilities and expansion capabilities will result in increased delay times, decreases in airport capacity, and increased costs to the airlines and the traveling public.

From a national perspective, it is in the interest of the FAA to maintain an airline hub at Lambert. The FAA believes that due to its central location in the U.S. and its local market, St. Louis is a natural hubbing location. St. Louis is the only place within hundreds of miles in any direction where there are both a very large air travel origination/destination market and airport capacity that can handle substantial hubbing activity. Keeping the traffic that now hubs at St. Louis flowing smoothly and efficiently is critical to the entire national aviation system.

MULTIPLE AIRPORT SYSTEMS

Shifting some of Lambert's operations to another airport to relieve existing and future forecast capacity problems has been debated and studied for several years. Recent studies have found that, even though there are nearby available facilities capable of handling commercial jet traffic, such as Scott Air Force Base/Mid-America Airport (Scott AFB/MAA), the overflow of commercial jet operations from Lambert to other airports in the region would not efficiently solve the capacity problem because most of the aviation activity is associated with airline hubbing. The lack of a sponsor for airport expansion in another political jurisdiction is a reality that the FAA is authorized to consider under CEQ regulations. Correspondence from St. Clair County, the operator of MAA (which is a joint-use facility with SCOTT AFB), indicates that St. Clair supports Lambert as the regional hub.

Use of multiple airports would complicate the hubbing issue, because an adequate level of peak-hour operations required to maintain hubbing operations at one location might not be obtainable if traffic were split between two airports. In this case, both airports would lose. In addition, a threshold of 10 to 12 million originating passengers is needed for a community to support a second commercial service airport. The St. Louis forecasts indicate that originating passengers for the St. Louis metropolitan area in the year 2015 would be approximately 8.7 million, below the threshold for a second commercial service airport.

The continued use of Lambert as a major airline hub is in question, unless expanded to accommodate future demand. St. Louis competes with other airline hubs that are being or have been expanded. Unless more operational capability is provided, Lambert's ability to compete will be limited.

ECONOMIC BENEFITS

Lambert plays an important role in supporting the economic goals of the St. Louis metropolitan region. Over the years, Lambert has evolved into one of the largest employment and income centers in the region. The proposed Runway 12W/30W project will strengthen Lambert as a major economic asset that serves as a vital link to the nation and world, as well as a significant employment and income center.

5. ALTERNATIVES ANALYSIS

In addition to the relevant environmental statutes, the FAA in its consideration of alternatives, has been mindful of its statutory charter to encourage the development of civil aeronautics and safety of air commerce in the United States (*49 U.S.C. 40104*). FAA has also considered the congressional policy declaration that airport construction and improvement projects that increase the capacity of facilities to accommodate passenger and cargo traffic be undertaken to the maximum feasible extent so that safety and efficiency increase and delays decrease (*49 U.S.C. 47101(a)(7)*).

While the FAA does not have the authority to control or direct the actions and decisions of the STLAA relative to planning for this project, it does have the authority to withhold project approval, including Federal funding and the other Federal actions discussed in this ROD. It was from this perspective that the various alternatives were considered in terms of evaluating and comparing their impacts to determine whether there was an alternative superior to that proposed by STLAA, or whether STLAA's proposal would cause impacts warranting disapproval of the Federal actions discussed in this ROD, including the withholding of Federal funds for the project.

The FAA identified numerous alternatives to the proposal (reference FEIS Section 3.2). During this exploration of alternatives, all reasonable alternatives were carefully examined, ranging from doing nothing to specific runway alignments at Lambert. After considering all reasonable alternatives, the FAA selected the construction of Runway 12W/30W and associated projects as the agency's preferred alternative in the FEIS. The FAA identified Alternative X-1, the No-Action Alternative, as the environmentally preferable alternative. Other alternatives were eliminated for a variety of reasons as discussed below.

The DEIS alternatives evaluation utilized a three-tiered evaluation process that concentrated on the purpose and need for the proposed project. The first tier evaluated whether the various alternatives met the purpose and need criteria established in Section 2.0 of the DEIS. Alternatives that satisfied these criteria were retained for evaluation under the second tier of analysis. The second tier evaluated the "constructability" (ability to phase and construct the alternative while maintaining continuous 24-hour operations, ability to maintain the hub at Lambert, and ability to operate the terminal and existing runways during construction), and the benefit/cost ratio (BCR) of the alternatives (BCR of less than "1" indicates costs outweigh economic benefits, greater than "1" indicates economic benefits outweigh costs). Alternatives that met these criteria were retained for evaluation under the third tier of analysis. The third tier evaluated multiple specific criteria relating to operational efficiency (taxi times, delay times), cost per passenger (lower costs vs. higher costs) and environmental impacts (noise, land use, social, etc.).

As part of Tier 3, the FAA analyzed the best representative alternatives from the remaining families of alternative runway alignments. The best representative selected for detailed analysis within each family was the best overall environmentally, particularly as to resources protected under special purpose environmental laws. This approach is consistent with guidance in CEQ's Forty Questions (Question 1), which provides that: "When there are potentially a very large number of alternatives, only a reasonable number of examples, covering the full spectrum of alternatives, must be analyzed and compared in the EIS. ... What constitutes a reasonable range of alternatives depends on the nature of the proposal and the facts in each case."

Alternatives that met the criteria under the third tier of analysis, were the best in their families and had the least overall environmental impact were retained for detailed analysis in subsequent sections of the DEIS. Table S.1 contains a summary of the tiered analysis used in the alternatives analysis for the DEIS (Appendix J of this ROD, FEIS Summary).

The alternatives explored in the FEIS include the following:

REASONABLE ALTERNATIVES EXAMINED AND ELIMINATED FROM DETAILED ANALYSIS

- Other modes of transportation, including surface transportation alternatives such as rail, bus and automobiles.

- Construct a new airport to replace Lambert.

- A multiple-airport system with a supplemental airport in addition to Lambert.

- Airfield alignment alternatives:
  North Airfield Alternatives: N-1, NE-1, NE-1a
  West Airfield Alternatives: W-1E, W-2
  South Airfield Alternatives: Modified S-1
  Canted Airfield Alternative: C-1

- Other on-airport alternatives:
  Bridgeton's Lambert 2020 Plan
  Hyland Plan
  Alternative runway lengths
  Existing facility with advanced navigational aids

These alternatives were rejected for the following reasons:

1. Other modes of transportation do not fulfill the main needs for improving Lambert. They do not meet local aviation needs, nor enhance the economic contribution of Lambert to the region, or strengthen Lambert's role in the NAS. Other modes, including automobiles, buses and rail, have a complementary role to air travel, not a replacement one. Further, the other modes do not provide the fast, flexible and efficient long-distance transportation needed by the public and provided by Lambert.

2. The construction of a new regional airport is not a viable solution to satisfy the projected capacity deficiency at Lambert in the foreseeable future due to time and cost requirements.

3. Although several other airports exist in the region, none--individually or collectively--can adequately accommodate the anticipated traffic from Lambert, fulfilling the need for the new runway. Multiple reasons are responsible: airline hubbing, lack of facilities at other airports, detrimental environmental impacts and airspace conflicts and constraints.

4. Although several on-airport runway alignment alternatives were considered, most were eliminated from detailed study. The FEIS examined in detail only those alternatives that provide for a similar magnitude of development and have the capability of providing simultaneous independent IFR arrival operations, which are considered critical to the operation of the airline hub. The airfield alignment alternatives and other on-airport alternatives not retained for detailed study were considered either: (a) to be infeasible and/or imprudent (in the case of alternatives not retained at Tiers 1 or 2), or (b) to present equivalent or greater impacts to parks and wetlands (in the case of alternatives not retained at Tier 3, the “best in family” comparison).

ALTERNATIVES CONSIDERED IN DETAIL

No-Action Alternative (X-1)

The No-Action Alternative would not accomplish the critical elements of the purpose and need that the selected alternative will provide. The No-Action Alternative (X-1) is depicted in Figure S.1 of the FEIS Summary (Appendix J of this ROD). Although the No-Action Alternative would be the least disruptive in terms of development impacts, it would not solve the capacity needs or delays existing at Lambert Airport, and thus would not achieve the purposes and needs for the proposed action. The No-Action Alternative would not provide capacity, delay reductions nor benefits to the community. In addition, the No-Action Alternative would not give Lambert the necessary operating flexibility provided by the selected alternative. To do nothing would, under some circumstances, actually exacerbate environmental conditions; for example, selection of the No-Action Alternative would worsen air quality as compared to the selected alternative. The environmental impacts associated with Alternative X-1 include increased air emissions and energy consumption due to added delay.

Alternative S-1

Alternative S-1 consists of the following developments, which would be initiated and/or completed by the year 2002:

- Land acquisition (approximately 1,332 acres) and associated relocation of homes and businesses.
- Construction of a new 9,000-foot parallel runway south of highway I-70. The new runway would be laterally separated by at least 5,500 feet from existing Runway 12L/30R. Although a PRM, for enhanced air traffic control of existing operations, has been installed at Lambert (projected commissioning scheduled for November 1998), Alternative S-1 would not require the use of a PRM.
- Construction of two new dual taxiway bridges across I-70.
- Construction of related taxiways, lighting, navigational aids, grading, drainage and utility relocations.
- Implementation of air traffic control procedures below 3,000 feet above ground level (AGL).
- Renovation and expansion of existing terminal facilities and associated aprons.
- Demolition of portions of the East Terminal Complex for Connector Taxiway construction.
- Relocation of airline support facilities.
- Implementation of mitigation measures and acquisition of permits.
- Improvements to I-70/Airport Terminal Interchange.

- Relocation of the Missouri Air National Guard (MoANG) and Navy/Marine Corps Reserve facilities.

- Realignment of McDonnell Boulevard, Lambert International Boulevard, and portions of the Metro Link light rail.

- Closure of numerous local roads between I-70 and what would become Lambert's new southern boundary.

Alternative S-1 also has one Phase II project that would be developed between the years 2002 and 2015:

- Construction of new landside terminal facilities, west of the existing terminal, possibly located at the current location of the MoANG and Navy/Marine Corps Reserve facilities. A portion of the terminal facilities may be located west of Runway 6/24.

The S-1 Alternative is depicted in Figure S.2 of the FEIS Summary (Appendix J of this ROD).

The S-1 concept was refined during the DEIS to ensure that the proposed parallel taxiways over I-70 would meet FAA design criteria. It was found that both pairs of taxiways would need to be shifted in order to meet FAA taxiway grade criteria of 1.5 percent. The shift in the east pair would require demolition of the East Terminal Complex and relocation of a portion of the Metro Link commuter rail system. The shift in the west pair from a perpendicular alignment to a slightly northwest diagonal alignment was also necessary to allow the taxiways to clear I-70 and meet FAA taxiway grade criteria.

Operational Considerations

Operationally, Alternative S-1 fulfills all of the first tier purpose and need review criteria, because it would allow dual simultaneous IFR arrival operations during IMC, improve VFR capacity at Lambert, help enhance the NAS, allow the passenger hub to remain at Lambert, and would be consistent with local planning and economic goals.

Of the reasonable alternatives retained for detailed evaluation, the FAA acknowledges that Alternative S-1 is superior from an operational standpoint. Alternative S-1 has a shorter stagger of runway threshold locations than Alternative W-1W. The absence of this stagger eliminates the double dependency of departures from the future center runway (existing Runway 12R/30L) with arrivals on the outboard runways (30R and 30W) in west flow conditions. Alternative S-1 would be more airfield-efficient and would reduce taxi times when compared to Alternative W-1W.

Financial Feasibility

A detailed analysis of the financial implications of each of the reasonable alternatives was prepared as part of the MPS. The results of this analysis indicate that for Alternative S-1, year 2015, the total savings in annual aircraft operating cost is calculated to be $329 million, cost per passenger is projected at $13, total construction cost is estimated to be $2.4 billion and the BCR is calculated to be 1.8. With a BCR of 1.8, the economic benefits of implementing this alternative are almost twice as great as the costs associated with its construction. However, the refined design of Alternative S-1, shifting the taxiways, would add approximately $75 to $100 million to the cost of Alternative S-1. This would bring the cost of Alternative S-1 up to approximately $2.5 billion and the per-passenger cost to over $13. The BCR would consequently be reduced to less than 1.8.

Environmental Impacts

Alternative S-1 would result in adverse environmental impacts including: the acquisition and displacement of established land uses, such as homes, schools, churches, and businesses; shifting aircraft noise exposure patterns over sensitive areas; impacting park and archaeological resources; requiring development in wetland and floodplain areas and potentially disrupting several hazardous materials sites.

Alternative S-1 would require the acquisition of approximately 4,528 households (relocating approximately 9,725 people), 210 businesses, 8 schools and 6 churches. The areas of acquisition would include the northern part of the City of St. Ann (displacing approximately 2,556 people), all of the City of Edmundson (approximately 1,107 people), two-thirds of the City of Woodson Terrace (2,640 people), the southwest part of the City of Berkeley (1,847 people), part of Bridgeton (406 people) and part of the City of St. John (1,169 people). Operations on the new south runway could increase aircraft noise levels at the University of Missouri-St. Louis campus to the southeast. Alternative S-1 would directly affect nine park and recreational areas (57 total acres), requiring replacement.

Alternative W-1W

Alternative W-1W consists of the following developments, which would be initiated and/or completed by the year 2002 (Phase I):

- Land acquisition (approximately 1,568 acres) and associated relocations of homes and businesses.

- Construction of a new runway complex parallel to and southwest of existing runways 12L/30R and 12R/30L. Runway 12W/30W would be 9,000 feet in length and 150 feet in width and would be capable of handling air carrier jet aircraft. The parallel runway would be laterally separated by 4,100 feet from existing Runway 12L/30R and would be south and west of existing Runway 6/24. A PRM, for enhanced air traffic control of existing operations, has been installed at Lambert (projected commissioning scheduled for November 1998). Alternative W-1W would require the use of a PRM.

- Construction of related taxiways, lighting, navigational aids, grading, drainage, and utility relocations.

- Implementation of air traffic control procedures below 3,000 feet AGL.

- Renovation and expansion of existing terminal facilities and associated aprons.

- Relocation of airline support facilities.

- Relocation of the MoANG and Navy/Marine Corps Reserve facilities.

- Realignment of Lindbergh Boulevard and construction of a roadway tunnel for those portions of Lindbergh Boulevard impacted by the construction of the new runway and the optional future extension of existing Runway 12R/30L.

- Realignment or relocation of roadways, including Natural Bridge Road, Bonfils Road, Fee Fee Road, Cypress Road, Gist Road, Lambert International Boulevard, Missouri Bottom Road and McDonnell Boulevard.

- Improvements to the I-70/Airport Terminal Interchange.

- Implementation of mitigation measures and acquisition of permits.

Alternative W-1W, Phase II projects that would be developed between the years 2002 and 2015 include the following:

- Construction of new landside terminal facilities (up to approximately 110 gates), west of the existing terminal, possibly located at the current location of the MoANG and Navy/Marine Corps Reserve facilities. A portion of the terminal facilities may be located west of Runway 6/24.

Phase III projects are beyond the 20-year planning period and are not specifically programmed for implementation. Possible projects that may be developed in Phase III, after the year 2015, include:

- Construction of a 2,500-foot extension to the northwest end of existing Runway 12R/30L.
- Additional construction of new west landside terminal facilities.
- Construction of a new airport access roadway from I-270 to the new west landside terminal complex.
- Demolition of the existing terminal complex and construction of new east airfield terminal concourses.

Alternative W-1W is depicted in Figure S.3 of the FEIS Summary (Appendix J of this ROD).

Operational Considerations

Operationally, Alternative W-1W fulfills all of the first tier purpose and need review criteria in the FEIS, because it would allow dual simultaneous IFR arrival operations, improve VFR capacity at Lambert, help enhance the NAS, allow the passenger hub to remain at Lambert and would be consistent with local planning and economic goals.

Financial Feasibility

The results of the MPS financial feasibility analysis indicate that for Alternative W-1W, in the year 2015, the total savings in annual aircraft operating cost is calculated to be $297 million, cost per passenger is projected at $10.50, total construction cost is estimated to be $2.2 billion, and the BCR is calculated to be 2.2. The BCR of 2.2 indicates that the economic benefits of implementing this alternative are more than twice as great as the costs associated with its construction. An independent benefit/cost analysis (BCA), conducted by FAA’s Systems and Policy Analysis Division (APO-200), determined that Alternative W-1W had a BCR of 2.6.

Environmental Impacts

The adverse environmental impacts that would result from Alternative W-1W include the acquisition and displacement of established land uses including homes, schools, churches and businesses; shifting aircraft noise exposure patterns over sensitive areas; impacting park, historic and archaeological resources; requiring development in wetland and floodplain areas and potential disruption of several hazardous materials sites.

Alternative W-1W would require the acquisition of approximately 2,324 households (relocating approximately 5,680 people), 75 businesses, 6 schools, 6 churches and one nursing home for airfield development and surface transportation improvements. The areas of acquisition would be in the City of Bridgeton (displacing approximately 5,404 people), and the City of St. Ann (displacing 276 people). Alternative W-1W would directly affect four park and recreational areas (26 total acres), requiring replacement. The 12W end of the proposed runway would also be located within 10,000 feet of an existing active landfill and would not be consistent with FAA's current runway siting guidelines without mitigation.

THE FAA'S SELECTED ALTERNATIVE (ALTERNATIVE W-1W)

The FAA finds that the selected alternative is preferred principally because it enhances capacity and reduces delay for Lambert and the total NAS. The FAA in this ROD approves the preferred alternative.

Alternative W-1W was selected rather than Alternative S-1 because it meets purpose and need and is environmentally superior to S-1. Alternative W-1W has fewer impacts on people to be relocated, and less severe impacts on resources protected under special purpose laws (e.g., parks, wetlands).

The FAA has made its required special purpose law determinations that there is no possible, prudent and practicable alternative to Alternative W-1W, based upon the following information (see also Appendix J of this ROD, Table S.1A, page S-9):

- Both development alternatives would have unavoidable impacts on resources protected under Section 303 of the Department of Transportation Act and Section 6(f) of the Land and Water Conservation Fund Act. There are no possible or prudent alternatives to the use of these resources. Alternative W-1W will use approximately half the park and recreational resources and acres that would be required for Alternative S-1.

- Both Alternatives W-1W and S-1 would have unavoidable wetland impacts due to the proximity of wetlands to the airport. Consequently, there are no practicable alternatives to filling of wetlands. Alternative W-1W has the least amount (acreage) of wetland impacts.

- There is no practicable alternative to the floodplain impacts of Alternative W-1W. Mitigation measures to minimize the floodplain impacts can be accomplished. The floodplain encroachment will not be considered significant.

The FAA has also considered that the preferred alternative proposed in the FEIS has withstood extensive public scrutiny throughout the public involvement process. The FAA recognizes that some segments of the community strongly oppose Alternative W-1W. Lambert has been conducting ongoing negotiations with the neighboring cities to resolve issues related to the impacts and mitigation proposed in the FEIS.

Because the FAA determined that Alternative W-1W is the least impacting alternative, overall, it selected Alternative W-1W as the preferred alternative. A comparative table summarizing Alternatives X-1, S-1 and W-1W is contained in Table S.2 of the FEIS Summary (Appendix J of this ROD).

However, a few key comparisons of impacts to the communities are:

	Alternative S-1	**Alternative W-1W**
Number of people to be relocated	9,725	5,680
Number of households to be relocated	4,528	2,324
Number of residential parcels to be acquired	2,902	1,937
Number of businesses to be relocated	210	75
Number of schools to be acquired	8	6
Number of churches to be acquired	6	6
Number of nursing homes to be acquired	0	1
Number of parks directly affected	9	4
Acreage of parks directly affected	57	26
Acreage of parks affected	10.8	9.7
Acreage of floodplains affected	51	57

Accordingly, having considered: (1) the policies set forth at *49 U.S.C. Sections 40104 and 47101*, (2) the ability of the alternatives to meet the purpose and need, and (3) the administrative record which concerns these development projects, the FAA hereby selects the W-1W development recommended in the FEIS.

The FAA's approval of these expansion and improvement projects in this ROD signifies that these projects meet FAA standards for agency approval discussed in Section 3 of this ROD. It does not, however, signify an FAA commitment to provide a specific level of financial support for these projects, which must await future decisions under the criteria prescribed by *49 U.S.C. 47115(d) and 49 U.S.C. 40117*.

6. MAJOR IMPACTS AND MITIGATION

In accordance with 40 CFR 1505.3, the FAA will take appropriate steps, through Federal funding grant assurances and conditions, PFC "use" approvals, airport layout plan approvals and contract plans and specifications to ensure that the following mitigation actions are implemented during project development. The FAA will monitor the implementation of these mitigation actions as necessary. The approvals contained in this ROD are specifically conditioned upon full implementation of these mitigation measures. These mitigation actions will be made the subject of a special condition included in future airport grants to the STLAA.

A detailed environmental analysis of the potential environmental impacts resulting from the construction and operation of the selected alternative was accomplished as part of the FEIS. Two study periods were examined, 2002 and 2015. The year 2002 is projected to be the first year that the new runway and associated development will be operational. The year 2015 is the outside planning period of the MPS and when most of the ALP's recommendations will be operational. Twenty-two different environmental impact categories were examined.

SUPPLEMENTAL TECHNICAL REPORTS

Supplemental technical reports have been prepared, published and distributed separately from the FEIS. These reports address the potential direct and indirect effects to resources protected under special Federal laws. The following lists each of these reports and the relevant Federal law:

- Section 303 and 6(f) Evaluation - *49 U.S.C. Sections 303* [Recodified from and commonly known as Section 4(f) of the Department of Transportation Act 1966]; and the Land and Water Conservation Fund Act;
- Section 106 Documentation associated with the Final Environmental Impact Statement - Section 106 of the National Historic Preservation Act of 1966; and
- Draft and Final General Conformity Determinations - Federal Clean Air Act and State of Missouri requirements.

IMPACTS AND MITIGATION

This section of the ROD includes a summary of the mitigation measures, discussed more fully in the FEIS, Section 6.3, for each environmental impact category.

The primary responsibility for implementation of the mitigation program rests with the STLAA. The FAA will have oversight responsibility and will condition grant agreements and/or PFC “use” approvals upon completion of the mitigation program by the City of St. Louis. Mitigation measures for those impact categories where mitigation measures are necessary to avoid or minimize significant environmental impacts, as well as identified or adopted monitoring and enforcement programs, are summarized below. The FAA finds that all practical means to avoid or minimize environmental harm have been adopted, through appropriate mitigation planning.

Noise and Compatible Land Use Impacts and Mitigation

Because of the effects of the introduction of quieter Stage 3 aircraft, noise levels are projected to decrease in future years. For this reason, even with the selected alternative, there will be a significant reduction in land area and population impacted by noise in the years 2002 and 2015 when compared to current conditions. For future year comparisons, Alternative W-1W will impact fewer people within the Day-Night Equivalent Sound Level (DNL) 65 dB contour than Alternative S-1, but more than Alternative X-1, in both 2002 and 2015. A review of the proposed roadway improvements and realignments for Alternative W-1W indicates that traffic noise impacts would be minimal. Noise impacts resulting from the proposed airport development will be mitigated through measures identified in Section 6.3.1 of the FEIS.

The noise mitigation program for the selected alternative consists of operational and land use control measures. The program was developed in a manner which is consistent with the previous and ongoing noise mitigation and abatement programs implemented by the STLAA. The main objective of this program is to mitigate noise impacts associated with the selected alternative’s aircraft operations by recommending appropriate measures consistent with the approved 1997 Part 150 Noise Compatibility Program Update. Although the mitigation program outlined below is designed to be consistent with the ongoing Lambert Part 150 process, the mitigation measures described below are associated with the specific impacts of Lambert’s proposed expansion. It is the obligation of the City of St. Louis to implement the mitigation for the expansion.

The land use mitigation program is based on the potential noise impacts identified through the comparison of the year 2002 No-Action and selected alternative noise contours. The year 2002 selected alternative noise contours were chosen for the mitigation program, because they are larger in size than the year 2015 noise contours. The mitigation program consists of:

Land Acquisition for Mitigation of Noise Impacts Due to Alternative W-1W

The STLAA will acquire all residential and residentially zoned areas located within the 70 DNL noise contour for the year 2002, as well as all mobile home parks within the 65 DNL noise contour. It is anticipated that any of these land uses not acquired through the STLAA's ongoing Part 150 acquisition program for the existing airport will be acquired through the acquisition program for the construction of Alternative W-1W.

Voluntary Noise Mitigation Program

The STLAA will offer a voluntary noise mitigation program to eligible homeowners (located in the 65 DNL noise contour for the year 2002). Each eligible homeowner within this area will be offered the choice of one of three options: sales assistance, sound insulation or easement purchase. In exchange for one of these three options, the airport will receive an avigation easement.

Noise Mitigation Assurance

This element of the noise mitigation program enables STLAA to concentrate the voluntary and land acquisition measures on the areas actually experiencing the annual average DNL noise levels predicted in the FEIS, Section 5.1, after the opening of the new west runway. Using a permanent noise monitoring system, STLAA will monitor and analyze the noise levels resulting from actual, normal operation of the new west runway. If that actual experience diverges from the contours projected, an adjustment will be made to the boundaries of the areas eligible for the mitigation programs. The STLAA will reassess the average-annual noise characteristics of Lambert approximately 18 months after the new runway opens.

Accommodate New Runway in the Permanent Noise Management System

The STLAA is in the process of installing a new permanent noise management (monitoring) system, which will assist in the management of the noise program and monitor the effectiveness of operational noise mitigation measures. The STLAA will add or relocate noise monitoring stations to monitor operations on Runway 12W/30W and associated flight tracks. Appropriate sites will be selected to provide data for monitoring of Runway 12W/30W to assist STLAA in re-assessing the boundaries of the mitigation programs.

Noise Abatement Departure Procedures

This voluntary procedure, already in use for existing runways, involves the reduction of thrust for departing air-carrier aircraft to reduce noise levels in sensitive areas. Once

Runway 12W/30W is commissioned (or operational), commercial jet airline departures will be requested to use the voluntary "Distant Noise Abatement Departure Procedure," as defined in FAA Advisory Circular 91-53A.

Social Impacts and Mitigation; Environmental Justice Impacts

Residential and business displacements are the principal social impacts associated with the selected alternative. The selected alternative will result in the acquisition and relocation of numerous residences and businesses. Other direct social impacts involve the relocation of community facilities such as schools and churches. A large degree of community disruption will be experienced in the City of Bridgeton due to the selected alternative. All acquisitions and relocations will comply with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970. STLAA will develop a detailed plan for the relocation of all properties including residential, commercial, public, and nonprofit organizations. The program will be consistent with FAA Advisory Circular 150/5100-17, Land Acquisition and Relocation Assistance for Airport Improvement Program Assisted Projects.

Surface transportation patterns will be altered and temporarily disrupted with the selected alternative. Measures to mitigate surface transportation impacts are discussed in Section 6.3.13 of the FEIS and later in this Section of the ROD. The acquisition and relocation of residential and commercial properties will be required to accommodate the proposed surface transportation improvements associated with the selected alternative.

Acquisition of property will result in the loss of assessed valuation and, therefore, tax revenue to local taxing units through the year 2002. However, this loss should be offset between the years 2002 and 2015 by the development of commercial, industrial, office, and mixed land uses in or adjacent to the previously acquired areas. For that reason and because per capita tax revenues will likewise be maintained, formal mitigation actions for tax base impacts are not required. Implementation of the selected alternative will not result in disproportionately adverse impacts on minority or low-income populations. For example, the racial characteristics within the acquisition areas are approximately 95 percent white; 3 percent black; and less than 2 percent other races. Low-income persons make up approximately 1.5 percent of the total number of impacted persons. The measures to mitigate social impacts, discussed in Section 6.3.2 of the FEIS, are summarized below.

Acquisition and Relocation Program

This program will minimize the impacts of property acquisition and relocation on displaced residents, businesses and churches by providing services to educate, inform and respond to the needs of those affected, both individually and collectively. This program will also provide for the acquisition and relocation of public and private schools and other public facilities included within the development area for the selected alternative. This program will include measures to minimize the adverse effects associated with the displacement of these facilities.

Acquisitions and relocations will proceed in keeping with the following mitigation objectives:

- Comply with the Uniform Relocation Assistance and Real Property Acquisition Policies Act.

- Comply with the Missouri Airport Relocation Act, R.S. Mo. Section 305.600, *et seq.*

- Develop a detailed Relocation Plan that addresses the specific needs of relocated residents, such as access to employment, access to social services, residency in existing school districts, and access to commercial facilities.

- Educate residents about the Uniform Act and the STLAA's Relocation Plan by holding community meetings prior to the actual acquisition process.

- Work to maintain neighborhood relationships by providing comparable housing areas that can accommodate multiple households from acquisition areas.

- Coordinate with the St. Louis County Housing Authority, the Missouri Housing Development Corporation and the U.S. Department of Housing and Urban Development to provide access to housing assistance programs that meet the identified needs of displaced households.

- Provide information to the real estate industry on the project displacements and acquisition/relocation process. Communicate with real estate agents through the St. Louis Association of Realtors to facilitate access to the real estate market for needed replacement properties.

- Work closely with churches through the relocation process to determine facility needs based on net impact to church membership and to maintain church communities.

- Work with school districts and private schools to determine facility needs based on the net student enrollment impacts.

- Relocate acquired schools in existing enrollment areas to cause the least disruption to students.

Acquisitions related to construction will be completed before the opening of the new runway, estimated to be the year 2002. For those acquisitions not necessary for construction but for noise mitigation, the airport shall have made an offer for acquisition prior to the opening of the new runway, estimated to be the year 2002.

Induced Socioeconomic Impacts

Between 1998 and 2002, economic impacts of the airport expansion project and surface transportation improvements will be related primarily to construction employment, loss of market area population for certain retail developments, and the acquisition of commercial properties. The selected alternative will generate significantly greater construction employment than the No-Action Alternative. However, considering the long-term impacts of the airport, these short-term construction employment increases will not be significant. Loss of market area population will create isolated impacts for several retail establishments along Natural Bridge Road and Pear Tree Lane with the acquisition and relocation of commercial property. These localized impacts will not be significant when assessed from a regional perspective or for the local economy but could be significant to individual businesses, especially those businesses that depend on neighborhood patronage. Impacts to the local economy and the tax base will be short term, as anticipated induced growth and development resulting from airport expansion will replace initial tax base losses.

Since no adverse impacts are anticipated as a result of induced socioeconomic impacts, mitigation is not required.

Air Quality Impacts and Mitigation

Lambert is located in an area designated as moderate non-attainment for ozone and maintenance for carbon monoxide (CO). Based on recent monitoring data, the City of St. Louis may be redesignated by EPA as serious non-attainment for ozone. Air emissions from aircraft, motor vehicles, ground support equipment and adjacent roadway improvements associated with Lambert are expected to increase somewhat in the future as enplanements and aircraft operations increase. However, comparison of the Build and No-Build Alternative in 2002 shows that emissions resulting from the selected alternative are predicted to be lower, in nearly all cases, than emissions from the No-Build Alternative. Project-related emissions, including construction, do not exceed *de minimis* levels in 2002 for any pollutant (including nitrogen oxides, CO and volatile organic compounds (VOCs)). In spite of the increased airport capacity, emissions reductions result from decreased aircraft delay and queuing times attributable to the proposed improvements to Lambert. The only exception to this is the predicted increase in NO_X emissions over the No-Build condition some time between the years 2002 and 2015. However, this long-range (2015) estimate is beyond SIP forecasts and potentially imprecise due to likely changes in the future aircraft fleet and fuel combustion technology. These long-range estimates are subject to change, should only be used for planning or information purposes and are not appropriate for conformity determination. Notwithstanding the above, total emissions associated with Lambert are not expected to result in any violation of the National Ambient Air Quality Program (NAAQS), nor interfere with the goals of the State Implementation Plan (SIP).

Lambert-related emissions for aircraft and fueling are accounted for in the SIP through the year 2005. The action does not cause or contribute to a violation of the NAAQS. The project-related emissions are not regionally significant. Based on these findings, the FAA determined, in its Final General Conformity Determination, that the planned improvements to Lambert conform to the goals of the SIP and meet the requirements of the General Conformity Rule and the Clean Air Act.

Both EPA and MDNR reviewed the Draft General Conformity Determination developed for this project and determined that all of the relevant issues were addressed (see FEIS Appendix A, EPA letter dated November 7, 1997, and MDNR letter dated November 20, 1997). On June 29, 1998, the FAA published in the *St. Louis Post Dispatch* notice of its Final General Conformity Determination. Copies of the Final General Conformity Determination were provided to EPA and MDNR. In accordance with the Clean Air Act, and EPA General Conformity Regulations, the FAA has demonstrated that the selected alternative will conform with the Missouri SIP for achieving and maintaining the NAAQS for ozone and carbon monoxide, respectively.

As noted in this ROD, Section 11.C, after consultation with the Missouri Department of Natural Resources (MDNR) (the Governor's designated agency for air quality), the Governor of Missouri certified that there is a reasonable assurance that the project will meet all applicable air quality standards in accordance with Section 509(b)(7) of the Airport and Airway Improvement Act, recodified under *49 U.S.C. 47106(c)* (letter dated August 11, 1998, in Appendix I).

Further Studies and Ongoing and Planned Activities to Minimize Air Pollution

The FAA and STLAA have agreed to explore EPA's request to establish additional air quality monitors in the airport area. Also, the MPS identified certain terminal area improvement concepts that included roadway, parking structure, transit and terminal structure developments. These improvements have the potential to influence air quality for workers, passengers and visitors. However, the MPS did not provide design-specific details to enable the meaningful analysis of the carbon monoxide impacts of future terminal facilities. The FAA and STLAA have agreed that when terminal design progresses sufficiently, the STLAA will conduct a carbon monoxide hot-spot analysis for terminal expansion to ensure that the terminal structure is designed efficiently from an air-quality standpoint. The results of the terminal carbon monoxide hot-spot analysis will be submitted to EPA and MDNR.

While specific measures to mitigate for air-quality impacts were not required for the preferred alternative, some air-pollutant minimization efforts were considered reasonable and proposed by STLAA. Ongoing or planned STLAA air-quality minimization measures, contained in Section 6.3.3 of the FEIS, are summarized below:

- **Continued Membership in the St. Louis Regional Clean Cities Program:** The City of St. Louis, the owner and operator of Lambert, is a participating member of the St. Louis Regional Clean Cities Program, which is a partnership of public- and private-sector entities, who encourage voluntary emissions reductions through awareness, education and demonstration.

- **Conversion to Alternative, Cleaner Burning Fuels:** Lambert is using alternative, cleaner burning fuels in its maintenance vehicles. This program involves the retrofit or procurement of airport service vehicles capable of burning alternative fuel types, which emit fewer pollutants. An alternative fuel station will supply fuel for airport service vehicles. Construction of this facility is scheduled for 1998.

- **Use of Low Volatile Organic Compound (VOC) Traffic Coatings:** To limit both VOC and hazardous air pollution emissions, STLAA has switched to the use of coating materials for the airfield and roadway improvements, which emit extremely low levels of VOCs. These materials include paints and asphalt-seal coating.

- **Continued Compliance with the Stationary Source Operating Permit and Air Emission Source Survey:** STLAA has voluntarily chosen to limit its annual emissions below 100 tons per year for hazardous air pollutants. Lambert is placing a cap on the amount of fuel consumed at the East and West Power Plants.

Water Quality Impacts and Mitigation

Many of the routine operations that will occur at Lambert as a result of the selected alternative will affect the water quality of Coldwater Creek. Stormwater runoff from runways, taxiways, apron areas, storage areas, gates and surface transportation improvements has the potential to be contaminated. These areas may contain pollutants such as oil, grease, sediments and deicing agents that may require detention and/or treatment. In addition, effluent from oil/water separators or waste reduction activities on the airport may also contribute to degradation of water quality. As runoff from the above activities is subject to the requirements of the NPDES permit process, all future stormwater discharges will be required to comply with the permit-established pollutant limits.

As noted in Section 11.C of this ROD, after consultation with the MDNR (the Governor's designated agency for water quality), the Governor of Missouri certified that there is a reasonable assurance that the project will meet all applicable water quality standards in accordance with Section 509(b)(7) of the Airport and Airway Improvement Act, recodified under *49 U.S.C. 47106(c)* (letter dated August 11, 1998, in Appendix I).

The proposed airport improvements will result in an increase in potable water demand and wastewater generation. However, with the acquisition of additional land for airport development and noise compatibility, overall or net airport area water demand and wastewater generation will be less than the existing airport area demand. Proposed water quality mitigation measures are described in detail in Section 6.3.4 of the FEIS and summarized below:

- **Implement Glycol Deicing Master Plan System:** Airlines operating at Lambert currently use glycol fluids for the deicing of aircraft. This fluid has the potential to pass through the airport's drainage system into local surface waters. The airport is currently in the process of implementing a Glycol Deicing Master Plan, which centralizes the collection of deicing fluids for recycling and treatment. It is anticipated that this system will handle 90 percent of the storm events encountered during the deicing season. In addition, a central deicing facility for narrow body aircraft will be used when applicable for westbound departures from existing Runways 30R and 30L.

- **Implement Stormwater Management Options:** Lambert's NPDES permit regulates the discharge of stormwater to Coldwater Creek by imposing effluent limitation, monitoring and reporting obligations. The airport has undertaken voluntary management options to reduce pollutants entering the stormwater system. These include the use of potassium acetate and heated sand for runway/taxiway deicing, the use of remote aircraft deicing facilities and diversion and treatment of runoff containing deicing fluid to wastewater treatment plants. The STLAA will implement similar management options for the new runway and taxiways.

- **Create Stormwater Detention Areas For Attenuation of Stormwater Runoff:** Runoff from new impervious areas (associated with buildings, parking, apron, runway and roadway areas) will be directed to stormwater detention areas for peak discharge attenuation. These detention areas may consist of grassed swales, dry detention areas or underground vaults, which will allow stormwater to be detained prior to discharging to Coldwater, Cowmire or Maline Creeks.

- **Increase Airport Potable Water Storage and Pressure Capacity:** Potable water storage tank and booster pump capacity will be evaluated to ensure that adequate potable water and fire-protection supply and pressure requirements are met.

- **Review Wastewater Discharge Capacity:** The airport will be required to consult with the Metropolitan Sewer District (MSD) on future wastewater discharges to determine whether methods for increasing wastewater discharge capacity are needed.

- **Close Wastewater Lines in Acquisition Areas:** Existing wastewater lines will be removed or plugged prior to discharging to the MSD wastewater main lines. Otherwise, inflow of stormwater could occur through broken pipe joints and contribute to additional flow to the wastewater treatment plant. Closing abandoned lines will help offset future wastewater contributions from the airport expansion by reducing infiltration flows to the wastewater treatment plant.

With regard to normal airport operations, the airport sponsor, through its grant assurances with the FAA, commits to suitably operating and maintaining the airport and all facilities in a safe and serviceable condition and complying with all applicable Federal laws, regulations, executive orders and other mandatory requirements related to water quality.

Section 303 and Section 6(f) Impacts and Mitigation

The selected alternative will directly affect four park and recreation area Section 303 sites. Three of the sites adversely affected by the selected alternative are also protected under Section 6(f). The selected alternative, including the associated surface transportation improvements, also has the potential to directly and indirectly affect several historic and archaeological sites protected under Section 106 of the National Historic Preservation Act. These sites will be mitigated through a Section 106 Memorandum of Agreement (MOA) (Appendix H of this ROD). The project will also have indirect adverse impacts upon Section 303 and 6(f) sites. The selected alternative will not result in any incompatible park areas due to aircraft noise. In terms of avoidance alternatives, review of the tiered alternatives evaluation prepared in Section 3.0, Alternatives, of the FEIS, indicates that there are no prudent and feasible alternatives to the use of the Section 303 and 6(f) sites.

The FAA has coordinated with the public and agencies having jurisdiction over the affected sites to determine site significance and to develop mitigation measures necessary to meet Section 303 and 6(f) requirements. Generally, the entity responsible for conversion of the Section 6(f) parkland to other use is the local government entity where the Section 6(f) facilities are located, in this case, the City of Bridgeton. By letter dated January 16, 1997, the City of Bridgeton, through its counsel, has advised that it does not intend to initiate the 6(f) conversion process. A coordination meeting with the City of Bridgeton was held on April 18, 1997, with the mayor and key staff members to discuss Draft EIS comments relative to Section 303/6(f) issues, and to solicit input from the City of Bridgeton regarding future plans and goals for their parks and recreation program. Items listed in the City of Bridgeton's comprehensive plan were discussed regarding candidate mitigation options. The City of Bridgeton has stated that it will not initiate the Section 6(f) conversions for Lambert.

Since the FAA is issuing this ROD that approves the Federal actions needed to implement the selected alternative, the City of St. Louis and the STLAA will initiate condemnation proceedings and take possession of the parklands. The City of St. Louis and STLAA will then be responsible for the conversion of the 6(f) property as the owner of the parkland and local project sponsor. MDNR will be the authorized agency to document the adequacy of the replacement lands (see FEIS Appendix A, Department of Interior (DOI) letter commenting on FEIS.)

Measures to minimize harm to Section 303 and 6(f) resources are summarized in Section 6.3.5 of the FEIS. The Section 303 and 6(f) Evaluation, published separately, provides detailed information about the effects of the proposed improvements on Section 303 and 6(f) resources and describes the mitigation plans developed. The STLAA will provide mitigation that fulfills both the Section 303 and Section 6(f) requirements. Conceptual mitigation plans have been developed to minimize harm to the affected resources. The mitigation measures proposed in Section 6.3.5 of the FEIS are summarized below.

Develop and Replace Existing Parks and Associated Facilities

The selected alternative will directly affect three Section 6(f) properties, consisting of a portion of Oak Valley Park (approximately 5 acres), all of Freebourn Park (approximately 14 acres), and Cardinal Park (approximately 4 acres). The selected alternative will also affect one Section 303 resource, Bridgeton Memorial Park, which is approximately 3 acres in size.

Candidate replacement areas have been identified and are under consideration as mitigation for both Section 303 and Section 6(f) direct effects at Freebourn, Oak Valley and Cardinal parks. Definitive locations will be determined during final design of the project. Playgrounds, ballfields, ball courts and fitness and nature trails are some of the potential recreational opportunities that could be provided at each new site. Potential mitigation areas exceed an acre-for-acre replacement ratio to provide the opportunity for maximum flexibility in the actual types and locations of facilities. Because the STLAA has committed to exceeding an acre-for-acre replacement ratio as well as meeting fair-market value requirements, the proposed mitigation exceeds the minimum mitigation requirements and provides significant improvement to the recreational resources in the affected area.

The selected alternative will result in direct impacts to one Section 303 resource (Bridgeton Memorial Park), which is not a Section 6(f) resource. STLAA proposes to provide separate mitigation for the direct effects to this site. Candidate replacement property for this Section 303 resource, which is approximately 3 acres in size, would be located near other cemetery property close to the City of Bridgeton. In addition, the construction of a new neighborhood park in south Bridgeton, to supplement those facilities already in place, is also under consideration. This activity will commence when the Property Acquisition Program is implemented.

Expand and Enhance Existing Parks and Recreational Areas

Indirect effects associated with the selected alternative have been identified at four sites: O’Connor Park, Berry Hill Golf Course, Oak Valley Park and Carrollton Buffer Zone. As mitigation for these effects, enhanced vehicular access to these sites is under study. In addition, a new bicycle trail is being considered to link the City of Bridgeton’s recreation resources to the regional bicycle network. This link to the regional bicycle network would occur via the Missouri Highway 370 bridge leading to St. Charles and would directly connect with the Katy Trail. A bicycle facility is already provided on the bridge. Potential trailheads could be located at the Bridgeton Municipal Athletic Complex and the (proposed) expanded O’Connor Park/Carrollton Buffer Zone Park Complex. The proposed new bicycle trail would increase and replace lost patronage, enhance the area’s existing bicycling opportunities, provide a logical and accessible origin/destination point for trail users and be consistent with regional bicycle plans.

In addition to the proposed recreational bicycle trail, local roadway improvements associated with the selected alternative would provide the opportunity to integrate paved, striped bicycle lanes as a part of these roadway improvements. New bicycle lanes would enhance existing multi-modal transportation options, including linking community and neighborhood parks within the City of Bridgeton, as well as ultimately providing access to the regional trail network. Consultation with local and regional planning agencies has indicated that such improvements are consistent with long-range multi-modal plans for the area. The STLAA will assist in funding as appropriate. This activity will be scheduled concurrent with airport expansion.

Reasonably Equivalent Replacement Of Converted DOI Section 6(f) Lands

Mitigation for Section 6(f) impacts will consist of replacement of the converted Section 6(f) lands with land of equal or greater value and usefulness. At the time of conversion, appraisals will be conducted in accordance with the Uniform Appraisal Standards for Federal Land Acquisition (Interagency Land Acquisition Conference, 1992) to assure that fair market values of the replacement facilities will be at least equal to that of any converted Section 6(f) sites. This activity will commence when the Property Acquisition Program is implemented.

Historic, Architectural, and Archaeological Impacts and Mitigation

An evaluation of the potential impacts to historic and archaeological resources was accomplished in accordance with the requirements of Section 106 of the National Historic Preservation Act of 1966, as amended. The FAA has determined that the selected alternative will have an adverse effect on historic resources and may have an effect on archaeological resources eligible for listing in the National Register. The State Historic Preservation Officer (SHPO) has concurred in this determination.

The FEIS states that in the event artifacts are discovered during construction activities, construction in the area will be halted immediately in order to record the finding, determine its level of significance, and develop appropriate mitigation measures.

An MOA has been prepared stipulating measures to be implemented to avoid, reduce or mitigate the adverse effects from this project on historic properties. The Missouri SHPO, the Advisory Council on Historic Preservation (Advisory Council), the STLAA, and the City of Bridgeton have been consulted on the MOA and provided comments on the agreement document throughout its development (see FEIS Appendix N-1, November 18, 1997, letter from MDNR, and November 14, 1997, letter from City of Bridgeton). The FAA solicited final comments on the MOA from the consulting parties, including the City of Bridgeton.

The MOA, in compliance with Section 106 of the National Historic Preservation Act, has been signed by the FAA, STLAA and MDNR. The City of Bridgeton did not concur with the MOA and chose not to sign the agreement. The agreement was executed by the Council on May 29, 1998. As part of the FAA's comprehensive efforts to involve all appropriate commenters, the FAA will continue to work with the appropriate agencies. In reaching its conclusions relative to the National Historic Preservation Act, the FAA's findings are supported by the FEIS, and the Department of Transportation Section 303/Section 6(f) Evaluation. Execution of the MOA satisfies the FAA's Section 106 responsibilities for all actions associated with the selected alternative. The stipulations of the MOA are discussed in Section 6.3.6 of the FEIS. A final copy of the entire MOA is included in Appendix H of this ROD.

Memorandum of Agreement

Specifically, the stipulations within the MOA, summarized below, ensure that:

- The FAA will consult with the SHPO and the Council to seek ways to reduce or mitigate the adverse effects on the five (5) above ground historic properties within the undertaking's APE. These properties include the Bridgeton Inn, the Airport News Building, the Emmanuel Blum House, the Blum Store, and the De Hatre House.

- The FAA will prepare a preservation management plan, in consultation with the SHPO, that ensures the long-term protection of archaeological resources within the APE of the selected alternative which the FAA and the SHPO agree are considered eligible for listing on the National Register of Historic Places and that can be preserved in place.

- Those sites that the FAA and the SHPO agree are considered eligible for listing in the National Register of Historic Places and that cannot be preserved in place shall be treated in accordance with a data recovery plan.

- As the Village à Robert Cemetery (which is encompassed by the current Bridgeton Memorial Park Cemetery) cannot be preserved in place, it shall be treated in accordance with a data recovery plan.

The MOA also states that all human remains and funerary objects excavated during the data recovery will be reburied in a location where their subsequent disturbance is unlikely and in a manner as similar as possible to the manner in which they were originally interred. The location and method of reburial, and the memorialization and commemoration of the reburial site(s), will be made in consultation with descendants of individuals that were buried within the cemetery.

Biotic Communities Impacts

The selected alternative will impact upland and wetland communities. Although the project will reduce existing vegetation and small, fragmented areas of wildlife habitat, none of the affected areas are characterized by unique vegetative patterns. Development will impact biotic communities within the Cowmire Creek watershed, in addition to those of the Coldwater Creek watershed. The project will place aircraft at lower altitudes over the Missouri River floodplain, which may have the potential to disrupt feeding and nesting activities of birds in a flyway area. However, the anticipated impacts will be minimal and will not require mitigation.

Threatened and Endangered Species Impacts

Several Federally listed plant and animal species have historically occurred in the airport area. Based on information obtained and correspondence received, the expansion project for Lambert would not have an effect on Federal or state listed threatened and endangered species or areas designated as “critical habitat” by the U.S. Fish and Wildlife Service (FWS). In accordance with Section 7 of the Endangered Species Act, the FAA’s consulted with the FWS. The FWS concurred that Alternative W-1W will likely have no adverse effects on listed species or their habitats (letter dated September 1, 1994, in Appendix A of the FEIS). Therefore, mitigation measures are not required.

Wetlands Impacts and Mitigation

The airfield development and associated surface transportation improvements will result in impacts to existing wetlands. The various types of impacts will include loss of wetlands as a result of earthwork or construction, removal of existing vegetation and re-vegetation with grasses, or the clearing of trees and shrubs to ground level. Based on the conceptual plans used in the preparation of the FEIS, the selected alternative will impact approximately 9.7 acres. The majority of the wetlands that will be impacted have been previously disturbed and exhibit low habitat values. Their current status exhibits erosion, dumping, loss of canopy cover and extensive ditching.

Final design plans will be prepared in such a manner as to avoid, minimize and mitigate wetland impacts to the greatest extent practicable, as required by applicable rules and regulations. These plans will be developed during the permitting process and as construction plans are finalized. A formal jurisdictional wetland delineation with agencies having jurisdiction over this project will be conducted during the permitting process. Wetlands have been avoided to the extent practicable. Measures to mitigate wetland impacts have been developed, are contained in Section 6.3.7 of the FEIS and summarized below.

- **Enhance and Replace Existing Wetlands:** This program will mitigate for the removal of existing wetland areas by enhancing and/or replacing existing wetland areas. Enhancing and replacing existing wetland areas on-airport has been eliminated from further consideration because of the potential safety hazard associated with aircraft bird strikes. Off-site mitigation options that remain under consideration include: mitigation within the Coldwater Creek watershed, mitigation within the Cowmire Creek watershed or a combination.

- **Candidate Mitigation Sites:** Several candidate wetland mitigation sites have been examined; however, none have been formally designated for the Lambert wetland mitigation program at this time. Final mitigation requirements will be determined during the Section 404 permit application review process in consultation with the COE.

The wetland mitigation program will be initiated upon Section 404 permit approval. For any particular affected wetland area, the wetland mitigation (enhancement or replacement) will be completed prior to the removal of the existing wetland.

Floodplains Impacts and Mitigation

The project will result in additional development within the 100-year floodplain. Surface transportation improvements associated with the selected alternative will impact the 100-year floodplain as well. The project will impact approximately 22.3 acres for year 2002 and 35 acres for year 2015 in the Coldwater Creek floodplain. Therefore, this project will result in a floodplain encroachment. Mitigation will be developed to compensate for potential increased flooding caused by the proposed development. Mitigation measures to minimize the floodplain impacts will be accomplished so that the floodplain encroachment would not be considered significant. Floodplains have been avoided to the extent practicable, in light of greater impacts on protected resources in other impact categories. Measures to mitigate floodplain impacts, which are contained in Section 6.3.8 of the FEIS, are summarized here.

- **Limit Fill Within Floodplain Areas:** During design of the proposed runways and taxiways, the placement of fill within the floodplains adjacent to Coldwater Creek will be minimized. However, airport runways and taxiways must be designed to meet specific criteria related to runway profiles and cross slope. Some fill within the floodplain areas is unavoidable. Infield areas will be graded to reduce potential floodplain impacts.

- **Provide Stormwater Detention Areas:** To offset potential filling of shallow floodplain areas and construction of new impervious areas, detention storage volume may be provided to reduce peak discharges downstream, provide for floodplain storage compensation volume and avoid airport-induced increases of flood elevations upstream. The detention areas will be of shallow depth to minimize standing water in the ponds, thereby reducing attractiveness of the ponds to birds, which are a potential safety hazard to aircraft. Underground detention vaults may also be used. Detention areas will be constructed concurrently with the construction of new impervious areas.

Farmland Impacts

Development will not adversely impact any prime or unique farmlands or soil types as designated by the U.S. Department of Agriculture, Natural Resource Conservation Service. The areas have already been converted into urban uses, such as residential and commercial, and no longer retain their previous agricultural designation. Since there are no impacts anticipated, mitigation measures are not proposed.

Energy Supply and Natural Resources Impacts

Energy consumption at Lambert is expected to increase as activity increases. Aircraft and vehicle energy consumption estimates for the selected alternative are predicted to be less when compared to the No-Build Alternative. This reduction is a consequence of declining aircraft and vehicle fuel consumption resulting from shorter aircraft queuing times and moderate improvements to the roadway network surrounding Lambert. There are no known sources of mineral or energy resources in the Lambert area that will be impacted. Development of the selected alternative will not require the use of unusual materials or those that are in short supply in the Lambert area. Since there are no impacts anticipated, specific measures to mitigate energy consumption are not proposed.

Light Emissions Impacts and Mitigation

Areas sensitive to changes in light emissions are located in the vicinity of the proposed lighting systems. The proposed project will have the potential to create off-airport, light emission impacts. Through shielding and screening techniques, light emission impacts on surrounding residential areas will be minimized. Future light emission levels from airborne aircraft or aircraft operating on the ground are not anticipated to adversely impact surrounding residential areas. Proposed light emissions mitigation measures, described in Section 6.3.9 of the FEIS, include using light shields to direct light emissions away from residential or other sensitive areas. This measure will pertain primarily to the terminal area and roadway pole-mounted lighting.

Solid Waste Impacts and Mitigation

Alternative W-1W would increase the quantity of solid waste generated at the airport. This is primarily due to increased passenger flow and operations at the airport, increased airport tenant operations, and construction activity. Alternative W-1W would result in the generation of approximately 49,000 more cubic yards per year of solid waste as compared to the existing condition. However, this increase is not anticipated to adversely impact the area's solid waste handling practices or disposal facility capacity. Airport-generated solid waste levels comprise only a small percentage of the total waste produced in the metropolitan area, and existing solid waste disposal facilities have sufficient capacity to accommodate projected future solid waste generation levels.

While specific measures to mitigate for demolition-waste impacts were not required for the preferred alternative, some waste minimization efforts were considered reasonable and proposed by STLAA. These planned efforts to minimize demolition waste, contained in Section 6.3.10 of the FEIS, include the development and implementation of a construction recycling and salvage pilot program. This program will maximize recovery and reuse of construction materials, and reduce the waste entering landfills. Examples of the types of measures which may be considered in the pilot program are: conducting a salvage operation process to remove reusable building components and interior furnishings such as doors, windows, cabinets and plumbing fixtures and segregating building components and interior finishings by type and offering them for resale or reuse. The recycling and salvage management pilot program will be developed and approved prior to initiation of demolition and construction activities.

Several active landfills are located in the vicinity of Lambert. The Laidlaw Combined Sanitary and Demolition Landfill, at its closest point, is located approximately 9,166 feet west of the northwest end of proposed Runway 12W/30W. This is not consistent with FAA’s runway siting guideline of 10,000 feet, which was developed to protect aircraft from potential bird strikes. The new runway will be compatible with all area landfills in accordance with FAA Order 5200.5A, as described in detail in Section 6.3.10 of the FEIS. STLAA will attempt to develop an agreement with the operator of the landfill to implement one of the following options:

- Re-prioritize the landfill utilization plan so that the subject portion (i.e., that portion within the FAA’s 10,000-foot radius of incompatibility) of the landfill is utilized first;

- Require that STLAA be able to direct available fill that cannot be reasonably recycled from the construction projects to the subject portions of the landfill;

- Require that organic waste be capped in the landfill before the new runway is opened and that only clean fill (such as construction materials) be placed in the subject portions of the landfill once the runway is operational.

Should it not be practical to completely fill the subject landfill through the above measures, the STLAA will purchase an easement from the landfill operator which will provide the operator compensation for any lost revenue associated with the unused excess capacity. Any plan to convert or close the landfill must provide for a one-year bird-repelling program. Repelling efforts will begin 6 months before opening of the new runway and continue for a minimum of 6 months thereafter. The program will be in effect from dawn until dusk.

Coastal Barriers and Coastal Zone Management Program Impacts

The proposed improvements will not affect or involve the Coastal Zone Management Program or the Coastal Barriers Resources Act of 1982. Since there will be no impacts, mitigation measures have not been proposed.

Wild and Scenic Rivers Impacts

Review of the U.S. Department of the Interior's National Inventory of Wild and Scenic Rivers indicated that there are no designated "Wild and Scenic Rivers" within a 1,000-foot radius of Lambert. There will be no impact on any rivers designated as "Wild and Scenic"; therefore, mitigation measures are not warranted.

Construction Impacts and Mitigation

Construction impacts resulting from the airport development alternatives, including surface-transportation-related improvements, may include but are not limited to temporary impacts, such as soil erosion, increased air emissions, water quality degradation, noise disturbance and disrupted surface transportation patterns. These temporary impacts are short term in nature and can be minimized through the establishment and utilization of environmental controls and best management practices (BMPs).

To minimize construction impacts, environmental controls as specified in Advisory Circular 150/5370.10A will be included throughout the preparation of the plans and specifications for each of the proposed construction projects. These controls will be established to minimize the temporary air, water, noise, erosion, and light impacts typically associated with construction activities. STLAA will also incorporate all applicable State of Missouri and St. Louis County construction and environmental control provisions into the plans and specifications developed for all roadway and off-site airport-related improvements. Construction and environmental control measures will be developed as part of the preparation of plans and specifications for each airport development project and will be implemented with the initiation of demolition and construction activities.

Design, Art and Architecture Impacts

Design, art and architectural applications will be a consideration in the design and operation of the proposed improvements to the terminal facilities. Therefore, no mitigation measures are required.

Hazardous Materials Impacts and Mitigation

Several areas in the vicinity of Lambert have been reported to or have the potential to contain hazardous materials, hazardous wastes and/or petroleum products that have resulted in environmental contamination. Some of these sites have undergone preliminary investigations and will either be evaluated further, cleaned up or will require no further action by the responsible parties. Other sites have not been investigated. These sites have been identified and located so that they can be avoided or, if necessary, properly addressed during the planning and development of the proposed airport improvements. It is not expected that the project will involve any sites that are significantly impacted by hazardous materials, petroleum products or environmental contamination. Therefore mitigation measures *per se* are not required. However, BMPs developed as a means to minimize potential impacts are discussed in Section 6.3.12 of the FEIS. Examples of such BMPs include the following practices:

- **Assess and Remediate Contaminated Sites:** In accordance with state regulations, sites that are contaminated with hazardous materials will be fully assessed to determine the types and areas of the impacts. These sites will be cleaned up or other appropriate corrective measures will be undertaken.

- **Conduct Environmental Audits of Properties Prior to Acquisition:** The STLAA will conduct surveys of existing facilities requiring demolition to evaluate any potential involvement with asbestos, lead paint and/or other regulated materials. Site assessments will be included as part of the property acquisition process. Sites found to contain hazardous wastes, other regulated materials and/or environmental contamination will be properly addressed.

- **Develop/Implement Asbestos and Hazardous Materials Management Plan:** When materials containing asbestos or classified as hazardous are encountered during demolition, appropriate precautions will be followed. These include the employment of certified contractors trained and equipped to work under such conditions and the strict adherence to standards, practices and guidelines governing the handling and disposal of these materials.

Surface Transportation Impacts and Mitigation

Development will impact significant surface transportation facilities located in the airport vicinity. It will require the modification and/or realignment of several local and regional roadways to accommodate the proposed expansion of the airport.

It is estimated that after the year 2010, the additional aviation activity will result in increased associated surface traffic. Sections 5.22 and 6.3.13 of the FEIS provide a detailed analysis of the anticipated environmental impacts and mitigation measures associated specifically with the surface transportation improvements that would result from the proposed development.

Based on the assessment of surface transportation impacts detailed in Section 5.22 of the FEIS, there are no specific mitigation measures required for associated roadway improvements for the selected alternative. However, means to minimize impacts associated with the proposed roadway improvements, including construction of the Lindbergh Tunnel, are presented below.

- **Maintenance of Traffic Plan:** The Missouri Department of Transportation (MoDOT) will develop a staged implementation plan. This staging plan will identify what portions of the proposed roadway improvements will be constructed during each phase of the implementation plan, what the overall sequence of construction will be, and how traffic flow/access will be maintained during the construction phases. This staged construction plan will be coordinated with the appropriate county and city agencies prior to the beginning of construction. The maintenance of traffic plan will be developed during the preliminary engineering and final design of the improvements.

- **Roadway Improvement Safety Plan:** To mitigate the potential for vehicular accidents, fire and/or explosions occurring in the proposed

Lindbergh Tunnel, all applicable state and local fire codes will be adhered to during the design of the tunnel. The tunnel will also be designed to meet or exceed the current MoDOT lighting criteria/standards.

- **Visual Impacts from I-70/Airport Access Improvements:** Retaining walls will be incorporated into the construction design plans and implemented prior to the beginning of any roadway construction. The plans for retaining walls will be developed during the design phase of the I-70/Airport Interchange improvements and are dependent on specific requirements of MoDOT.

MITIGATION SUMMARY

The FAA has provided a comprehensive mitigation program, which establishes measures to mitigate the adverse effects of construction and operation of the proposed development. This program was developed to meet applicable Federal and state requirements and in consideration of local guidelines. The concerns and interests of the public and government agencies were also addressed. The mitigation program is described in Section 6.3, Mitigation, of the FEIS. A summary of the mitigation requirements for Alternative W-1W is contained in Table S.3 in Appendix J of this ROD.

Alternative mitigation measures considered in the FEIS are conditions of approval of the project in this ROD, and the project sponsor, the STLAA, has agreed to them. The FAA will monitor the implementation of these mitigation actions as necessary to assure they are carried out as project commitments. The FAA finds that these measures constitute all reasonable steps to minimize harm and all practicable means to avoid or minimize environmental harm from the selected alternative.

7. PUBLIC AND AGENCY INVOLVEMENT

From the outset, the concerns of the public have been considered. Both the STLAA and the FAA have been forthcoming with the communities about the project through extensive opportunities for public involvement. The interests of communities have been considered throughout the decision-making process regarding expansion at Lambert. This is shown in part by the information provided below.

Because of Lambert's impact on the surrounding communities, the FAA and the STLAA have conducted open public meetings to inform the public of the expansion plans. The FAA and the STLAA have received thousands of public comments throughout the EIS process. To the extent practicable, all of these comments have been reviewed to ensure that the needs and concerns of the public were considered and addressed. Based on the extensive opportunities for public participation, the FAA is satisfied that full consideration has been given to the public's views on airport expansion plans.

PUBLIC INVOLVEMENT PROCESS

Public involvement included the following:

- Three EIS scoping meetings were held on September 6 and 7, 1995.

- A scoping comment period extended from August 17 through September 21, 1995. A summary of the scoping comments is provided in Appendix J of the FEIS.

- A public workshop on the environmental process was held on June 11, 1996. There were 476 people in attendance. The meeting was advertised in the *St. Louis Post Dispatch* and other local newspapers. In addition, approximately 13,000 postcards were mailed to residents in the vicinity of the airport announcing the meeting and extending an invitation to the public to attend.

- The DEIS was distributed to local libraries, city halls and to principal commenting agencies. The DEIS was available for review from September 27, 1996, through January 17, 1997.

- The DEIS was available for more than the minimum 45 days required by CEQ regulations. The comment period for the DEIS opened on September 27, 1996. The initial comment period was extended twice, once in response to a request by the City of Bridgeton. The comment period on the DEIS closed on January 17, 1997.

- A public workshop/public hearing to receive comments on the DEIS was held on October 28, 1996, more than 30 days after the DEIS was released for review. Approximately 1,580 people attended.

- Over 15,000 comments were received from the public and agencies in response to the DEIS. The comments were reviewed and considered by the FAA in the preparation of the FEIS. All comments received were summarized and responded to in the FEIS (Appendices S, T, U, V, and W of the FEIS).

- The STLAA used a total of six newsletters to distribute information to approximately 13,000 airport neighbors and to provide information about commonly asked questions regarding airport expansion.

- The FEIS was distributed to local libraries, city halls and the principal commenters on the DEIS. The FEIS was available for review from December 22, 1997, through February 17, 1998.

The public involvement process for this project was documented in Section 7.0 of the FEIS. The list of recipients of the DEIS and FEIS is found in Section 8.2. DEIS and FEIS review locations are listed in Section 8.2.2.

Subsequent to the release of the FEIS and the end of the review period, a series of meetings was held prior to the ROD with certain interested organizations and citizens of local communities in the vicinity of Lambert. The purpose of these meetings was to allow these groups to air their concerns with the proposed expansion of Lambert and Alternative W-1W to FAA headquarters personnel.

ADDITIONAL MEETINGS

May 13, 1998

At the request of Senator Christopher Bond and Congressman Jim Talent, FAA Administrator Jane Garvey met in Washington, D.C., with citizens and representatives of organizations and local governments concerned with the proposed expansion of Lambert. Those meeting with the Administrator on May 13, 1998, were representatives of the Air Line Pilots Association (ALPA), National Air Traffic Controllers Association (NATCA), the City of Bridgeton, the City of St. Charles, St. Charles County, and Citizens Against Airport Noise (CAAN). Representatives from Congressman Talent's and Senator Bond's offices also attended.

ALPA, NATCA, the City of Bridgeton, St. Charles County, and CAAN gave presentations. The participants generally supported expansion at Lambert; however, they all oppose Alternative W-1W. Among the reasons given for opposing W-1W, ALPA and NATCA oppose W-1W based on the safety and capacity questions they raised. The represented communities oppose W-1W on the basis of noise concerns and general dissatisfaction with the adequacy of the FAA's EIS and hearing process. The impact to the City of Bridgeton would be a new runway in the city and impacts to approximately 2,324 households, 6 churches, 6 schools, 1 nursing home and 75 businesses. All support a real-time simulation study of Alternative W-1W.

The represented communities expressed a need to see that the STLAA and the FAA are concerned about noise and impacts to the historic district of St. Charles. The City of St. Charles believes that its historic district was ignored and that FAA did not hold a public hearing in St. Charles. St. Charles wants assurance that the EIS is accurate in its prediction of noise impacts. St. Charles desires an enforceable settlement agreement with STLAA if the FAA approves W-1W.

The attendees requested that they be given an opportunity to meet face-to-face with FAA personnel (program office and other specialists) to discuss their concerns, and that FAA authorize a real-time simulation study for the expansion project at Lambert.

The Administrator acknowledged that the meeting was helpful and raised important issues that the FAA would consider further. The Administrator stated that the FAA would take the time needed to study the issues raised.

June 9, 1998

As a follow-on to the FAA Administrator's meeting of May 13, 1998, representatives of ALPA and NATCA met in Washington, D.C., on June 9, 1998, with various FAA technical specialists and representatives of FAA's Headquarters and Regional Airports program offices. Also attending were representatives of Leigh Fisher Associates, the consultants to St. Louis on the MPS, who conducted the MPS capacity simulations. ALPA and NATCA wanted to present their concerns regarding the MPS, which they felt had not been considered during the planning and environmental processes.

ALPA and NATCA asserted that inaccurate assumptions and/or input data used for the MPS simulations resulted in an overstatement of benefits projected for the preferred Alternative W-1W and an understatement of benefits for the existing airfield. They also asserted that a real-time simulation study is needed to verify their opinion that: (1) it would be impossible to operate Alternative W-1W as proposed or (2) the capacity penalties required to make W-1W work would reduce the project benefit/cost ratio to a point where it would no longer be attractive to TWA. ALPA and NATCA submitted, and discussion was held on, a list of eighteen questions regarding simulation assumptions affecting the outcome of the MPS that they claim are incorrect or inappropriate.

FAA committed itself to carefully reviewing the ALPA and NATCA concerns. The ALPA and NATCA representatives expressed appreciation for the opportunity to discuss these matters with FAA headquarters personnel on a face-to-face basis.

June 16, 1998

As another follow-on to the FAA Administrator's meeting of May 13, 1998, representatives of ALPA, NATCA, the City of Bridgeton, the City of St. Charles, St. Charles County and CAAN met with the FAA Associate Administrator for Airports, Susan Kurland, on June 16, 1998, in Washington, D.C. Also in attendance were various FAA technical specialists and other representatives of FAA's Headquarters and Regional Airports program offices, and a representative from Congressman Talent's office.

For the most part, the presentations were a reiteration of the points brought up before in the meetings of May 13, 1998, and/or June 9, 1998, although in some cases in more detail. The parties either wanted to present their concerns regarding the MPS, which they felt had not been considered during the planning and environmental processes, or to express their general dissatisfaction with the adequacy of the FAA's EIS. They again expressed their opinion that a real-time simulation study is necessary to demonstrate that Alternative W-1W can be operated as proposed. The communities offered to provide the funding for the study.

The FAA reiterated its commitment to carefully review the concerns and issues raised.

July 20, 1998

In furthering the study of the issues, concerns and criticisms expressed during the above outlined meetings of May 13, June 9, and June 16, 1998, with FAA, the FAA's Acting Deputy Administrator, Monte Belger, gave the City of St. Louis the opportunity to meet with officials of FAA. That meeting was held in Washington, D.C., on July 20, 1998, with the St. Louis Director of Airports and his staff and consultants. In addition to the Acting Deputy Administrator, FAA was represented by the Associate Administrator for Regulation and Safety, the Associate Administrator for Airports and the Acting Associate Administrator for Air Traffic Services.

In addition to responding to a number of questions raised on certain safety aspects of Alternative W-1W, the City of St. Louis provided the FAA with a briefing, from its perspective, on several current issues before the FAA involving Alternative W-1W. As background, they provided a summary of the Lambert MPS planning process. They then provided comments on what they believed to be misleading allegations about Alternative W-1W. They also provided responses to questions raised by the FAA Flight Standards Office regarding the operation of Alternative W-1W, and responded as well to the 18 concerns raised by ALPA and NATCA in their June 9 meeting with FAA.

July 23, 1998

FAA Administrator, Jane Garvey; Acting Deputy Administrator, Monte Belger; Associate Administrator for Airports, Susan Kurland; and the Assistant Administrator of Government and Industry Affairs, Bradley Mims, attended a meeting at Congressman Richard Gephardt's office in Washington, D.C., on July 23, 1998, to discuss Lambert's proposed expansion.

Congressman Gephardt indicated that he had convened the meeting so that St. Louis public officials could make the case personally to the FAA Administrator in support of issuance of the ROD for the Alternative W-1W runway development project

St. Louis Mayor, Clarence Harmon, stressed that the Lambert expansion was the most critical project before the City of St. Louis in terms of the future economic viability of the city. Mr. Harold Gregory, representing the Let's Get On With Our Lives coalition, indicated his group has 1,100 petitions requesting a buyout and urged the Administrator to issue the ROD at the earliest possible time. Mr. Richard Fleming, President and CEO of the St. Louis Regional Commerce and Growth Association, told the FAA Administrator that each year of delay results in an estimated $400 million in business opportunities, 4,400 lost jobs, and $1.4 million in lost taxes. Ms. Norma Kaehler, Managing Director of TWA's Washington Government Affairs Office, indicated that TWA strongly supports the W-1W expansion plan. It is important to TWA from an operational viewpoint that the new runway proceed as soon as possible. Mr. Thomas Chapman, Southwest Airlines Government Affairs Director in Washington, paralleled TWA's comments. Lastly, the St. Louis Director of Airports, Leonard Griggs, stated that St. Louis believes that a real-time study of the planned runway operations is unnecessary and would cause a lengthy delay before the ROD could be issued. He reminded the group that Alternative W-1W has been coordinated with airline pilot and controller groups, and representatives of FAA's Flight Standard organization have been included in these past technical discussions. He urged the FAA Administrator to deny the pending request for a real-time study at St. Louis and to approve the ROD without delay.

8. COOPERATING AGENCIES

The environmental process involved the following cooperating agencies:

- U.S. Air Force - for environmental processing of relocation of the MoANG.
- U.S. Navy - for environmental processing of relocation of Naval and Marine Reserve Corps facilities.
- U.S. Army Corps of Engineers - for coordination of wetland impact and mitigation issues.
- Federal Highway Administration - for environmental processing of related roadway improvements.

A cooperating agency is an agency that has jurisdiction by law or special expertise regarding any environmental impact resulting from a proposed action or reasonable alternative. These agencies and the reasons for their inclusion in the process as cooperating agencies are described below.

U.S. AIR FORCE

The proposed expansion of Lambert involves the relocation and/or improvement of the MoANG, which falls under the jurisdiction of the USAF. To provide for additional terminal expansion, the Lambert development plan proposes to relocate the MoANG from its present location on the south side of the airfield to the northeast side of the airfield. The FEIS examined the potential environmental impacts associated with the relocation of the MoANG facilities and associated actions. This information will assist the USAF in meeting its specific environmental obligations.

The USAF has notified the FAA that it will prepare its own separate ROD at the appropriate time, once negotiations between the USAF and STLAA have progressed to the point that specific replacement facilities are identified and being finalized.

U.S. NAVY

The proposed expansion of Lambert involves the relocation and/or improvement of a Naval Reserve facility located on the south side of the airport. To provide for additional terminal expansion, the Lambert development plan proposes to relocate the Navy facility from its present location near the MoANG on the south side of the airfield to another site in the airport vicinity. The FEIS examined the potential environmental impacts associated with the relocation of the Navy facilities and associated actions. This information will assist the Navy in meeting its specific environmental obligations.

The Navy's ROD preparation would be similar to the USAF's in that it will be prepared at the appropriate time, once negotiations between the Navy and STLAA have progressed to the point that specific replacement facilities are identified and in the process of being finalized.

U.S. ARMY CORPS OF ENGINEERS

The proposed expansion of Lambert has the potential to impact wetlands, floodplains, and water quality--all under the jurisdiction of the COE. For that reason, the FEIS examined the potential environmental impacts to those resources and possible mitigation concepts. The involvement of the COE in conceptual mitigation planning at the EIS stage facilitates the subsequent preparation of permits, which may be required after the preparation of detailed design plans. The FEIS fulfills the National Environmental Policy Act (NEPA) requirements of the COE.

The COE will not need to prepare its own ROD for this project. It will approve a Section 404 permit application to be submitted by STLAA at the appropriate time after design plans are sufficiently finalized.

FEDERAL HIGHWAY ADMINISTRATION

The proposed expansion of Lambert involves the relocation and/or improvement of roadways under the jurisdiction of the FHWA. These roadways include improvements to portions of I-70 and relocation of a portion of Lindbergh Boulevard (U.S. 67) through a tunnel. The FEIS examined the potential environmental impacts associated with the modification of these and other local roadways. The FEIS fulfills the NEPA requirements of the FHWA.

The FHWA asked the FAA to include the following section in its ROD, which the FHWA will adopt regarding that agency's Federal actions.

Decisions Relative to Surface Transportation Actions

Airport development Alternative W-1W will impact significant surface transportation facilities located in the airport vicinity. Alternative W-1W will require the modification and/or realignment of several local and regional roadways to accommodate the proposed expansion of the airport. Section 5.22 of the FEIS provides a summary of the anticipated environmental impacts associated with surface transportation improvements that would result from the airport development alternative. This section of the EIS was designed to fulfill the NEPA requirements of both MoDOT and FHWA and addresses transportation impacts. Both MoDOT and FHWA assisted the FAA in the development of this section of FAA's FEIS. Only the incremental impacts of the roadway improvements are discussed in Section 5.22 of the FEIS, which is provided in a format consistent with the FHWA Technical Advisory T 6640.8A, "Guidance for Preparing and Processing Environmental and Section 303 Documents." The other portions of Section 5.0 of the FEIS address the cumulative impacts of the airport and roadway improvements. Measures to mitigate surface transportation impacts have been developed and are contained in Section 6.3.13 of the FEIS.

The proposed action is to expand Lambert-St. Louis International Airport, and Alternative W-1W was identified as the selected alternative to improve the airport. The selected alternative appears on Figures S-3 and 2.1 of the FEIS. Associated with that airport action are the following roadway location changes, along with an explanation of the proposed action and purpose/need for each of those changes:

Roadway	**Proposed Action**	**Purpose/Need**
Lindbergh Blvd (U.S. 67) [FEIS Figure 5.32]	Horizontal and vertical realign-ment through a tunnel 3,400' long by 6 lanes wide.	To accommodate new parallel runway and midfield terminal area, and to provide sufficient capacity to meet projected traffic demands.
Improvements to I-70/Airport Terminal Interchange and Terminal Area Roadway [FEIS Figure 5.31]	Improvements to I-70 in terminal area: improved system of access ramps and increased capacity along mainline. Re-alignment and expansion of on-airport terminal area roadway and ramp facilities, including parts of Lambert International Blvd., that provide access to terminal buildings and parking facilities.	To provide acceptable level of service by alleviating current congestion problems and accommodating future needs. To improve operational efficiency of the terminal area roadway system and provide added land area for proposed terminal expansion.
Natural Bridge Rd. (SR 115) [FEIS Figure 5.34]	Relocation of this road to the south, and relocate Natural Bridge-Lindbergh interchange immediately south of proposed Lindbergh tunnel.	To accommodate new parallel runway and midfield development and provide capacity to meet projected traffic demands.
McDonnell Blvd. [FEIS Figure 5.35]	Relocation of about 6,000 feet of Blvd., along I-70 right-of-way	To maximize the amount of land available for the relocation of the MoANG.
Missouri Bottom Rd. [FEIS Figure 5.38]	Relocation of the intersection of Missouri Bottom Rd. and Lindbergh Blvd.	To avoid conflict with the Lindbergh Blvd. north tunnel entrance/exit.
Local and neighbor-hood roadways [FEIS Figures 5.36 and 5.3.7]	Closure or relocation of numerous local and neighborhood roadways	To accommodate new parallel runway and midfield development. Acquisition of homes will make some roads no longer necessary.

Figure 5.29 of the FEIS provides a general location or description of area roadways that will be affected by Alternative W-1W. Figures 5.31 through 5.38 of the FEIS show individual roadway concepts, including the preferred alternative selected for each concept.

The final recommendation for the aviation-related preferred alternative selection, as well as the surface transportation-related preferred alternative selections, was accomplished through an assessment of the social, economic, engineering and environmental consequences of the alternatives, in combination with public involvement. After release of the DEIS, a public hearing was held on the airport improvements, and comments were grouped by category. Twenty-one comments were received relative to roadway improvements. Summaries of comments received on the DEIS and responses to those comments are located in Appendix V, number 27, of the FEIS.

Through the surface transportation alternatives screening process (described in Section 5.22.4 of the FEIS), it became apparent that the selected alternatives for each roadway had the least detrimental social, economic, engineering and environmental impacts. Additional discussion of the selected alternatives for roadway improvements appears in Section 5.22.4 of the FEIS. The selection of a preferred alternative to implement a solution for Lambert's capacity problems was completed in December 1997, with the concurrent release of the FEIS documentation. The FAA's FEIS review period ended on February 17, 1998.

While the aviation element of the overall project received strong opposition, the surface transportation alternatives received no strong public opposition. No notable concerns relative to surface transportation alternatives arose that would alter or prevent the selection of the preferred alignments.

Surface Transportation Alternatives Considered

A discussion of the process leading up to the selection of aviation-related facilities described in Alternative W-1W (including Runway 12W-30W) is provided in Section 5 of this ROD.

Per FHWA requirements, Transportation System Management (TSM) alternatives, such as High-Occupancy-Vehicle (HOV) lanes, park-and-ride lots, and employer-sponsored ridesharing programs, were examined. Public transit alternatives, such as bus systems and rail, were also considered. Based on the results of the evaluation process, it was concluded that the TSM strategy, and the transit strategy by themselves would not fulfill the safety and mobility goals of this project. As such, these two strategies were eliminated from this study for further evaluation as stand-alone solutions.

It has been concluded that the No-Build Alternative does not address the purpose and need of this project. However, it was the baseline alternative for the FEIS and is required by Federal law to be evaluated in concert with the other project alternatives.

The surface transportation alternative described below was found to be the only alternative to solve the safety and capacity problems associated with the selected aviation-related elements in Alternative W-1W.

The MPS identified surface transportation elements on the proposed ALP. However, the details provided on the ALP were conceptual in nature, requiring further refinement by the FAA, FHWA, MoDOT, STLAA and the FAA's FEIS consultant as part of the FEIS. This refinement consisted of traffic capacity analyses and development of alternative concepts that would more effectively meet roadway design standards and provide acceptable levels of service for surface vehicle traffic. Projected traffic volumes were developed based on traffic count data and methodologies provided by MoDOT. For each of the roadways discussed below that will be impacted by the new Runway 12W/30W, numerous alternatives were evaluated to determine the best solution to the surface transportation problems for that affected roadway area. In some instances, only one roadway concept is provided. This is primarily due to severe constraints imposed by the adjacent roadway system, the land uses, and the existing right-of-way.

The process leading to the selection of the preferred alternative for each of these roadway areas is summarized below and discussed in detail in the FEIS, Section 5.22.2.2 and in Appendix K, Roadway Concepts. Figure 5.29 in the FEIS depicts all the proposed roadway improvements associated with Alternative W-1W. Figures 5.31 through 5.38 in the FEIS show individual roadway concepts.

Lindbergh Boulevard (U.S. 67)

The implementation of new Runway 12W-30W will create a conflict with the existing alignment of Lindbergh Boulevard. Because Lindbergh Boulevard (U.S. 67) is a principal artery within St. Louis County, all of the alternatives developed and evaluated kept this roadway in service. Four alternatives for Lindbergh Boulevard were evaluated and are depicted in Figure 5.32 of the FEIS.

Alternative D, the preferred alternative, included the construction of a tunnel for Lindbergh Boulevard underneath the proposed Runway 12W-30W between the intersection of relocated Natural Bridge Road and relocated Missouri Bottom Road.

This alternative shifts the tunnel alignment approximately 200 to 300 feet to the west of the existing alignment of Lindbergh Boulevard.

Alternative D was selected because, among other reasons: (1) the horizontal alignment provides for a 60 mph design speed; (2) the vertical alignment provides for a 65 mph design speed; (3) the relocated Lindbergh Boulevard alignment would allow construction of the tunnel to occur while traffic was using the existing Lindbergh alignment. This alternative also offered the additional advantages of allowing the TWA training facility to remain at its present site and making 50 more acres available for future airport terminal expansion.

Improvements to I-70/Airport Terminal Interchange and Terminal Area Roadways

Improved capacity and access will be needed in the terminal area to provide an acceptable level of service. I-70 improvements include an improved system of access ramps and increased capacity along the mainline. These improvements are needed to provide an acceptable level of service by alleviating current congestion problems and to accommodate future needs. Re-alignment and expansion of terminal area roadways is required to improve operational efficiency and provide additional land area for terminal expansion. These improvements are depicted in Figure 5.31 of the FEIS.

Only one alternative, depicted in Figure 5.31 of the FEIS, was considered reasonable. This alternative involves the widening of I-70, adding ramps, reconstructing bridges, and reconstructing crossroads over I-70. In addition, this alternative involves improvements to the terminal access roadway system and reconstruction of the existing elevated Metro Link guideway.

This alternative was selected as the preferred alternative primarily based on its lesser right-of-way acquisition, fewer structures, lesser roadway length, and longer distances between successive ramps when compared to the other development concepts.

Natural Bridge Road (SR 115)

Because of the development of new Runway 12W-30W, Natural Bridge Road (SR 115) will require a relocation south with a new interchange to accommodate new parallel runway and midfield development.

Due to the need to maintain service on Natural Bridge Road and because of the high costs associated with some of the other alternatives, only one alternative was retained for the relocation of Natural Bridge Road. The relocation configuration is depicted in Figure 5.33 of the FEIS.

The major consideration of this proposed element involved alternatives for the new interchange that will be required at Lindbergh Boulevard and relocated Natural Bridge Road. Five alternative interchange configurations for Natural Bridge and Lindbergh Boulevard were evaluated and are depicted in Figure 5.34 of the FEIS.

Alternative E, which was selected as the preferred alternative, will be a partial cloverleaf interchange. The primary factors that led to the selection of this interchange configuration as the best type for this location are: (1) the available ramps to/from the north and (2) the need to maintain access between the Natural Bridge Road and Lindbergh Boulevard. There is a need to provide continuous traffic flow on Lindbergh Boulevard; therefore, the traffic signal on Lindbergh Boulevard was replaced with on/off ramps. To improve operations and safety for vehicles, other modifications are also provided.

McDonnell Boulevard

The proposed relocation of the MoANG will require relocation of McDonnell Boulevard east along the I-170 right-of-way and the reconfiguration of the intersection of I-170 and Airport Road.

Only one roadway alignment alternative, depicted in Figure 5.35 of the FEIS, was found to be reasonable and practicable for this roadway. McDonnell Boulevard will remain as a two-lane roadway from the end of the extended centerline of existing Runway 30R to the intersection of Airport Road. Internal roadways between existing McDonnell Boulevard and I-170 may be modified to meet the need of the MoANG.

The airport's future land use plans call for this area to be used by the MoANG. This alignment maximizes the efficient use of this land for the MoANG and other future airport-related developments.

Missouri Bottom Road

Relocation of the intersection of Missouri Bottom Road and Lindbergh Boulevard (approximately 1,800 feet north of its existing location) will be required to avoid conflict with the Lindbergh Boulevard north tunnel entrance/exit.

Only one alternative was considered reasonable for this improvement. It is depicted in Figure 5.38 of the FEIS. The development of the new Runway 12W-30W will require tunneling of Lindbergh Boulevard under the new runway. To safely maintain a connection between Missouri Bottom Road and Lindbergh Boulevard, the intersection of these roads will need to be relocated so that it will not conflict with the north tunnel entrance/exit. This alternative was selected as preferred because the shortest distance that will allow safe connection of this intersection is the 1,800 feet relocation to the north.

Local and Neighborhood Roadways

Closure or relocation of numerous local and neighborhood roadways will be needed to accommodate new parallel runway and midfield terminal development. Unnecessary roadways will also be removed.

Bonfils Drive - Bonfils Drive improvements that would be associated with Alternative W-1W include the realignment of Bonfils Drive from Gist Road to Natural Bridge Road. The two alternatives evaluated for this action are depicted in Figure 5.36 of the FEIS.

With Alternative B, the new roadway will be realigned so it will not travel through the proposed Runway Protection Zone (RPZ) of Runway 12W. The future road will be two lanes (approximately 4,700 feet long) and will serve as the local connector between Gist Road and Natural Bridge Road.

The primary consideration in evaluating the alternatives for this action were safety considerations involving the location and use of a public roadway within the active RPZ of future Runway 12W. FAA guidelines state that, whenever possible, roadways should be located outside the RPZ for the safety of the traveling public, as well as the safety of people and structures on the ground. For these reasons, Alternative B was selected as the preferred alternative for the relocation of Bonfils Drive.

Gist Road/Fee Fee Road - These two roadways are currently connected by a 90-degree intersection. Only one alternative runway alignment was found to be reasonable and practicable. Figure 5.37 of the FEIS depicts the preferred alternative for the Gist Road/Fee Fee Road improvements.

The proposed improvements will eliminate a portion of Fee Fee Road from Gist Road to relocated Natural Bridge Road (approximately 3,000 feet) and eliminate the existing T-intersection. The alignment of Gist Road in the vicinity of the existing Fee Fee Road intersection will be modified to provide a 300-foot turning radius. Gist Road will remain a two-lane facility. Because alternative north-south routes are available within proximity of Fee Fee Road (Lindbergh Boulevard and Bonfils Drive), the closure of Fee Fee Road in this area was determined to be the most reasonable and practicable alternative.

Summary of Proposed Roadway Development Plans for Alternative W-1W

All the above options were discussed at length during seven separate coordination meetings and six conference calls of the team overseeing the surface transportation projects. The team consisted of the cooperating agencies, FAA, FHWA and MoDOT, along with the airport sponsor, STLAA, and FAA's consultant, Greiner.

The individual roadway alternatives selected as the preferred, which make up the proposed development plan for each roadway area discussed above, are summarized as follows:

- Realignment of McDonnell Boulevard.
- Tunneling of Lindbergh Boulevard (Alternative D).
- Reconfiguration of the Lindbergh Boulevard/Natural Bridge Road Interchange (Alternative E).
- Improvements to the I-70/Airport Terminal Interchange.
- Realignment of Natural Bridge Road.
- Realignment of Bonfils Drive (Alternative B).
- Removal of approximately 3,000 feet of Fee Fee Road.
- Realignment of the intersection of Gist Road and Fee Fee Road.
- Terminal Area Roadway improvements.
- Relocation of portions of Gist Road and Fee Fee Road.
- Terminal area improvements and the relocation of Lambert International Boulevard.
- Realignment of Missouri Bottom Road.

Section 303 (Formerly Called Section 4(f)) and Section 6 Resources

There are no Section 303 (formerly called Section 4(f)) or Section 6(f) resources that will be impacted by the surface transportation elements of the overall project. The

Section 303/Section 6(f) impacts, associated with the aviation element, are discussed in Section 6 of this ROD.

Measures to Minimize Harm

All practicable measures to minimize harm have been incorporated into the decision for the selected alternative, W-1W, and its associated surface transportation elements.

The project will require approximately 24.2 acres of land for roadway right-of-way, consisting of 12 residential parcels, 7 commercial/industrial parcels, and 17 tax exempt parcels. These include six single-family residences, a 133-unit apartment complex, and the Drury Office Building. The proposed roadway improvements would not disproportionately impact low-income or minority groups. The acquisition and relocation program will be conducted in accordance with the Uniform Relocation Assistance and Real Properties Act of 1970, as amended in 1987 (*42 U.S.C. 4601*). A summary of the environmental impacts of surface transportation for Alternative W-1W follows:

Relocations	
Homes	6
Rental Units	133
Commercial Buildings	1
Population	276
Wetlands (acres)	1.8
Floodplains (acres)	2.3
Parks	0
Hazardous Material Sites	10

Section 6.3 of the FEIS provides further information regarding mitigation for surface transportation elements of Alternative W-1W. Efforts will be made to minimize disruption of communities and hardships on neighborhoods during construction of the roadway improvements through the development and implementation of a Maintenance of Traffic Plan and a Roadway Improvement Safety Plan.

Farmland impacts have been addressed. Because the area is zoned for urban uses and is fully developed, the criteria established in the Farmland Protection Policy Act do not apply and mitigation is not warranted.

Cultural resources have been addressed in accordance with regulations (36 CFR 800) implementing Section 106 of the National Historic Preservation Act (*16 U.S.C. 470*). The FAA determined that the surface transportation improvements may have an adverse effect on currently identified historic properties and additional, yet-to-be-identified historic properties. An MOA was required for the FEIS. The MOA was developed to specify measures to be implemented to avoid, reduce or mitigate any adverse effects. The MOA also details eligibility assessment and treatment measures for any additional archaeological and historic architectural resources that may be present in the undertaking's Area of Potential Effect (APE). The MOA was prepared in consultation with the Missouri SHPO and the Advisory Council on Historic Preservation and was executed by the Advisory Council on Historic Preservation on May 29, 1998. This satisfies the Section 106 responsibilities for all actions associated with the proposed surface transportation improvements. A final copy of the MOA is included in ROD Appendix H.

Due to the proximity of the alignment to residential areas, a carefully planned and executed drilling and blasting program will be implemented. The requirements of this blasting program will be governed by local, state and Federal regulations. This program can involve the following activities: pre-blast survey, vibration criteria, contractor's blasting plan, vibration monitoring during blasting, and post-blasting survey. This type of program has been successfully used on a large number of projects, including blasting in urban areas and along natural gas and electrical lines.

Motor vehicle emissions caused by the proposed action are estimated to be well below the *de minimis* levels requiring a determination to demonstrate conformity with the SIP. Emissions from all airport-related sources were evaluated in the Final General Conformity Determination, which FAA made available on June 19, 1998.

Job construction specifications will require erosion control measures to prevent sedimentation. MoDOT's Sediment and Erosion Control Plan, as approved by the MDNR, will be implemented to prevent pollution caused by construction activities. As described in detail in the FEIS, compliance with the provisions of the MDNR's stormwater regulations and the provisions of the NPDES permit will also minimize adverse water quality impacts.

MoDOT will implement BMPs for stormwater control and comply with MDNR stormwater regulations and the provisions of the NPDES, a general permit issued for road construction projects statewide.

Wetlands have been avoided to the extent practicable. The position of the selected alternatives have been chosen to minimize impacts to wetlands. The surface transportation elements associated with Alternative W-1W will require a structure across Coldwater Creek, the relocation of a culvert crossing for McDonnell Boulevard, and possible modifications to an existing ditch system. Final mitigation measures, if required, will be decided in coordination with the U.S. Army Corps of Engineers with the assistance of the U.S. Fish and Wildlife Service. Stormwater, NPDES and COE

Section 404 permits will be obtained prior to construction of any of the proposed roadway facilities. Mitigation measures addressing stormwater NPDES and COE Section 404 permits are discussed in Section 6.3 of the FEIS.

The proposed surface transportation improvements associated with Alternative W-1W will impact approximately 2.0 acres of Coldwater Creek floodplain and 0.3 acre of Cowmire Creek floodplain. Floodplain impacts have been reduced by holding right-of-way requirements to a minimum.

Wells found during construction will be sealed to prevent groundwater pollution from construction and from future road maintenance.

The project will not have adverse effects on any Federally listed endangered or threatened species.

Noise studies as detailed in the FEIS, dependent upon final design, indicate that traffic noise impacts will be minimal because: (1) noise-sensitive sites will be part of the relocation program associated with the airport alternative; (2) remaining noise-sensitive sites will experience traffic noise from another existing roadway; or (3) noise-sensitive sites will be impacted by aircraft noise. The mitigation of noise impacts all along the roadway project is unlikely. Consideration of noise barriers for residential properties adjacent to the highway project will be in accordance with the MoDOT policy on noise abatement. Mitigation of aircraft noise impacts is discussed in Section 6 of this ROD.

Ten sites (depicted in Figure 5.28 of the FEIS) potentially involving hazardous materials and/or environmental contamination, could be impacted by the surface transportation elements of Alternative W-1W. The preferred method of mitigation for hazardous waste sites is avoidance. The sites that cannot be avoided will require additional site inspection and characterization of material releases. It is not anticipated that remediation of potential contaminants will require substantial amounts of work. Sites requiring remediation will need to have a Remedial Action Plan developed with approval by the MDNR prior to implementation.

Monitoring or Enforcement Program

The proposed project will be subject to further review by Federal and state agencies and local units of government. Some permits will need to be obtained. This review and permit process will ensure that the included mitigation measures are implemented.

Comments on FEIS

The FEIS was approved for circulation on December 19, 1997, and was distributed to the agencies and individuals noted within the document on December 22, 1997. Those receiving a copy of the FEIS were provided 30 days to respond with comments. The Notice of Availability of the FEIS was published in the Federal Register on January 2, 1998. Only one letter, from Mr. Wilfred H. Adelt, mentioned the roadway projects. No other comments on the surface transportation projects were received on the FEIS.

Mr. Adelt suggested that the Lindbergh Boulevard tunnel will negatively impact the main thoroughfare between north and south St. Louis County. The response to that comment is as follows: The FAA has coordinated the proposed roadway changes, including the tunneling of Lindbergh Boulevard, with the FHWA and MoDOT. The environmental impacts of the roadway changes are contained in the FEIS Section 5.22. The proposed tunnel will not separate ties to neighborhoods, families or local businesses, or adversely affect community cohesion. The tunnel will be built to the appropriate level of service to accommodate the traffic needs of the roadway.

9. RELATED PLANNING ISSUES

Several commenting parties, principally ALPA and NATCA, maintain that Alternative W-1W will not provide the needed capacity at Lambert (Appendices C and G of this ROD). This belief is based in part on their view that the proposed operation of the expanded airport is unsafe and, therefore, cannot be operated as planned.

The major technical issues raised include:

- Safety

- Capacity
  - National Airspace System Capacity Benefits
  - Runway Stagger/Departure Dependency
  - PRM/No Transgression Zone (NTZ) Issue
  - Real Time Simulation
  - SIMMOD Input
  - Terminal Expansion
  - Benefit/Cost Analyses
  - ALPA/NATCA 18 points

SAFETY

Concerns have been expressed about safety issues and capacity/delay estimates developed during the MPS and EIS processes. In analyzing and comparing capacity and delay reduction benefits of various alternatives during the planning and environmental review processes, both the FAA and the City of St. Louis gave the highest priority to safety requirements in accordance with FAA's statutory mandate. Safety of operation is a prerequisite for operation and expansion of any airport. The FAA has rules (such as FAA Order 7110.65L, Air Traffic Control) and local air traffic control procedures, that govern the operation and interaction of aircraft in virtually any conceivable situation and combination of weather conditions. These rules include such things as in-trail, horizontal and vertical separations. The same rules applied by FAA's Air Traffic Division in operating existing airports are applied in airport planning to estimate the capacity and delay benefit of alternatives. The existing airport or any expanded airport will be operated safely in accordance with the rules established by FAA and applied by the Air Traffic Division.

The FAA has carefully considered all safety issues raised during the EIS process. Safety implications related to airfield layout are addressed by designing facilities in accordance with FAA design standards. The selected alternative, W-1W, is designed in accordance with Advisory Circular 150/5300-13. Alternative W-1W enhances safety because it reduces the project number of runway crossings with the existing airfield in 2015 from approximately 800 to 580 per day. See Appendix C of this ROD, response to Comment 8. See also Appendix G.

The selected alternative, W-1W, will use procedures that are already approved by FAA and used daily at airports throughout the United States. It was developed using FAA approved airport design standards for airfield layout.

CAPACITY

Estimates of capacity and delay are complex. The capacity and associated delay of a particular airport is influenced by a large number of variables, including the runway layout, taxiway system, terminal layout, gate utilization, weather variability, volume of demand, peaking characteristics of demand, airline operating strategies and fleet mix, to name a few. Estimating how well some future runway configuration will perform becomes a nearly impossible task, unless computer models are used to simulate the operation of the future airport. These models are very useful in analyzing different alternatives by changing one or two of the variables for comparative runs of the model and observing the differences in average annual delay that result. Such computer models have been used throughout this process.

The hourly capacity numbers for any specific set of circumstances produced as a result of this modeling are of far less importance than the relative magnitude of delay estimated. Any comparison or discussion of hourly capacity numbers for a specific case that does not include the associated delay results in an incomplete understanding of the operating efficiency of the case.

ALPA has stated that the runway stagger, which influences the dependence of departures from the existing Runway 30L on arrivals to the new Runway 30W, negates the advantage of the new runway. The FAA and the MPS consultant have always agreed that the departure dependence will exist. The condition was included in the modeling assumptions. The result is that the proposed expansion provides sufficient delay reduction to produce a very favorable benefit/cost ratio and acceptable projected delay levels through the planning period (the year 2015).

All of the inconsistencies in capacity/delay figures cited by ALPA have been derived from taking numbers from one study that used one set of assumptions and comparing them to another study that used different assumptions. Valid comparisons depend on use of the same assumptions and variables. Simulations for capacity and delay analysis are conducted by comparing each alternative with the existing airport and changing one variable at a time while keeping all the other variables constant.

Generally, capacity and delay estimates have more importance for comparative purposes than for any given absolute value.

The planning process for Lambert included capacity/delay analyses utilizing four different computer models: the FAA Runway Capacity Model, the FAA Annual Delay Model, SIMMOD and the National Airspace System Performance Analysis Capability (NASPAC) model. The assumptions and conditions used as input for these models were extensively discussed and coordinated with appropriate parties. In the case of the first three models, this included the Airfield and Airspace Working Group (AAWG). This group was comprised of representatives such as the St. Louis Air Traffic Control Tower (ATCT), ALPA, the airlines, Air Transport Association (ATA), and others. In the case of the National Airspace System Performance Analysis Capability (NASPAC) analysis, the FAA's William J. Hughes Technical Center (FAA Technical Center) performed the study, with input coordinated with FAA Airports Division and the St. Louis ATCT.

In the alternatives analysis stage of the master planning process, FAA's capacity and delay models were used to compare the relative operational efficiency of the various alternatives. The assumptions and results of this analysis are documented in Section 2 of the Master Plan Supplement Technical Compendium (MPSTC). Additionally, a sensitivity analysis was performed to assess the impact of changing circumstances that occurred during the planning process.

Once STLAA selected its preferred alternative, W-1W, different simulations were performed utilizing the more sophisticated SIMMOD computer model. The goals of the SIMMOD analysis were twofold: (1) to evaluate the most efficient means of operating the preferred airfield alternative, W-1W, reconfirming its overall operational benefits; and (2) to evaluate effects on aircraft delays and taxiing times of potential refinements to the operation and layout of Alternative W-1W. For these reasons, eighteen simulations were performed. The conditions and results of the model simulations are documented in Section 6 of the MPSTC.

The FAA Technical Center also performed capacity and delay simulation modeling to compare the preferred alternative (W-1W) to the existing airfield. This analysis utilized FAA's NASPAC computer model. Assumptions, conditions and results of this study are documented in a report published by the FAA Technical Center in June 1997, entitled "Evaluation of the Proposed Lambert-St. Louis Airport Expansion" and are discussed elsewhere in this section of the ROD.

Within each analysis, the alternatives being compared were subjected to the same sets of variables, which could affect the capacity/delay results of the study. This is necessary in order to draw valid comparisons between alternatives. Results of studies performed under different assumptions and circumstances do not provide for valid comparisons.

The proposed expansion does rely on the use of a PRM to allow dual simultaneous independent IFR approaches to the outboard runways. This procedure has been tested and approved by the FAA. Simultaneous IFR approaches to closely spaced parallel runways were subjected to real-time simulations prior to the FAA approving them. In addition, a PRM was installed and operated for over a year in Raleigh-Durham, North Carolina.

In summary, the proposed expansion at Lambert has been subjected to simulations using the FAA Runway Capacity Model, the Annual Delay Model, the SIMMOD model, and the NASPAC model. In each case, the proposed expansion has shown the potential to increase capacity and significantly reduce projected delays.

National Airspace System Capacity Benefits

The lack of airfield capacity at high-activity airports in the United States is a frequent cause of "bottlenecks" in the nation's aviation system. Lambert is identified as 1 of 23 existing delay-problem airports in the FAA's 1994 Aviation Capacity Enhancement Plan; therefore, the proposed project at the airport is crucial to the development of needed capacity for the NAS.

In 1997, the FAA Technical Center conducted a study of the proposed expansion of Lambert-St. Louis International Airport to determine the expected benefits of the proposed project to Lambert and the NAS. The study was initiated at the request of FAA Central Region Airports Division. A report documenting the methodology used and results of the study was published in June 1997.

The NASPAC Simulation Modeling System (SMS) was used to perform the task. The NASPAC SMS is a discrete event simulation model that tracks aircraft as they progress through the NAS and compete for Air Traffic Control (ATC) resources, e.g., airports, sectors, flow control restrictions and arrival and departure fixes. The NASPAC evaluates system performance based on the demand placed on resources modeled in the NAS and records statistics at the 50 busiest national airports and 8 associated airports.

The study used the model to calculate local and system-wide delays, with and without the new runway proposed for the airport. Monetary benefits of the new runway were calculated using the NASPAC Cost of Delay Module. The Cost of Delay Module calculates the passenger and operational delay cost based on actual cost reported by the airlines to the Department of Transportation's Office of Aviation Statistics. The results of the study indicate that the construction of the new runway would provide substantial monetary benefits to the airlines and the user community due to the abatement of operational and passenger delays locally and in the NAS.

Data were presented for operational delay, passenger delay and delay savings. Operational delay occurs whenever an aircraft has to compete for an ATC system resource. Passenger delay reflects the "ripple-effects" in the NAS and shows the lateness of a flight at the destination airport. The delay savings represent the difference in delay with or without the Lambert expansion project. The delay savings assumed that the current NAS stays essentially the same for the study period (2005 - 2015), with some new technologies introduced and some airspace procedures revised.

The new runway will reduce operational delay at Lambert by 63 percent in 2005, 65 percent in 2010 and 66 percent in 2015. NAS-wide, operational delay will be reduced by 5 percent in 2005, 8 percent in 2010 and 14 percent in 2015 with the implementation of the improvements at Lambert.

The new runway will also reduce passenger delay at Lambert by 55 percent in 2005, 52 percent in 2010 and 57 percent in 2015. NAS-wide, passenger delay will be reduced by 7 percent in 2005, 9 percent in 2010 and 18 percent in 2015.

Delay savings in monetary terms was also analyzed by the NASPAC model. The monetary savings indicated do not represent actual cash savings but an estimate of what could be saved by the airlines and passengers with the implementation of the Lambert expansion project. The benefits to the airlines were based on their direct cost as reported to the Department of Transportation. The passenger cost was assumed to be $45.50 per passenger hour, if they were reimbursed for lost time caused by delays in the system.

The estimated savings that could be realized by implementing the new runway at Lambert would result in significant operational and passenger delay savings both at Lambert and NAS-wide. In terms of cumulative operational delay savings during the study period (2005 - 2015), the model predicted a $1.9 billion savings at Lambert and a $5.1 billion savings NAS-wide. Likewise, cumulative passenger delay savings over the study period was predicted to be $1.4 billion at Lambert and $9.5 billion NAS-wide.

Runway Stagger/Departure Dependency

The selected alternative, W-1W, includes construction of one new parallel runway located 4,100 feet south of the existing north parallel runway (30R). The threshold of the proposed new runway is staggered approximately 12,200 feet to the west from the threshold of existing Runway 30R. This location, along with the location of the existing south parallel runway (30L), results in departures from either of the existing runways being dependent on arrivals to the new runway in IFR west flow conditions.

Critics of the W-1W plan claim this operation is unsafe and inefficient and, therefore, does not provide the capacity necessary to reduce delays as the MPS and FEIS suggest it will.

The stagger of Alternative W-1W increases safety because simultaneous arrivals will occur on runways separated by 4,100 feet instead of 3,400 feet. This is 600 feet more than the minimum lateral spacing of 3,400 feet allowed under PRM operations for straight-in approaches. The effects of the runway stagger and the dependency of departures have been thoroughly analyzed in the MPS. In addition, these issues have been addressed in the FEIS, in particular, see the responses to Comments 2-39, 2-64, 2-65, 2-137,2-142, 2-144 and 2-150 in Appendix V. The SIMMOD input and ALPA/NATCA 18 points are discussed below.

Precision Runway Monitor/No Transgression Zone Issue

This issue has both safety and capacity aspects. It also relates to the real-time simulation issue discussed below. The safety and capacity of operational procedures contemplated for use with Alternative W-1W has been the subject of numerous comments previously responded to in the FEIS. See FEIS response to Comment 1-50.

The Precision Runway Monitor (PRM) is a system comprised of a rapid update radar, an enhanced color graphic monitor and a software package, which aids the air traffic controller in more accurately monitoring the position of aircraft on final approach to a runway. As noted above, use of a PRM to allow dual simultaneous independent IFR approaches to closely spaced parallel runways has been subjected to real-time simulation and approved by the FAA. The FAA has certified PRM for use to provide simultaneous independent approaches with parallel runways separated by at least 3,000 feet (FAA Order 8260.39) (3,400 feet for straight-in approaches). PRM is the primary tool that has allowed the FAA to achieve this. The W-1W proposal for St. Louis includes outboard runways spaced 4,100 feet apart, and stipulates that a PRM would be required to provide independent approaches. Runways spaced 4,300 feet apart allow simultaneous independent approaches without a PRM.

One of the features of the PRM system is a digital map displayed on a computer terminal monitored by an air traffic controller. The digital map includes an area designated as the No Transgression Zone (NTZ). The NTZ is generally centered between the approach paths of the runways being monitored with the PRM. In the case of the Lambert expansion, the outboard runways are separated by 4,100 feet. The NTZ is 2,000 feet wide, centered between the runways. Therefore, the edge of the NTZ is

1,050 feet from the centerline of each outboard runway. Since the existing two parallel runways are 1,300 feet apart, the future center runway will be 250 feet inside the NTZ. The purpose of the NTZ is to assure proper horizontal separation between arrivals.

When operating the proposed expanded airport in IFR conditions in west flow, the plan envisions approaches to the outboard runways, existing 30R and the new runway 30W (which will be designated 30L after expansion), while allowing a departure on existing Runway 30L (which would be 30C after expansion). With the PRM in operation, this will result in the departure off existing Runway 30L (30C after expansion) entering the NTZ. With the current software design for the operation of PRM, the departure would generate an alarm notifying the controller monitoring the PRM that an aircraft has penetrated the NTZ.

Some commenters have expressed concerns that PRM has not been specifically tested with the approximately 12,200-foot stagger contemplated for Alternative W-1W or with simultaneous approaches to the outboard runways with departures from the center runway. Others comment that use of PRM with a staggered runway and departures on a center runway in the NTZ exceeds the parameters for PRM certification. The FAA has carefully considered whether use of the PRM is authorized in these circumstances. The Air Traffic Division and Flight Standards Division reviewed the plan for operation of Alternative W-1W and requirements under Air Traffic Control Handbook 7110.65 Chapters 3 and 5 and PRM procedures in FAA Order 8260.39 as they apply to that plan in detail. That review indicates that the planned operation of the runway configuration is authorized as explained below:

When operating in IFR conditions in west flow, aircraft will arrive on the outboard Runways 30W (which will be designated 30L after expansion) and 30R, while departing 30C. Departures from Runway 30C will be dependent on arrivals to both outboard runways. Before a departure is released from Runway 30C the air traffic controller will apply the provisions of FAA Order 7110.65L Paragraph 5-9-8 c.3, which defines conditions for termination of radar monitoring. Internal air traffic procedures will specify that when provisions of paragraph 5-9-8 c.3 have been applied, radar monitoring shall be terminated and no action will be required in response to any alarm that may be generated by aircraft departing runway 30C. The fact that a departure from the center runway (current 30L) is inside the NTZ is not relevant because radar monitoring will have been terminated for the approach, and PRM is not used to separate departures.

W-1W does not depend upon a change in the PRM software to deactivate alarms for departures to assure safety. The purpose of the NTZ is to enable controllers to detect loss of separation between simultaneous approaches. To conduct operations as planned, modification of the software may be required. If such a software modification is required it will be subject to appropriate testing not involving real-time simulation.

This review of the proposed procedures determined that they are authorized by current ATC guidance and consistent with procedures that would require real-time simulation, as discussed below, are necessary. This determination is documented in letters dated July 31, 1998, from the FAA Administrator, Jane Garvey, to Congressmen James Talent and Richard Gephardt (Appendix I of this ROD). The result of this review and documentation is to confirm that the proposed expanded runway configuration can be operated safely as planned and depicted in the MPS and the FEIS and that real-time simulation is not necessary to verify the safety of the procedures.

Real-Time Simulation

The request for real-time simulation was first submitted to the FAA in a letter dated December 29, 1997, from ALPA representative, Dean Adam, to John Turner, Central Region Administrator, FAA. In that letter, ALPA stated that real-time simulation was the only way to resolve capacity questions surrounding the W-1W proposal. Real-time simulation was subsequently requested to address claimed significant safety impacts and to confirm the operational assumptions in the MPS and FEIS, particularly in west flow. ALPA considers such a study essential to determine whether controllers can actually pair arrivals of aircraft having different approach speeds as simulated by computer modeling. ALPA also views testing as needed to address safe use of the NTZ for departures on the center runway.

Real-time simulation is the process by which computers, flight simulators, target generators and radar scopes, operated by real air traffic controllers and actual pilots, replicate actual flight operations in an air traffic control environment. The controllers are located in a radar lab (normally at the FAA Technical Center) while the pilots operate flight simulators at various locations throughout the country, many of which are leased from airline training departments.

The process begins with a definition of requirements. Next comes the design of the simulation, which involves the development of scenarios to reflect such variables as fleet mix, weather conditions, runway configuration and use, air traffic procedures, navigational aids, approach speeds and in-trail and lateral separation. Then the actual real-time simulation is completed. If further risk analysis is required, the data is sent to the FAA's Aeronautical Center for use in a computer simulation system. Analysis of the resulting data leads to a final report.

Real-time simulation has been used by FAA numerous times to test the viability of new procedures that have been developed for specific applications. Notably, the real-time simulation process has been used by FAA to test simultaneous independent parallel IFR approaches to closely spaced parallel runways using a PRM, when it was a new approach aid system. As a result of this and other analyses, FAA approved dual simultaneous independent IFR approaches to parallel runways spaced as close as 3,400 feet apart using PRM. Subsequently, FAA approved dual simultaneous independent IFR approaches to parallel runways spaced as close as 3,000 feet apart (3,400 feet for straight-in approaches) using PRM, with a 2½ degree offset of one of the approaches.

Real-time simulation was deemed unnecessary for this project because the procedures to be used with Alternative W-1W are authorized under existing procedures that are used daily at airports throughout the United States. Some commenters stated that real-time simulation would show that Alternative W-1W would not have the capacity claimed in comparison to other alternatives, particularly in west flow conditions. As new and untested procedures are not needed to support Alternative W-1W, real-time simulation would have no bearing on estimates of capacity and delay. While real-time simulation is a valuable tool in analyzing new and untested procedures and special situations, it is not a capacity tool. It does not provide capacity/delay numbers for comparison of alternatives.

SIMMOD Review

ALPA has commented throughout the environmental review process that various characteristics of Alternative W-1W were not properly reflected in the computer modeling and simulation analysis used by the airport's consultant and by the FAA in determining capacity. ALPA contends that incorrect information was used as input to the computer models, particularly the SIMMOD model. Others have commented that the SIMMOD capacity calculations overstate the capacity of Alternative W-1W and understate that of the existing airfield and Alternative NE-1a and that all alternatives should be evaluated using SIMMOD.

Some of the factors ALPA believes were incorrectly analyzed include the runway stagger, the dependency of departures from the center runway, the ground movements in front of the terminal, the arrival rates for the existing parallel runways, the arrival rates for the Dependent Converging Instrument Approach (DCIA) operation for the existing airfield, runway crossings and the effects of wake turbulence.

During the MPS, the City of St. Louis compared alternatives using the results of the FAA Airfield Capacity Model and the FAA Annual Delay Model. Numerous sensitivity analyses were performed throughout the planning and environmental review process using the capacity and delay models in order to determine what, if any, effect the suggested changes would have on the alternatives analysis. The latest of these analyses was conducted for the No-Action, S-1, NE-1a and three scenarios for W-1W in response to a list of 18 points that ALPA presented to FAA during a meeting on June 9, 1998 (Appendix C of this ROD).

After the capacity and delay models were used to make estimates that enabled the City of St. Louis to select its preferred alternative, Alternative W-1W, the SIMMOD was used to refine comparisons between Alternative W-1W and the No-Action Atlernative. Although FAA had already conducted one study that confirmed the results of the MPS SIMMOD analysis, to further address concerns about the adequacy of FAA's independent review, the FAA Technical Center reviewed the input files used by the consultant for the SIMMOD analysis, as well as the procedures used for modeling the runway crossings, departure dependencies and taxiway movements in front of the terminal.

The results of the FAA Technical Center review of the SIMMOD analysis of the proposed expansion are documented in an August 1998 report**.** The Technical Center established that the analysis was performed in conformance with the accepted standard practice and the results obtained are reasonable. The Technical Center's letter dated July 29, 1998, summarizing the results of this review, is documented in Appendix I of this ROD. As it is reasonable for the FAA to select Alternative W-1W based upon the comparison with other alternatives, it would not be useful to conduct additional SIMMOD analyses to refine other alternatives.

Terminal Expansion

One of the issues raised concerns the plan for expansion of the terminal facilities included in the overall expansion plan for Lambert.

The local press reported in May 1998, that TWA (the major hub operator at Lambert) was pressing the airport for immediate construction of a new 60-gate terminal. It was also reported that TWA was contemplating withdrawing its support of the W-1W plan, if the airline did not get its new terminal by the time the new runway was to open. This report stirred controversy, because the MPS and the FEIS envisioned development of new terminal facilities on a more gradual schedule.

The MPS and the FEIS documented terminal development to the west of the current terminal location, including a location west of Runway 06/24 (Figure S.3 in Appendix J of this ROD). The FEIS addresses impacts of terminal development relating to location (footprint) of new facilities and gates to accommodate the forecast aviation demand through 2015. It was estimated that 105 to 110 total gates would be necessary to accommodate the aviation demand in 2015. As part of the mitigation program in the FEIS, STLAA has agreed that when terminal design progresses sufficiently, the STLAA will conduct a carbon monoxide hot-spot analysis for terminal expansion to ensure that the terminal structure is designed efficiently from an air quality standpoint.

At the request of the FAA, the STLAA and TWA subsequently clarified the level and extent to which negotiations for new terminal facilities for TWA had progressed (see letters from STLAA and TWA in Appendix F of this ROD). Both parties reported that preliminary discussions had taken place, but that both STLAA and TWA were in full support of the expansion plan as developed in the MPS and documented in the FEIS.

An issue directly related to the terminal expansion plan that has been the subject of comments is the ground movement on Taxiway Delta in front of (and adjacent to) Concourse C. The current configuration of this taxiway in relationship to the terminal requires that aircraft using the gates on the north side of Concourse C push back into the taxiway. This restricts the efficient utilization of the taxiway.

This limitation was identified at the alternatives analysis stage in the MPS process. A number of possible solutions to the problem were explored with the participation of the AAWG. Some of those solutions were:

1. Remove a section of Concourse C near the main terminal to allow one-way taxi flow into the "back alley" between Concourses C and D, with opposite flow along the north side of Concourse C.

2. Move Runway 12R/30L 300 feet north of its present location to allow enough room to clear push backs from the terminal with a new parallel taxiway.

3. Reduce the width of Runway 12R/30L to 150 feet (presently 200 feet) to allow room to shift Taxiways Alfa and Delta 50 feet to the north.

4. Eliminate approximately 11 conventional gate positions on the north side of Concourse C, replacing them with 5 "power-in, power-out" gate positions to eliminate push backs into the taxiway--to be accomplished when terminal expansion to the west of the present terminal provides enough gates to compensate for the six-gate net loss required by the plan. This is the solution that was selected.

In summary, terminal development up to a total of 110 gates is covered in the FEIS. Terminal development west of the current terminal and some terminal development west of Runway 6/24 is documented in the FEIS. The proposed terminal areas are shown in green in Figure S.3 of the FEIS (Appendix J of this ROD). Impacts of the terminal facilities were considered for each of the 22 environmental categories examined in the FEIS and documented in the FEIS. The only additional analysis needed is a carbon monoxide hot-spot analysis unique to exact terminal design. Terminal development in excess of 110 total gates would need additional environmental review.

Benefit/Cost Analyses

Two separate benefit/cost analyses were prepared during the study process. The first was conducted by the MPS contractor for STLAA. A second independent BCA was conducted by the FAA.

Master Plan Supplement Benefit/Cost Analysis

Benefit/cost ratios (BCR) were computed in the MPS. Benefits included aircraft travel time and delay savings, while costs were calculated using construction costs to be incurred from 1996 to 2015. According to the analysis prepared by STLAA, the new runway at Lambert (Runway 12W/30W) would have a BCR of 2.2, indicating that its economic benefits are over two times greater than the project cost, and that it is economically preferable to not constructing the runway.

FAA's Independent Benefit/Cost Analysis

As a supplement to the analysis of the Lambert expansion plan (W-1W) for the FEIS, and in anticipation of a request for funding under the Airport Improvement Program (AIP), the FAA Airports Division requested the FAA's Systems and Policy Analysis Division (APO-200), Office of Aviation Policy and Plans, to conduct an independent BCA of the proposed plan.

In July 1997, the FAA performed and completed an independent BCA for Lambert. The analysis, performed by FAA's Systems and Policy Analysis Division, Office of Aviation Policy and Plans, compared Alternative W-1W with the No-Action Alternative. The methodology, assumptions and results of the analysis are documented in a report entitled "Benefit-Cost Analysis for Lambert-St. Louis International Airport Capacity Enhancement Project," dated July 31, 1997.

The results of the FAA analysis indicate that Alternative W-1W has a BCR of 2.6 compared to the No-Action Alternative, making it economically preferable to the No-Action Alternative.

The FAA report also includes a risk analysis, which calculates the effect of cost overruns, construction schedule slippage, traffic growth variations, and combinations of these variables. The risk analysis indicates that Alternative W-1W has a high probability of maintaining a BCR greater that 1.0 under a wide variety of scenarios.

In summary, regardless of whether one relies upon the BCR of 2.2 from the MPS or the FAA's BCR of 2.6, the BCR for Alternative W-1W is clearly advantageous.

Air Line Pilots Association/National Air Traffic Controllers Association 18 Points

ALPA and NATCA presented a written list of 18 concerns to FAA senior staff at a meeting on June 9, 1998, and submitted basically the same list when they met with the Associate Administrator for Airports on June 16, 1998.

In response to these concerns, the FAA Airports and Air Traffic staff met with STLAA and its consultant to determine the variables to examine in a "sensitivity" analysis. A sensitivity analysis is a process of reevaluation or recalculation of a previously completed analysis using one or more changed variables. The purpose of the sensitivity analysis is to see what effect the changed variables have on the results of the analysis, or how sensitive the results of the analysis are to the variables that are the subject of the sensitivity analysis. In this case, at the request of the FAA, STLAA and its consultant performed a sensitivity analysis to determine what effect the use of the variables suggested by ALPA and NATCA would have on the results of the capacity/delay analysis and the overall analysis of the alternatives. The results of the sensitivity analysis indicate that incorporation of the ALPA/NATCA data would make no significant difference in the capacity/delay and cost/benefit analysis relative comparison of the alternatives. The details of the sensitivity analysis are included in Appendix C of this ROD.

In recent comments, both ALPA and Bridgeton have misinterpreted FAA's use of different assumptions as proof that the assumptions and analyses in the MPS and the FEIS are incorrect. The sensitivity analysis was done with, among other assumptions, a lower arrival rate of 60 arrivals per hour instead of 72 per hour during VFR 1 conditions for the No-Action Alternative and Alternative W-1W. It also examined the effect of using outboard runways during VFR 1 and 2 conditions and west flow with Alternative W-1. These analyses were done to accommodate and address concerns about the validity and integrity of the process.

The operational assumptions used in the planning and EIS processes remain reasonable and valid. The arrival rate of 72 arrivals per hour includes ample time for voice communication between pilots and controllers and for clearances. The assumptions used in the MPS and the FEIS are consistent with operational efficiency. During good weather and west flow, it would be more efficent to use the new runway for departures and the existing runways for simultaneous independent arrivals than to sequence departures between gaps in simultaneous arrivals to the outboard runways given the demand for departures at Lambert.

10. ENVIRONMENTAL ISSUES RAISED ABOUT THE FEIS

During the 30-day review period, comments were received from the following in response to the FEIS:

Federal Agencies

- Department of Health and Human Services
- Department of the Interior
- Department of Transportation, Federal Transit Administration
- US Environmental Protection Agency

Local Agencies/Interest Groups

- City of Woodson Terrace
- St. Clair County Board
- St. Charles R-6 School District
- Office of the County Executive, St. Charles County
- City of Bridgeton
- City of St. Charles
- National Air Traffic Controllers Association
- Air Line Pilots Association
- People Building Community
- St. Charles County Citizens Against Aircraft Noise
- Bridgeton Air Defense

Interested Citizens

- 161 letters from interested citizens

Letters from the public echoed many of the comments received from the local governments and interest groups. Most of their comments were in the areas of noise, airport planning, alternatives and public involvement.

No substantive comments were received from the public on the following categories after the release of the FEIS: hazardous materials; water quality; historic, architectural and archaeological resources; biotic communities; endangered and threatened species; wetlands; farmlands; energy and natural resources; light emissions; solid waste impacts; construction impacts; cost considerations; environmental justice; surface transportation; floodplains; and design, art and architecture.

The FAA has carefully assessed and considered comment letters received on the FEIS in making its decision. Copies of these letters are available for inspection at the FAA Regional office. While not every comment in every letter has been addressed, Appendices A, B, C, D, E and G of this ROD provide detailed responses to comments on major issues raised by the principal commenting agencies and citizen groups. Airport planning issues raised in comments on the FEIS are summarized previously, in Section 9 of this ROD. The major environmental issues raised in comments on the FEIS are summarized below.

1. Flawed purpose statement includes dual simultaneous independent arrivals

Commenters contend that dual simultaneous independent arrivals are not a legitimate purpose and need.

The purpose and need statements contained in the FEIS present an accurate description of the purpose for the project and the reasons why the proposed Lambert action is needed. The FEIS, Section 2.0, Purpose and Need, identifies four major elements of the purpose of the proposed Federal action.

The first major element listed is associated with capacity and aircraft delay. One of the sub-items identified under capacity and delay is the development of a capability for dual simultaneous independent IFR arrival operations. This capability was identified as far back as the FAA's 1986 Capacity Enhancement Study, done by the FAA Technical Center. It was subsequently identified in the master planning process. Both the FAA and STLAA determined, based on the forecasts of aviation demand and analysis of existing airfield capacity, that a third parallel runway and a separation of at least 3,400 feet between the outboard parallel runways would have the greatest potential to reduce aircraft delays during adverse weather conditions. This capability was identified as a subordinate item under the general purpose of enhancing capacity and reducing delays, reflecting the operational importance of improving airport capacity during poor weather (IFR and VFR-3) conditions. This was the major capacity problem identified by the master planning process and confirmed by the FAA Technical Center's independent evaluation.

The City of Bridgeton commented both on the DEIS and on the FEIS that the FAA has unduly narrowed the purpose and need and skewed the analysis of alternatives by relying upon simultaneous instrument arrival capability as a factor. The inclusion of dual simultaneous independent IFR arrival operations at Lambert did not unduly narrow or restrict the consideration of alternatives.

It was reasonable to include simultaneous arrival capability during instrument meteorological conditions as a sub-element of the general purpose and need of enhancing capacity based on the 1986 and master planning studies. Simultaneous arrival capability did not skew the analysis of alternatives because it was one of seven project goals or factors weighed by FAA, along with reducing delay and enhancing capacity generally both at Lambert and in the NAS during visual meteorological conditions, consistency with local planning, and consistency with economic goals (FEIS, Section 3.2, p. 3-3-3-6). These factors, derived from the purpose and need section of the EIS (FEIS Section 2.0), are listed in Section 4 of this ROD. Subsequently, operational efficiency, financial and environmental concerns were considered in the decisionmaking process.

While independent arrival capability during IMC was dispositive in dismissing Alternative NE-1a in the DEIS, two other similar north airfield alternatives met this requirement and were retained for further consideration in Tier 2.

Even if simultaneous independent arrival capability in IMC was an overriding factor, the analysis of alternatives was not skewed because all but one of the eight development alternatives carried forward from the MPS met the criteria. In addition to Alternative W-1W, of the onsite airfield alternatives, Alternatives NE-1, N-1, C-1, W-1E, W-2 and S-1 met the simultaneous arrival capability criteria (FEIS, Table 3.7, p. 3-35). Alternative S-1, which had simultaneous independent arrival capability, was one of the reasonable alternatives evaluated fully throughout the EIS process. A recent NASA study indicates that additional runways, providing independent IFR capability, are one of the most promising strategies for improving capacity in the NAS (Pages 24-26 of the NASA study, attached to the City of Bridgeton's comments on the FEIS dated February 2, 1998). That the FAA and STLAA view independent arrival capability as important and the most plausible goal is not unreasonable because others might consider the lower levels of capacity and delay reduction of NE-1a tolerable.

The analysis of alternatives was also not skewed because the FAA has done supplemental analysis to assure that it did not elevate independent arrival capability over the larger project goals. In the DEIS, the FAA examined the FAA Runway Capacity Model and FAA Annual Delay Model results that estimated the capacity and delay associated with Alternative W-1W, and Alternative S-1, along with the other alternatives N-1, NE-1, NE-1a, C-1, W-1E, W-2 and the No-Action Alternative. This analysis indicated that Alternative W-1W provides greater capacity benefits than the No-Action Alternative. In response to comments on the DEIS, the FAA examined Alternative NE-1a in more detail in the FEIS (FEIS Section 3.3.4.1). Further examination in the FEIS indicates that Alternative NE-1a was not a reasonable alternative because it has substantially higher average annual delays, total annual delay and more runway crossings than the alternatives studied in detail in the EIS (MPS Section 3, Attachment D-2).

In response to further comments from the City of Bridgeton, ALPA and NATCA, that questioned the validity of the modeling assumptions used in the FEIS, the STLAA, with oversight from the FAA, conducted a sensitivity analysis in June 1998 that included Alternative NE-1a. This sensitivity analysis assumed, for the sake of argument, the truth of four different assumptions posited by these commenters. The sensitivity analysis indicated that Alternative W-1W increases capacity and reduces delays better than Alternative NE-1a and the No-Action Alternative. The commenters do not identify any alternative that provides capacity or delay reduction benefits comparable to or greater than Alternative W-1W but lacks simultaneous independent arrival capability.

This comment is very similar to prior comments on the DEIS. See responses to Comments 1-14, 1-21 and 1-49 in FEIS Appendix V.

2. FEIS flawed based on tiering process for screening alternatives

There were concerns that the FEIS and its alternatives analysis do not meet the requirements of NEPA, because the tiering process used by FAA to screen alternatives was flawed.

While some commenters believe that the FEIS is flawed, the FEIS is a comprehensive document that fully meets the spirit, intent and requirements of NEPA as well as other substantive statutes. The FAA prepared an evaluation of the proposed action through the EIS process as required by NEPA. The purpose of an EIS is to consider alternatives, present probable environmental impacts and examine possible mitigation to address the significant adverse environmental impacts of those alternatives. The FEIS identifies significant adverse environmental impacts for the preferred alternative and contains appropriate mitigation for those significant adverse environmental impacts.

The FAA solicited comments from interested parties, starting with the scoping process on the DEIS, and continuing throughout, so that it could correct any deficiencies in the documents and provide any additional analyses needed in the FEIS. As examples, because of comments received on the DEIS, the FAA supplemented its FEIS noise analysis with grid points outside the 65 DNL contour, and supplemented the air quality analysis to further describe issues of interest to EPA and MDNR.

The FAA worked closely with each jurisdictional agency to ensure that its concerns were adequately addressed in the FEIS. The EPA expressed satisfaction with the Draft General Conformity Determination, which demonstrated that the project meets the requirements of the Clean Air Act (EPA letter dated April 22, 1998, in Appendix A of this ROD). The DOI and MDNR commented on requirements of the Land and Water Conservation Fund Act and DOT Section 303 (also referred to as Section 4(f)) and had no outstanding issues remaining. Along with the FAA and the STLAA, the SHPO and Advisory Council on Historic Preservation signed an MOA (Appendix H of this ROD) that satisfies the requirements of the National Historic Preservation Act. The Corps of Engineers was consulted and had no objections to the proposed wetlands mitigation concept. These examples demonstrate that the FAA has fulfilled the procedural and substantive requirements of NEPA as well as other environmental statutes and requirements.

Regarding the FAA's tiering process and alternatives analysis, a full and comprehensive range of alternatives was explored by the FAA in the Federal EIS process. The EIS examined the alternatives of using a multiple airport system, using existing or proposed regional airports as a replacement or supplement to Lambert, development of a new airport, other modes of transportation and use of other runway configurations at Lambert.

The Council on Environmental Quality (CEQ) regulations require that reasonable alternatives be comprehensively considered and an explanation be provided as to why other alternatives were eliminated from detailed consideration. The FAA used a three-tiered analysis process, which the EPA acknowledged as meeting the requirements of NEPA, to determine the reasonable alternatives that were subject to detailed analysis. Alternatives that were not considered reasonable were not retained for detailed evaluation. In order to be carried through for detailed analysis, an alternative had to meet all the purposes and needs for the proposed action.

In its letter dated February 27, 1998, the EPA expressed concerns regarding the alternatives analysis in the FEIS. The FAA provided additional explanation to EPA in a letter dated April 9, 1998, and the EPA responded, in a letter dated April 22, 1998, that its remaining concerns had been resolved (Appendix A of this ROD contains these letters). In that letter, the EPA stated the following: "I believe it is important to note that while we may have expressed disagreements or requested clarification in the areas of air quality and noise impacts, our comments on the FEIS should not be viewed as questioning whether the FEIS met the spirit, intent, and requirements of NEPA in these two issue areas. Our comments concerning NEPA requirements were directed solely at the issue of the alternatives analysis contained in the FEIS, and particularly the role of economic factors in the screening process for the alternatives."

The tiered alternatives analysis presented a logical, objective means to screen all alternatives considered in the study. The tiered evaluation retained two reasonable alternatives, W-1W and S-1, for detailed evaluation, not just the sponsor's proposed action. In its letter of April 22, 1998, the EPA stated that the tiered screening analysis of alternatives, based on the particular purposes and needs identified for this project, represented an adequate screening of the alternatives consistent with the requirements of NEPA. In its response to FAA's clarification of the alternatives analysis, the EPA responded: "As we indicated in our earlier correspondence, our Agency supports the concept of screening a full range of alternatives against a project's purpose and needs to identify which alternatives are reasonable, and are carried forward for detailed analysis. We believe this approach meets the spirit, the intent, and the requirements of NEPA, provided that the process is conducted in a valid, legitimate manner. With the additional clarification provided in your letter of April 9, 1998, we better understand how FAA conducted the tiered alternatives screening, and believe that the analysis of alternatives, based on the particular purpose and needs identified for this project, represents an adequate screening of the alternatives consistent with the requirements of NEPA." Thus, the FAA's analysis of alternatives fulfills the requirements of NEPA.

These comments also do not raise entirely new issues, but are similar to comments previously raised on the DEIS. Tiering was discussed in the FEIS Appendix V, responses to Comments 2-74, 2-77, 2-78, 2-121, 2-131, 2-132, 2-133, and 2-134. The alternatives selection process was discussed in the FEIS responses to Comments 211, 2-15, 2-29, 2-58, 2-72 and 2-85.

In summary, the FEIS, including its alternatives analysis, is a comprehensive document that fully meets the spirit, intent and requirements of NEPA.

3. Use of Scott AFB/MAA

Citizens questioned why Mid-America Airport (MAA) could not be used as an alternative to supplement or replace Lambert.

The FAA believes that the effects of the future development of MAA on Lambert have been fully considered in the FEIS. The use of other airports, including MAA, as a hub or to supplement Lambert is not considered a viable alternative to the planned development of Lambert. At the present time, it appears that the capital investment required, the travel distance involved, and the impact on airline hub operations exceed the benefits derived. However, all airports in the St. Louis area were examined in the FEIS to determine their capability to handle commercial traffic.

In order to be carried through for detailed analysis, an alternative had to meet all the purposes and needs for the proposed action. Alternatives eliminated during Tier 1 of the analysis did not meet aviation-related project purposes and needs and were not considered reasonable. All off-site alternatives were found to be unreasonable alternatives in terms of the first tier of the analysis. In the EIS, we discussed specifically how the off-site alternatives, such as MAA, did not maintain a passenger hub at Lambert, a key component of the project need. If a proposed alternative could not enable Lambert to effectively function as a hub by safely accommodating projected levels of aviation activity at an acceptable level of delay, then it would serve no purpose to carry that alternative forward for detailed evaluation.

The lack of a sponsor for airport expansion in another political jurisdiction is a reality that the FAA is authorized to consider under CEQ regulations and the rule of reason. The FAA has received correspondence from St. Clair County, the operator of MAA (which is a joint-use facility with Scott AFB), that indicates it supports Lambert as the regional hub (FEIS Appendix A, pages A-20 and A-21). There has been no correspondence from St. Clair County or any other political entity in the region that indicates the desire to be the sponsor of such a hub airport.

Section 3.3.3 of the FEIS contains a thorough analysis of the MAA alternative. Also, comments on this alternative were received after release of the DEIS and FAA provided explanation of its elimination from consideration in FEIS Appendix V responses to Comments 2-3, 2-33, 2-45, 2-60 and 2-120.

4. Selection of Modified S-1 alternative

Some groups favored the Modified S-1 alternative, which was supported by ALPA, and believed FAA should select that alternative rather than Alternative W-1W.

An analysis contained in Section 3.3.4.3 of the FEIS details the environmental impacts associated with the Modified S-1 alternative. ALPA has proposed two versions of the Modified S-1 plan. It was estimated that the 1993 version would involve the purchase of nearly twice the number of homes, and the overall environmental impact would greatly exceed Alternative S-1. While the 1996 version would affect substantially fewer homes, simple review of the Modified S-1 plan reveals that it would so severely impact I-70 that the cost and construction difficulties make it unreasonable and also less desirable than Alternative S-1. As indicated in the FEIS analysis, this alternative would have significantly greater environmental impacts when compared to Alternative S-1. Therefore, after examination of the Modified S-1 alternative, the FAA eliminated it from further consideration, because there were no operational or cost advantages when compared to Alternative S-1.

These comments do not present significantly new issues. Similar comments were made on the DEIS. FAA previously provided responses to those comments (FEIS Appendix V responses to Comments 2-5, 2-27, 2-104, 2-140 and 2-155).

5. Selection of Alternative NE-1a

NATCA and other commenters suggested that FAA should select Alternative NE-1a as its preferred alternative. In comments provided on the DEIS, NATCA outlined numerous reasons why it believes that runways separated by 2,500 feet would meet Lambert's needs.

Although Alternative NE-1a provides only a 2,500-foot separation between the outboard runways, it was included and studied in detail in the MPS at the request of the airlines. One of the purposes of the proposed action is to increase IFR capacity, as well as VFR capacity. Alternative NE-1a was eliminated from detailed environmental analysis in the DEIS because it provides less than the 3,400-foot separation needed for simultaneous, independent arrivals in either IFR or VFR weather conditions.

In comments provided on the DEIS, NATCA outlined numerous reasons why it believed that runways separated by 2,500 feet would meet Lambert's needs. FAA's detailed responses to NATCA's comments are provided in responses to Comments 1-52, 2-157 and 2-158 in the FEIS Appendix V. Other FEIS Appendix V responses to comments that discuss Alternative NE-1a include Numbers 2-27, 2-40, 2-89, 2-90, 2-119, 2-126 and 2-139. In response to these comments, FAA conducted further analysis of NE-1a in the FEIS (FEIS Section 3.3.4.1). The analysis indicated that Alternative NE-1a increases the number of runway crossings over existing conditions, as well as over Alternative W-1W. Additionally, more significant interactions between arrivals and departures would be expected with NE-1a as compared to the other alternatives. Thus, the FAA did examine the alternative preferred by NATCA, NE-1a, but eliminated it from further consideration.

6. Selection of the Lambert 2020 alternative

The City of Bridgeton stated that the FAA should select the Lambert 2020 alternative, which was proposed by the City of Bridgeton.

The City of Bridgeton's Lambert 2020 Plan as submitted was very general in nature. However, the Lambert 2020 Plan is very similar to Alternative NE-1a, particularly as to runway location. The Lambert 2020 Plan calls for a third parallel runway in the same location as Alternative NE-1a. It does not meet the purpose and need, primarily because the runway spacing would only be 2,500 feet, which would not permit simultaneous, independent arrivals in poor weather conditions.

Section 3.3.4.5 of the FEIS provides further details regarding the elimination of this alternative. The Lambert 2020 plan was also previously discussed in FEIS Appendix V responses to Comments 2-24, 2-109 and 2-141.

7. EPA concerns with noise impact analysis and noise mitigation program

The EPA expressed concerns that the noise impact analysis and noise mitigation program, as described in the DEIS, werenot adequate. Those concerns were addressed in the FEIS, Appendix V, responses to Comments 3-77, 3-78, 3-79, 3-87 and 3-99.

The EPA was under the impression from the DEIS that the FAA deferred mitigation to a Part 150 study, which was not our intention. The FEIS states that mitigation for the EIS is separately required and not dependent upon a Part 150 study (Section 6.3.1 of the FEIS).

Regarding noise impacts, the FAA believes it provided a comprehensive analysis of noise impacts, including an analysis of the areas that will experience a 3-dB increase in the 60 to 65 DNL contour. Although it was not the type of analysis that the EPA expressed an interest in seeing, FAA believes that the extended analysis is within the framework of the Federal Interagency Committee on Noise (FICON) guidelines and public disclosure requirements under NEPA.

With respect to the EPA's suggestion for clarification of proposed mitigation, as stated in the FEIS, the FAA has determined that the mitigation programs will consist of: (1) for areas 70 DNL and higher, residential and residentially zoned areas will be acquired; and (2) for areas 65-70 DNL, a voluntary mitigation program (sound insulation or residential sales transaction assistance) will be offered for residences and community facilities, including schools, and mobile home parks will be acquired. For areas between 60-65 DNL, we have determined that mitigation measures are neither appropriate nor practical. We note also that the STLAA has an ongoing, FAA-approved FAR Part 150 Noise Compatibility Program, which already provides mitigation for existing and future noise impacts around the airport.

The FEIS noise mitigation program was explained to EPA staff, who concurred that it is sufficient. Therefore, the FAA believes its noise analysis and mitigation program adequately meet the spirit, intent and disclosure requirements of NEPA.

The development of Alternative W-1W will not reverse ongoing efforts to provide relief to residents impacted by existing airport noise. The airport is continuing with its Part 150 program, approved by the FAA in 1997, to address noise issues related to existing airport operations.

The STLAA is planning to install a new permanent noise monitoring and flight tracking system, intended to assist in the management of its noise program and monitor the effectiveness of operational noise mitigation measures, such as directing aircraft to turn over the Missouri River bottoms. Once a full year's noise and flight track data showing the actual noise levels and flight tracks resulting from the operation of the new west runway are available and have been analyzed, an adjustment will be made to the mitigation program, if appropriate.

8. Increases in noise and overflights in communities west of Lambert

Citizens in communities west of the airport, such as Bridgeton, St. Charles and Maryland Heights, question the noise analysis and believe there will be large increases of noise and overflights in their communities

The noise exposure analysis was prepared by Greiner and reviewed and approved by the FAA. Flight tracks were developed by Greiner under the direction of the FAA, utilizing information from FAA Air Traffic Control Specialists, analysis of Automated Radar Terminal System (ARTS) data and information gathered during field observations. The FAA's Integrated Noise Model (INM) was used to model dispersed flight tracks, which represent corridors of aircraft flight activity. Departure and arrival flight tracks used in the noise analysis represent average conditions, including both instrument and visual flight conditions. Flight tracks for Alternative W-1W were developed based on a 3-parallel runway configuration. The aircraft operations mix was developed through coordination with the FAA ATCT, airlines, the Missouri Air National Guard and other airport users. Information was also obtained from aircraft manufacturers regarding aircraft performance characteristics of existing and new generation aircraft. Projections of future operations were closely coordinated with the FAA and aircraft operators. Therefore, the noise exposure analysis and noise exposure maps contained in the FEIS are based on the most accurate information available regarding the current and predicted future operation of the airport. The flight paths projected do represent annual average conditions. We note, however, that flight paths may change from day to day because of wind, weather or other conditions.

Although noise measurements are not required for an FEIS, since the airport has had a permanent Noise Monitoring System, data collected by the Noise Monitoring System were used for the EIS. The purpose was to provide validation of, or adjustments to, the data base provided in the INM computer model. On-site noise measurements provided data to compare with that provided by the prediction model for the existing condition. Measured values were compared with the noise levels derived from the INM. On the basis of this comparison, it was concluded that the measured values of these sites were within reasonable conformance with values calculated by the computer program. No manual adjustments not already included in the computer model were required due to terrain or climatic variations. The INM noise analysis results correlated to within 1 dB of the actual monitored results (Section 4.2.4.2 of the FEIS).

Airplanes will fly over St. Charles or Maryland Heights. Departing flight tracks will not be concentrated over the central portions of the City of St. Charles. For the existing runways and the proposed new runway, departure corridors to the southwest would be over the Missouri River Bottoms. This would generally place aircraft over the Missouri River Bottoms, rather than over the City of St. Charles. Departure Track T46, as shown in Figure 5.7 of the FEIS, will be located over St. Charles. Tracks T47, T48 and T49 are also departing flight tracks from Runway 30W, which do not go over the City of St. Charles. As indicated in the FEIS Appendix F, Table F.21, of all the departures on Runway 30W, only 33 percent of general aviation and small and medium commercial jets will utilize Track T46. All large commercial jets and military jets, as well as 67 percent of general aviation and small and medium commercial jets departing from Runway 30W, will utilize Tracks T47, T48 and T49, which do not impact the City of St. Charles.

In summary, after Runway 12W/30W is operational, certain neighborhoods in St. Charles and other communities west of the airport will be overflown more directly and at shorter slant ranges than they are at present. Because of the effects of the introduction of quieter Stage 3 aircraft, noise levels are projected to decrease in future years. With the implementation of Alternative W-1W and the increased percentage of Stage 3 aircraft, the FEIS grid point analysis conducted for locations C01 through C06 in St. Charles indicates that noise levels at these locations will be well below the DNL 65 dB threshold. By the year 2002, aircraft noise levels will have decreased to below DNL 60 dB, with or without Runway 12W-30W.

Similar comments previously received on the DEIS regarding noise increases and flight tracks were addressed in responses to Comments 3-17, 3-86, 3-93, 3-102, 3-103, 3-107 and 29-62 in Appendix V of the FEIS.

9. Current noise levels in St. Charles

According to an independent noise study commissioned by the City of St. Charles and prepared by Engineering Dynamics International (EDI), St. Charles is currently experiencing high noise levels.

The current noise situation in St. Charles is not associated with the proposed Runway 12W/30W alternative. While some areas in St. Charles may currently experience noise levels between DNL 60 and 65 dB, they are not related to the proposed expansion, including Runway 12W/30W.

Section 4.2.4.2 of the FEIS contains a detailed analysis of the existing noise environment in the Lambert study area. Based on the information contained in this section, the St. Charles area is outside the DNL 65 dB contour area. This conclusion is supported by the results of both the St. Charles County Government study, prepared by EDI, and the FEIS. The EDI report was considered by the FAA in its preparation of the FEIS. In Appendix V of the FEIS, responses to Comments 3-43 and 3-54 address the findings of the EDI report.

10. Inappropriate use of 65 DNL as cutoff for noise impacts or mitigation

St. Charles citizens expressed the opinion that DNL 65 is not an appropriate cutoff for noise impacts or mitigation.

NEPA requires Federal agencies to evaluate the environmental consequences of a project's environmental impacts and to determine whether they are potentially significant. In some impact categories, that significance is determined by reliance upon certain thresholds or standards. In this case, the FAA used the 1.5 dB or greater increases in noise within the DNL 65 dB.

In 1979, Congress directed the FAA to adopt regulations to establish standard methodologies for measuring noise and guidelines for determining noise levels at which land uses are compatible with various levels of noise exposure (*49 U.S.C. 47502*). In 1981, the FAA issued 14 CFR Part 150. Under FAA guidelines, residential land uses are compatible with noise exposure levels below DNL 65 dB. The FAR Part 150 guidelines were established after years of extensive consideration by various agencies (i.e., EPA, HUD, FAA) of the impact of aircraft noise on people. FAA's policy decision regarding the selection of DNL 65 dB as the threshold of significant noise impact is based upon a variety of noise studies such as <u>Impact of Noise on People</u> (USDOT, May 1977) and <u>Guidelines for Considering Noise in Land Use Planning and Control</u> (Federal Interagency Committee on Urban Noise, June 1980). This study states that "a valid indicator of noise impact is the changing percentage of population associated with a given response category." The study indicates that at DNL 65 dB, 30 percent of the population rate noise as unacceptable, while 70 percent rate noise as acceptable. Use of the 65 DNL contour as the threshold of significance under FAA Orders 1050.1D and 5050.4A, which implement NEPA, is well established and has been judicially approved.

As discussed below, a DNL grid point analysis was done for certain noise-sensitive locations, including some residential areas in St. Charles. However, the FAA properly determined not to analyze alternative mitigation measures in areas surrounding the airport like St. Charles that would experience less than significant cumulative noise exposure levels as a result of the proposed action. The FICON report indicates that few mitigation measures are appropriate or practical in areas below DNL 65 dB. Noise abatement adjustments to flight procedures tend to be viewed as the most likely candidates for mitigating noise at lower levels, because they are within Federal control and do not involve changes in land use. However, this tool also has limitations. In order for a noise abatement flight procedure to be considered for analysis, there should be a reasonable expectation that a noise benefit of worthwhile magnitude would result and that implementation of the procedure is appropriate and practicable. Procedural changes usually involve moving noise around rather than eliminating it and may actually result in noise increases for some people, while reducing noise for others. It is generally expected that Federal priority will be given to mitigating noise at higher levels. It would not normally be a mitigating practice to increase the impacted population at higher noise levels in order to reduce increases at lower noise levels.

Recognizing that residents located outside the DNL 65 contour experience noise exposure, the FAA did examine noise at residential and other noise-sensitive facilities located in areas less than DNL 65. The noise impacts to St. Charles that can be expected with the implementation of Alternative W-1W are evaluated in Appendix Q of the FEIS. Table Q-1 in Appendix Q of the FEIS indicated that DNL levels will increase at three of the six grid points analyzed. However, in no instance was the DNL level in excess of DNL 60 dB with the proposed action. The table also indicates that the DNL level will decrease at three of the six grid point locations, again, with none of the locations experiencing DNL levels greater than DNL 60 dB with the proposed action. Therefore, residential land uses in St. Charles are compatible under Federal guidelines and no mitigation is required. No mitigation is warranted in St. Charles.

Comments on the DEIS stated that DNL 65 dB is not an appropriate standard for the examination of noise impacts or the establishment of the mitigation program for the Lambert expansion. The FAA explained this issue in the responses to Comments 3-10, 3-45, 3-56, 3-58, 3-67, 3-100, and 3-101 in Appendix V of the FEIS.

In summary, DNL is an appropriate noise metric and DNL 65 dB is an appropriate standard of significance. The FICON report states in Section 3 Airport Noise Policy Recommendations, “All Federal agencies have now adopted DNL as the metric for airport noise analysis in NEPA (EIS/EA) documents.”

11. Use of supplemental metrics for speech interference and sleep disturbance

Commenters requested that FAA should use supplemental metrics to determine speech interference and sleep disturbance impacts in St. Charles.

In keeping with the guidance provided by FICON, the use of supplemental metrics (such as single-event analysis) is best left to the discretion of individual agencies. At the onset of the study, and again later in the study after additional information was available, the FAA made a policy decision that the noise analysis in the FEIS would be based on DNL contour analyses. The FAA further found that the use of supplemental metrics to analyze noise conditions in the City of St. Charles was not necessary. However, in response to comments received on the DEIS, the FAA did prepare a DNL Grid Point analysis for several sites located within St. Charles County. The results of this analysis, contained in Appendix Q of the FEIS, indicate that DNL levels at each of the six modeled locations would be below DNL 60 dB for both the 2002 and 2015 study years.

<u>Time-Above Analysis</u> - The FAA's decision that a Time-above analysis is not needed in St. Charles is based upon the results of the DNL grid point analyses, which indicate that St. Charles will experience noise levels below DNL 60 dB. The time-above analysis has no standards or guidelines against which it can be compared, so it provides relatively limited information.

<u>Speech Interference and Sleep Deprivation</u> - As discussed above, supplemental noise analysis was done by evaluating noise impacts and noise-sensitive areas in St. Charles (FEIS Appendix Q). This analysis confirmed that the cumulative noise exposure levels will not exceed DNL 60 dB with the proposed action.

The FEIS does not include supplemental noise analysis concerning speech interference or sleep deprivation in St. Charles. <u>Impact of Noise on People</u> (USDOT May 1977) indicates that below DNL 65 dB less than 10 percent sentence interference occurs outdoors with normal voice level and 2 meters separation. Indoor interference does not begin to appear until the DNL 70 dB level is reached. At these levels of cumulative noise exposure, only 8 percent of the population experience sleep disruption at DNL 65 dB and only 1 percent at DNL 55 dB. At levels below DNL 60 dB, less than 2 percent sentence interference occurs outdoors with normal voice level and 2 meters separation. Based on these indicators, the FAA decided that the FEIS did not need to analyze potential speech interference or sleep deprivation impacts in areas surrounding Lambert that would be exposed to aviation noise at levels below DNL 60 dB.

With regard to the St. Charles historic river front district, in particular, the FAA did not analyze speech interference or sleep deprivation impacts for that area, because the INM grid analysis included in Appendix Q of the FEIS indicates that St. Charles will be below DNL 60 dB. The FICON report states in Section 3 Airport Noise Policy Recommendations, "...because public health and welfare effects below DNL 60 dB have not been well established, the FICON decided not to recommend evaluation of aviation noise impacts below DNL 60 dB." Since St. Charles is below DNL 60 dB with the proposed airport noise exposure, further evaluations of aviation noise impacts, such as speech interference and sleep deprivation effects, in St. Charles were not deemed necessary for the FEIS.

In addition, although not required, STLAA has committed to monitor noise for one year and to adjust the boundaries of the noise mitigation program in the unlikely event that actual noise levels exceed those predicted in the FEIS.

12. Unacceptable noise and vibration impacts in the St. Charles historic district, the Goldenrod Showboat and Frontier Park

Citizens of St. Charles believe that noise and vibration impacts will be unacceptable in the St. Charles historic district and two of its unique resources, the Goldenrod Showboat and Frontier Park.

The issues of noise exposure and vibrations on the City of St. Charles and its historic district have been thoroughly discussed throughout the FEIS (Sections 5.1 and 5.5). The effects of Alternative W-1W on the City of St. Charles, including noise and vibration impacts, are also documented in FEIS Appendix Q and FEIS Appendix V in numerous responses to comments, such as numbers 3-17, 3-43, 3-54, 3-56, 3-57, 3-58, 3-68, 36, 11-2, 11-6, 23-46, 23-47, 23-53, 23-54, 23-55, 23-56, 23-57, and 23-58.

The FAA uses 1.5 dB increases in the DNL 65 dB noise contour as the standard for evaluating the effects of increases in aircraft noise on historic properties used as residences and for outdoor music areas or amphitheaters, fulfilling the requirements of 36 CFR 800.9. This is based on FAA's land-use compatibility guidelines under 14 CFR Part 150. For other historic properties, the FAA considers whether noise or other impacts due to the proximity of the project substantially impair the activities, features, or attributes of the resource.

The historic properties in the City of St. Charles, including the Goldenrod Showboat, are not expected to be within the DNL 65 dB noise contour as a result of Alternative W-1W. The results of the FAA's noise analysis indicate that with the proposed W-1W improvements, cumulative aircraft noise levels will be below DNL 60 dB in the St. Charles historic district, including the Goldenrod Showboat and Frontier Park. DNL grid sites in St. Charles for future years 2002-2015 will range between DNL 48 and 58 dB (FEIS Appendix Q). Therefore, neither the Goldenrod Showboat, a national historic landmark used for performances, nor Frontier Park, used for festivals, will be significantly impacted by the project.

There are no impacts in St. Charles that require mitigation, and there will be no new substantial incompatible land uses as defined by FAR Part 150 guidelines. Impact of Noise on People (USDOT May 1977) indicates that at levels below DNL 60 dB, less than 2 percent sentence interference occurs outdoors with normal voice level and 2 meters separation. Indoor sentence interference will occur even less frequently as a result of the exterior-to-interior noise reduction provided by the Goldenrod Showboat. Aircraft noise levels of this magnitude will not have a significant impact on the many plays and events that occur on the Goldenrod Showboat or the festivals in Frontier Park.

One commenter noted that people occupy and care for many of the historic buildings. Under FAA noise compatibility guidelines, these buildings will continue to be compatible land uses appropriate for residential homes. Therefore, the proposed alternative will have no effect on historic properties within the City of St. Charles. The Missouri SHPO and the Advisory Council have concurred with the FAA on the area of potential effect, which encompassed land areas above DNL 65 dB.

To summarize, regarding noise impacts on historic properties in St. Charles, noise levels below DNL 60 dB are not considered significant. All land uses, including historic properties, are considered compatible with noise levels below DNL 60 dB. Given that noise levels in St. Charles are projected to be below DNL 60 dB with Runway 12W/30W in operation, it is unlikely that noise will significantly impact the daily lives of the citizenry of St. Charles, their carefully preserved national historic district, or the annual outdoor celebrations of their heritage. Therefore, the FAA has concluded that the new runway will not significantly affect the heart of St. Charles or its national historic district.

Regarding vibration impacts, generally, overflights by fixed-wing, subsonic aircraft do not generate vibration levels of the frequency or intensity to result in damage to structures. It has been found that exposure to normal weather conditions, such as thunder and wind, usually have more potential that could result in significant structural vibration than aircraft. Two recent studies that involved the measurement of vibration level resulting from aircraft operations upon sensitive historic structure concluded that aircraft operations do not result in significant structural vibration. Additional details regarding this comment are addressed in Section 5.1.6, Vibration Resulting from Aircraft Operations, in the FEIS.

13. Effect of Bridgeton's planning and zoning laws on airport expansion

The City of Bridgeton believes that the effects of its planning and zoning laws on the proposed Lambert expansion were not adequately considered by the FAA and STLAA.

In April 1996, the City of Bridgeton sued the City of St. Louis to block the proposed expansion plan. The lawsuit alleged that City of St. Louis officials were taking away Bridgeton's constitutional right to determine how its land is used, by expanding the airport onto land not zoned for airport use. The City of Bridgeton stated that Missouri law gives its residents control over airport expansion by allowing city officials to determine whether any land is zoned for airport use. The suit asserted that Missouri Revised Statutes, Section 305 prohibits the City of St. Louis from building an airport or landing field in any city in violation of zoning regulations. Since the proposed airport acquisition area in Bridgeton has not been zoned for airport use by the City of Bridgeton, the City of Bridgeton asserted that the proposed expansion plan cannot be built. The suit also claimed that the right of the City of Bridgeton to determine this zoning is guaranteed by the Missouri State Constitution and State statutes, and that as a Constitutional Charter City, Bridgeton is granted by the Missouri Constitution (Article VI, Section 19(a)) full authority to designate zoning within its borders.

The City of St. Louis moved to dismiss the lawsuit on the grounds that it was premature before the FAA issues its Record of Decision. On the merits, St. Louis maintained that the Missouri courts held in a previous suit of a similar nature, that upon balancing the needs of a community, i.e., a local city versus the needs of a metropolitan area for an airport, the needs of the metropolitan area are superseding.

The court dismissed the case, stating that until the FAA issues a ROD, no legal grounds exist to try the case. The outcome of the litigation does not affect the decisions of the FAA following completion of the FEIS. Whether the City of St. Louis is required to obtain a local permit is, in the circumstances, a matter of local law and is not relevant to the approval of the Federal actions pertaining to the expansion of Lambert. The FAA assumes that if the ordinances are finally determined to be applicable to the City of St. Louis, then the City of St. Louis will comply with them or will be exempted.

For the reasons discussed above, there may be little or no inconsistency with local plans. With regard to any restrictions on land acquisition by the City of St. Louis for essential aviation safety and aircraft operation purposes, the FAA notes that such planning policies may be of questionable applicability and legal validity, both under state and Federal law.

This issue was covered previously in the FEIS Sections 5.2.5.1 and 5.2.5.3 and in FEIS Appendix V responses to Comments 5-53, 6-23, and 6-24.

14. Effects of Alternative W-1W on the City of Bridgeton

The City of Bridgeton and its citizens commented that Alternative W-1W would destroy a large part of Bridgeton and there would be effects on the Bridgeton City Hall/Police Station complex.

The FAA acknowledges that Alternative W-1W will cause significant impacts to the City of Bridgeton including community disruption; displacement of residents; acquisition of community properties, parkland, historic properties, and community facilities; and changes to the local road network. Section 6.3 of the FEIS outlines specific measures to mitigate these impacts.

The FAA recognizes that people's lives will be adversely affected by the acquisition of their homes. The FAA will take all measures available to ensure that the STLAA minimizes the impacts as much as possible and to ensure that programs are implemented in a fair and equitable manner. The disruption of established neighborhoods and displacement of residents will be mitigated by ensuring that all property acquisitions and relocations are implemented according to the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970. The airport has committed to expediting and streamlining the acquisition process, after project approval, to minimize the amount of time residents will have to remain in neighborhoods where acquisition would be required. A relocation plan, developed in accordance with the Uniform Relocation Act, will be designed to minimize relocation impacts as much as possible. The relocation counselor assigned to each resident will provide advisory assistance to alleviate the stress associated with moving to a new location.

Because there will be a small area of new residential noncompatible land use in Bridgeton, the FEIS includes specific mitigation for the residential portion of Bridgeton that will be impacted by levels above DNL 65 dB (Section 6.3.1 and Figures 6.2 and 6.3 in the FEIS). Mitigation is not included for the portions of Bridgeton that will be impacted by noise levels below DNL 65 dB, because they are considered a compatible land use.

Section 5.3 of the FEIS discusses the acquisition of commercial properties in Bridgeton. All properties acquired will be entitled to fair market value, including commercial properties, and will be subject to the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970.

The realignment and/or closure of portions of the local roadway network will be minimized in order to reduce the impacts to the local communities. Those roadways that will be removed are associated with facilities within the acquisition areas. Other areas will be adequately served by the relocated roads. Prior to the construction of any proposed roadway improvements, MoDOT will develop a Maintenance of Traffic Plan designed to reduce impacts of roadway construction and maintain access during construction (Section 6.3.13 of the FEIS).

The effects on Bridgeton City Hall/Police Station complex were previously addressed in the FEIS Appendix V, responses to Comments 5-43, 29-46, 29-58 and 29-74. Alternative W-1W will not have a direct impact on the Bridgeton City Hall. The FEIS indicates that with the proposed action Bridgeton City Hall would be in the 70 DNL noise contour. Unless the existing structure includes noise attenuation of 25 dB, City Hall would be rendered incompatible in light of its governmental services and office uses, even without noise insulation measures. St. Louis will offer to provide any necessary soundproofing and is willing to work with Bridgeton to relocate City Hall, if necessary.

Parks and recreation facilities to be impacted by Alternative W-1W are described in Section 5.7 of the FEIS. The City of Bridgeton has been consulted regarding these impacts and the potential candidate mitigation sites. The proposed candidate mitigation sites are described in detail in the Section 303 and 6(f) Evaluation, which was released concurrently with the FEIS, and summarized in Section 6.3.5 of the FEIS.

The FAA has considered alternatives that avoid historic properties. As discussed in the Section 303 document, the FAA determined that due to environmental and social consequences, there was no prudent or feasible alternative to avoid the following historic properties in the City of Bridgeton: the Bridgeton Inn, the Airport News Building, the Emmanuel Blum House, the Blum Store, and the De Hatre House, which are eligible for inclusion in the National Register of Historic Places; and the Village à Robert Cemetery (which encompasses the current Bridgeton Memorial Park), which is eligible for inclusion in the National Register of Historic Places under National Register Criterion D. Therefore, there will be an adverse effect on these historic properties, pursuant to 36 CFR 800.9(b). Treatment measures for these adversely affected historic properties are included within the MOA for the selected alternative, W-1W. The MOA was signed by FAA, the SHPO, and the Advisory Council. The STLAA signed as a concurring party. The City of Bridgeton was invited to participate as a concurring party to the MOA, but it chose not to concur in the MOA. The Advisory Council executed the MOA on May 29, 1998. A copy of the MOA is included in Appendix H of this ROD.

15. People Building Community survey objections

People Building Community objects to a survey accomplished as part of the MPS, and referenced in the FEIS, which claims that the majority of residents want to be acquired. A detailed description of this survey, conducted in October 1995, by a subcontractor to the MPS consultant, is contained in Section 8 of the MPS. People Building Community wants FAA recognition of the results of the Peters Marketing Research Survey showing strong Bridgeton opposition to expansion. The FAA's responses to comments on the FEIS submitted by People Building Community are contained in Appendix A of this ROD.

The FAA did not rely on the results of the referenced survey to make its decision. Its existence was only mentioned in the FEIS for informational purposes. Its mention was not intended to minimize or dismiss the concerns of neighboring communities. While the conduct of social surveys might provide information of interest to area residents, the information would not alter or affect the conclusions of an EIS process. The purpose of the EIS was to analyze the potential environmental impacts of the proposed improvements upon the communities surrounding the airport. In some cases, there were no impacts to the communities. In others, there were even positive effects overall. Where there were significant adverse impacts, the EIS examined mitigation to lessen the adverse impacts. The FAA's EIS identified the anticipated impacts associated with the alternatives analyzed and outlined the proposed measures for mitigation for significant impacts associated with the Alternative W-1W.

It is recognized that the impact categories of principal concern to neighboring residents are noise and land acquisition. The social impacts resulting from the airport development would include the displacement of persons, homes, businesses, and community facilities. These would be mitigated by ensuring that all property acquisition and relocations be implemented according to the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970.

The FAA recognizes that the acquisition/relocation process can be a difficult and emotionally upsetting experience for homeowners. As part of its land acquisition programs, the STLAA offers advisory services to those being relocated. Part of that advisory service is to notify those relocatees of special programs being offered by different agencies. This includes first-time home buyer programs, loan information, and assistance in understanding the various documents.

The FAA has acknowledged throughout the EIS process that some segments of the community strongly oppose the proposed plan. The comments provided by agencies, associations, elected officials and individuals have been thoroughly evaluated by the FAA during the EIS process and have been carefully considered in the development of this ROD. This included the FAA's review of the results of the Peters Marketing Research Survey, which People Building Community requested the FAA to consider. This survey was conducted to determine how many Bridgeton residents feel about the airport expansion.

The FAA acknowledges that there are also residents in the area of the proposed expansion, including Bridgeton residents, who feel they have been held hostage by the expansion process. Given the length of time needed to prepare the planning studies on the proposed expansion, this is understandable. The STLAA has received approximately 250 letters from residents, who indicated that they either need or want to move from their residence because of different hardship situations (STLAA letter dated

July 9, 1998, in Appendix I). The STLAA has received inquiries from another 150 residents, who wish to have their property purchased and move on with their lives. Many of those citizens have also called the FAA's Regional Office over the last several months to express those same views to the FAA decisionmakers on the ROD. The Let's Get On With Our Lives group, which consists of over 1,200 people living in the area proposed for acquisition, has requested that the FAA make a final decision on the Lambert as quickly as possible so that they can relocate (Don Vandervort letter, dated July 9, 1998, in Appendix I).

The FAA has carefully assessed and considered both sides of the issue in making its decision. Fair consideration has been given to the interests of communities in or near the project location throughout the EIS process.

16. Bridgeton's non-concurrence in DOT Section 303/DOI Section 6(f) process

Bridgeton has notified the FAA that it cannot concur in the DOT Section 303/DOI Section 6(f) process, because it believes that the alternative selected did not safeguard park land and other resources warranting special protection. Bridgeton commented on this issue after release of the DEIS, and its position has not changed since that time. For FAA's responses to Bridgeton's comments on this issue, see FEIS Appendix V, numbers 2-78, 10-10, 10-26, 10-27 and 10-34.

FAA environmental documents must provide evidence that replacement of affected Section 6(f) lands to the satisfaction of the Secretary of the Interior will be accomplished. Through its grant agreements, the FAA will require STLAA to comply with mitigation provisions of the FEIS related to replacement of Section 303 and Section 6(f) lands.

As documented in the Section 303/Section 6(f) Evaluation and the FEIS Section 5.7, the FAA will require STLAA to provide the responsible jurisdiction with the funds necessary to replace the converted land. In this case, the City of Bridgeton is considered to be the project sponsor, or subgrantee. It is generally held that in the event the subgrantee is unable or unwilling to replace the converted property, the State becomes fully responsible for actual replacement. Since the City of Bridgeton has declined to participate in the process of selecting and securing replacement lands, responsibility for replacement falls upon the MDNR. If Bridgeton continues to decline to participate in the process, the FAA will require STLAA to provide the funds to the MDNR for replacement of converted lands, providing that conversions-in-use are approved.

On January 28, 1998, the Department of Interior provided its final comments on the FEIS, the Section 303/Section 6(f) Evaluation, and the Section 106 process. Appendix

A of the ROD contains the DOI letter and FAA's responses to those comments. The receipt of DOI's comments completes consultation under Sections 303/6(f).

17. Bridgeton's non-concurrence in MOA for historic/archaeological resources

The City of Bridgeton notified the FAA that it could not concur in the MOA for proposed improvements at Lambert, because the City did not agree with the selection of Alternative W-1W.

As discussed in Section 6 of this ROD, on May 29, 1998, the Advisory Council executed the MOA for the proposed improvements at Lambert (Appendix H of this ROD). Other signatories to the MOA are the FAA and the Missouri SHPO. The STLAA signed the MOA as a concurring party.

The MOA stipulates measures to be implemented to avoid, reduce, or mitigate the adverse effects from this project on historic properties. The SHPO, the Council, the STLAA, and the City of Bridgeton have been consulted on the MOA and provided comments on the agreement document throughout its development (FEIS Appendix N-1, November 18, 1997, letter from MDNR, and November 14, 1997, letter from City of Bridgeton). The FAA solicited final comments on the MOA from the consulting parties, including the City of Bridgeton. As noted above under response to Comment 14, the City of Bridgeton chose not to sign the agreement.

On June 10, 1998, the FAA notified the following parties that the MOA for the Section 106 process had been executed by the Advisory Council: Deputy SHPO at MDNR; DOI; MoDOT, STLAA, and Bridgeton. By entering into and having STLAA carry out the terms of the Agreement, FAA has fulfilled its responsibilities under Section 106 of the National Historic Preservation Act and the Advisory Council's regulations.

18. Analysis of special purpose laws

Compliance with special purpose laws (e.g., for wetlands, water quality, and floodplains) was raised in comments on the DEIS, which are addressed in the FEIS Appendix V response to Comment 2-78.

All of the development alternatives studied in detail have unavoidable impacts on resources protected under Section 303 of the Department of Transportation Act and Section 6(f) of the Land and Water Conservation Fund Act. There are no possible or prudent alternatives to the use of these resources. Of the development alternatives, Alternative W-1W would use approximately half the park and recreational resources and acres required for S-1.

All of the reasonable alternatives have unavoidable wetland impacts due to the proximity of wetlands to the airport. Consequently, there are no practicable alternatives to filling of wetlands. Of the development alternatives evaluated, Alternative W-1W would have the least amount (acreage) of wetland impacts. This information is displayed in Table S.1A of the FEIS (Appendix J of this ROD, page S-9).

Impacts of the project on water quality have been examined in Section 5.6 of the FEIS. See also response to Comment 9-6 in Appendix V of the FEIS. The MDNR also provided its assurance that state water quality standards would be met with the project (MDNR letter dated November 20, 1997, in Appendix A of the FEIS). On August 11, 1998, the Governor of the State of Missouri provided a letter to the FAA certifying that there is reasonable assurance that the proposed construction and operation of the expansion of Lambert will be located, designed, constructed and operated so as to comply with applicable water quality standards (Governor's letter dated August 11, 1998, in Appendix I of this ROD.)

Potential impacts on floodplains were thoroughly evaluated in the FEIS. There is no practicable alternative to the floodplain impacts of the proposed project. Mitigation measures to minimize the floodplain impacts can be accomplished for each alternative so that the floodplain encroachment would not be considered significant. The floodplain mitigation measures are described in the FEIS Section 6.3.8. See also response to Comment 25-4 in FEIS Appendix V.

19. Adequacy of air quality conformity determination

The City of Bridgeton believes the air quality conformity determination prepared by the FAA is inadequate.

Bridgeton's comments on air quality issues were addressed in the FEIS Appendix V responses to Comments 7-18, 7-19, and 7-31 and in the Final General Conformity Determination. Based on EPA, MDNR, and other comments on the DEIS, the FAA has revised and supplemented the air quality analysis in the FEIS and prepared a Draft and Final General Conformity Determination. These documents and supporting underlying material are available for public review. Both EPA and MDNR indicated that the Draft General Conformity Determination was adequate. The Governor has also certified a reasonable assurance that the project will be designed, built, and operated in conformance with applicable air quality standards (Appendix I of this ROD).

The FAA has been very diligent in addressing air quality concerns. In response to comments made by the City of Bridgeton on the DEIS, the FAA revised its air quality analysis to address the effects of FAA Safety Notice N7110.157, "Wake Turbulence," upon the operational assumptions for air quality emission inventories. This notice, which was issued during preparation of the DEIS, has the effect of reducing airport capacity due to recategorization of certain aircraft types and a resulting increase in separation standards. The Safety Notice results in potentially constraining the 2015 No-Action Alternative at approximately 532,000 operations a year instead of 595,000 as originally projected in the DEIS. The results of the revised analysis show that, with the exception of NOx emissions in 2015, the development alternatives improve air quality in the St. Louis area in comparison with the No-Action Alternative. This is largely the result of increased airfield operational efficiency and reduced delay periods (FEIS Section 5.5.6).

In consultation with the EPA and MDNR, the FAA prepared Draft and Final General Conformity Determinations to address emissions associated with Alternatives S-1 and W-1W, specifically focusing on NOx, CO and VOCs. In December 1997, the FAA issued its Draft General Conformity Determination, along with the FEIS. In June 1998, the FAA issued the Final General Conformity Determination. It was subsequently announced in the *St. Louis Post Dispatch*. By issuing this Final Determination, the FAA has fulfilled its affirmative responsibilities to assure conformity of proposed Federal actions under Section 176(c) of the Clean Air Act, as amended in 1990.

20. Concerns of EPA regarding FAA's air quality modeling assumptions in DEIS

The EPA had questions regarding the assumptions used by FAA in its air quality modeling assumptions in the DEIS.

Based upon the EPA comments received on the air quality analysis in the DEIS, the FAA revised and supplemented information in the FEIS. That information was summarized in the FEIS Section 5.5, and is included in Appendices A and M. The FEIS Appendix V contains responses to EPA's comments on the DEIS (Comments 7-18, 7-69, 7-72, 7-73, 7-81 and 7-85).

Regarding air quality modeling, while EPA agreed that there would be no significant air quality impacts associated with the proposed project, it stated that its conclusion was based on air modeling done by MDNR. The Emissions Dispersion Modeling System (EDMS) is the FAA's preferred model for performing air quality analysis on airports and was utilized in this case for developing project emission inventories for NEPA and general conformity purposes. The development alternative would reduce carbon monoxide (CO) emissions compared to the No-Action and the project so that the project was clearly *de minimis* for CO under general conformity requirements. Although no further analysis was necessary, in response to requests from EPA and MDNR the FAA also conducted a microscale dispersion analysis to address "CO hotspots." It was determined, with EPA's concurrence, that the CAL3QHC and ISCST3 models would be appropriate to conduct this dispersion analysis. Based on the entire assessment of air quality, including modeling, we concluded that there would be no significant impacts to air quality in the St. Louis area. The modeling conducted by MDNR provided independent, definitive, corroboration of the conclusion. The EPA and MDNR have agreed that inclusion in this ROD of the results of the modeling done by MDNR resolves the air quality concerns expressed in EPA's letter dated February 27, 1998.

As noted above, MDNR provided its assurance that state air quality standards would be met with the project (MDNR letter dated November 20, 1997, in Appendix A of FEIS). On August 11, 1998, the Governor of the State of Missouri provided a letter to the FAA certifying that there is reasonable assurance that the proposed construction and operation of the expansion of Lambert will be located, designed, constructed and operated so as to comply with applicable air quality standards (Governor's letter dated August 11, 1998, in Appendix I of this ROD.)

As discussed in number 19 above, on June 19, 1998, the FAA made its Final General Conformity Determination. A legal notice announcing the Final General Conformity Determination was published in the *St. Louis Post Dispatch* on June 29, 1998. By publishing this Final Determination, the FAA has fulfilled its responsibilities under Section 176(c) of the Federal Clean Air Act.

Therefore, the FAA believes that the analysis of air quality impact satisfies the requirements of NEPA, including public disclosure requirements, and other air quality statutes.

21. Length of FEIS review period

Citizens commented that thirty days to review the FEIS was too short and believed the FAA ignored their comments.

FAA carefully reviewed all comments made by the public and local, state, and Federal agencies during the EIS process. The DEIS was available for review and comment from September 27, 1996 through January 17, 1997. A public hearing, attended by over 1580 people, was held, affording each of them the opportunity to provide written or verbal comments to court reporters. The FAA then carefully reviewed over 15,000 letters received on the DEIS. The FAA aggregated these comments and concerns into 29 major categories for review and written response by qualified personnel. All suggestions were taken into consideration and changes were made to the FEIS where appropriate. In addition, the FEIS was revised in some instances to make it clearer and easier to read and understand. All letters, as categorized, were available for public review at Lambert and at the FAA Regional office in Kansas City, Missouri. All comments received, whether in the form of testimony given to the court reporters at the public hearing or in the form of letters, were summarized, and responses were provided in the FEIS Appendices S, T, U, and V. Appendix W contained a list of commenters. The FEIS Volumes 1, 2, and 3 were available at 21 city halls and 11 libraries.

The 30-day review period after release of the FEIS is not a public comment period, but rather a minimum period that a Federal agency must wait before issuing a Record of Decision. The FEIS review period is required by CEQ regulation to be no less than 30 days. The review period for this FEIS was approximately 58 days. Late filed comments were considered as practicable. Much of the material provided to the public in the FEIS was not new information, as it was simply clarification or enhancement and refinement of material already in the EIS or was in other documents available during review of the DEIS. CEQ regulations permit the FAA to summarize and respond to comments in the FEIS.

Appendices A and B of this ROD contain responses to comments received during the FAA's review or "waiting" period. Appendices C, D, E and G of this ROD contain responses to comments from ALPA, NATCA, Bridgeton Air Defense, the City of Bridgeton, the City of St. Charles, the St. Charles County Executive, and U.S. Congressman Talent. All comments received by the FAA were reviewed and considered during the decision-making process for this ROD.

22. Inappropriate public hearing format

Commenters stated that the public hearing format was inappropriate. They would have preferred a "town hall" format. Commenters indicated that the FAA failed to provide an adequate opportunity for public input in a "formal" public hearing; therefore, they concluded that fair consideration had not been given to the interests of the communities near the project location.

The FAA recognizes that the "town hall" format is the more traditional approach. However, the format the FAA chose to use was equally acceptable and appropriate. The FAA exceeded NEPA requirements, which do not require Federal agencies to conduct public hearings, when it held the public hearing for the proposed action at Lambert. Federal agencies have wide latitude to structure public hearings as appropriate to facilitate public input for consideration in the decision-making process.

The public hearing was also held to afford an opportunity for a public hearing "to consider the economic, social and environmental effects of the [project] and the [project's] consistency with the objectives of any planning that the community has carried out" (*49 U.S.C. 47106(c)(1)(A)(I)*). The City of St. Louis must certify that this opportunity was provided to qualify for eligibility to receive funds for major airport development projects under the FAA's Airport Improvement Program.

Title 49 U.S.C. 47106(c)(1)(A)(I) does not dictate the manner in which the hearing should be held. No case law requires that a "town hall" or any specific type of hearing take place. The public hearing held for the proposed project met and exceeded the statutory standard that opportunity be provided to consider the effects of the proposed action. The record demonstrates that such opportunity was provided in this case.

The public hearing was held near the airport during the hours of 3 p.m. to 8 p.m. on October 28, 1996. Approximately 1,580 people attended. It was held in an open meeting format. The public could interact with FAA personnel and FAA's consultants at numerous displays or stations, and react to hearing materials provided, presentations made, and the DEIS. Persons could leave written comments, provide oral comments to court reporters, or submit written comments to FAA up until January 17, 1997.

Citizens accessed the public hearing area from an entryway where they were given a proposed project information packet, which contained information about the public hearing format, how to make public comments and a copy of the FEIS Summary about the proposed project itself. Citizens then proceeded through a videotape area, which provided additional information about the proposed project.

In the large hearing room, FAA employees and government contractors, who were involved in the environmental study process, were present the entire time to answer questions and explain exhibits, which were provided to give further information about the proposed project. Government representatives were clearly identified by name tags and circulated through the hearing room to provide opportunity for face-to-face information exchange. All government representatives and contractors present responded to all information sought from them and answered all questions asked of them. This format allowed citizens to view the materials and absorb information at their own pace. Citizens were able to talk to government and contractor representatives directly to obtain meaningful information exchange. In addition, the format allowed citizens to confer among themselves or in small groups with government or contractor representatives in an open forum.

In the middle of the hearing room, all citizens were given opportunity to provide written comments on the proposed project or comments of other persons. In an adjacent area, four court reporters were available to record verbal comments. Citizens had the choice to comment in writing, or verbally to a court reporter. This hearing format provided meaningful, informed community input to this public project. The public was informed about potential economic, social and environmental impacts of the proposed project by government representatives through the information packet, information displays and exhibits and the face-to-face interaction and information exchange. The opportunity for public comment was afforded in an orderly and open manner. All citizens who wished to comment at the hearing were provided with the opportunity to do so.

The format of the public hearing was selected to allow the attendees to view the materials at their leisure and talk to study team members. In addition, the format allowed for the attendees to talk among themselves and study team members in an open forum. Citizens had the choice to comment in writing or verbally to a court reporter. These are the same choices that would have been available had the FAA used an alternate format.

All comments received were responded to in the FEIS. In this way, informed public comments generated by the public hearing process were communicated to the public and taken into account by decision-makers. The public hearing provided ample opportunity to consider the "economic, social and environmental effects" of the proposed project (*40 U.S.C. 47106(c)(1)(A)*).

For a review of FAA's responses to comments received specifically regarding the public hearing format, see FEIS Appendix V Comments 21-17, 21-26, 21-27, 23-17, and 23-23.

23. Potential conflict of interest for FAA contractor

St. Charles Executive Ortwerth believes that FAA's contractor had a conflict of interest, because data compiled by Greiner were used in the MPS, as well as the EIS, and because St. Louis paid Greiner.

Specifically the commenter argues that Greiner had a conflict of interest for the following reasons:

- Greiner could not assist the FAA in accomplishing an independent review of alternatives as the FAA claims in FEIS response to Comment 2-72 because in April 1995 Greiner prepared an environmental evaluation of alternatives and baseline environmental information for the MPS.

- The MPS indicates that Greiner prepared the environmental evaluation of alternatives. Greiner did not prepare the information for the EIS then provide it to St. Louis as claimed in response to Comment 23-39 of the FEIS because Greiner did the work in April 1995 and scoping for the EIS began in September 1995.

- Greiner was intimately involved in developing the justification for the project; there is no evidence to justify that the FAA conducted an independent review of alternative studies of the alternatives rejected; very little independent work has been generated that distinguishes the EIS from the MPS prepared by the City of St. Louis.

- Greiner was paid by the project sponsor.

Under 40 CFR 1506.5(c) if a Federal agency decides to select a consultant to prepare the EIS, the consultant must “execute a disclosure statement ... specifying that [it has] no financial or other interest in the outcome of the project. A consultant with a known conflict of interest “should be disqualified from preparing the EIS.” (CEQ 40 Questions, 46 Federal Register 18,026 18,031)

Whether there is a conflict of interest depends upon the definition of “financial or other interest” under 40 CFR 1506.5(c). In 1981, the CEQ interpreted the provision “broadly to cover any known benefits other than general enhancement of reputation.” (CEQ 40 Questions 46 Federal Register at 18,031). Even then, the CEQ instructed agencies that contractors may bid in competition with others for future work on a project if the contractor has “no promise of future work or other interest in the outcome of the project.” (40 Questions at 18,031). Subsequently, the CEQ clarified that, absent an agreement to perform construction on the proposed project or actual ownership of construction site, it is “doubtful that an inherent conflict of interest will exist” unless “the contract for the EIS preparer contains ... incentive clauses or guarantees of any future work on the project.” (Guidance Re: NEPA Regulations, 48 Federal Register 34,263 34,266, CEQ, 1983).

In this case, after a competitive bidding process, the FAA selected URS Greiner in November 1992 to prepare the EIS. Greiner’s contract was executed with STLAA in 1993.

In April 1995, the FAA requested that Greiner prepare preliminary environmental evaluations so that the FAA could begin to meet its responsibilities to evaluate other reasonable alternatives in preparation for the EIS. To assure consistency in the environmental analysis done as part of the ongoing Part 150, environmental and master planning studies, the FAA had Greiner submit this baseline environmental information and its environmental analysis of alternatives to St. Louis for use in its master planning and airport noise compatibility (14 CFR Part 150) studies. This practice was instituted several years ago as a practical matter to ensure consistency between the two processes. It arose, in part, as a result of a lawsuit filed by the City of Bridgeton, which challenged approval of the use of passenger facility charges for noise mitigation projects. The major issue was the adequacy of the environmental analysis, because the noise analysis done by the consultant that prepared the Part 150 study differed from that done by another consultant as part of a concurrent environmental study.

This practice does not constitute a conflict of interest. URS Greiner has executed the disclosure statement required under 40 CFR 1506.6(c) specifying that it has no financial or other interest in the outcome of the project. URS Greiner's only assignment at Lambert has been to assist the FAA in the EIS and at no time during the Lambert expansion process have they been involved in any other contract that could be construed to represent a conflict of interest. There have been no guarantees of future work or incentive clauses in the EIS contract.

While Greiner did prepare the environmental overview for the FAA, which was used as an appendix in the MPS, it did not participate in the STLAA's development of the airport facility needs or the selection of its preferred alternative for the project. Nor did Greiner's preparation of this factual information interfere with its ability to assist the FAA in using its judgment to independently review the range of primary and secondary alternatives to decide which to analyze in the FEIS. The FAA was actively participating in the MPS process at this point. This participation included independent operational analysis and input regarding the development and analysis of alternatives. Once the MPS was submitted to the FAA, as required, the FAA then independently reviewed and analyzed the development alternatives identified in the MPS as well as exploring other alternatives not identified in the MPS. These alternatives included different runway layouts, construction of a new airport facility as well as some publicly submitted alternatives. For a discussion on FAA involvement in the analysis of alternatives, see Section 3.0 of the FEIS.

Moreover, preparation of this information did not give Greiner any incentive to promote the Alternative W-1W over the No-Action Alternative. Providing information to St. Louis, at the FAA's direction, did not result in an enforceable promise, contract, or expectation of future work on the project or other interest in the outcome of the project so as to compromise the integrity of the NEPA process.

To the extent that FAA's practice could be perceived to give rise to a conflict, the FAA exercised a sufficient degree of supervision to cure any defect arising from the perceived conflict and preserve the objectivity and integrity of the NEPA process.

When an agency is integrally involved in the preparation of an EIS, that involvement diminishes the threat posed by any potential conflicts of interest because the agency then has the opportunity to direct the analysis and supplement areas it deems deficient. The record indicates that FAA exercised substantial supervision over the preparation of the EIS. Even after Greiner was hired, FAA continued to perform all management activities and only used Greiner's personnel for technical expertise or to supplement staff where there was insufficient manpower. FAA managers made all major decisions involved in the FEIS and Greiner's representatives reported to those managers, sometimes on a daily basis, to receive direction. Throughout the environmental process, approximately 90 percent of one FAA environmental program manager's work hours were dedicated solely to managing Greiner and its work products. Other FAA personnel, including airport planning specialists and air traffic controllers, reviewed and corrected Greiner work products, as needed. In addition, FAA prepared, without Greiner's assistance, those portions of the FEIS addressing airport planning and air traffic control issues, particularly responses to comments in FEIS Appendix V. The FAA independently and extensively reviewed all of Greiner's analyses, commented on Greiner's field data and written product, noted deficiencies in the data and analyses, gave direction to the work, and frequently required Greiner to gather more facts or perform supplemental analysis on aspects of the project. This degree of supervision exercised by the FAA protected the integrity and objectivity of the EIS.

Finally, with respect to the commenter's final point, the payment of Greiner by the City of St. Louis does not present a conflict of interest. Greiner was selected by the FAA to prepare the EIS using a common practice known as third-party contracting. Under this practice, the City of St. Louis entered into a contract with Greiner to fund work done on the EIS under the direction and supervision of the FAA. Approved by CEQ, third-party contracting is utilized by many Federal agencies during the preparation of an EIS (40 CFR 1506.5(c) and Forty Most Asked Questions No. 16). So long as the lead agency, or in certain cases the cooperating agency, selects the consulting firm to do the work, the project sponsor is permitted to pay the consultant. Once selected, the preparer's responsibility is to the lead agency to prepare an EIS that complies with NEPA. Third-party contracting is a voluntary practice that is ultimately beneficial to both the agency and the applicant. By paying for the preparation of the EIS, the applicant ensures that movement of its application will not be determined by the budgetary constraints of the agency it is dealing with. At the same time, the agency in question is able to focus its resources on analysis and evaluation rather than the preparation of the EIS.

In this case, the FAA selected Greiner to prepare the EIS. Greiner's responsibility was solely to the FAA to prepare an EIS that met NEPA regulations and FAA's NEPA procedures. As required by CEQ regulations, a memorandum of understanding (MOU) was executed between St. Louis and FAA setting out the procedures to be followed during the third-party contract process. Under the MOA, it was the FAA's responsibility to determine the scope of the EIS, evaluate all environmental data and analysis submitted by Greiner or St. Louis, and to revise or cause additional study and analysis to be performed as necessary.

In conclusion, none of the commenter's concerns have raised issues sufficient to show that the objectivity and integrity of the NEPA process has been compromised.

Greiner's actions were within the scope of its duties. It has properly disclosed that it had no interest, financial or otherwise, in the outcome of the project. The FAA independently evaluated the alternatives analysis and exercised supervision over Greiner's work.

This matter is also discussed in response to the City of St. Charles FEIS Comment FL0004, Comments 28 through 36 of this ROD.

24. <u>FAA realizes Lambert will not operate as planned and must prepare a revised or supplemental EIS</u>

According to commenters, the FAA has revealed that Lambert will not operate as planned and must withdraw and revise the FEIS or prepare a supplemental EIS to address the proposed new runway use. Specifically, ALPA, NATCA and the City of Bridgeton indicate that the FAA now plans to use the new Runway 12W/30W primarily for arrivals, instead of exclusively for departures in west flow during VFR 1 and 2 conditions (good weather) as analyzed in the MPS and the FEIS. As proof, the City of Bridgeton relies upon an excerpt from a preliminary draft memorandum prepared by Leigh Fisher Associates dated June 16, 1998. The memorandum states, in relevant part, "For W-1W, the Tower representatives recommended assuming no significant use of visuals to the close parallels (see response to Comment 7 below)." The commenters claim that this change in runway use would significantly impact communities southeast of the airport and requires a revised or supplemental EIS.

The commenters are correct that the environmental impacts in the FEIS, including the noise contours (or footprint), were predicated upon the assumption that the new runway would be used primarily, but not exclusively, for departures during good weather and in west flow. Thus, there would be some arrivals to the new runway. The FAA has not changed its plans for runway use. The statement in the Leigh Fisher Associates preliminary draft memorandum cannot be read in isolation, but rather in the broader context of the sensitivity analysis and related hypothetical assumption concerning arrival rates to which it relates. Appendix C of this ROD clarifies that although this assumption was made, it was only for purposes of modeling. The original assumptions in the MPS and FEIS remain valid. That the FAA elected to include a scenario that featured use of outboard runways during visual conditions and west flow (the "W-1W Outboards Case," see Appendix C, response to Comment 7), did not reflect an FAA realization, decision or intention to change the planned operation of new Runway 12W/30W.

This statement "For W-1W, the Tower representatives recommended assuming no significant use of visuals to the close parallels" is best understood in the context of the related comment from ALPA to which it also responds. As part of its 18 concerns, ALPA also commented that the MPS and FEIS incorrectly assumed that visuals to the existing closely spaced runways would be independent and arrive at a rate of 80 per hour and should have assumed a rate of 60 per hour instead. This change in assumption clearly would have the effect of increasing delays at the existing airport and under Alternative W-1W. By the referenced statement, the controllers at the June 15 meeting meant that, if the arrival rate during visual and west flow use of the closely spaced existing parallel runways was assumed to be only 60 aircraft per hour, then they agreed with ALPA that it should also be assumed that they would try to minimize delays by using the new runway more for arrivals than for departures. That is, to boost the arrival rate they would seek to use both outboard runways (the existing 30R and the new 30W) primarily for arrivals in west flow during VFR-1 and 2 conditions, instead of limiting its use to departures. The capacity studies done for the MPS estimated an arrival rate of 72 aircraft an hour, not 80 as asserted by ALPA.

Internal agency deliberations after the June 15, 1998, meeting and the preparation of this preliminary draft memorandum by St. Louis' consultant, including discussions with the Air Traffic Division of the Central Region, have confirmed that the FAA has not changed plans to operate Alternative W-1W. Those discussions have also confirmed that the assumptions used in the MPS and FEIS are reasonable and reflect the proposed operation of the airport. The results of the sensitivity analysis confirm that an arrival rate of 60 per hour is an unreasonable assumption. It results in delays greater than those currently experienced at the airport now. This issue is discussed in more detail in Appendix G, response to Comment 7.

11. THE AGENCY FINDINGS

In accordance with applicable law, the FAA makes the following determinations for this project, based upon the appropriate information and data contained in the FEIS and the administrative record.

A. The project is consistent with existing plans of public agencies for development of the area surrounding the airport (*49 U.S.C. 47106(a)(1)*).

The determination prescribed by this statutory provision is a precondition to agency approval of airport project funding applications. It has been the long-standing policy of the FAA to rely heavily upon actions of metropolitan planning organizations (MPOs) to satisfy the project consistency requirement of *49 U.S.C. 47106 (a) (1*) [see, e.g., *Suburban O'Hare Com'n* v. *Dole*, *787 F.2d 186, 199 (7th Cir., 1986)*]. Furthermore, both the legislative history and consistent agency interpretations of this statutory provision make it clear that reasonable, rather than absolute consistency with these plans is all that is required.

Under the provisions of both Federal and state law, the East-West Gateway Coordinating Council (EWGCC) has been designated as the MPO for the St. Louis metropolitan area and given primary responsibility for transportation planning in the region. On December 3, 1997, the EWGCC notified the FAA that it endorsed the EIS on the basis that it represented an accurate assessment of the related costs, operational feasibility, and community and environmental impacts. Furthermore, the EWGCC's board had voted to support Alternative W-1W (FEIS Section 5.2.5.3). Thus, Alternative W-1W is reasonably consistent with the plans of public agencies having broad geographic responsibilities in the area.

If the focus is limited to municipalities where land would be acquired for airport expansion, four of the five municipalities (St. Ann, Edmundson, Berkeley, and Hazelwood) have land-use policies for the acquisition areas consistent with W-1W. Alternative W-1W is not consistent with the zoning plans of the City of Bridgeton, but it is not clear that as a matter of state law, Bridgeton is authorized to enforce a zoning plan that is inconsistent with needed airport development.

The FAA finds that the project is reasonably consistent with the existing plans of public agencies authorized by the state in which the airport is located to plan for the development of the area surrounding the airport. The FAA is satisfied that it has fully complied with *49 U.S.C. 47106 (a)(1).*

With regard to this issue, however, the FAA has also reviewed the substantial documentation in the administrative record demonstrating that throughout the environmental process the STLAA has shown concern for the impact of the proposed development actions on surrounding communities. Moreover, the STLAA has attempted to ensure consistency of its project proposals with the planning efforts of neighboring communities. The administrative record for this ROD includes details of coordination between the STLAA and neighboring jurisdictions concerning local planning proposals, along with documents describing the public meetings, hearings, and other means by which public participation in project planning was accommodated. Further discussion of consistency of the proposed development projects with public agency planning is summarized in the FEIS Section 5.2.5.3.

The proposed Lambert expansion lies almost totally within the boundaries of the City of Bridgeton. The extent to which City of Bridgeton regulations apply to Lambert Airport development is unresolved. Meanwhile, the STLAA has offered to assist the City of Bridgeton in land-use planning activities, to address any issues relating to the proposed Lambert development.

The City of Bridgeton has engaged in land-use planning actions, which appear designed to limit airport expansion. Its local plans and ordinances establish zoning policies (a prohibition on use of lands acquired by public entities to be used for new commercial activities). These ordinances purport to restrict the use of some lands within Bridgeton's jurisdiction (e.g., for the new runway), needed by the STLAA in order to implement important safety and aircraft operation aspects of its preferred alternative.

In any event, it is not clear that the development actions proposed in the MPS would be subject to any of the plans and ordinances adopted by the City of Bridgeton. Thus there may be little or no inconsistency with local plans. Implementation of STLAA's preferred alternative would not be expected to result, after mitigation, in any significant increases of noise on land of these neighboring jurisdictions. With regard to any restrictions on land acquisition by STLAA for essential aviation safety and aircraft operation purposes, the FAA notes that such planning policies may be of questionable applicability and legal validity, both under state and Federal law.

In making its determination under *49 U.S.C. 47106 (a) (1)*, the FAA has considered the fact that local governments have been represented on the EWGCC and have participated as members of that organization in its decision to authorize the new runway project at Lambert (although some of these local governments may have disagreed, as individual EWGCC members, with that ultimate decision). The FAA has also recognized the fact that none of these jurisdictions has regulatory authority over airport operations, since long-established doctrines of Federal preemption preclude these communities from regulating aircraft operations conducted at Lambert.

Given the FAA determination in this ROD, under appropriate Federal law, that there is a compelling need for the proposed Lambert improvements, as documented in the FEIS, it is inappropriate for local communities to attempt to exercise local zoning control in a manner which would conflict with the domestic and international aviation requirements of this airport. If there were a conflict between Federal and local policies, the local policies must give way to the Federal policies, under the doctrine of Federal preemption.

B. The interest of the communities in or near where the project may be located was given fair consideration (*49 U.S.C. 47106(b)(2)*).

The determination prescribed by this statutory provision is a precondition to agency approval of airport development project funding applications. The regional planning process over the past decade and the environmental process for this project-specific EIS, which began in 1995 and extended to this point of decision, provided numerous opportunities for the expression of and response to issues put forward by communities in and near the project location. Nearby communities and their residents have had the opportunity to express their views during the DEIS public comment period, at a public hearing, as well as during the review period following public issuance of the FEIS. The FAA's consideration of these community views is set forth in FEIS Appendices J, U, and V and in Appendices A, B, C, D, E and G of this ROD.

Thus, the FAA has determined that throughout the environmental process, beginning at its earliest planning stages, fair consideration was given to the interest of communities in or near the project location.

C. The State of Missouri has certified in writing that there is reasonable assurance that the project will be located, designed, constructed and operated in compliance with applicable air and water quality standards (*49 U.S.C. Section 47106(c)(1)(B)*).

The determination prescribed by this statuary provision is a precondition to agency approval of airport development project funding applications involving a new runway. By letter dated August 11,1998, (Appendix I of this ROD), after consultation with the MDNR (the Governor’s designated agency for air and water quality), the Governor of Missouri, certified that there is a reasonable assurance that the project will meet all applicable air and water quality standards.

The FAA concludes that the airport project evaluated in the FEIS will be located, designed, constructed and operated so as to comply with applicable air and water quality standards.

D. Effect on Natural Resources (*49 U.S.C. Section 47106(c)(1)(C)*).

Under this statutory provision, after consultation with the Secretary of the Interior and the Administrator of the EPA, the FAA may approve funding of a new runway having a significant adverse effect on natural resources, only after determining that no possible and prudent alternative to the project exists and that every reasonable step has been taken to minimize the adverse effect.

As documented in the FEIS, FAA has consulted extensively with both Interior and EPA. For several natural resource impact categories with established significance levels, the FAA finds that, without implementation of the mitigation summarized in Section 6.3 of the FEIS, the selected alternative would have a significant adverse effect. However, given the inability of other alternatives discussed in the FEIS, to satisfy the purpose and needs of the project, we have concluded that no possible and prudent alternative exists to development of the proposed alternative. As discussed in Section 6 of this ROD, and documented throughout the FEIS and the administrative record, every reasonable step has been taken to minimize adverse environmental effects resulting from the project.

In order to consider further mitigation under NEPA, and to address any possible adverse environmental effects resulting from the projects approved in this ROD, the FAA has decided to condition such approval upon the mitigation measures described in Section 6.3 of the FEIS and in Section 6 of this ROD. This conditional approval will be enforced through a special condition included in future Federal airport grants and PFC "use" approvals to the STLAA.

The FAA has determined that all reasonable steps have been taken to minimize any adverse effects on natural resources through mitigation.

E. Appropriate action, including the adoption of zoning laws, has been or will be taken to the extent reasonable to restrict the use of land next to or near the airport to uses that are compatible with normal airport operations (*49 U.S.C. Section 47107(a)(10)*).

The sponsor assurance prescribed by this statutory provision is a precondition to agency approval of airport development project funding applications. In addition to the actions described in Section 11.A of this ROD, the STLAA has worked extensively with local jurisdictions to develop and implement plans and policies to ensure compatible land use in the airport vicinity.

FEIS Section 5.2 describes the current status of zoning and land use planning for lands near the airport. The Airport has an existing noise compatibility program, designed to either reduce noise at the source or mitigate the noise received by sensitive land uses in the airport vicinity. As explained in the FEIS Section 6.3.1, with planned mitigation, development of the project will not result in any increased significant impacts on non-compatible land uses.

The FAA requires satisfactory assurances, in writing, that appropriate action, including the adoption of zoning laws, has been or will be taken to restrict, to the extent reasonable, the use of land adjacent to or in the immediate vicinity of the airport to activities and purposes compatible with normal airport operations, including landing and takeoff of aircraft. Appendix I of the FEIS contains Lambert's land use compatibility assurance.

Based upon the administrative record for this ROD, the FAA has concluded that existing and planned noise reduction programs at Lambert provide for appropriate action to ensure compatible land use in the airport vicinity.

F. Clean Air Act, Section 176 (c) (1) Conformity Determination Regarding Lambert-St. Louis International Airport Master Plan Supplement Development Actions (*42 U.S.C. Section 7506(c)*).

The determination prescribed by this statutory provision is a precondition for Federal Agency support or approval of airport development actions which are projected to exceed the *de minimis* air emission levels prescribed at 40 CFR Section 93.153. The EPA regulations more generally governing the conformity determination process are found at 40 CFR Part 93, Subpart B.

In the 1997 FEIS, the FAA made a Draft General Conformity Determination on the Lambert MPS proposals (FEIS Sections 5.5.6 and 5.5.7). Pursuant to EPA regulations, the FAA announced the availability of the Draft General Conformity Determination in the *St. Louis Post Dispatch*, and provided notice to appropriate Federal, state and local public agencies. The agencies and the general public were invited to review and comment on the Draft General Conformity Determination. Comments received on the Draft General Conformity Determination and responses to those comments are presented in the Final General Conformity Determination. The FEIS Appendix A presents letters from the EPA (dated November 7, 1997) and MDNR (dated November 20, 1997). In their letters, these air quality agencies concurred with the conformity determination analysis conclusions for general conformity under the Clean Air Act. The Final General Conformity Determination was prepared and a notice of the FAA's determination was published in the *St. Louis Post Dispatch* on June 28, 1998. No comments or requests were received regarding the Final General Conformity Determination.

In order to achieve public disclosure and to address community concerns, the FEIS presented an analysis of air quality impacts utilizing the regulatory structure set forth in the EPA conformity regulations. The FEIS analysis (Section 5.5) demonstrates that the project would not cause or contribute to any new exceedances of air quality standards. As confirmed by the MDNR, the project conforms to the Missouri SIP.

Because projects at Lambert are governed by the moderate non-attainment designation for ozone and the maintenance area designation for carbon monoxide, the FAA needed to determine that the project will not cause or contribute to any new violations of the NAAQS in the project area or the metropolitan area. The FEIS and other supporting documentation provided the FAA the information needed to make that determination. The computer modeling predicted that the carbon monoxide NAAQS would not be exceeded in the future with or without the proposed improvements. The FEIS showed that the project will not increase the frequency or severity of any existing violations of any NAAQS and that the project will not delay timely attainment of the NAAQS or any required interim emission reduction in the project area.

Based upon the air quality information and discussion presented in the FEIS and its appendices, the Final General Conformity Determination, and upon supporting material in the administrative record, the FAA finds that the development actions will not cause or contribute to any air quality standards being exceeded and conform to the Missouri SIP and the NAAQS.

G. For this project, involving new construction which will directly affect wetlands, there is no practicable alternative to such construction. The proposed action includes all practicable measures to minimize harm to wetlands that may result from such use. (Executive Order 11990, as amended).

This executive order requires all Federal agencies to avoid providing assistance for new construction located in wetlands, unless there is no practicable alternative to such construction, and all practicable measures to minimize harm to wetlands are included in the action.

The FEIS, Section 5.11 documents that the preferred development alternative selected by the STLAA from the MPS will directly affect approximately 9.7 acres of wetlands. The FEIS alternatives analysis (FEIS Section 3.3) identifies no reasonable alternative to developing a new runway at Lambert. The FAA additionally concludes that there is no practicable alternative to constructing such a runway, resulting in these wetland impacts, given the purposes and needs documented in the FEIS, consideration of environmental and economic factors, and land-use issues.

The FEIS, Section 5.11 states that the S-1 development alternative of a 9,000-foot runway would result in impacts to more wetlands (10.8 acres) than would Alternative W-1W (9.7 acres). The FEIS demonstrates that these are low quality wetlands. Two of their significant functions, floodwater attenuation and floodwater storage, would be fully mitigated within the airport basin. Additionally wetland functions for these wetlands will be mitigated as part of the overall wetlands mitigation program.

Alternatives of staggering runway ends or relocating the entire runway are not practicable, because, among other reasons, they would increase delays, have additional detrimental environmental effects, require considerable additional cost and complicate air traffic control procedures. Considering these and other reasons described more fully in Section 3.0 of the FEIS, and taking into consideration cost, existing air traffic control and aviation technology and logistics, in light of the overall purpose of the runway project, the FAA finds that there is no practicable alternative to the wetland loss associated with the 9,000-foot runway.

As noted in the FEIS Section 5.11, the COE has worked with the FAA as a cooperating agency to ensure that all practicable measures will be taken to minimize harm to wetlands, impacted through development of the selected alternative. This will be accomplished by using BMPs during construction and developing a wetland compensatory mitigation site. Following issuance of this ROD, the COE, in consultation with the MDNR, will complete its processing of a Section 404 permit, required for the STLAA to proceed with development impacting wetlands. The project approvals in this ROD and this wetlands determination are expressly conditioned upon permit approval and conditions to be outlined by the COE, and upon the STLAA accomplishing the wetlands mitigation measures identified in the FEIS and any COE permit approval.

Although it is generally preferable to attempt to mitigate wetland loss through replacement wetlands in the same watershed, this is not the case where such replacement would create man-made wetlands in the vicinity of airport aircraft movement areas. FAA Advisory Circular 150/5300-33, dated May 1, 1997, states the FAA's opposition to wetland mitigation projects located within 10,000 feet of airports serving turbine-powered aircraft (such as Lambert), due to the safety hazard such wetlands present as attractants of wildlife, which significantly increase the risk of bird/aircraft strikes.

The safety standards set forth in this FAA policy statement are recommended for the operators of all public-use airports. Furthermore, for airport sponsors who are the recipients of Federal grant funding, adherence to safety standards set forth in FAA advisory circulars is a requirement of standard grant assurance #34, as acknowledged in paragraph 4-6.a. of Advisory Circular 150/5200-33.

This recent agency policy guidance supports the FEIS determination that the replacement wetlands for the Lambert development actions should not be located in the vicinity of the airport. Given the potential hazard associated with the creation of wildlife attractions within 10,000 feet of jet runways, the FAA and COE agreed that it is prudent to permit the STLAA to replace these impacted wetlands outside of the Lambert watershed.

As detailed in the FEIS Section 6.3.7, a wetland mitigation program has been developed to offset the impacts of the project and to recognize other long-term biological problems. The mitigation plan calls for replacing the filled wetlands. Several candidate wetland mitigation sites have been examined. Final mitigation requirements will be determined during the Section 404 permit application and review process in consultation with the COE.

H. For this project, involving a significant encroachment on a floodplain, there is no practicable alternative to the selected development of the preferred alternative. The proposed action conforms to all applicable state and/or local floodplain protection standards. (Executive Order 11988).

This executive order, together with applicable DOT and FAA orders, establish a policy to avoid supporting construction within a 100-year floodplain where practicable, and where avoidance is not practicable, to ensure that the construction design minimizes potential harm to or within the floodplain.

Section 5.12 of the FEIS explains that, without mitigation, construction and operation of the MPS preferred alternative could result in adverse floodplain impacts in the Coldwater Creek floodplain.

As outlined in the "Alternatives" discussion in Section 5 of this ROD, and in the FEIS, there is no practicable alternative to the selected alternative. Development of this alternative achieves the purposes and needs for the projects in the most cost-effective manner with the least impact on the surrounding land uses. As shown in the FEIS Section 6.3.8, a mitigation program has been designed, which will create a floodplain so that there would be no net loss of flood storage capacity or increased risk of loss of human life or property damage. This program has been designed to comply with applicable requirements of the permitting agencies, with whom the FAA and the STLAA have been coordinating, in order to ensure that the construction design minimizes potential harm to or within the floodplain. Each of these agencies have agreed with the mitigation plan in concept, and coordination will continue throughout the permitting process.

I. Relocation Assistance (*42 U.S.C. Section 4601 et seq.*).

These statutory provisions, imposed by Title II of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, require that state or local agencies, undertaking Federally-assisted projects which cause the involuntarily displacement of persons or businesses, must make relocation benefits available to those persons impacted.

As detailed in the FEIS Section 5.3, the selected development alternative will displace approximately 2,324 households, 75 businesses, and 6 schools, 6 churches, and one nursing home.

The FAA will require Lambert to provide fair and reasonable relocation payments and assistance payments pursuant to the provision of the Uniform Relocation Assistance and Real Property Acquisition Policies Act. Comparable decent, safe, and sanitary dwellings are available for occupancy on the open market.

J. For any use of lands with significant historic sites, there is no prudent and feasible alternative to using the land; the project includes all possible planning to minimize harm resulting from the use (*49 U.S.C. Section 303(c)*).

The FEIS Section 5.7 concluded that the MPS development actions would involve either the use or constructive use of resources protected by this statutory provision, more commonly referred to as "4(f)" resources. The selected alternative would directly affect four park and recreation area Section 303 sites and indirectly affect four sites. One of the sites, Oak Valley Park, would have both direct and indirect effects. Three of the sites are also protected under Section 6(f) of the Land and Water Conservation Fund Act of 1965 (*16 U.S.C. Section 460l-8(f)3*).

In terms of avoidance alternatives, review of the tiered alternatives evaluation prepared in Section 3.0 of the FEIS indicated that there are no prudent and feasible alternatives to the identified impacts to Section 303 and 6(f) sites. The FAA has coordinated with the public and agencies having jurisdiction over the impacted sites to determine site significance and to develop mitigation measures necessary to meet Section 303 and 6(f) requirements. The agencies involved in the coordination were the DOI, the MDNR, the Council, STLAA, and the City of Bridgeton.

A coordination meeting with the City of Bridgeton was held on April 18, 1997, with the mayor and key staff members to discuss Draft EIS comments relative to Section 303/6(f) issues, and to solicit input from the City of Bridgeton regarding future plans and goals for their parks and recreation program. Items listed in the City of Bridgeton’s comprehensive plan were discussed regarding candidate mitigation options. The City of Bridgeton has stated that it will not initiate the Section 6(f) conversions for Lambert. Measures to minimize harm to Sections 303 and 6(f) resources are summarized in Section 6.3.5 of the FEIS.

As discussed at FEIS Section 5.8, the FAA determined the project will impact five structures of historic significance. Assuming such "historical significance" and such "use," the referenced FEIS Section 5.8 demonstrates that there is no prudent or feasible alternative to any such use. Furthermore, based upon the planned mitigation (discussed at FEIS Section 6.3.6), the FAA concludes that there has been all possible planning to minimize any harm resulting from use of historic or archaeological resources.

The Missouri SHPO has been consulted concerning these determinations. Treatment measures for these adversely affected historic properties are included within the MOA for the selected alternative, W-1W. It stipulates measures to be implemented to avoid, reduce or mitigate the adverse effects this project will have on historic properties. The MOA was signed by the FAA, the Missouri SHPO, and the Advisory Council. The STLAA signed as a concurring party. The City of Bridgeton was invited to participate as a concurring party to the MOA, but it chose not to concur in the MOA. The Advisory Council executed the MOA on May 29, 1998. A copy of the MOA is included in Appendix H of this ROD.

K. There are no disproportionately high or adverse human health or environmental effects from the project on minority or low-income populations. (Executive Order 12898).

Environmental justice concerns were addressed in Section 5.3 of the FEIS, and it was concluded that no minority or low-income group would be disproportionately affected by displacements occurring as a result of the selected alternative. The FEIS contains a discussion of environmental justice issues relative to the selected alternative. It was concluded that the impacts from the proposed MPS improvements will not disproportionately affect minority or low-income communities.

L. The FAA has given this proposal the independent and objective evaluation required by the Council on Environmental Quality. (40 CFR 1506.5).

As the FEIS outlined, a lengthy process led to the ultimate identification of the selected alternative, disclosure of potential impacts and selection of appropriate mitigation measures. This process began with the FAA competitive selection of an independent EIS contractor, continuing throughout the preparation of the DEIS and FEIS, and culminating in this ROD. The FAA provided input, advice and expertise throughout the planning and technical analysis, along with administrative direction and legal review of the project. From its inception, the FAA has taken a strong leadership role in the environmental evaluation of this project and has maintained its objectivity.

12. APPROVALS AND FAA ORDER

FHWA APPROVAL

I have carefully considered the FHWA's goals and objectives in relation to the surface transportation aspects of the proposed MPS development actions discussed in the FEIS. After careful review of Section 5.22 of the FEIS and Section 8 of this ROD, I find the surface transportation projects described in this ROD meet the FHWA's NEPA requirements.

[signature]
FHWA Approving Official

9-30-98
Date

FAA APPROVAL AND ORDER

Having determined that the agency's preferred alternative, Alternative W-1W, is the only possible, prudent, and practicable alternative, the remaining decision is whether to approve or not approve the agency actions necessary for implementation of the project. Approval would signify that applicable Federal requirements relating to airport development planning have been met, and would permit the City of St. Louis to proceed with the proposed development and possibly receive Federal funding for eligible items. Not approving these actions would prevent the City of St. Louis from proceeding with Federally supported development in a timely way.

I have carefully considered the FAA's goals and objectives in relation to various aeronautical aspects of the proposed MPS development actions discussed in the FEIS. These include the purposes and needs to be served by the projects, the alternative means of achieving them, the environmental impacts of these alternatives, the mitigation necessary to preserve and enhance the environment, and the costs and benefits of achieving these purposes and needs in terms of effective and fiscally responsible expenditure of Federal funds. I have also considered comments received by the FAA on the social, environmental and economic impacts of the proposed actions.

Therefore, under the authority delegated to me by the Administrator of the FAA, I find that the projects in this ROD are reasonably supported and approved. For those projects I, therefore, direct that action be taken to carry out the agency actions discussed more fully in Section 3 of this ROD, including:

A. Approval under existing or future FAA criteria of project eligibility for Federal grant-in-aid funds and/or PFC, including the following elements:

1. Land Acquisition
2. Site Preparation
3. Runway, Taxiway, and Runway Safety Area Construction
4. Landside Developments, including Roadways
5. Certain Navigational Aids
6. Acquisition/relocation of MoANG and Navy/Marine Corps Reserve Facilities
7. Terminal Facility Improvements and New Terminal Facilities
8. Environmental Mitigation

B. Approval of a revised ALP, based on determinations through the aeronautical study process regarding obstructions to navigable airspace, and no FAA objection to the airport development proposal from an airspace perspective.

C. Approval for relocation and/or upgrade of various navigational aids.

D. The development of air traffic control and airspace management procedures to effect the safe and efficient movement of air traffic to and from the proposed new runway, including the development of a system for the routing of arriving and departing traffic and the design, establishment, and publication of standardized flight operating procedures, including instrument approach procedures and standard instrument departure procedures.

E. Review and subsequent approval of an amended Airport Certification Manual for Lambert-St. Louis International Airport (per 14 CFR Part 139).

Finally, based upon the administrative record of this project, I certify, as prescribed by 49 U.S.C. 44502 (b), that implementation of the proposed project is reasonably necessary for use in air commerce.

Concur:

John C. Curry
John C. Curry
Regional Counsel, Central Region

Sept. 30, 1998
Date

Approved:

John E. Turner
John E. Turner
Regional Administrator, Central Region

Sep 30, 1998
Date

RIGHT OF APPEAL

This decision constitutes the Federal approval for the actions identified above and any subsequent actions approving a grant of Federal funds to the City of St. Louis. Today's action is taken pursuant to 49 U.S.C. Subtitle VII, Parts A and B, and constitutes a final order of the Administrator subject to review by the Courts of Appeals of the United States in accordance with the provisions of 49 U.S.C. Section 46110.

**U.S. Department
of Transportation
Federal Aviation
Administration**

NEWS:
PUBLIC AFFAIRS STAFF
Atlanta, GA

FOR IMMEDIATE RELEASE

Sept. 30, 1998
Contact: Kathleen Bergen
816-426-5626

FAA ISSUES RECORD OF DECISION ON LAMBERT-ST. LOUIS INTERNATIONAL AIRPORT

The Federal Aviation Administration has approved Lambert-St. Louis International Airport's proposed airside and landside improvements, commonly known as Alternative W-1W. This Record of Decision (ROD) in favor of W-1W deems the improvements eligible for federal financial assistance and commits the airport operator to specific conditions including environmental mitigation measures. The ROD was signed today by FAA Central Region Administrator John E. Turner.

The approved alternative was selected from numerous proposals considered during the environmental process. A central feature of W-1W is a new staggered parallel runway configuration, suitable for use by air carriers, to be located on the southwest side of the airport in Bridgeton, Mo. The plan also includes property acquisition, terminal expansion, roadway improvements and relocation of several airport tenants.

The principal features of the ROD, which is based on a review of the administrative record, including the Final Environmental Impact Statement, include:

- A statement of the agency's decision;
- Identification of all alternatives considered by the FAA, including the environmentally preferable one, and
- Mitigation measures planned to prevent or minimize environmental harm.

The FAA issued its Final Environmental Impact Statement on Dec. 19, 1997, finding that the city of St. Louis's proposed alternative met the requirements of the National Environmental Policy Act (NEPA).

By Oct. 14, 1998, the ROD will be available for review at the following locations:

The City Halls of:

Bel Nor; Bel-Ridge; Berkeley; Bridgeton; Calverton Park; Cool Valley; Edmundson; Ferguson; Greendale; Hazelwood; Kinloch; Maryland Heights; Normandy; Northwoods; Pasadena Hills; Village of Pasadena Park; St. Ann; St. John; Woodson Terrace; St. Charles City; St. Charles County.

Libraries:

St. Louis County: St. Louis County-Main Branch; Bridgeton Trails Branch; Florrisant Valley Branch; Indian Trains Branch; Indian Trains Branch, Lewis and Clark Branch; Prairie Commons Branch; Rock Road Branch.

St. Charles County: Kathryn Linnemann Branch; Kisker Road Branch; Spencer Road Branch.

Federal Agencies:

FAA Central Regional Office, 601 E. 12th St., Kansas City, Mo.; FAA Headquarters, 800 Independence Ave., Washington, D.C.

Lambert-St. Louis International Airport
Planning and Development Office, 4610 N. Lindbergh, Bridgeton, Mo.

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Memorandum of Agreement Between
the Federal Aviation Administration,
the U.S. Air Force,
the U.S. Army,
the U.S. Environmental Protection Agency,
the U.S. Fish and Wildlife Service, and
the U.S. Department of Agriculture
to Address Aircraft-Wildlife Strikes

PURPOSE

The signatory agencies know the risks that aircraft-wildlife strikes pose to safe aviation.

This Memorandum of Agreement (MOA) acknowledges each signatory agency's respective missions. Through this MOA, the agencies establish procedures necessary to coordinate their missions to more effectively address existing and future environmental conditions contributing to aircraft-wildlife strikes throughout the United States. These efforts are intended to minimize wildlife risks to aviation and human safety, while protecting the Nation's valuable environmental resources.

BACKGROUND

Aircraft-wildlife strikes are the second leading causes of aviation-related fatalities. Globally, these strikes have killed over 400 people and destroyed more than 420 aircraft. While these extreme events are rare when compared to the millions of annual aircraft operations, the potential for catastrophic loss of human life resulting from one incident is substantial. The most recent accident demonstrating the grievous nature of these strikes occurred in September 1995, when a U.S. Air Force reconnaissance jet struck a flock of Canada geese during takeoff, killing all 24 people aboard.

The Federal Aviation Administration (FAA) and the United States Air Force (USAF) databases contain information on more than 54,000 United States civilian and military aircraft-wildlife strikes reported to them between 1990 and 1999[1]. During that decade, the FAA received reports indicating that aircraft-wildlife strikes, damaged 4,500 civilian U.S. aircraft (1,500 substantially), destroyed 19 aircraft, injured 91 people, and killed 6 people. Additionally, there were 216 incidents where birds struck two or more engines on civilian aircraft, with damage occurring to 26 percent of the 449 engines involved in these incidents. The FAA estimates that during the same decade, civilian U.S. aircraft sustained $4 billion worth of damages and associated losses and 4.7 million hours of aircraft downtime due to aircraft-wildlife strikes. For the same period,

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[1] FAA estimates that the 28,150 aircraft-wildlife strike reports it received represent less than 20% of the actual number of strikes that occurred during the decade.

USAF planes colliding with wildlife resulted in 10 Class A Mishaps[2], 26 airmen deaths, and over $217 million in damages.

Approximately 97 percent of the reported civilian aircraft-wildlife strikes involved common, large-bodied birds or large flocks of small birds. Almost 70 percent of these events involved gulls, waterfowl, and raptors (Table 1).

About 90 percent of aircraft-wildlife strikes occur on or near airports, when aircraft are below altitudes of 2,000 feet. Aircraft-wildlife strikes at these elevations are especially dangerous because aircraft are moving at high speeds and are close to or on the ground. Aircrews are intently focused on complex take-off or landing procedures and monitoring the movements of other aircraft in the airport vicinity. Aircrew attention to these activities while at low altitudes often compromises their ability to successfully recover from unexpected collisions with wildlife and to deal with rapidly changing flight procedures. As a result, crews have minimal time and space to recover from aircraft-wildlife strikes.

Increasing bird and wildlife populations in urban and suburban areas near airports contribute to escalating aircraft-wildlife strike rates. FAA, USAF, and Wildlife Services (WS) experts expect the risks, frequencies, and potential severities of aircraft-wildlife strikes to increase during the next decade as the numbers of civilian and military aircraft operations grow to meet expanding transportation and military demands.

SECTION I.

SCOPE OF COOPERATION AND COORDINATION

Based on the preceding information and to achieve this MOA’s purpose, the signatory agencies:

A. Agree to strongly encourage their respective regional and local offices, as appropriate, to develop interagency coordination procedures necessary to effectively and efficiently implement this MOA. Local procedures should clarify time frames and other general coordination guidelines.

B. Agree that the term “airport” applies only to those facilities as defined in the attached glossary.

C. Agree that the three major activities of most concern include, but are not limited to:

1. airport siting and expansion;

[2] See glossary for the definition of a Class A Mishap and similar terms.

2. development of conservation/mitigation habitats or other land uses that could attract hazardous wildlife to airports or nearby areas; and

3. responses to known wildlife hazards or aircraft-wildlife strikes.

D. Agree that "hazardous wildlife" are those animals, identified to species and listed in FAA and USAF databases, that are most often involved in aircraft-wildlife strikes. Many of the species frequently inhabit areas on or near airports, cause structural damage to airport facilities, or attract other wildlife that pose an aircraft-wildlife strike hazard. Table 1 lists many of these species. It is included solely to provide information on identified wildlife species that have been involved in aircraft-wildlife strikes. It is not intended to represent the universe of species concerning the signatory agencies, since more than 50 percent of the aircraft-wildlife strikes reported to FAA or the USAF did not identify the species involved.

E. Agree to focus on habitats attractive to the species noted in Table 1, but the signatory agencies realize that it is imperative to recognize that wildlife hazard determinations discussed in Paragraph L of this section may involve other animals.

F. Agree that not all habitat types attract hazardous wildlife. The signatory agencies, during their consultative or decisionmaking activities, will inform regional and local land use authorities of this MOA's purpose. The signatory agencies will consider regional, local, and site-specific factors (e.g., geographic setting and/or ecological concerns) when conducting these activities and will work cooperatively with the authorities as they develop and implement local land use programs under their respective jurisdictions. The signatory agencies will encourage these stakeholders to develop land uses within the siting criteria noted in Section 1-3 of FAA Advisory Circular (AC) 150.5200-33 (Attachment A) that do not attract hazardous wildlife. Conversely, the agencies will promote the establishment of land uses attractive to hazardous wildlife outside those siting criteria. Exceptions to the above siting criteria, as described in Section 2.4.b of the AC, will be considered because they typically involve habitats that provide unique ecological functions or values (e.g., critical habitat for federally-listed endangered or threatened species, ground water recharge).

G. Agree that wetlands provide many important ecological functions and values, including fish and wildlife habitats; flood protection; shoreline erosion control; water quality improvement; and recreational, educational, and research opportunities. To protect jurisdictional wetlands, Section 404 of the Clean Water Act (CWA) establishes a program to regulate dredge and/or fill activities in these wetlands and navigable waters. In recognizing Section 404 requirements and the Clean Water Action Plan's goal to annually increase the Nation's net wetland acreage by 100,000 acres through 2005, the signatory agencies agree to resolve aircraft-wildlife conflicts. They will do so by avoiding and minimizing wetland impacts to the maximum extent practicable, and will work to compensate for all associated unavoidable wetland impacts. The agencies agree to work with landowners and communities to encourage and support wetland restoration or enhancement efforts that do not increase aircraft-wildlife strike potentials.

H. Agree that the: U.S. Army Corps of Engineers (ACOE) has expertise in protecting and managing jurisdictional wetlands and their associated wildlife; U.S. Environmental Protection Agency (EPA) has expertise in protecting environmental resources; and the U.S. Fish and Wildlife Service (USFWS) has expertise in protecting and managing wildlife and their habitats, including migratory birds and wetlands. Appropriate signatory agencies will cooperatively review proposals to develop or expand wetland mitigation sites, or wildlife refuges that may attract hazardous wildlife. When planning these sites or refuges, the signatory agencies will diligently consider the siting criteria and land use practice recommendations stated in FAA AC 150/5200-33. The agencies will make every effort to undertake actions that are consistent with those criteria and recommendations, but recognize that exceptions to the siting criteria may be appropriate (see Paragraph F of this section).

I. Agree to consult with airport proponents during initial airport planning efforts. As appropriate, the FAA or USAF will initiate signatory agency participation in these efforts. When evaluating proposals to build new civilian or military aviation facilities or to expand existing ones, the FAA or the USAF, will work with appropriate signatory agencies to diligently evaluate alternatives that may avoid adverse effects on wetlands, other aquatic resources, and Federal wildlife refuges. If these or other habitats support hazardous wildlife, and there is no practicable alternative location for the proposed aviation project, the appropriate signatory agencies, consistent with applicable laws, regulations, and policies, will develop mutually acceptable measures, to protect aviation safety and mitigate any unavoidable wildlife impacts.

J. Agree that a variety of other land uses (e.g., storm water management facilities, wastewater treatment systems, landfills, golf courses, parks, agricultural or aquacultural facilities, and landscapes) attract hazardous wildlife and are, therefore, normally incompatible with airports. Accordingly, new, federally-funded airport construction or airport expansion projects near habitats or other land uses that may attract hazardous wildlife must conform to the siting criteria established in the FAA Advisory Circular (AC) 150/5200-33, Section 1-3.

K. Agree to encourage and advise owners and/or operators of non-airport facilities that are known hazardous wildlife attractants (See Paragraph J) to follow the siting criteria in Section 1-3 of AC 150/5200-33. As appropriate, each signatory agency will inform proponents of these or other land uses about the land use’s potential to attract hazardous species to airport areas.

The signatory agencies will urge facility owners and/or operators about the critical need to consider the land uses' effects on aviation safety.

L. Agree that FAA, USAF, and WS personnel have the expertise necessary to determine the aircraft-wildlife strike potentials of various land uses. When there is disagreement among signatory agencies about a particular land use and its potential to attract hazardous wildlife, the FAA, USAF, or WS will prepare a wildlife hazard assessment. Then, the appropriate signatory agencies will meet at the local level to review the assessment. At a minimum, that assessment will:

1. identify each species causing the aviation hazard, its seasonal and daily populations, and the population's local movements;

2. discuss locations and features on and near the airport or land use attractive to hazardous wildlife; and

3. evaluate the extent of the wildlife hazard to aviation.

M. Agree to cooperate with the airport operator to develop a specific, wildlife hazard management plan for a given location, when a potential wildlife hazard is identified. The plan will meet applicable FAA, USAF, and other relevant requirements. In developing the plan, the appropriate agencies will use their expertise and attempt to integrate their respective programmatic responsibilities, while complying with existing laws, regulations, and policies. The plan should avoid adverse impacts to wildlife populations, wetlands, or other sensitive habitats to the maximum extent practical. Unavoidable impacts resulting from implementing the plan will be fully compensated pursuant to all applicable Federal laws, regulations, and policies.

N. Agree that whenever a significant aircraft-wildlife strike occurs or a potential for one is identified, any signatory agency may initiate actions with other appropriate signatory agencies to evaluate the situation and develop mutually acceptable solutions to reduce the identified strike probability. The agencies will work cooperatively, preferably at the local level, to determine the causes of the strike and what can and should be done at the airport or in its vicinity to reduce potential strikes involving that species.

O. Agree that information and analyses relating to mitigation that could cause or contribute to aircraft-wildlife strikes should, whenever possible, be included in documents prepared to satisfy the National Environmental Policy Act (NEPA). This should be done in coordination with appropriate signatory agencies to inform the public and Federal decision makers about important ecological factors that may affect aviation. This concurrent review of environmental issues will promote the streamlining of the NEPA review process.

P. Agree to cooperatively develop mutually acceptable and consistent guidance, manuals, or procedures addressing the management of habitats attractive to hazardous wildlife, when those habitats are or will be within the siting criteria noted in Section 1-3 of FAA AC 5200-33. As appropriate, the signatory agencies will also consult each other when they propose revisions to any regulations or guidance relevant to the purpose of this MOA, and agree to modify this MOA accordingly.

SECTION II.
GENERAL RULES AND INFORMATION

A. Development of this MOA fulfills the National Transportation Safety Board's recommendation of November 19, 1999, to form an inter-departmental task force to address aircraft-wildlife strike issues.

B. This MOA does not nullify any obligations of the signatory agencies to enter into separate MOAs with the USFWS addressing the conservation of migratory birds, as outlined in Executive Order 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds*, dated January 10, 2001 (66 *Federal Register*, No. 11, pg. 3853).

C. This MOA in no way restricts a signatory agency's participation in similar activities or arrangements with other public or private agencies, organizations, or individuals.

D. This MOA does not alter or modify compliance with any Federal law, regulation or guidance (e.g., Clean Water Act; Endangered Species Act; Migratory Bird Treaty Act; National Environmental Policy Act; North American Wetlands Conservation Act; Safe Drinking Water Act; or the "no-net loss" policy for wetland protection). The signatory agencies will employ this MOA in concert with the Federal guidance addressing wetland mitigation banking dated March 6, 1995 (60 *Federal Register*, No. 43, pg. 12286).

E. The statutory provisions and regulations mentioned above contain legally binding requirements. However, this MOA does not substitute for those provisions or regulations, nor is it a regulation itself. This MOA does not impose legally binding requirements on the signatory agencies or any other party, and may not apply to a particular situation in certain circumstances. The signatory agencies retain the discretion to adopt approaches on a case-by-case basis that differ from this MOA when they determine it is appropriate to do so. Such decisions will be based on the facts of a particular case and applicable legal requirements. Therefore, interested parties are free to raise questions and objections about the substance of this MOA and the appropriateness of its application to a particular situation.

F. This MOA is based on evolving information and may be revised periodically without public notice. The signatory agencies welcome public comments on this MOA at any time and will consider those comments in any future revision of this MOA.

G. This MOA is intended to improve the internal management of the Executive Branch to address conflicts between aviation safety and wildlife. This MOA does not create any right, benefit, or trust responsibility, either substantively or procedurally. No party, by law or equity, may enforce this MOA against the United States, its agencies, its officers, or any person.

H. This MOA does not obligate any signatory agency to allocate or spend appropriations or enter into any contract or other obligations.

I. This MOA does not reduce or affect the authority of Federal, State, or local agencies regarding land uses under their respective purviews. When requested, the signatory agencies will provide technical expertise to agencies making decisions regarding land uses within the siting criteria in Section 1-3 of FAA AC 150/5200-33 to minimize or prevent attracting hazardous wildlife to airport areas.

J. Any signatory agency may request changes to this MOA by submitting a written request to any other signatory agency and subsequently obtaining the written concurrence of all signatory agencies.

K. Any signatory agency may terminate its participation in this MOA within 60 days of providing written notice to the other agencies. This MOA will remain in effect until all signatory agencies terminate their participation in it.

SECTION III. PRINCIPAL SIGNATORY AGENCY CONTACTS

The following list identifies contact offices for each signatory agency.

Federal Aviation Administration
Office Airport Safety and Standards
Airport Safety and
Compliance Branch (AAS-310)
800 Independence Ave., S.W.
Washington, D.C. 20591
V: 202-267-1799
F: 202-267-7546

U.S. Air Force
HQ AFSC/SEFW
9700 Ave., G. SE, Bldg. 24499
Kirtland AFB, NM 87117
V: 505-846-5679
F: 505-846-0684

U.S. Army
Directorate of Civil Works
Regulatory Branch (CECW-OR)
441 G St., N.W.
Washington, D.C. 20314
V: 202-761-4750
F: 202-761-4150

U.S. Environmental Protection Agy.
Office of Water
Wetlands Division
Ariel Rios Building, MC 4502F
1200 Pennsylvania Ave., SW
Washington, D.C. 20460
V: 202-260-1799
F: 202-260-7546

U.S. Fish and Wildlife Service
Division of Migratory Bird Management
4401 North Fairfax Drive, Room 634
Arlington, VA 22203
V: 703-358-1714
F: 703-358-2272

U.S. Department of Agriculture
Animal and Plant Inspection Service
Wildlife Services
Operational Support Staff
4700 River Road, Unit 87
Riverdale, MD 20737
V: 301-734-7921
F: 301-734-5157

Signature Page

Original Signed by:

Woodie Woodward **12/17/2002**

Associate Administrator for Airports, Date
Federal Aviation Administration

Original Signed by:

Kenneth W. Hess **27 May 2003**

Chief of Safety, Date
U. S. Air Force

Original Signed by:

R.L. Brownlee **December 9, 2002**

Assistant Secretary of the Army (Civil Works), Date
U.S. Army

Original Signed by:

G. Tracy Mehan, III **1/17/03**

Assistant Administrator, Office of Water, Date
U.S. Environmental Protection Agency

Original Signed by:

Paul R. Schmidt **7/29/03**

Assistant Director, Migratory Birds Date
and State Programs,
U.S. Fish and Wildlife Service

Original Signed by:

Richard D Curnow **9 January 2003**

Acting Deputy Administrator, Wildlife Services Date
U.S. Department of Agriculture

GLOSSARY

This glossary defines terms used in this MOA.

Airport. All USAF airfields or all public use airports in the FAA's National Plan of Integrated Airport Systems (NPIAS). Note: There are over 18,000 civil-use airports in the U.S., but only 3,344 of them are in the NPIAS and, therefore, under FAA's jurisdiction.

Aircraft-wildlife strike. An aircraft-wildlife strike is deemed to have occurred when:

1. a pilot reports that an aircraft struck 1 or more birds or other wildlife;
2. aircraft maintenance personnel identify aircraft damage as having been caused by an aircraft-wildlife strike;
3. personnel on the ground report seeing an aircraft strike 1 or more birds or other wildlife;
4. bird or other wildlife remains, whether in whole or in part, are found within 200 feet of a runway centerline, unless another reason for the animal's death is identified; or
5. the animal's presence on the airport had a significant, negative effect on a flight (i.e., aborted takeoff, aborted landing, high-speed emergency stop, aircraft left pavement area to avoid collision with animal)

(Source: *Wildlife Control Procedures Manual*, Technical Publication 11500E, 1994).

Aircraft-wildlife strike hazard. A potential for a damaging aircraft collision with wildlife on or near an airport (14 CFR 139.3).

Bird Sizes. Title 40, Code of Federal Regulations, Part 33.76 classifies birds according to weight:

small birds weigh less than 3 ounces (oz).
medium birds weigh more than 3 oz and less than 2.5 lbs.
large birds weigh greater than 2.5 lbs.

Civil aircraft damage classifications. The following damage descriptions are based on the *Manual on the International Civil Aviation Organization Bird Strike Information System*:

Minor: The aircraft is deemed airworthy upon completing simple repairs or replacing minor parts and an extensive inspection is not necessary.

Substantial: Damage or structural failure adversely affects an aircraft's structural integrity, performance, or flight characteristics. The damage normally requires major repairs or the replacement of the entire affected component. Bent fairings or cowlings; small dents; skin punctures; damage to wing tips, antenna, tires or brakes, or engine blade damage not requiring blade replacement are specifically excluded.

Destroyed: The damage sustained makes it inadvisable to restore the aircraft to an airworthy condition.

Significant Aircraft-Wildlife Strikes. A significant aircraft-wildlife strike is deemed to have occurred when any of the following applies:

1. a civilian, U.S. air carrier aircraft experiences a multiple aircraft-bird strike or engine ingestion;
2. a civilian, U.S. air carrier aircraft experiences a damaging collision with wildlife other than birds; or
3. a USAF aircraft experiences a Class A, B, or C mishap as described below:

    A. **Class A Mishap:** Occurs when at least one of the following applies:
        1. total mishap cost is $1,000,000 or more;
        2. a fatality or permanent total disability occurs; and/or
        3. an Air Force aircraft is destroyed.

    B. **Class B Mishap:** Occurs when at least one of the following applies:
        1. total mishap cost is $200,000 or more and less than $1,000,000; and/or
        2. a permanent partial disability occurs and/or 3 or more people are hospitalized;

    C. **Class C Mishap:** Occurs when at least one of the following applies:
        1. cost of reported damage is between $20,000 and $200,000;
        2. an injury causes a lost workday (i.e., duration of absence is at least 8 hours beyond the day or shift during which mishap occurred); and/or
        3. an occupational illness causing absence from work at any time.

Wetlands. An ecosystem requiring constant or recurrent, shallow inundation or saturation at or near the surface of the substrate. The minimum essential characteristics of a wetland are recurrent, sustained inundation or saturation at or near the surface and the presence of physical, chemical, and biological features indicating recurrent, sustained inundation, or saturation. Common diagnostic wetland features are hydric soils and hydrophytic vegetation. These features will be present, except where specific physiochemical, biotic, or anthropogenic factors have removed them or prevented their development.

(Source the 1987 Delineation Manual; 40 CFR 230.3(t)).

Wildlife. Any wild animal, including without limitation any wild mammal, bird, reptile, fish, amphibian, mollusk, crustacean, arthropod, coelenterate, or other invertebrate, including any part, product, egg, or offspring there of (50 CFR 10.12, *Taking, Possession, Transportation, Sale, Purchase, Barter, Exportation, and Importation of Wildlife and Plants*). As used in this MOA, "wildlife" includes feral animals and domestic animals while out of their owner's control (14 CFR 139.3, *Certification and Operations: Land Airports Serving CAB-Certificated Scheduled Air Carriers Operating Large Aircraft (Other Than Helicopters)*)

Table 1. Identified wildlife species, or groups, that were involved in two or more aircraft-wildlife strikes, that caused damage to one or more aircraft components, or that had an adverse effect on an aircraft's flight. Data are for 1990-1999 and involve only civilian, U.S. aircraft.

Birds	No. reported strikes
Gulls (all spp.)	874
Geese (primarily, Canada geese)	458
Hawks (primarily, Red-tailed hawks)	182
Ducks (primarily Mallards.)	166
Vultures (primarily, Turkey vulture)	142
Rock doves	122
Doves (primarily, mourning doves)	109
Blackbirds	81
European starlings	55
Sparrows	52
Egrets	41
Shore birds (primarily, Killdeer & Sandpipers)	40
Crows	31
Owls	24
Sandhill cranes	22
American kestrels	15
Great blue herons	15
Pelicans	14
Swallows	14
Eagles (Bald and Golden)	14
Ospreys	13
Ring-necked pheasants	11
Herons	11
Barn-owls	9
American robins	8
Meadowlarks	8
Buntings (snow)	7
Cormorants	6
Snow buntings	6
Brants	5
Terns (all spp.)	5
Great horned owls	5
Horned larks	4
Turkeys	4
Swans	3
Mockingbirds	3
Quails	3
Homing pigeons	3
Snowy owls	3
Anhingas	2

Birds	No. reported strikes
Ravens	2
Kites	2
Falcons	2
Peregrine falcons	2
Merlins	2
Grouse	2
Hungarian partridges	2
Spotted doves	2
Thrushes	2
Mynas	2
Finches	2
Total known birds	2,612

Mammals	No. reported strikes
Deer (primarily, White-tailed deer)	285
Coyotes	16
Dogs	10
Elk	6
Cattle	5
Bats	4
Horses	3
Pronghorn antelopes	3
Foxes	2
Raccoons	2
Rabbits	2
Moose	2
Total known mammals	340

Ring-billed gulls were the most commonly struck gulls. The U.S. ring-billed gull population increased steadily at about 6% annually from 1966-1988. Canada geese were involved in about 90% of the aircraft-goose strikes involving civilian, U.S. aircraft from 1990-1998. Resident (non-migratory) Canada goose populations increased annually at 13% from 1966-1998. Red-tailed hawks accounted for 90% of the identified aircraft-hawk strikes for the 10-year period. Red-tailed hawk populations increased annually at 3% from 1966 to 1998. Turkey vultures were involved in 93% of he identified aircraft-vulture strikes. The U.S. Turkey vulture populations increased at annually at 1% between 1966 and 1998. Deer, primarily white-tailed deer, have also adapted to urban and airport areas and their populations have increased dramatically. In the early 1900's, there were about 100,000 white-tailed deer in the U.S. Current estimates are that the U.S. population is about 24 million.

U.S. Department
of Transportation

**Federal Aviation
Administration**

Advisory Circular

Subject: HAZARDOUS WILDLIFE ATTRACTANTS ON OR NEAR AIRPORTS

Date: 8/28/2007

Initiated by: AAS-300

AC No: 150/5200-33B

Change:

1. PURPOSE. This Advisory Circular (AC) provides guidance on certain land uses that have the potential to attract hazardous wildlife on or near public-use airports. It also discusses airport development projects (including airport construction, expansion, and renovation) affecting aircraft movement near hazardous wildlife attractants. Appendix 1 provides definitions of terms used in this AC.

2. APPLICABILITY. The Federal Aviation Administration (FAA) recommends that public-use airport operators implement the standards and practices contained in this AC. The holders of Airport Operating Certificates issued under Title 14, Code of Federal Regulations (CFR), Part 139, Certification of Airports, Subpart D (Part 139), may use the standards, practices, and recommendations contained in this AC to comply with the wildlife hazard management requirements of Part 139. Airports that have received Federal grant-in-aid assistance must use these standards. The FAA also recommends the guidance in this AC for land-use planners, operators of non-certificated airports, and developers of projects, facilities, and activities on or near airports.

3. CANCELLATION. This AC cancels AC 150/5200-33A, *Hazardous Wildlife Attractants on or near Airports*, dated July 27, 2004.

4. PRINCIPAL CHANGES. This AC contains the following major changes, which are marked with vertical bars in the margin:

a. Technical changes to paragraph references.

b. Wording on storm water detention ponds.

c. Deleted paragraph 4-3.b, *Additional Coordination.*

5. BACKGROUND. Information about the risks posed to aircraft by certain wildlife species has increased a great deal in recent years. Improved reporting, studies, documentation, and statistics clearly show that aircraft collisions with birds and other wildlife are a serious economic and public safety problem. While many species of wildlife can pose a threat to aircraft safety, they are not equally hazardous. Table 1 ranks the wildlife groups commonly involved in damaging strikes in the United States according to their relative hazard to aircraft. The ranking is based on the 47,212 records in the FAA National Wildlife Strike Database for the years 1990 through 2003. These hazard rankings, in conjunction with site-specific Wildlife Hazards Assessments (WHA), will help airport operators determine the relative abundance and use patterns of wildlife species and help focus hazardous wildlife management efforts on those species most likely to cause problems at an airport.

Most public-use airports have large tracts of open, undeveloped land that provide added margins of safety and noise mitigation. These areas can also present potential hazards to aviation if they encourage wildlife to enter an airport's approach or departure airspace or air operations area (AOA). Constructed or natural areas—such as poorly drained locations, detention/retention ponds, roosting habitats on buildings, landscaping, odor-causing rotting organic matter (putrescible waste) disposal operations, wastewater treatment plants, agricultural or aquaculture activities, surface mining, or wetlands—can provide wildlife with ideal locations for feeding, loafing, reproduction, and escape. Even small facilities, such as fast food restaurants, taxicab staging areas, rental car facilities, aircraft viewing areas, and public parks, can produce substantial attractions for hazardous wildlife.

During the past century, wildlife-aircraft strikes have resulted in the loss of hundreds of lives worldwide, as well as billions of dollars in aircraft damage. Hazardous wildlife attractants on and near airports can jeopardize future airport expansion, making proper community land-use planning essential. This AC provides airport operators and those parties with whom they cooperate with the guidance they need to assess and address potentially hazardous wildlife attractants when locating new facilities and implementing certain land-use practices on or near public-use airports.

6. MEMORANDUM OF AGREEMENT BETWEEN FEDERAL RESOURCE AGENCIES. The FAA, the U.S. Air Force, the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, and the U.S. Department of Agriculture - Wildlife Services signed a Memorandum of Agreement (MOA) in July 2003 to acknowledge their respective missions in protecting aviation from wildlife hazards. Through the MOA, the agencies established procedures necessary to coordinate their missions to address more effectively existing and future environmental conditions contributing to collisions between wildlife and aircraft (wildlife strikes) throughout the United States. These efforts are intended to minimize wildlife risks to aviation and human safety while protecting the Nation’s valuable environmental resources.

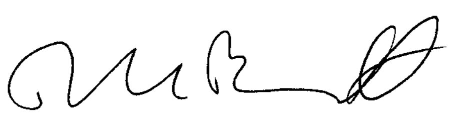

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Table 1. Ranking of 25 species groups as to relative hazard to aircraft (1=most hazardous) based on three criteria (damage, major damage, and effect-on-flight), a composite ranking based on all three rankings, and a relative hazard score. Data were derived from the FAA National Wildlife Strike Database, January 1990–April 2003.[1]

Species group	Ranking by criteria: Damage[4]	Ranking by criteria: Major damage[5]	Ranking by criteria: Effect on flight[6]	Composite ranking[2]	Relative hazard score[3]
Deer	1	1	1	1	100
Vultures	2	2	2	2	64
Geese	3	3	6	3	55
Cormorants/pelicans	4	5	3	4	54
Cranes	7	6	4	5	47
Eagles	6	9	7	6	41
Ducks	5	8	10	7	39
Osprey	8	4	8	8	39
Turkey/pheasants	9	7	11	9	33
Herons	11	14	9	10	27
Hawks (buteos)	10	12	12	11	25
Gulls	12	11	13	12	24
Rock pigeon	13	10	14	13	23
Owls	14	13	20	14	23
H. lark/s. bunting	18	15	15	15	17
Crows/ravens	15	16	16	16	16
Coyote	16	19	5	17	14
Mourning dove	17	17	17	18	14
Shorebirds	19	21	18	19	10
Blackbirds/starling	20	22	19	20	10
American kestrel	21	18	21	21	9
Meadowlarks	22	20	22	22	7
Swallows	24	23	24	23	4
Sparrows	25	24	23	24	4
Nighthawks	23	25	25	25	1

[1] Excerpted from the *Special Report for the FAA, "Ranking the Hazard Level of Wildlife Species to Civil Aviation in the USA: Update #1, July 2, 2003".* Refer to this report for additional explanations of criteria and method of ranking.
[2] Relative rank of each species group was compared with every other group for the three variables, placing the species group with the greatest hazard rank for $\geq$ 2 of the 3 variables above the next highest ranked group, then proceeding down the list.
[3] Percentage values, from Tables 3 and 4 in Footnote 1 of the *Special Report*, for the three criteria were summed and scaled down from 100, with 100 as the score for the species group with the maximum summed values and the greatest potential hazard to aircraft.
[4] Aircraft incurred at least some damage (destroyed, substantial, minor, or unknown) from strike.
[5] Aircraft incurred damage or structural failure, which adversely affected the structure strength, performance, or flight characteristics, and which would normally require major repair or replacement of the affected component, or the damage sustained makes it inadvisable to restore aircraft to airworthy condition.
[6] Aborted takeoff, engine shutdown, precautionary landing, or other.

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SECTION 1.

GENERAL SEPARATION CRITERIA FOR HAZARDOUS WILDLIFE ATTRACTANTS ON OR NEAR AIRPORTS.

1-1. INTRODUCTION. When considering proposed land uses, airport operators, local planners, and developers must take into account whether the proposed land uses, including new development projects, will increase wildlife hazards. Land-use practices that attract or sustain hazardous wildlife populations on or near airports can significantly increase the potential for wildlife strikes.

The FAA recommends the minimum separation criteria outlined below for land-use practices that attract hazardous wildlife to the vicinity of airports. Please note that FAA criteria include land uses that cause movement of hazardous wildlife onto, into, or across the airport's approach or departure airspace or air operations area (AOA). (See the discussion of the synergistic effects of surrounding land uses in Section 2-8 of this AC.)

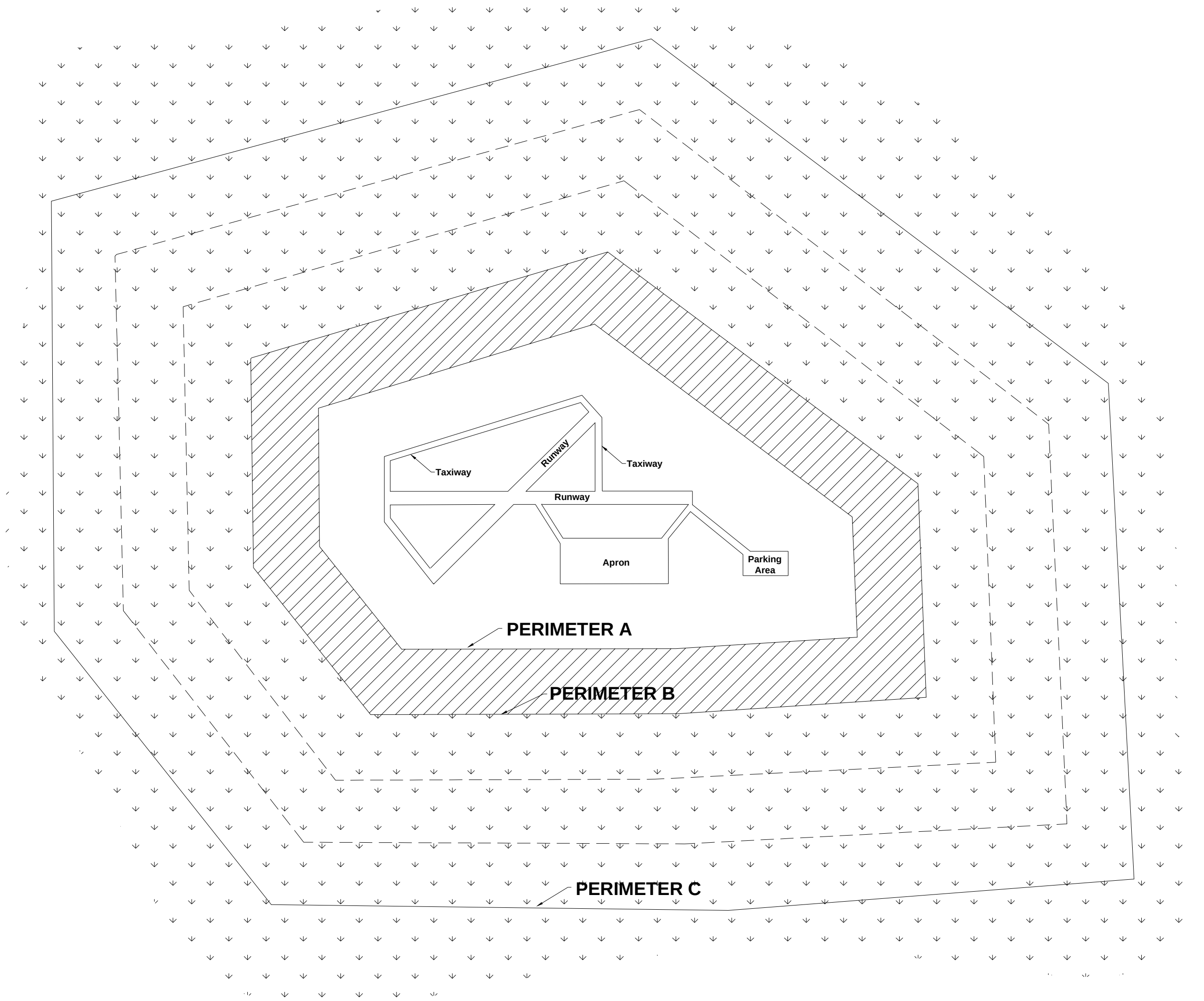
The basis for the separation criteria contained in this section can be found in existing FAA regulations. The separation distances are based on (1) flight patterns of piston-powered aircraft and turbine-powered aircraft, (2) the altitude at which most strikes happen (78 percent occur under 1,000 feet and 90 percent occur under 3,000 feet above ground level), and (3) National Transportation Safety Board (NTSB) recommendations.

1-2. AIRPORTS SERVING PISTON-POWERED AIRCRAFT. Airports that do not sell Jet-A fuel normally serve piston-powered aircraft. Notwithstanding more stringent requirements for specific land uses, the FAA recommends a separation distance of 5,000 feet at these airports for any of the hazardous wildlife attractants mentioned in Section 2 or for new airport development projects meant to accommodate aircraft movement. This distance is to be maintained between an airport's AOA and the hazardous wildlife attractant. Figure 1 depicts this separation distance measured from the nearest aircraft operations areas.

1-3. AIRPORTS SERVING TURBINE-POWERED AIRCRAFT. Airports selling Jet-A fuel normally serve turbine-powered aircraft. Notwithstanding more stringent requirements for specific land uses, the FAA recommends a separation distance of 10,000 feet at these airports for any of the hazardous wildlife attractants mentioned in Section 2 or for new airport development projects meant to accommodate aircraft movement. This distance is to be maintained between an airport's AOA and the hazardous wildlife attractant. Figure 1 depicts this separation distance from the nearest aircraft movement areas.

1-4. PROTECTION OF APPROACH, DEPARTURE, AND CIRCLING AIRSPACE. For all airports, the FAA recommends a distance of 5 statute miles between the farthest edge of the airport's AOA and the hazardous wildlife attractant if the attractant could cause hazardous wildlife movement into or across the approach or departure airspace.

Figure 1. Separation distances within which hazardous wildlife attractants should be avoided, eliminated, or mitigated.



PERIMETER A: For airports serving piston-powered aircraft, hazardous wildlife attractants must be 5,000 feet from the nearest air operations area.

PERIMETER B: For airports serving turbine-powered aircraft, hazardous wildlife attractants must be 10,000 feet from the nearest air operations area.

PERIMETER C: 5-mile range to protect approach, departure and circling airspace.

SECTION 2.

LAND-USE PRACTICES ON OR NEAR AIRPORTS THAT POTENTIALLY ATTRACT HAZARDOUS WILDLIFE.

2-1. GENERAL. The wildlife species and the size of the populations attracted to the airport environment vary considerably, depending on several factors, including land-use practices on or near the airport. This section discusses land-use practices having the potential to attract hazardous wildlife and threaten aviation safety. In addition to the specific considerations outlined below, airport operators should refer to *Wildlife Hazard Management at Airports,* prepared by FAA and U.S. Department of Agriculture (USDA) staff. (This manual is available in English, Spanish, and French. It can be viewed and downloaded free of charge from the FAA's wildlife hazard mitigation web site: http://wildlife-mitigation.tc.FAA.gov.). And, *Prevention and Control of Wildlife Damage,* compiled by the University of Nebraska Cooperative Extension Division. (This manual is available online in a periodically updated version at: ianrwww.unl.edu/wildlife/solutions/handbook/.)

2-2. WASTE DISPOSAL OPERATIONS. Municipal solid waste landfills (MSWLF) are known to attract large numbers of hazardous wildlife, particularly birds. Because of this, these operations, when located within the separations identified in the siting criteria in Sections 1-2 through 1-4, are considered incompatible with safe airport operations.

a. Siting for new municipal solid waste landfills subject to AIR 21. Section 503 of the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century (Public Law 106-181) (AIR 21) prohibits the construction or establishment of a new MSWLF within 6 statute miles of certain public-use airports. Before these prohibitions apply, both the airport and the landfill must meet the very specific conditions described below. These restrictions do not apply to airports or landfills located within the state of Alaska.

The airport must (1) have received a Federal grant(s) under 49 U.S.C. § 47101, et. seq.; (2) be under control of a public agency; (3) serve some scheduled air carrier operations conducted in aircraft with less than 60 seats; and (4) have total annual enplanements consisting of at least 51 percent of scheduled air carrier enplanements conducted in aircraft with less than 60 passenger seats.

The proposed MSWLF must (1) be within 6 miles of the airport, as measured from airport property line to MSWLF property line, and (2) have started construction or establishment on or after April 5, 2001. Public Law 106-181 only limits the construction or establishment of some new MSWLF. It does not limit the expansion, either vertical or horizontal, of existing landfills.

NOTE: Consult the most recent version of AC 150/5200-34, *Construction or Establishment of Landfills Near Public Airports,* for a more detailed discussion of these restrictions.

b. Siting for new MSWLF not subject to AIR 21. If an airport and MSWLF do not meet the restrictions of Public Law 106-181, the FAA recommends against locating MSWLF within the separation distances identified in Sections 1-2 through 1-4. The separation distances should be measured from the closest point of the airport's AOA to the closest planned MSWLF cell.

c. Considerations for existing waste disposal facilities within the limits of separation criteria. The FAA recommends against airport development projects that would increase the number of aircraft operations or accommodate larger or faster aircraft near MSWLF operations located within the separations identified in Sections 1-2 through 1-4. In addition, in accordance with 40 CFR 258.10, owners or operators of existing MSWLF units that are located within the separations listed in Sections 1-2 through 1-4 must demonstrate that the unit is designed and operated so it does not pose a bird hazard to aircraft. (See Section 4-2(b) of this AC for a discussion of this demonstration requirement.)

d. Enclosed trash transfer stations. Enclosed waste-handling facilities that receive garbage behind closed doors; process it via compaction, incineration, or similar manner; and remove all residue by enclosed vehicles generally are compatible with safe airport operations, provided they are not located on airport property or within the Runway Protection Zone (RPZ). These facilities should not handle or store putrescible waste outside or in a partially enclosed structure accessible to hazardous wildlife. Trash transfer facilities that are open on one or more sides; that store uncovered quantities of municipal solid waste outside, even if only for a short time; that use semi-trailers that leak or have trash clinging to the outside; or that do not control odors by ventilation and filtration systems (odor masking is not acceptable) do not meet the FAA's definition of fully enclosed trash transfer stations. The FAA considers these facilities incompatible with safe airport operations if they are located closer than the separation distances specified in Sections 1-2 through 1-4.

e. Composting operations on or near airport property. Composting operations that accept only yard waste (e.g., leaves, lawn clippings, or branches) generally do not attract hazardous wildlife. Sewage sludge, woodchips, and similar material are not municipal solid wastes and may be used as compost bulking agents. The compost, however, must never include food or other municipal solid waste. Composting operations should not be located on airport property. Off-airport property composting operations should be located no closer than the greater of the following distances: 1,200 feet from any AOA or the distance called for by airport design requirements (see AC 150/5300-13, *Airport Design*). This spacing should prevent material, personnel, or equipment from penetrating any Object Free Area (OFA), Obstacle Free Zone (OFZ), Threshold Siting Surface (TSS), or Clearway. Airport operators should monitor composting operations located in proximity to the airport to ensure that steam or thermal rise does not adversely affect air traffic. On-airport disposal of compost by-products should not be conducted for the reasons stated in 2-3f.

f. Underwater waste discharges. The FAA recommends against the underwater discharge of any food waste (e.g., fish processing offal) within the separations identified in Sections 1-2 through 1-4 because it could attract scavenging hazardous wildlife.

g. Recycling centers. Recycling centers that accept previously sorted non-food items, such as glass, newspaper, cardboard, or aluminum, are, in most cases, not attractive to hazardous wildlife and are acceptable.

h. Construction and demolition (C&D) debris facilities. C&D landfills do not generally attract hazardous wildlife and are acceptable if maintained in an orderly manner, admit no putrescible waste, and are not co-located with other waste disposal operations. However, C&D landfills have similar visual and operational characteristics to putrescible waste disposal sites. When co-located with putrescible waste disposal operations, C&D landfills are more likely to attract hazardous wildlife because of the similarities between these disposal facilities. Therefore, a C&D landfill co-located with another waste disposal operation should be located outside of the separations identified in Sections 1-2 through 1-4.

i. Fly ash disposal. The incinerated residue from resource recovery power/heat-generating facilities that are fired by municipal solid waste, coal, or wood is generally not a wildlife attractant because it no longer contains putrescible matter. Landfills accepting only fly ash are generally not considered to be wildlife attractants and are acceptable as long as they are maintained in an orderly manner, admit no putrescible waste of any kind, and are not co-located with other disposal operations that attract hazardous wildlife.

Since varying degrees of waste consumption are associated with general incineration (not resource recovery power/heat-generating facilities), the FAA considers the ash from general incinerators a regular waste disposal by-product and, therefore, a hazardous wildlife attractant if disposed of within the separation criteria outlined in Sections 1-2 through 1-4.

2-3. WATER MANAGEMENT FACILITIES. Drinking water intake and treatment facilities, storm water and wastewater treatment facilities, associated retention and settling ponds, ponds built for recreational use, and ponds that result from mining activities often attract large numbers of potentially hazardous wildlife. To prevent wildlife hazards, land-use developers and airport operators may need to develop management plans, in compliance with local and state regulations, to support the operation of storm water management facilities on or near all public-use airports to ensure a safe airport environment.

a. Existing storm water management facilities. On-airport storm water management facilities allow the quick removal of surface water, including discharges related to aircraft deicing, from impervious surfaces, such as pavement and terminal/hangar building roofs. Existing on-airport detention ponds collect storm water, protect water quality, and control runoff. Because they slowly release water after storms, they create standing bodies of water that can attract hazardous wildlife. Where the airport has developed a Wildlife Hazard Management Plan (WHMP) in accordance with Part 139, the FAA requires immediate correction of any wildlife hazards arising from existing storm water facilities located on or near airports, using appropriate wildlife hazard mitigation techniques. Airport operators should develop measures to minimize hazardous wildlife attraction in consultation with a wildlife damage management biologist.

Where possible, airport operators should modify storm water detention ponds to allow a maximum 48-hour detention period for the design storm. The FAA recommends that airport operators avoid or remove retention ponds and detention ponds featuring dead storage to eliminate standing water. Detention basins should remain totally dry between rainfalls. Where constant flow of water is anticipated through the basin, or where any portion of the basin bottom may remain wet, the detention facility should include a concrete or paved pad and/or ditch/swale in the bottom to prevent vegetation that may provide nesting habitat.

When it is not possible to drain a large detention pond completely, airport operators may use physical barriers, such as bird balls, wires grids, pillows, or netting, to deter birds and other hazardous wildlife. When physical barriers are used, airport operators must evaluate their use and ensure they will not adversely affect water rescue. Before installing any physical barriers over detention ponds on Part 139 airports, airport operators must get approval from the appropriate FAA Regional Airports Division Office.

The FAA recommends that airport operators encourage off-airport storm water treatment facility operators to incorporate appropriate wildlife hazard mitigation techniques into storm water treatment facility operating practices when their facility is located within the separation criteria specified in Sections 1-2 through 1-4.

b. New storm water management facilities. The FAA strongly recommends that off-airport storm water management systems located within the separations identified in Sections 1-2 through 1-4 be designed and operated so as not to create above-ground standing water. Stormwater detention ponds should be designed, engineered, constructed, and maintained for a maximum 48–hour detention period after the design storm and remain completely dry between storms. To facilitate the control of hazardous wildlife, the FAA recommends the use of steep-sided, rip-rap lined, narrow, linearly shaped water detention basins. When it is not possible to place these ponds away from an airport's AOA, airport operators should use physical barriers, such as bird balls, wires grids, pillows, or netting, to prevent access of hazardous wildlife to open water and minimize aircraft-wildlife interactions. When physical barriers are used, airport operators must evaluate their use and ensure they will not adversely affect water rescue. Before installing any physical barriers over detention ponds on Part 139 airports, airport operators must get approval from the appropriate FAA Regional Airports Division Office. All vegetation in or around detention basins that provide food or cover for hazardous wildlife should be eliminated. If soil conditions and other requirements allow, the FAA encourages the use of underground storm water infiltration systems, such as French drains or buried rock fields, because they are less attractive to wildlife.

c. Existing wastewater treatment facilities. The FAA strongly recommends that airport operators immediately correct any wildlife hazards arising from existing wastewater treatment facilities located on or near the airport. Where required, a WHMP developed in accordance with Part 139 will outline appropriate wildlife hazard mitigation techniques. Accordingly, airport operators should encourage wastewater treatment facility operators to incorporate measures, developed in consultation with a wildlife damage management biologist, to minimize hazardous wildlife attractants. Airport operators should also encourage those wastewater treatment facility operators to incorporate these mitigation techniques into their standard operating practices. In addition, airport operators should consider the existence of wastewater treatment facilities when evaluating proposed sites for new airport development projects and avoid such sites when practicable.

d. New wastewater treatment facilities. The FAA strongly recommends against the construction of new wastewater treatment facilities or associated settling ponds within the separations identified in Sections 1-2 through 1-4. Appendix 1 defines wastewater treatment facility as “any devices and/or systems used to store, treat, recycle, or reclaim municipal sewage or liquid industrial wastes.” The definition includes any pretreatment involving the reduction of the amount of pollutants or the elimination of pollutants prior to introducing such pollutants into a publicly owned treatment works (wastewater treatment facility). During the site-location analysis for wastewater treatment facilities, developers should consider the potential to attract hazardous wildlife if an airport is in the vicinity of the proposed site, and airport operators should voice their opposition to such facilities if they are in proximity to the airport.

e. Artificial marshes. In warmer climates, wastewater treatment facilities sometimes employ artificial marshes and use submergent and emergent aquatic vegetation as natural filters. These artificial marshes may be used by some species of flocking birds, such as blackbirds and waterfowl, for breeding or roosting activities. The FAA strongly recommends against establishing artificial marshes within the separations identified in Sections 1-2 through 1-4.

f. Wastewater discharge and sludge disposal. The FAA recommends against the discharge of wastewater or sludge on airport property because it may improve soil moisture and quality on unpaved areas and lead to improved turf growth that can be an attractive food source for many species of animals. Also, the turf requires more frequent mowing, which in turn may mutilate or flush insects or small animals and produce straw, both of which can attract hazardous wildlife. In addition, the improved turf may attract grazing wildlife, such as deer and geese. Problems may also occur when discharges saturate unpaved airport areas. The resultant soft, muddy conditions can severely restrict or prevent emergency vehicles from reaching accident sites in a timely manner.

2-4. WETLANDS. Wetlands provide a variety of functions and can be regulated by local, state, and Federal laws. Normally, wetlands are attractive to many types of wildlife, including many which rank high on the list of hazardous wildlife species (Table 1).

NOTE: If questions exist as to whether an area qualifies as a wetland, contact the local division of the U.S. Army Corps of Engineers, the Natural Resources Conservation Service, or a wetland consultant qualified to delineate wetlands.

a. Existing wetlands on or near airport property. If wetlands are located on or near airport property, airport operators should be alert to any wildlife use or habitat changes in these areas that could affect safe aircraft operations. At public-use airports, the FAA recommends immediately correcting, in cooperation with local, state, and Federal regulatory agencies, any wildlife hazards arising from existing wetlands located on or near airports. Where required, a WHMP will outline appropriate wildlife hazard mitigation techniques. Accordingly, airport operators should develop measures to minimize hazardous wildlife attraction in consultation with a wildlife damage management biologist.

b. New airport development. Whenever possible, the FAA recommends locating new airports using the separations from wetlands identified in Sections 1-2 through 1-4. Where alternative sites are not practicable, or when airport operators are expanding an existing airport into or near wetlands, a wildlife damage management biologist, in consultation with the U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers, and the state wildlife management agency should evaluate the wildlife hazards and prepare a WHMP that indicates methods of minimizing the hazards.

c. Mitigation for wetland impacts from airport projects. Wetland mitigation may be necessary when unavoidable wetland disturbances result from new airport development projects or projects required to correct wildlife hazards from wetlands. Wetland mitigation must be designed so it does not create a wildlife hazard. The FAA recommends that wetland mitigation projects that may attract hazardous wildlife be sited outside of the separations identified in Sections 1-2 through 1-4.

(1) Onsite mitigation of wetland functions. The FAA may consider exceptions to locating mitigation activities outside the separations identified in Sections 1-2 through 1-4 if the affected wetlands provide unique ecological functions, such as critical habitat for threatened or endangered species or ground water recharge, which cannot be replicated when moved to a different location. Using existing airport property is sometimes the only feasible way to achieve the mitigation ratios mandated in regulatory orders and/or settlement agreements with the resource agencies. Conservation easements are an additional means of providing mitigation for project impacts. Typically the airport operator continues to own the property, and an easement is created stipulating that the property will be maintained as habitat for state or Federally listed species.

Mitigation must not inhibit the airport operator's ability to effectively control hazardous wildlife on or near the mitigation site or effectively maintain other aspects of safe airport operations. Enhancing such mitigation areas to attract hazardous wildlife must be avoided. The FAA will review any onsite mitigation proposals to determine compatibility with safe airport operations. A wildlife damage management biologist should evaluate any wetland mitigation projects that are needed to protect unique wetland functions and that must be located in the separation criteria in Sections 1-2 through 1-4 before the mitigation is implemented. A WHMP should be developed to reduce the wildlife hazards.

(2) Offsite mitigation of wetland functions. The FAA recommends that wetland mitigation projects that may attract hazardous wildlife be sited outside of the separations identified in Sections 1-2 through 1-4 unless they provide unique functions that must remain onsite (see 2-4c(1)). Agencies that regulate impacts to or around wetlands recognize that it may be necessary to split wetland functions in mitigation schemes. Therefore, regulatory agencies may, under certain circumstances, allow portions of mitigation to take place in different locations.

(3) Mitigation banking. Wetland mitigation banking is the creation or restoration of wetlands in order to provide mitigation credits that can be used to offset permitted wetland losses. Mitigation banking benefits wetland resources by providing advance replacement for permitted wetland losses; consolidating small projects into larger, better-designed and managed units; and encouraging integration of wetland mitigation projects with watershed planning. This last benefit is most helpful for airport projects, as wetland impacts mitigated outside of the separations identified in Sections 1-2 through 1-4 can still be located within the same watershed. Wetland mitigation banks meeting the separation criteria offer an ecologically sound approach to mitigation in these situations. Airport operators should work with local watershed management agencies or organizations to develop mitigation banking for wetland impacts on airport property.

2-5. DREDGE SPOIL CONTAINMENT AREAS. The FAA recommends against locating dredge spoil containment areas (also known as Confined Disposal Facilities) within the separations identified in Sections 1-2 through 1-4 if the containment area or the spoils contain material that would attract hazardous wildlife.

2-6. AGRICULTURAL ACTIVITIES. Because most, if not all, agricultural crops can attract hazardous wildlife during some phase of production, the FAA recommends against the used of airport property for agricultural production, including hay crops, within the separations identified in Sections 1-2 through 1-4. . If the airport has no financial alternative to agricultural crops to produce income necessary to maintain the viability of the airport, then the airport shall follow the crop distance guidelines listed in the table titled "Minimum Distances between Certain Airport Features and Any On-Airport Agricultural Crops" found in AC 150/5300-13, *Airport Design*, Appendix 17. The cost of wildlife control and potential accidents should be weighed against the income produced by the on-airport crops when deciding whether to allow crops on the airport.

a. **Livestock production.** Confined livestock operations (i.e., feedlots, dairy operations, hog or chicken production facilities, or egg laying operations) often attract flocking birds, such as starlings, that pose a hazard to aviation. Therefore, The FAA recommends against such facilities within the separations identified in Sections 1-2 through 1-4. Any livestock operation within these separations should have a program developed to reduce the attractiveness of the site to species that are hazardous to aviation safety. Free-ranging livestock must not be grazed on airport property because the animals may wander onto the AOA. Furthermore, livestock feed, water, and manure may attract birds.

b. **Aquaculture.** Aquaculture activities (i.e. catfish or trout production) conducted outside of fully enclosed buildings are inherently attractive to a wide variety of birds. Existing aquaculture facilities/activities within the separations listed in Sections 1-2 through 1-4 must have a program developed to reduce the attractiveness of the sites to species that are hazardous to aviation safety. Airport operators should also oppose the establishment of new aquaculture facilities/activities within the separations listed in Sections 1-2 through 1-4.

c. **Alternative uses of agricultural land.** Some airports are surrounded by vast areas of farmed land within the distances specified in Sections 1-2 through 1-4. Seasonal uses of agricultural land for activities such as hunting can create a hazardous wildlife situation. In some areas, farmers will rent their land for hunting purposes. Rice farmers, for example, flood their land during waterfowl hunting season and obtain additional revenue by renting out duck blinds. The duck hunters then use decoys and call in hundreds, if not thousands, of birds, creating a tremendous threat to aircraft safety. A wildlife damage management biologist should review, in coordination with local farmers and producers, these types of seasonal land uses and incorporate them into the WHMP.

2-7. GOLF COURSES, LANDSCAPING AND OTHER LAND-USE CONSIDERATIONS.

a. **Golf courses.** The large grassy areas and open water found on most golf courses are attractive to hazardous wildlife, particularly Canada geese and some species of gulls. These species can pose a threat to aviation safety. The FAA recommends against construction of new golf courses within the separations identified in Sections 1-2 through 1-4. Existing golf courses located within these separations must develop a program to reduce the attractiveness of the sites to species that are hazardous to aviation safety. Airport operators should ensure these golf courses are monitored on a continuing basis for the presence of hazardous wildlife. If hazardous wildlife is detected, corrective actions should be immediately implemented.

b. **Landscaping and landscape maintenance.** Depending on its geographic location, landscaping can attract hazardous wildlife. The FAA recommends that airport operators approach landscaping with caution and confine it to airport areas not associated with aircraft movements. A wildlife damage management biologist should review all landscaping plans. Airport operators should also monitor all landscaped areas on a continuing basis for the presence of hazardous wildlife. If hazardous wildlife is detected, corrective actions should be immediately implemented.

Turf grass areas can be highly attractive to a variety of hazardous wildlife species. Research conducted by the USDA Wildlife Services' National Wildlife Research Center has shown that no one grass management regime will deter all species of hazardous wildlife in all situations. In cooperation with wildlife damage management biologist, airport operators should develop airport turf grass management plans on a prescription basis, depending on the airport's geographic locations and the type of hazardous wildlife likely to frequent the airport

Airport operators should ensure that plant varieties attractive to hazardous wildlife are not used on the airport. Disturbed areas or areas in need of re-vegetating should not be planted with seed mixtures containing millet or any other large-seed producing grass. For airport property already planted with seed mixtures containing millet, rye grass, or other large-seed producing grasses, the FAA recommends disking, plowing, or another suitable agricultural practice to prevent plant maturation and seed head production. Plantings should follow the specific recommendations for grass management and seed and plant selection made by the State University Cooperative Extension Service, the local office of Wildlife Services, or a qualified wildlife damage management biologist. Airport operators should also consider developing and implementing a preferred/prohibited plant species list, reviewed by a wildlife damage management biologist, which has been designed for the geographic location to reduce the attractiveness to hazardous wildlife for landscaping airport property.

c. Airports surrounded by wildlife habitat. The FAA recommends that operators of airports surrounded by woodlands, water, or wetlands refer to Section 2.4 of this AC. Operators of such airports should provide for a Wildlife Hazard Assessment (WHA) conducted by a wildlife damage management biologist. This WHA is the first step in preparing a WHMP, where required.

d. Other hazardous wildlife attractants. Other specific land uses or activities (e.g., sport or commercial fishing, shellfish harvesting, etc.), perhaps unique to certain regions of the country, have the potential to attract hazardous wildlife. Regardless of the source of the attraction, when hazardous wildlife is noted on a public-use airport, airport operators must take prompt remedial action(s) to protect aviation safety.

2-8. SYNERGISTIC EFFECTS OF SURROUNDING LAND USES. There may be circumstances where two (or more) different land uses that would not, by themselves, be considered hazardous wildlife attractants or that are located outside of the separations identified in Sections 1-2 through 1-4 that are in such an alignment with the airport as to create a wildlife corridor directly through the airport and/or surrounding airspace. An example of this situation may involve a lake located outside of the separation criteria on the east side of an airport and a large hayfield on the west side of an airport, land uses that together could create a flyway for Canada geese directly across the airspace of the airport. There are numerous examples of such situations;

therefore, airport operators and the wildlife damage management biologist must consider the entire surrounding landscape and community when developing the WHMP.

SECTION 3.

PROCEDURES FOR WILDLIFE HAZARD MANAGEMENT BY OPERATORS OF PUBLIC-USE AIRPORTS.

3.1. INTRODUCTION. In recognition of the increased risk of serious aircraft damage or the loss of human life that can result from a wildlife strike, the FAA may require the development of a Wildlife Hazard Management Plan (WHMP) when specific triggering events occur on or near the airport. Part 139.337 discusses the specific events that trigger a Wildlife Hazard Assessment (WHA) and the specific issues that a WHMP must address for FAA approval and inclusion in an Airport Certification Manual.

3.2. COORDINATION WITH USDA WILDLIFE SERVICES OR OTHER QUALIFIED WILDLIFE DAMAGE MANAGEMENT BIOLOGISTS. The FAA will use the Wildlife Hazard Assessment (WHA) conducted in accordance with Part 139 to determine if the airport needs a WHMP. Therefore, persons having the education, training, and expertise necessary to assess wildlife hazards must conduct the WHA. The airport operator may look to Wildlife Services or to qualified private consultants to conduct the WHA. When the services of a wildlife damage management biologist are required, the FAA recommends that land-use developers or airport operators contact a consultant specializing in wildlife damage management or the appropriate state director of Wildlife Services.

NOTE: Telephone numbers for the respective USDA Wildlife Services state offices can be obtained by contacting USDA Wildlife Services Operational Support Staff, 4700 River Road, Unit 87, Riverdale, MD, 20737-1234, Telephone (301) 734-7921, Fax (301) 734-5157 *(http://www.aphis.usda.gov/ws/)*.

3-3. WILDLIFE HAZARD MANAGEMENT AT AIRPORTS: A MANUAL FOR AIRPORT PERSONNEL. This manual, prepared by FAA and USDA Wildlife Services staff, contains a compilation of information to assist airport personnel in the development, implementation, and evaluation of WHMPs at airports. The manual includes specific information on the nature of wildlife strikes, legal authority, regulations, wildlife management techniques, WHAs, WHMPs, and sources of help and information. The manual is available in three languages: English, Spanish, and French. It can be viewed and downloaded free of charge from the FAA's wildlife hazard mitigation web site: http://wildlife-mitigation.tc.FAA.gov/. This manual only provides a starting point for addressing wildlife hazard issues at airports. Hazardous wildlife management is a complex discipline and conditions vary widely across the United States. Therefore, qualified wildlife damage management biologists must direct the development of a WHMP and the implementation of management actions by airport personnel.

There are many other resources complementary to this manual for use in developing and implementing WHMPs. Several are listed in the manual's bibliography.

3-4. WILDLIFE HAZARD ASSESSMENTS, TITLE 14, CODE OF FEDERAL REGULATIONS, PART 139. Part 139.337(b) requires airport operators to conduct a Wildlife Hazard Assessment (WHA) when certain events occur on or near the airport.

Part 139.337 (c) provides specific guidance as to what facts must be addressed in a WHA.

3-5. WILDLIFE HAZARD MANAGEMENT PLAN (WHMP). The FAA will consider the results of the WHA, along with the aeronautical activity at the airport and the views of the airport operator and airport users, in determining whether a formal WHMP is needed, in accordance with Part 139.337. If the FAA determines that a WHMP is needed, the airport operator must formulate and implement a WHMP, using the WHA as the basis for the plan.

The goal of an airport's Wildlife Hazard Management Plan is to minimize the risk to aviation safety, airport structures or equipment, or human health posed by populations of hazardous wildlife on and around the airport.

The WHMP must identify hazardous wildlife attractants on or near the airport and the appropriate wildlife damage management techniques to minimize the wildlife hazard. It must also prioritize the management measures.

3-6. LOCAL COORDINATION. The establishment of a Wildlife Hazards Working Group (WHWG) will facilitate the communication, cooperation, and coordination of the airport and its surrounding community necessary to ensure the effectiveness of the WHMP. The cooperation of the airport community is also necessary when new projects are considered. Whether on or off the airport, the input from all involved parties must be considered when a potentially hazardous wildlife attractant is being proposed. Airport operators should also incorporate public education activities with the local coordination efforts because some activities in the vicinity of your airport, while harmless under normal leisure conditions, can attract wildlife and present a danger to aircraft. For example, if public trails are planned near wetlands or in parks adjoining airport property, the public should know that feeding birds and other wildlife in the area may pose a risk to aircraft.

Airport operators should work with local and regional planning and zoning boards so as to be aware of proposed land-use changes, or modification of existing land uses, that could create hazardous wildlife attractants within the separations identified in Sections 1-2 through 1-4. Pay particular attention to proposed land uses involving creation or expansion of waste water treatment facilities, development of wetland mitigation sites, or development or expansion of dredge spoil containment areas. At the very least, airport operators must ensure they are on the notification list of the local planning board or equivalent review entity for all communities located within 5 miles of the airport, so they will receive notification of any proposed project and have the opportunity to review it for attractiveness to hazardous wildlife.

3-7 COORDINATION/NOTIFICATION OF AIRMEN OF WILDLIFE HAZARDS. If an existing land-use practice creates a wildlife hazard and the land-use practice or wildlife hazard cannot be immediately eliminated, airport operators must issue a Notice to Airmen (NOTAM) and encourage the land–owner or manager to take steps to control the wildlife hazard and minimize further attraction.

SECTION 4.

FAA NOTIFICATION AND REVIEW OF PROPOSED LAND-USE PRACTICE CHANGES IN THE VICINITY OF PUBLIC-USE AIRPORTS

4-1. FAA REVIEW OF PROPOSED LAND-USE PRACTICE CHANGES IN THE VICINITY OF PUBLIC-USE AIRPORTS.

a. The FAA discourages the development of waste disposal and other facilities, discussed in Section 2, located within the 5,000/10,000-foot criteria specified in Sections 1-2 through 1-4.

b. For projects that are located outside the 5,000/10,000-foot criteria but within 5 statute miles of the airport's AOA, the FAA may review development plans, proposed land-use changes, operational changes, or wetland mitigation plans to determine if such changes present potential wildlife hazards to aircraft operations. The FAA considers sensitive airport areas as those that lie under or next to approach or departure airspace. This brief examination should indicate if further investigation is warranted.

c. Where a wildlife damage management biologist has conducted a further study to evaluate a site's compatibility with airport operations, the FAA may use the study results to make a determination.

4-2. WASTE MANAGEMENT FACILITIES.

a. Notification of new/expanded project proposal. Section 503 of the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century (Public Law 106-181) limits the construction or establishment of new MSWLF within 6 statute miles of certain public-use airports, when both the airport and the landfill meet very specific conditions. See Section 2-2 of this AC and AC 150/5200-34 for a more detailed discussion of these restrictions.

The Environmental Protection Agency (EPA) requires any MSWLF operator proposing a new or expanded waste disposal operation within 5 statute miles of a runway end to notify the appropriate FAA Regional Airports Division Office and the airport operator of the proposal (40 CFR 258, *Criteria for Municipal Solid Waste Landfills*, Section 258.10, *Airport Safety*). The EPA also requires owners or operators of new MSWLF units, or lateral expansions of existing MSWLF units, that are located within 10,000 feet of any airport runway end used by turbojet aircraft, or within 5,000 feet of any airport runway end used only by piston-type aircraft, to demonstrate successfully that such units are not hazards to aircraft. (See 4-2.b below.)

When new or expanded MSWLF are being proposed near airports, MSWLF operators must notify the airport operator and the FAA of the proposal as early as possible pursuant to 40 CFR 258.

b. Waste handling facilities within separations identified in Sections 1-2 through 1-4. To claim successfully that a waste-handling facility sited within the separations identified in Sections 1-2 through 1-4 does not attract hazardous wildlife and does not threaten aviation, the developer must establish convincingly that the facility will not handle putrescible material other than that as outlined in 2-2.d. The FAA strongly recommends against any facility other than that as outlined in 2-2.d (enclosed transfer stations). The FAA will use this information to determine if the facility will be a hazard to aviation.

c. Putrescible-Waste Facilities. In their effort to satisfy the EPA requirement, some putrescible-waste facility proponents may offer to undertake experimental measures to demonstrate that their proposed facility will not be a hazard to aircraft. To date, no such facility has been able to demonstrate an ability to reduce and sustain hazardous wildlife to levels that existed before the putrescible-waste landfill began operating. For this reason, demonstrations of experimental wildlife control measures may not be conducted within the separation identified in Sections 1-2 through 1-4.

4-3. OTHER LAND-USE PRACTICE CHANGES. As a matter of policy, the FAA encourages operators of public-use airports who become aware of proposed land use practice changes that may attract hazardous wildlife within 5 statute miles of their airports to promptly notify the FAA. The FAA also encourages proponents of such land use changes to notify the FAA as early in the planning process as possible. Advanced notice affords the FAA an opportunity (1) to evaluate the effect of a particular land-use change on aviation safety and (2) to support efforts by the airport sponsor to restrict the use of land next to or near the airport to uses that are compatible with the airport.

The airport operator, project proponent, or land-use operator may use FAA Form 7460-1, *Notice of Proposed Construction or Alteration*, or other suitable documents similar to FAA Form 7460-1 to notify the appropriate FAA Regional Airports Division Office. Project proponents can contact the appropriate FAA Regional Airports Division Office for assistance with the notification process.

It is helpful if the notification includes a 15-minute quadrangle map of the area identifying the location of the proposed activity. The land-use operator or project proponent should also forward specific details of the proposed land-use change or operational change or expansion. In the case of solid waste landfills, the information should include the type of waste to be handled, how the waste will be processed, and final disposal methods.

a. Airports that have received Federal grant-in-aid assistance. Airports that have received Federal grant-in-aid assistance are required by their grant assurances to take appropriate actions to restrict the use of land next to or near the airport to uses that are compatible with normal airport operations. The FAA recommends that airport operators to the extent practicable oppose off-airport land-use changes or practices within the separations identified in Sections 1-2 through 1-4 that may attract hazardous wildlife. Failure to do so may lead to noncompliance with applicable grant assurances. The FAA will not approve the placement of airport development projects pertaining to aircraft movement in the vicinity of hazardous wildlife attractants without appropriate mitigating measures. Increasing the intensity of wildlife control efforts is not a substitute for eliminating or reducing a proposed wildlife hazard. Airport operators should identify hazardous wildlife attractants and any associated wildlife hazards during any planning process for new airport development projects.

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APPENDIX 1. DEFINITIONS OF TERMS USED IN THIS ADVISORY CIRCULAR.

1. GENERAL. This appendix provides definitions of terms used throughout this AC.

1. **Air operations area.** Any area of an airport used or intended to be used for landing, takeoff, or surface maneuvering of aircraft. An air operations area includes such paved areas or unpaved areas that are used or intended to be used for the unobstructed movement of aircraft in addition to its associated runway, taxiways, or apron.

2. **Airport operator.** The operator (private or public) or sponsor of a public-use airport.

3. **Approach or departure airspace.** The airspace, within 5 statute miles of an airport, through which aircraft move during landing or takeoff.

4. **Bird balls.** High-density plastic floating balls that can be used to cover ponds and prevent birds from using the sites.

5. **Certificate holder.** The holder of an Airport Operating Certificate issued under Title 14, Code of Federal Regulations, Part 139.

6. **Construct a new MSWLF.** To begin to excavate, grade land, or raise structures to prepare a municipal solid waste landfill as permitted by the appropriate regulatory or permitting agency.

7. **Detention ponds.** Storm water management ponds that hold storm water for short periods of time, a few hours to a few days.

8. **Establish a new MSWLF.** When the first load of putrescible waste is received on-site for placement in a prepared municipal solid waste landfill.

9. **Fly ash.** The fine, sand-like residue resulting from the complete incineration of an organic fuel source. Fly ash typically results from the combustion of coal or waste used to operate a power generating plant.

10. **General aviation aircraft.** Any civil aviation aircraft not operating under 14 CFR Part 119, Certification: Air Carriers and Commercial Operators.

11. **Hazardous wildlife.** Species of wildlife (birds, mammals, reptiles), including feral animals and domesticated animals not under control, that are associated with aircraft strike problems, are capable of causing structural damage to airport facilities, or act as attractants to other wildlife that pose a strike hazard

12. **Municipal Solid Waste Landfill (MSWLF).** A publicly or privately owned discrete area of land or an excavation that receives household waste and that is not a land application unit, surface impoundment, injection well, or waste pile, as those terms are defined under 40 CFR § 257.2. An MSWLF may receive

other types wastes, such as commercial solid waste, non-hazardous sludge, small-quantity generator waste, and industrial solid waste, as defined under 40 CFR § 258.2. An MSWLF can consist of either a stand alone unit or several cells that receive household waste.

13. **New MSWLF.** A municipal solid waste landfill that was established or constructed after April 5, 2001.

14. **Piston-powered aircraft.** Fixed-wing aircraft powered by piston engines.

15. **Piston-use airport.** Any airport that does not sell Jet-A fuel for fixed-wing turbine-powered aircraft, and primarily serves fixed-wing, piston-powered aircraft. Incidental use of the airport by turbine-powered, fixed-wing aircraft would not affect this designation. However, such aircraft should not be based at the airport.

16. **Public agency.** A State or political subdivision of a State, a tax-supported organization, or an Indian tribe or pueblo (49 U.S.C. § 47102(19)).

17. **Public airport.** An airport used or intended to be used for public purposes that is under the control of a public agency; and of which the area used or intended to be used for landing, taking off, or surface maneuvering of aircraft is publicly owned (49 U.S.C. § 47102(20)).

18. **Public-use airport.** An airport used or intended to be used for public purposes, and of which the area used or intended to be used for landing, taking off, or surface maneuvering of aircraft may be under the control of a public agency or privately owned and used for public purposes (49 U.S.C. § 47102(21)).

19. **Putrescible waste.** Solid waste that contains organic matter capable of being decomposed by micro-organisms and of such a character and proportion as to be capable of attracting or providing food for birds (40 CFR §257.3-8).

20. **Putrescible-waste disposal operation.** Landfills, garbage dumps, underwater waste discharges, or similar facilities where activities include processing, burying, storing, or otherwise disposing of putrescible material, trash, and refuse.

21. **Retention ponds.** Storm water management ponds that hold water for several months.

22. **Runway protection zone (RPZ).** An area off the runway end to enhance the protection of people and property on the ground (see AC 150/5300-13). The dimensions of this zone vary with the airport design, aircraft, type of operation, and visibility minimum.

23. **Scheduled air carrier operation.** Any common carriage passenger-carrying operation for compensation or hire conducted by an air carrier or commercial

operator for which the air carrier, commercial operator, or their representative offers in advance the departure location, departure time, and arrival location. It does not include any operation that is conducted as a supplemental operation under 14 CFR Part 119 or as a public charter operation under 14 CFR Part 380 (14 CFR § 119.3).

24. **Sewage sludge.** Any solid, semi-solid, or liquid residue generated during the treatment of domestic sewage in a treatment works. Sewage sludge includes, but is not limited to, domestic septage; scum or solids removed in primary, secondary, or advanced wastewater treatment process; and a material derived from sewage sludge. Sewage does not include ash generated during the firing of sewage sludge in a sewage sludge incinerator or grit and screenings generated during preliminary treatment of domestic sewage in a treatment works. (40 CFR 257.2)

25. **Sludge.** Any solid, semi-solid, or liquid waste generated form a municipal, commercial or industrial wastewater treatment plant, water supply treatment plant, or air pollution control facility or any other such waste having similar characteristics and effect. (40 CFR 257.2)

26. **Solid waste.** Any garbage, refuse, sludge, from a waste treatment plant, water supply treatment plant or air pollution control facility and other discarded material, including, solid liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities, but does not include solid or dissolved materials in domestic sewage, or solid or dissolved material in irrigation return flows or industrial discharges which are point sources subject to permits under section 402 of the Federal Water Pollution Control Act, as amended (86 Stat. 880), or source, special nuclear, or by product material as defined by the Atomic Energy Act of 1954, as amended, (68 Stat. 923). (40 CFR 257.2)

27. **Turbine-powered aircraft.** Aircraft powered by turbine engines including turbojets and turboprops but excluding turbo-shaft rotary-wing aircraft.

28. **Turbine-use airport.** Any airport that sells Jet-A fuel for fixed-wing turbine-powered aircraft.

29. **Wastewater treatment facility.** Any devices and/or systems used to store, treat, recycle, or reclaim municipal sewage or liquid industrial wastes, including Publicly Owned Treatment Works (POTW), as defined by Section 212 of the Federal Water Pollution Control Act (P.L. 92-500) as amended by the Clean Water Act of 1977 (P.L. 95-576) and the Water Quality Act of 1987 (P.L. 100-4). This definition includes any pretreatment involving the reduction of the amount of pollutants, the elimination of pollutants, or the alteration of the nature of pollutant properties in wastewater prior to or in lieu of discharging or otherwise introducing such pollutants into a POTW. (See 40 CFR Section 403.3 (q), (r), & (s)).

30. Wildlife. Any wild animal, including without limitation any wild mammal, bird, reptile, fish, amphibian, mollusk, crustacean, arthropod, coelenterate, or other invertebrate, including any part, product, egg, or offspring thereof (50 CFR 10.12, *Taking, Possession, Transportation, Sale, Purchase, Barter, Exportation, and Importation of Wildlife and Plants*). As used in this AC, wildlife includes feral animals and domestic animals out of the control of their owners (14 CFR Part 139, Certification of Airports).

31. Wildlife attractants. Any human-made structure, land-use practice, or human-made or natural geographic feature that can attract or sustain hazardous wildlife within the landing or departure airspace or the airport's AOA. These attractants can include architectural features, landscaping, waste disposal sites, wastewater treatment facilities, agricultural or aquaculture activities, surface mining, or wetlands.

32. Wildlife hazard. A potential for a damaging aircraft collision with wildlife on or near an airport.

33. Wildlife strike. A wildlife strike is deemed to have occurred when:

a. A pilot reports striking 1 or more birds or other wildlife;

b. Aircraft maintenance personnel identify aircraft damage as having been caused by a wildlife strike;

c. Personnel on the ground report seeing an aircraft strike 1 or more birds or other wildlife;

d. Bird or other wildlife remains, whether in whole or in part, are found within 200 feet of a runway centerline, unless another reason for the animal's death is identified;

e. The animal's presence on the airport had a significant negative effect on a flight (i.e., aborted takeoff, aborted landing, high-speed emergency stop, aircraft left pavement area to avoid collision with animal) (Transport Canada, Airports Group, *Wildlife Control Procedures Manual*, Technical Publication 11500E, 1994).

2. RESERVED.

U.S. Department
of Transportation

Federal Aviation Administration

Advisory Circular

Subject: CONSTRUCTION OR ESTABLISHMENT OF LANDFILLS NEAR PUBLIC AIRPORTS

Date: January 26, 2006
Initiated by: AAS-300

AC No: 150/5200-34A
Change:

1. Purpose.

This advisory circular (AC) contains guidance on complying with Federal statutory requirements regarding the construction or establishment of landfills near public airports.

2. Application.

The guidance contained in the AC is provided by the Federal Aviation Administration (FAA) for use by persons considering the construction or establishment of a new municipal solid waste landfill (MSWLF) near a public airport. Guidance contained herein should be used to comply with MSWLF site limitations contained in 49 U.S.C. § 44718(d), as amended by section 503 of the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century, Pub. L. No. 106-181 (April 5, 2000), "Structures interfering with air commerce." In accordance with § 44718(d), as amended, these site limitations are not applicable in the State of Alaska.

In addition, this AC provides guidance for a state aviation agency desiring to petition the FAA for an exemption from the requirements of § 44718(d), as amended.

3. Cancellation

This AC cancels AC 150/52300-34, *Construction or Establishment of Landfills Near Public Airports*, dated August 8, 2000.

This revision contains no substantive changes to the original. Changes include revised and new website addresses, revised strike statistics, and regulation titles.

4. Related Reading Materials.

AC - 150/5200-33, *Hazardous Wildlife Attractions On or Near Airports*.

Wildlife Strikes to Civil Aircraft in the United States. FAA Wildlife Aircraft Strike Database Serial Reports.

Report to Congress: *Potential Hazards to Aircraft by Locating Waste Disposal Sites in the Vicinity of Airports,* April 1996, DOT/FAA/AS/96-1.

Title 14, Code of Federal Regulation, Part 139, Certification of Airports.

Title 40, Code of Federal Regulation, Part 258, Municipal Solid Waste Landfill Criteria.

Some of these documents and additional information on wildlife management, including guidance on landfills, are available on the FAA's Airports web site at http://www.faa.gov/airports_airtraffic/airports/ or http://wildlife-mitigation.tc.faa.gov

5. Definitions.

Definitions for the specific purpose of this AC are found in Appendix 1.

6. Background.

The FAA has the broad authority to regulate and develop civil aviation under the Federal Aviation Act of 1958, 49 U.S.C. § 40101, et. seq., and other Federal law. In section 1220 of the Federal Aviation Reauthorization Act of 1996, Pub. L. No. 104-264 (October 9, 1996), the Congress added a new provision, section (d), to 49 U.S.C. § 44718 to be enforced by the FAA and placing limitations on the construction or establishment of landfills near public airports for the purposes of enhancing aviation safety. Section 503 of the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century (AIR-21), Pub. L. No. 106-181 (April 5, 2000) replaced section 1220 of the 1996 Reauthorization Act, 49 U.S.C. § 44718 (d), with new language. Specifically, the new provision, § 44718(d), as amended, was enacted to further limit the construction or establishment of a municipal solid waste landfill (MSWLF) near certain smaller public airports.

In enacting this legislation, Congress expressed concern that a MSWLF sited near an airport poses a potential hazard to aircraft operations because such a waste facility attracts birds. Statistics support the fact that bird strikes pose a real danger to aircraft. An estimated 87 percent of the collisions between wildlife and civil aircraft occurred on or near airports when aircraft are below 2,000 feet above ground level (AGL). Collisions with wildlife at these altitudes are especially dangerous as aircraft pilots have minimal time to recover from such emergencies.

The FAA National Wildlife Aircraft Strike Database shows that more than 59,000 civil aircraft sustained reported strikes with wildlife from 1990 to 2004. Between 1990-2004, aircraft-wildlife strikes involving U. S. civil aircraft resulted in over $495 million/year worth of aircraft damage and associated losses and over 631,000 hours/year of aircraft down time.

From 1990 to 2004, waterfowl, gulls and raptors were involved in 77% of the 3,493 reported damaging aircraft-wildlife strikes where the bird was identified. Populations of Canada geese and many species of gulls and raptors have increased markedly over the last several years. Further, gulls and Canada geese have adapted to urban and suburban environments and, along with raptors and turkey vultures, are commonly found feeding or loafing on or near landfills.

In light of increasing bird populations and aircraft operations, the FAA believes locating landfills in proximity to airports increases the risk of collisions between birds and aircraft. To address this concern, the FAA issued AC 150/5200-33, *Hazardous Wildlife Attractions On or Near Airports*, to provide airport operators and aviation planners with guidance on minimizing wildlife attractants. AC 150/5200-33 recommends against locating municipal solid waste landfills within five statute miles of an airport if the landfill may cause hazardous wildlife to move into or through the airport's approach or departure airspace.

7. General.

Using guidance provided in the following sections, persons considering construction or establishment of a landfill should first determine if the proposed facility meets the definition of a new MSWLF (see Appendix 1). Section 44718(d), as amended, applies only to a new MSWLF. It does not apply to the expansion or modification of an existing MSWLF, and does not apply in the State of Alaska. If the proposed landfill meets the definition of a new MSWLF, its proximity to certain public airports (meeting the criteria specified in Paragraph 8 below) should be determined. If it is determined that a new MSWLF would be located within six miles of such a public airport, then either the MSWLF should be planned for an alternate location more than 6 miles from the airport, or the MSWLF proponent should request the appropriate State aviation agency to file a petition for an exemption from the statutory restriction.

In addition to the requirements of § 44718(d), existing landfill restrictions contained in AC 150/5200-33, *Hazardous Wildlife Attractions On or Near Airports* (see Paragraph 5, Background) also may be applicable. Airport operators that have accepted Federal funds have obligations under Federal grant assurances to operate their facilities in safe manner and must comply with standards prescribed in advisory circulars, including landfill site limitations contained in AC 150/5200-33.

8. Landfills Covered by the Statute.

The limitations of § 44718(d), as amended, only apply to a new MSWLF (constructed or established after April 5, 2000). The statutory limitations are not applicable where construction or establishment of a MSWLF began on or before April 5, 2000, or to an existing MSWLF (received putrescible waste on or before April 5, 2000). Further, an existing MSWLF that is expanded or modified after April 5, 2000, would not be held to the limitations of § 44718(d), as amended.

9. Airports Covered by the Statute.

The statutory limitations restricting the location of a new MSWLF near an airport apply to only those airports that are recipients of Federal grants (under the Airport and Airway Improvement Act of 1982, as amended, 49 U.S.C. § 47101, *et se*q.) and primarily serve general aviation aircraft and scheduled air carrier operations using aircraft with less than 60 passenger seats.

While the FAA does not classify airports precisely in this manner, the FAA does categorize airports by the type of aircraft operations served and number of annual passenger enplanements. In particular, the FAA categorizes public airports that serve air carrier operations. These airports are known as commercial service airports, and receive scheduled passenger service and have 2,500 or more enplaned passengers per year.

One sub-category of commercial service airports, nonhub primary airports, closely matches the statute requirement. Nonhub primary airports are defined as commercial service airports that enplane less than 0.05 percent of all commercial passenger enplanements (0.05 percent equated to 352,748 enplanements in 2004) but more than 10,000 annual enplanements. While these enplanements consist of both large and small air carrier operations, most are conducted in aircraft with less than 60 seats. These airports also are heavily used by general aviation aircraft, with an average of 81 based aircraft per nonhub primary airport.

In addition, the FAA categorizes airports that enplane 2,500 to 10,000 passengers annually as non-primary commercial service airports, and those airports that enplane 2,500 or less passengers annually as general aviation airports. Both types of airports are mainly used by general aviation but in some instances, they have annual enplanements that consist of scheduled air carrier operations conducted in aircraft with less than 60 seats. Of the non-primary commercial service airports and general aviation airports, only those that have scheduled air carrier operations conducted in aircraft with less than 60 seats would be covered by the statute. The statute does not apply to those airports that serve only general aviation aircraft operations.

To comply with the intent of the statute, the FAA has identified those airports classified as nonhub primary, non-primary commercial service and general aviation airports that:

1. Are recipients of Federal grant under 49 U.S.C. § 47101, et. seq.;

2. Are under control of a public agency;

3. Serve scheduled air carrier operations conducted in aircraft with less than 60 seats; and

4. Have total annual enplanements consisting of at least 51% of scheduled air carrier enplanements conducted in aircraft with less than 60 passenger seats.

Persons considering construction or establishment of a new MSWLF should contact the FAA to determine if an airport within six statute miles of the new MSWLF meets these criteria (see paragraph 11 below for information on contacting the FAA). If the FAA determines the airport does meet these criteria, then § 44718(d), as amended, is applicable.

An in-depth explanation of how the FAA collects and categorizes airport data is available in the FAA's National Plan of Integrated Airport Systems (NPIAS). This report and a list of airports classified as nonhub primary, non-primary commercial service and general aviation airports (and associated enplanement data) are available on the FAA's Airports web site at http://www.faa.gov/airports_airtraffic/airports/planning_capacity/.

10. Separation distance measurements.

Section 44718(d), as amended, requires a minimum separation distance of six statute miles between a new MSWLF and a public airport. In determining this distance separation, measurements should be made from the closest point of the airport property boundary to the closest point of the MSWLF property boundary. Measurements can be made from a perimeter fence if the fence is co-located, or within close proximity to, property boundaries. It is the responsibility of the new MSWLF proponent to determine the separation distance.

11. Exemption Process.

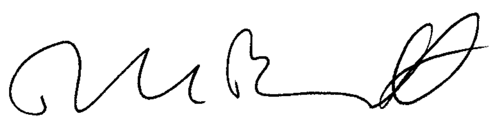
Under § 44718(d), as amended, the FAA Administrator may approve an exemption from the statute's landfill location limitations. Section 44718(d), as amended, permits the aviation agency of the state in which the airport is located to request such an exemption from the FAA Administrator. Any person desiring such an exemption should contact the aviation agency in the state in which the affected airport is located. A list of state aviation agencies and contact information is available at the National Association of State Aviation Officials (NASAO) web site at www.nasao.org or by calling NASAO at (301) 588-1286.

A state aviation agency that desires to petition the FAA for an exemption should notify the Regional Airports Division Manager, in writing, at least 60 days prior to the construction of a MSWLF. The petition should explain the nature and extent of relief sought, and contain information, documentation, views, or arguments that demonstrate that an exemption from the statute would not have an adverse impact on aviation safety. Information on contacting FAA Regional Airports Division Managers can be found on the FAA's web site at www.faa.gov.

After considering all relevant material presented, the Regional Airports Division Manager will notify the state agency within 30 days whether the request for exemption has been approved or denied. The FAA may approve a request for an exemption if it is determined that such an exemption would have no adverse impact on aviation safety.

12. Information.

For further information, please contact the FAA's Office of Airport Safety and Standards, Airport Safety and Operations Division, at (800) 842-8736, Ext. 7-3085 or via email at WebmasterARP@faa.gov. Any information, documents and reports that are available on the FAA web site also can be obtained by calling the toll-free telephone number listed above.



DAVID L. BENNETT
Director, Office of Airport Safety and Standards

APPENDIX 1. DEFINITIONS.

The following are definitions for the specific purpose of this advisory circular.

Construct a municipal solid waste landfill (MSWLF) means excavate or grade land, or raise structures, to prepare a municipal solid waste landfill as permitted by the appropriate regulatory or permitting authority.

Establish a municipal solid waste landfill (MSWLF) means receive the first load of putrescible waste on site for placement in a prepared municipal solid waste landfill.

Existing municipal solid waste landfill (MSWLF) means a municipal solid waste landfill that received putrescible waste on or before April 5, 2000.

General aviation aircraft means any civil aviation aircraft not operating under 14 CFR Part 119, Certification: Air carriers and commercial operators.

Municipal solid waste landfill (MSWLF) means publicly or privately owned discrete area of land or an excavation that receives household waste, and that is not a land application unit, surface impoundment, injection well, or waste pile, as those terms are defined under 40 CFR § 257.2. A MSWLF may receive other types of RCRA subtitle D wastes, such as commercial solid waste, nonhazardous sludge, small quantity generator waste and industrial solid waste, as defined under 40 CFR § 258.2. A MSWLF may consist of either a standalone unit or several cells that receive household waste.

New municipal solid waste landfill (MSWLF) means a municipal solid waste landfill that was established or constructed after April 5, 2000.

Person(s) means an individual, firm, partnership, corporation, company, association, joint-stock association, or governmental entity. It includes a trustee, receiver, assignee, or similar representative of any of them (14 CFR Part 1).

Public agency means a State or political subdivision of a State; a tax-supported organization; or an Indian tribe or pueblo (49 U.S.C. § 47102(15)).

Public airport means an airport used or intended to be used for public purposes that is under the control of a public agency; and of which the area used or intended to be used for landing, taking off, or surface maneuvering of aircraft is publicly owned (49 U.S.C. § 47102(16)).

Putrescible waste means solid waste which contains organic matter capable of being decomposed by micro-organisms and of such a character and proportion as to be capable of attracting or providing food for birds (40 CFR § 257.3-8).

Scheduled air carrier operation means any common carriage passenger-carrying operation for compensation or hire conducted by an air carrier or commercial operator for which the air carrier, commercial operator, or their representatives offers in advance the departure location, departure time, and arrival location. It does not include any operation that is conducted as a supplemental operation under 14 CFR Part 119, or is conducted as a public charter operation under 14 CFR Part 380 (14 CFR § 119.3).

Solid waste means any garbage, or refuse, sludge from a wastewater treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semi-solid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities, but does not include solid or dissolved materials in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges that are point sources subject to permit under 33 U.S.C. § 1342, or source, special nuclear, or by-product material as defined by the Atomic Energy Act of 1954, as amended (68 Stat. 923) (40 CFR § 258.2).

Appendix A-4:

Meeting Notes
September 7, 2010 Meeting with
St. Louis Airport Authority

Summary of Airport Meeting

On September 7, 2010, representatives of Bridgeton Landfill LLC and the Environmental Protection Agency met with representatives of the St. Louis Airport Authority. The following persons attended the meeting:

Mario Pandolfo, legal services manager for the City of St. Louis/Lambert Airport
Joletta Golik, environment/health & safety manager for Lambert Airport
Robert C. Alexander, Jr., US Dept. of Agriculture/APHIS/Wildlife Services
Bill Beck, outside counsel (Lathrop & Gage) on behalf of Bridgeton Landfill
Dan Gravatt, EPA Region 7
Cheryle Micinski, EPA Region 7
David Vasbinder, environmental health & safety for Bridgeton Landfill
Jessie Merrigan, outside counsel (Lathrop & Gage) for Bridgeton Landfill
Kate Whitby, local counsel (Spencer Fane) for Bridgeton Landfill
Joseph Nassif, outside counsel (Husch Blackwell) for the Airport
Gerard Slay, Senior Deputy Director/COO, St. Louis Airport Authority

The meeting was requested by EPA to follow up on concerns raised by the PRPs that the Negative Easement recorded on the property would prohibit construction of the “on-site cell” evaluated as part of the Supplemental Feasibility Study.

Cheryle Micinski provided background on the site and the administrative process to date. Dan Gravatt provided a summary of the alternatives considered in the SFS – the ROD remedy; full excavation and disposal of all radiologically-contaminated materials off-site; and full excavation and disposal of all radiologically-contaminated materials in a new on-site cell.

Outside counsel for the Airport raised multiple questions about the logistics of an excavation remedy and any efforts thus far to estimate the risks created by such a remedy. He then stopped the discussion to state that the Airport could not accept the significant risks that would be created by an excavation remedy – either for on-site or off-site disposal.

The Airport representatives passed around (but did not provide copies of) a document displaying the actual flight paths used by aircraft at the Airport. This diagram showed multiple flight patterns extending directly over the Landfill. The Airport representatives also mentioned statistics indicating a significant decrease in bird strikes since the 2005 closure of the sanitary landfill at the site.

Senior Deputy Director Gerard Slay stated that use of the rail loading facility located at the Airport (as presumed by the SFS for the excavation and off-site disposal alternative) would not work for the Airport.

Airport representatives, including USDA, also stated that an excavation remedy would create risks that they could not even calculate, and that monitoring and management of risks created by wildlife would be impossible. They noted that under the ROD remedy the site will present no risk to human health or the environment, and said that creating new risks by implementing an excavation remedy did not seem advisable.

The representative for USDA noted that he investigated multiple wildlife vectors during the investigation and study processes for the SLAPS and Weldon Springs sites, including not only birds but other wildlife which might remove and ingest or otherwise disperse radiological materials made accessible by an excavation remedy. He suggested that the same issues would be problematic at West Lake.

The Airport representatives stated that while they would expect any damages (to aircraft, etc.) to be paid for by EPA or the PRPs, the risks of a bird strike or other adverse impacts on the Airport would still be unacceptable. They stated that this would necessitate FAA review of either an on-site or off-site excavation remedy and likely would result in objections from airlines as well as the FAA. The Airport representatives were particularly concerned that either excavation alternative would take years to perform.

Cheryle Micinski asked whether the Airport's concerns would be alleviated by excavation of only Area 2 (outside the 10,000 foot range). The unanimous response was no. They stated that the entire area is within the Negative Easement and subject to FAA review if "new landfilling operations" were to occur. In particular, they explained that construction of an on-site disposal cell would <u>not</u> qualify as an expansion or change to an existing landfill, but would instead constitute "new operations" at the site and therefore would trigger FAA review. They also could not predict the changes that any excavation activities would cause to the migratory patterns of birds using the site, and could not take the risk that such changes would increase the local bird population.

In 2006 the Airport submitted a comment letter in support of the ROD remedy. While the Airport representatives believe that this letter still accurately states their position, the Airport's outside counsel indicated that he wants to revisit the possible exposure of MSW waste during any regrading or contouring activities under the ROD Remedy.

The Airport representatives concluded the meeting by indicating that their attendees were unanimous in viewing any excavation remedy for the site as unwarranted and unacceptable to the Airport because of the increased risks to aircraft that would be created by such a remedy.

EPA asked that the Airport confirm this view in writing. The Airport representatives stated that they would provide a letter outlining their concerns about the risks created by an excavation remedy and the regulatory and other barriers which would impact such a remedy. They indicated that they would try to send such a letter to EPA prior to the September 22nd technical meeting.

The Airport representatives emphasized that while they work hard to cooperate with EPA, they could not accept the known and significant risks that an excavation remedy would cause to airport operations.

EPA asked the USDA representative for a similar letter confirming USDA's concerns in writing, and he said that he did not have counsel for this project, but would attempt to get such a letter prepared.

Appendix A-5:

St. Louis Airport Authority
September 20, 2010 Letter

Rhonda Hamm-Niebruegge
Director

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Francis G. Slay
Mayor
City of St. Louis

September 20, 2010

Mr. Daniel Gravatt
Project Manager/Environmental Scientist
U.S. EPA – Region 7
901 North 5th Street
Kansas City, Kansas 66101

Re: West Lake Landfill: Comments on Work Plan for Supplemental Feasibility Study

Dear Mr. Gravatt:

As requested, the City of St. Louis ("the City"), the owner and operator of Lambert-St. Louis International Airport® ("Airport") has reviewed the June 4, 2010 Work Plan for Supplemental Feasibility Study Radiological-Impacted Material Excavation Alternatives Analysis: West Lake Landfill Operable Unit-1 ("Work Plan"). The City supports the Environmental Protection Agency's ("EPA") evaluation of remedial alternatives to address radiologically contaminated materials located at the West Lake Landfill (formerly known as the Bridgeton Landfill). The City takes seriously the presence of radioactive materials at the West Lake Landfill and the long term impact those radioactive materials may have on water resources. The City urges EPA to select a remedy for the cleanup of the West Lake Landfill radioactive wastes that is practical and ensures that these wastes no longer pose a threat to human health and the environment. However, the City must ensure that any action involving the West Lake Landfill does not unnecessarily jeopardize the City's public safety obligations with respect to Airport and its operations.

The Federal Aviation Administration ("FAA") and United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services ("USDA") previously determined that the West Lake Landfill was a hazardous wildlife attractant for the Airport. *See* June 2004 Lambert – St. Louis International Airport Wildlife Hazard Assessment for the Bridgeton Sanitary Landfill. The West Lake Landfill is located, at its closest point, within approximately 9,166 feet of Airport Runway 11/29 (formerly 12W/30W), which is inconsistent with FAA runway siting guideline requiring a 10,000 foot separation radius. *See* FAA Advisory Circular 150/5200 33B (Hazardous Wildlife Attractants on or near Airports). The FAA, in a September 1998 Record of

Decision ("1998 FAA ROD") concerning expanded operations at the Airport, directed the City to mitigate the West Lake Landfill to protect aircraft from bird strikes at the Airport. *See* September 30, 1998 FAA Record of Decision: Lambert-St. Louis International Airport, pg. 42 - 43. Pursuant to the requirements of the 1998 FAA ROD, the City entered into the Negative Easement Agreement ("NEA") with the Bridgeton Landfill operators, at significant cost, to prohibit depositing or dumping of new or additional putrescible waste on the entirety of the property after August 1, 2005, and to require the landfill operators to comply with laws and regulations concerning proper landfill cover, so as to reduce or mitigate wildlife hazards to aircraft and airport facilities. *See* Negative Easement Agreement at pg. 2 – 3. The restrictive covenants in the NEA for the Bridgeton Landfill, along with other FAA required programs, have successfully mitigated aircraft bird strikes at the Airport, and particularly runway 11/29 (formerly 12W/30W). *See* Lambert St. Louis International Airport 2005 – 2010 Bird Strike Report Summary. Although these FAA restrictions and requirements may be mentioned as guidance in the feasibility study undertaken at the insistence of EPA, we are informed that these restrictions should be considered applicable or relevant and appropriate requirements for remedy selection purposes.

After consultation with Airport engineers and USDA Wildlife Services staff, the City believes that the excavation alternatives described in the Work Plan would adversely affect wildlife mitigation measures taken by the Airport to protect aircraft from bird strikes; thereby placing the City in violation of the 1998 FAA ROD requiring that such mitigation efforts be undertaken and maintained. In addition, such action on the part of the former landfill operators would violate the NEA. The primary issue here is aircraft and passenger safety. Bird studies conducted by the USDA have identified 11 of the top 15 most hazardous bird species to aircraft (damage and effect on flight) at the West Lake Landfill and surrounding areas. Many of these bird species, which include vultures, geese, hawks, gulls, owls and pigeons, have been reported in the approximately 600+ bird strike incidents that have occurred at the Airport since the 1990s. The USDA Wildlife Service has advised the City that uncovered radiologically impacted municipal waste at the West Lake Landfill will serve as a food attractant for a variety of bird species and increase the risk of bird/aircraft strikes at the Airport. *See* September 17, 2010 USDA letter to the Airport.

The Work Plan contemplates that municipal waste in the landfill will be removed by excavation and disposed on the property during the creation of the on-site engineered disposal cell, in direct violation of Paragraph 1 of the NEA. Further, the radioactive municipal waste materials will remain exposed at the site throughout the duration of excavation and landfill activities without a daily cover, which is in violation of Missouri Solid Waste Regulation 10 CSR 80-3 (17)(C)(1) and Paragraph 2 of the NEA. Moreover, based on anticipated waste volumes and available funding, the response action contemplated in the Work Plan would, rationally speaking, appear to be a ten to twenty year effort. The FAA considers any facility handling uncovered quantities of municipal solid waste outside, even if only for a short time, incompatible with safe airport operations if they are located within a 10,000 foot radius of an active airport runway. *See* FAA Advisory Circular 150/5200 33B (Hazardous Wildlife Attractants On or Near

Airports) at pg. 4, § 2 – 2. Thus, the presence of uncovered municipal solid waste at the West Lake Landfill may place the City in violation of 1998 FAA ROD. The Work Plan does not explain how the Respondents/Operators will comply with the terms of the NEA or Missouri Solid Waste Regulation daily landfill soil cover requirements during excavation and transport of contaminated municipal solid waste from the landfill. Any remediation objective selected by EPA for the West Lake Landfill must ensure that the remediation activities do not create a wildlife attractant that presents an intolerable risk of aircraft bird strikes at the Airport.

The excavation, movement and transportation of radiologically impacted municipal waste required during the response action at the West Lake Landfill is consistent with the characteristics of an operational solid waste landfill, as described in the Missouri Solid Waste Regulations. As a result, certain operational requirements (i.e. daily cover and surface water management) and landfill site selection standards (i.e. airport safety, flood plains, wetlands, seismic impact zones and unstable areas) will apply to the excavation alternatives described in the Work Plan. _See_ 10 CSR 80-3.010 (4)(B)(1 – 6); 10 CSR 80-3.010(1)(C) (classifying non-compliant sanitary landfills as open dumps that are prohibited by law).

Missouri Solid Waste Regulations prohibit landfill operations within a 10,000 foot (3,048 meters) radius of any airport runway end used by turbojet aircraft unless the operators can demonstrate that the landfill operations pose no bird hazard to aircraft. _See_ 10 CSR §80-3 (Sanitary Landfill). The Respondents/Operators must demonstrate the remediation activities at the Bridgeton Landfill, portions of which are located within a 10,000 foot radius of the Airport's runway 11/29, do not pose a hazard to aircraft using the Airport's facilities; or at the very least, do not increase the likelihood of bird/aircraft collisions. _See_ Lambert – St. Louis International Airport Expansion Runway to Landfill Distance Study. It is very likely that the excavation and disposal alternatives contemplated in the Work Plan will disrupt the wildlife mitigation efforts undertaken by the City pursuant to the 1998 FAA ROD, and increase the likelihood of bird/aircraft collisions at the Airport. FAA Advisory Circular 150/5200 – 33B suggests that Respondents/Operators will not be able to mitigate the risk of wildlife strikes to aircraft during excavation and disposal activities at the Bridgeton/West Lake Landfill; as no facility has been able to demonstrate an ability to reduce and sustain hazardous wildlife to levels that existed before the putrescible–waste landfill began operating. _See_ Hazardous Wildlife Attractants On or Near Airports - Advisory Circular 150/5200 – 33B. In fact, FAA does not even allow landfill operators to conduct demonstrations of experimental wildlife control measures within a 10,000 foot radius of an airport because of this perfect failure rate. _Id._ Thus, it seems that the Respondents/Operators will not be able to demonstrate that excavation and landfill activities at the Bridgeton/West Lake Landfill do not pose a threat to aviation operations at the Airport, particularly since the FAA /USDA have already determined that the municipal waste operations at the Bridgeton/West Lake Landfill are a hazardous wildlife attractant for the Airport. _See_

June 2004 Lambert – St. Louis International Airport Wildlife Hazard Assessment for the Bridgeton Sanitary Landfill.[1]

Missouri Solid Waste Regulations also require all operating solid waste disposal sites to cover "disposed solid waste with six inches of earthen material at the end of each operating day, or at more frequent intervals, as necessary, to control disease vectors, fires, odors, blowing litter and scavenging . . .". *See* 10 CSR 80-3 (17)(C)(1). Missouri's Solid Waste Regulations should be applicable to the remediation activities contemplated at the West Lake Landfill, which consist of exposing municipal/putrescible waste that may attract wildlife, disease vectors, blowing liter and risks of fire. The risk of creating a wildlife attractant near the Airport mandates that Respondents/Operators comply with Missouri daily landfill cover requirements during any excavation or disposal activities at the West Lake Landfill. The necessity of compliance with 10 CSR 80-3(17) may further complicate the remediation objectives by creating additional quantities of radiologically contaminated soils for disposal and increase cost and duration estimates contemplated under the Work Plan. However, any failure to comply with the daily cover requirements would create an unacceptable risk to aviation operations at the Airport. The lack of daily cover would also contribute to the distribution of low level radioactive contamination throughout the site by allowing surface waters to come in contact with uncovered radiologically contaminated municipal waste material, and possibly air blown dust, without adequate controls. Missouri Solid Waste Regulations require all active solid waste disposal sites to minimize environmental hazards and conform to applicable ground and surface water quality standards. *See* 10 CSR 80-3 (8). The Work Plan does not explain how the Respondents/Operator's will manage daily landfill cover requirement, or the surface waters and wind blown dust that come into contact with radiologically-impacted waste materials exposed during remediation activities.

The City is also concerned that Respondents/Operators have not identified a viable disposal location for the radiologically-impacted municipal wastes and soils that will be excavated from the West Lake Landfill. The proposed on-site engineered disposal cell location (OU-2 Stockpile Area) is not an appropriate site for long term storage of the radiologically impacted waste due to regulatory and capacity restrictions, and there is no licensed treatment, storage or disposal facility that may accept a mixture of radiologically impacted soils and municipal waste. The Work Plan indicates that the existing OU-2 Stockpile Area is the only location on the West Lake Landfill property that the on-site engineered disposal cell may be sited due to the geomorphic flood plain. However, this location, approximately 8,000 feet from the Airport, is incompatible with

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[1] Similar to the Missouri solid waste regulations, the Missouri legislature specifically promulgated legally applicable requirements prohibiting the creation or establishment of airport hazards within 2 miles (10,560 feet) from an airport boundary. *See* Mo. Rev. Stat. § 305 (Aircraft and Airports). Local regulations further prohibit the use of land or water near the Lambert – St. Louis International Airport in such a manner as to create bird strike hazards, or otherwise in any way endanger or interfere with the landing, takeoff, or maneuvering of any aircraft intending to use the airport. *See* St. Louis County, Missouri Ordinance 1003.161 (Air Navigation Space Regulations – including height restrictions for structures near the Airport). To the extent remediation activities at the Bridgeton Landfill present a risk of bird/aircraft strikes, such activities are contrary to the interests of public health, safety and general welfare; and a violation of Missouri zoning laws.

state and federal regulations that prohibit the placement of a new solid waste disposal site within a 10,000 foot radius of an active runway, with one statute requiring a minimum separation 6 miles between the airport and a new disposal location. *See* 40 CFR §258.10 (Airport Safety); 40 CFR §258.16 (Closure of Unsafe Landfills); 10 CSR §80-3 (Sanitary Landfill); 49 USC 44718 (Structures Interfering with Air Commerce); FAA Advisory Circular 150/5200 – 34A (Construction or Establishment of Landfills Near Public Airports), *see also*, Negative Easement Agreement. Furthermore, it is not clear that the OU-2 Stockpile Area could accommodate the quantity of radiologically impacted waste (also unknown) that will be excavated from Radiological Areas 1 and 2, which would include additional quantities of contaminated landfill cover material generated on a daily basis. The process of selecting and evaluating a location for the on-site engineered disposal cell must comply with state and federal landfill siting requirements; but sets forth no methodology to address the direct prohibition against placement of a new landfill disposal site within a 10,000 foot radius of an active airport runway.

The EPA Responsiveness Summary and Work Plan also indicate that Respondents/Operators are aware of no licensed treatment, storage or disposal facility that can accept radiologically impacted soils and municipal solid waste; and there are no feasible methods of separating contaminated soils from municipal waste without creating additional unnecessary risks of harm to human health or the environment.

As a final comment, we respect the possibility, however unlikely, that the Earth City Levee System, which protects the area from a 500 year flood event, might be breached and flood waters might cover the current landfill site. However, when the City last reviewed EPA's prior selected remedy, it learned that such a circumstance would have little if any environmental significance in light of steps that would be taken to further cap the existing site under EPA Preferred Alternatives L4/F4. Recognizing that EPA must deal with possibilities and weigh their likelihood at times, the reality is that bird strikes happen at the Airport, even with the current reduction in attractant sites and mitigation measures. No one wants to be in the position of trading risks associated with an unlikelihood or theoretical possibility for reality. Any balancing of risks must take reality into account.

The City reserves the right to amend or provide additional comments concerning the proposed remediation activities at the West Lake Landfill. The City also requests that EPA and/or Respondents provide regular updates concerning their progress toward selecting a remedy for the West Lake Landfill.

Respectfully submitted,

Rhonda Hamm-Niebruegge

Rhonda Hamm-Niebruegge
Director of Airports

Appendix B

Estimated Three-Dimensional Extent of Radiologically Impacted Material

Estimated Three-Dimensional Extent of Radiologically Impacted Material, West Lake Landfill Operable Unit 1, Bridgeton, Missouri

S.S. PAPADOPULOS & ASSOCIATES, INC.
Environmental & Water-Resource Consultants

September 30, 2016

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Estimated Three-Dimensional Extent of Radiologically Impacted Material, West Lake Landfill Operable Unit 1, Bridgeton, Missouri

Prepared for:

The West Lake Landfill OU-1 Respondents:
Cotter Corporation (N.S.L.), Bridgeton Landfill, LLC., Rock Road Industries, Inc., and the United States Department of Energy

Prepared by:

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Executive Summary

This report details the estimation of the extent of radiologically-impacted material (RIM) within Areas 1 and 2 of Operable Unit 1 (OU-1) at West Lake Landfill, near Bridgeton, Missouri. The three dimensional distribution of RIM was estimated using indicator kriging in order to obtain estimates of the extent and volume of RIM to support final feasibility study (FFS) evaluations associated with potential partial or complete excavation alternatives. The RIM assessment emphasizes obtaining a "best estimate" of the extent of RIM in both Areas 1 and Areas 2 at concentrations in soil exceeding four concentration thresholds: 7.9 pico-Curies per gram (pCi/g), 52.9 pCi/g, 500 pCi/g and 1,000 pCi/g. Additional calculations are provided that (a) assess a range of RIM extents at these thresholds that is reasonably consistent with the sample data assuming that the "best estimate" is an unbiased estimate, to illustrate the uncertainty that exists when estimating the extent of RIM at the scale of the two Areas, and (b) assess the potential for bias in the "best estimate," as well as the directional tendency of any bias.

The main outputs of the calculations are maps of estimated RIM extent together with estimated volumes of RIM at the four concentration thresholds, and estimated volumes of clean (i.e., non-RIM) overburden and set-back material that would be required to be excavated should a complete or partial excavation remedy be selected based upon these RIM volumes. To three significant digits, the "best-estimate" volumes of RIM calculated for Areas 1 and 2, respectively, using the concentration threshold of 7.9 pCi/g (i.e., for the complete rad removal (CRR) alternative) are about 48,200 cubic yards (Area 1) and about 213,000 cubic yards (Area 2), respectively. However, the additional calculations completed to assess bias and uncertainty inherent in these results – which is not atypical of such material volume estimates – suggest that these "best estimates" are likely to be biased low, such that the true volumes likely lie above these best estimate values.

Further, the uncertainty inherent in these estimates could have substantial implications for remedy design and cost. Many aspects of the cost of an excavation remedy alternative would increase as the volume (extent) increases, although the increases may not scale linearly with increasing extent or volume. For purposes of providing approximate extents to support costing of remedy alternatives, additional calculations were deemed unwarranted. However, additional analyses may be warranted if a complete or partial excavation remedy is selected in order to refine the estimates in areas of greatest uncertainty; evaluate and mitigate bias through further discretization of the CDF; and, incorporate information on practical excavation lifts (thicknesses) and other implications for the volume of RIM to be handled.

The work presented in this report was undertaken to estimate the extent of RIM, and associated extents and volumes of RIM and non-RIM material, in support of calculations required for the FFS. Considerable caution is advised regarding the use of these results for any other purposes.

REPORT

Section 1
Introduction

The West Lake Landfill Superfund Site (the Site) is located in Bridgeton, St. Louis County, Missouri. The objective of the study described herein is to estimate the extent of radiologically-impacted material (RIM) within Areas 1 and 2 of Operable Unit 1 (OU-1) at West Lake Landfill, in order to support the costing and design of complete and partial excavation remedy alternatives for a final feasibility study (FFS). A map of Areas 1 and 2 is reproduced in Figure 1. This report describes the method selected to interpolate sample results; the data processing steps; the interpolation steps; and the post-processing steps implemented to obtain a discretized estimate of the continuous three-dimensional (3D) distribution of RIM. Assumptions and limitations are summarized, and a discussion is provided to guide the interpretation and use of the results of the RIM analysis.

Section 2
Method Selection

2.1 Overview

A variety of methods can be used to obtain a 3D estimate of the extent of a subsurface characteristic or property based upon irregularly-spaced sample data. On many occasions, geostatistical methods provide advantages over other techniques for the interpolation of environmental data (see, for example, Reed et. al, 2004). In particular, non-parametric techniques developed within the field of geostatistics have been shown to be robust in the presence of skewed data such as arise commonly in environmental applications (see for example, Deutsch and Journel, 1992; Journel and Deutsch, 1997). Reed et al. (2004) compare various interpolation methods, illustrating several advantages of geostatistical methods as well as the relative benefit of implementations that implement data transforms versus ordinary kriging (OK) of raw sample data to interpolate data characterized by high skewness, such as concentration data. Journel and Deutsch (1997) also detail the use of rank-order geostatistics, wherein sample data values are transformed into standardized ranks. For example, when undertaking Quantile Kriging (QK), a uniform-score "rank" transform is applied to the raw sample data, wherein the data are ranked in ascending order to define a cumulative distribution function (CDF) between zero and one. The values ascribed to each sampled location from the CDF are then interpolated (generally using OK) to un-sampled locations, such as a grid, and subsequently back-transformed to the original concentration units (Deutsch and Journel, 1992; Journel and Deutsch, 1997; Reed et. al, 2004).

Indicator kriging (IK) can be considered a form of prescribed rank or prescribed category kriging (see for example, Hohn, 1988; Cressie, 1993). The sample data values are compared to threshold concentration levels of interest, such as cleanup standards. In the case of a single concentration threshold, sample values that lie above the threshold are assigned an index value of 1.0, and sample values that lie below the threshold are assigned an index value of 0.0: interpolation of these indexes (typically using OK) results in a continuous distribution of values that range between zero and one that in the simplest case reflect the probability that the criterion is exceeded at the corresponding un-sampled location. When multiple threshold concentrations are of interest, multiple indicator kriging (MIK) can be implemented, wherein sample concentrations are transformed using a CDF to assign to each sample location a probability that each successive threshold concentration is not exceeded at that location: the transformed sample data are interpolated, again typically using OK, and a posterior or conditional CDF (CCDF) is obtained. Indicator kriging can also incorporate secondary or "soft" data in addition to the primary "hard" sample results for the quantity of interest, which can be particularly beneficial when the secondary data are more plentiful than the primary data.

Given the objectives of this task – i.e., to estimate the extent of RIM that is present above a small number of pre-defined concentration thresholds for purposes of the FFS – and the desire to incorporate more than one data type in the interpolation exercise, the extent of RIM within OU-1 Areas 1 and 2 was estimated in 3D using MIK. The MIK method is commonly used to identify regions of the subsurface that exhibit properties that exceed one or more defined threshold criterion and, as such, is well-suited to delineating RIM. Furthermore, as explained in Section 3, there are two distinct data types available as input for the interpolation – hard data in the form of sample results for radionuclides and soft data in the form of gamma and alpha radiation counts – and MIK provides a flexible and expedient mechanism for combining these data types. All kriging calculations were completed using the Fortran-based Geostatistical Library (GSLIB: Deutsch and Journal, 1992) indicator kriging program IK3D, compiled with dynamic memory allocation to facilitate the use of the relatively large soft dataset that is available at West Lake Areas 1 and 2.

2.2 Relationship Between Radium and Thorium Isotopes, Alpha Radiation and Gamma Emissions

Sampling at West Lake landfill OU-1 Areas 1 and 2 includes results for thorium-232 and thorium-230, plus radium-228 and radium-226. Thorium-232 and radium-228 comprise the parent and first daughter isotope of the primordial thorium series: thorium-232 decays to radium-228 via alpha radiation (half-life [$t_{1/2}$] = 1.4×10^{10} years), whereas radium-228 decays primarily via beta radiation ($t_{1/2}$ = 5.7 years). Although decay of thorium-232 does not produce high gamma emissions, decay of some of the daughter isotopes does, and can be used to infer the presence and relative concentration of radium-228. Thorium-230 and radium-226 comprise daughter isotopes of the uranium-238 series: thorium-230 decays to radium-226 via alpha radiation ($t_{1/2}$ = 7.54×10^{4} years), and radium-226 also decays primarily via alpha radiation ($t_{1/2}$ = 1.6×10^{3} years). Decay of the daughter isotopes of radium-226 produces relatively high gamma emissions that can be used to infer the presence and relative concentration of radium-226. The primary radionuclides detected in Areas 1 and 2 are those that arise in the uranium-238 decay series.

Given the foregoing, it might be expected that concentrations of radium and thorium would illustrate a general relation characterized by higher concentrations of one isotope being typically associated with (i.e., detected together with) higher concentrations of the other isotope, and vice-versa. Furthermore, it might be expected that concentrations of radium or thorium would typically be associated with elevated counts of either alpha radiation or gamma energy emissions. Although many factors might result in these relationships not necessarily being simple linear correlations – such as historical material leaching processes for beneficiation and its effect on secular equilibrium; variable decay rates and ingrowth; and the combining of individual radium and thorium isotope results from separate decay chains – empirical confirmation that these relationships exist under current conditions was one premise for the selection of the indicator kriging method to estimate the extent of RIM as detailed in this report.

Figure 2 depicts a scatter plot of radium-226 plus radium-228 concentrations (i.e., combined radium) versus thorium-230 plus thorium-232 concentrations (i.e., combined thorium) for collocated samples from Area 1. The data used to prepare Figure 2 are listed on Table A-1 (Appendix A), and described further in Section 3. Figure 3 depicts a similar scatter plot of combined radium concentrations versus combined thorium concentrations for collocated samples from Area 2. The data used to prepare Figure 3 are listed on Table A-2 (Appendix A), and described further in Section 3. In each of Figure 2 and Figure 3 there is a clear relationship between concentrations of combined radium and combined thorium.

Figure 4 depicts two scatter plots of recorded gamma energy emissions counts versus (a) combined thorium concentration and (b) combined radium concentration for Area 1. Sample data used to prepare Figure 4 are listed on Table A-1 (Appendix A), plotted for visual inspection in Appendix B and described further in Section 3. Figure 5 depicts two scatter plots of recorded gamma energy emissions counts versus (a) combined thorium concentration and (b) combined radium concentration for Area 2. The data used to prepare Figure 5 are listed on Table A-2 (Appendix A), plotted for visual inspection in Appendix B and described further in Section 3. Figures 4 and Figure 5 demonstrate relationships between the concentration of combined radium or the concentration of combined thorium and the gamma counts recorded at the same location, particularly at relatively high concentrations and counts. The strength of the relationship is less clear for combined radium in Area 1 (Figure 4(b)) where radium concentrations and gamma counts are both relatively low. The gamma energy emissions counts used to prepare Figures 4 and 5 are "raw" measurements that have not been corrected for baseline responses: the process of removing baseline responses from alpha and gamma recordings is detailed in Section 3.

2.3 Threshold Concentration Values

Based upon prior correspondence and site reports, the multiple indicator kriging analysis was designed to estimate the extent of RIM present within Area 1 and Area 2 at concentrations exceeding three pre-defined threshold concentrations values – those listed as thresholds 1, 2 and 4 below – that were previously established by U.S. Environmental Protection Agency (USEPA) for remedial evaluation purposes, and also at concentrations exceeding a fourth intermediate threshold value (i.e., threshold 3 below) as follows:

1. Combined radium *or* combined thorium at greater than 7.9 pCi/g
2. Combined radium *or* combined thorium at greater than 52.9 pCi/g
3. Combined radium *or* combined thorium at greater than 500 pCi/g
4. Combined radium *or* combined thorium at greater than 1,000 pCi/g

All data pre- and post-processing for the calculations described in this report emphasize these concentration thresholds. Note that emphasis is placed on the "or" because this also determines how results are evaluated.

Section 3
Data Processing

3.1 Overview of Data Types

The method of MIK as implemented in IK3D can implement ordinary or simple kriging (SK) of either categorically-coded or continuous CDF-type indicator data. IK3D also allows the direct input of previously-transformed indicator data, including soft data. In this sense, the soft data can comprise any quantitative or quantifiable independent information that is correlated with the primary hard sample data values. Because both data types are available for Areas 1 and 2 of OU-1, the use of MIK as implemented with IK3D for the purpose of estimating the extent of RIM in Areas 1 and 2 of OU-1 therefore requires the compilation of:

1. hard sample results, which comprise values of radium and of thorium within landfill soil and waste materials obtained from borings and other samples; and,

2. soft data results, which comprise gamma and alpha responses obtained either within borings (i.e., downhole) or from retrieved core material.

Processing of these hard and soft data types for use in the indicator kriging is described below. Figures 2 and 3 depict the sample locations at Areas 1 and 2, respectively, and identify those locations that possess hard data, soft data, or both data types.

The data used as inputs to these calculations were obtained by a variety of methods, from a variety of sources that reported to varying numbers of significant digits. It is common practice in reporting the results of calculations or measurements that significant digits implicitly indicate the uncertainty in the result: e.g., the last digit is considered uncertain and the larger digits are considered certain. For example, a result reported as 1.23 implies a minimum uncertainty of ±0.01 and a range of 1.22 to 1.24. Because the RIM mass-volume calculations comprise a large number of sequential steps, over-zealous truncation would propagate truncation errors that would render results uninterpretable. Therefore, all RIM mass-volume calculations used as input data at their full reported precision: however, results are tabulated to three significant digits to provide sufficient significant digits to compare results. It is recognized, and described in this report, that the mass-volume calculations are not *accurate* to three significant digits, and the presentation of results to three significant digits should not in this instance be interpreted as implying that there is only uncertainty in the third significant digit.

3.2 Hard Data Processing

Reported values of radium-226 and radium-228 provided by Engineering Management Support Inc. (EMSI) as documented in the Remedial Investigation (RI) Addendum (EMSI, 2016: Table 6-4 and 6-6) were combined to provide a single value for the total combined radium at each sample location. Similarly, reported values of thorium-230 and thorium-232 were combined to provide a single value for the total combined thorium at each sample location. Appendix A Table A-1 lists the individual and combined radium and thorium sample results for Area 1, and Table Appendix A Table A-2 lists the individual and combined radium and thorium sample results for Area 2, as reported in the RI Addendum by EMSI (EMSI, 2016: Table 6-5). These combined sample results were associated with easting and northing coordinates, and with corresponding sample elevations, such that each hard data point comprises an easting coordinate, northing coordinate, elevation, and result value (the result value comprising *either* combined radium *or* combined thorium). These combined values comprised the hard data inputs required to implement independent indicator kriging of combined radium and of combined thorium within each area of OU-1. The following additional hard data processing was completed prior to preparing inputs for the indicator kriging:

1. For duplicate or co-located samples (i.e., replicates), the maximum value was selected.

2. Sample elevations were adjusted following the procedure detailed in section 3.4 for both hard and soft data.

Figures 1 and 2 depict the sample location within Area 1 and Area 2, respectively, and identify which forms of hard and soft data are available at each location.

3.3 Soft Data Processing

The available soft data group broadly into five different types or classes of measurements – i.e., the 2015 and 2016 drilling and characterization efforts (herein identified as "recent") and previously existing data. These comprise recent Gamma Cone Penetration Testing (GCPT) data; recent downhole gamma counts; recent core gamma counts; recent core alpha counts; and gamma count records that were digitized from the previous studies. These data were obtained from several different characterization events at OU-1, and they exhibit different characteristics in terms of the range of response; the baseline response that is not associated with RIM; and the correlation with the primary hard data (i.e., radium and thorium sample results). To accommodate these differences between the data types, the different events and also between individual borings within the same event so that the variation soft data can be incorporated into the indicator kriging in a consistent manner, the gamma and alpha counts were processed in the following manner:

1. Baseline response values were estimated for each class of measurement at each individual borehole or core location. Initial values for these background values were estimated based upon the median and 25th percentile response values for that class of measurement at that boring, and were then updated through a visual review of the plotted data.

2. The estimated baseline response value for each class of measurement at each individual boring was subtracted from the raw measured response.

3. Having removed the estimated baseline response value, the adjusted counts were then normalized by scaling the values to lie between 0 (zero) and 1 (one), providing a normalized response for each class of measurement at each location.

Completion of the above steps results in one or more class of soft data for each boring, each in the form of a normalized (i.e., continuous between 0.0 and 1.0) indicator of the relative response (gamma or alpha count) versus depth within that boring. Appendix B presents plots of the gamma and alpha radiation response profiles for each boring or retrieved core section obtained in Area 1 and Area 2. The raw gamma and alpha responses, the normalized responses, and the hard data are each depicted.

The resulting normalized response could be encoded for use as soft data in the indicator kriging in one of two ways – in either instance, the encoding relies upon a presumed correlation between the normalized response and the presence and concentration of radium or thorium. First, the soft data could be encoded using zeros and ones comprising a discrete CDF: in this case, a value of one would identify that the soft data indicate (essentially, without any associated uncertainty) that the material at that location and depth represent RIM within a specific threshold concentration interval. Alternatively, the soft data could be encoded using a continuous CDF: in this case, the values of the default CDF would increase as the threshold concentration increases, and the normalized response would be used to "shift" the CDF to reflect evidence for the presence of RIM. For example: a relatively high normalized response at a specific location and depth would tend to indicate that there is RIM present at some concentration (the latter depending on the relation between the normalized response and the radium or thorium concentration), which in turn indicates that at that location and depth the probability of *not* exceeding the lower thresholds is relatively low.

For purposes of this analysis, the second approach was used. Where the normalized response data indicated negligible response, a global default CDF was used (as described and presented in Section 7), and this default CDF was updated to reflect increasingly high normalized responses that indicated a likely presence of RIM at the corresponding location and depth.

3.4 Changes in Land Surface Elevation

Two processes have, over time, resulted in changes in surface elevation for Areas 1 and 2 that may also result in a change in the representative elevation for samples and alpha and gamma responses that have been obtained from different borings at different times. The first of these, subsidence, occurs primarily due to the settlement and compaction of landfill waste, and results in a lowered surface elevation over time. The second of these, additional disposal of waste of fill or other materials, results in an increased surface elevation over time. To accommodate this, the following adjustment was made to the sample elevation that is calculated from the entries in Tables 1 and 2 (after EMSI, 2016). These adjustments are only applicable to older borings that have existed for a number of years, over which time subsistence has occurred.

1. Two digital elevation models (DEMs) raster files were obtained from Feezor Engineering Inc. (Feezor), the first representing conditions in the year 2005 (filename: "srf_topo_05127_bridgeton_05.tif") and the second representing conditions in the year 2015 (filename: "srf_03_10_2015.tif").

2. In addition to the above, a raster file was obtained from Feezor (filename: ("srf_v_05_15_compare.tif") representing the difference between the two surfaces represented by the DEM raster files listed above.

    a. A positive value in the elevation difference file "srf_v_05_15_compare.tif" indicates where the 2005 surface elevation was higher than the 2015 surface elevation.

    b. A negative value in the elevation difference file "srf_v_05_15_compare.tif" indicates where the 2005 surface elevation was lower than the 2015 surface elevation.

3. Positive elevation differences were interpreted as dominated by waste material compaction and settlement that may have caused materials that were obtained in previously-completed borings moving deeper within the landfill body. The calculated positive difference at each boring location was used to adjust the reference elevation of any samples obtained from that boring – including both hard data and soft data – such that it moved deeper.

4. Negative elevation differences were interpreted as the addition of new materials above the previous waste, and not to have resulted in a deepening of the sample reference elevations for preexisting borings.

Tables A-1 and A-2 list the combined radium and combined thorium hard data used as input for kriging for Area 1 and Area 2, respectively, following the hard data processing steps detailed above and the elevation adjustments.

Section 4
Kriging Process

4.1 Overview

Estimation of the 3D extent of RIM using MIK of the combined hard and soft data (prepared as detailed in the previous section) was accomplished via the following steps, which are further detailed in the subsections that follow:

- Variogram modeling
- Definition of the interpolation grid
- Preparation of calculation inputs
- Multiple indicator kriging

Calculations were undertaken in two distinct phases:

1. Initial calculations, which were completed to provide timely input to the FFS during May 2016;
2. Additional work undertaken during June and July 2016 to revisit, QA and finalize calculations.

4.2 Variogram Modeling

The weight that ascribed to each sampled value when interpolating at an intermediate un-sampled location using any form of kriging is a function of the separation distance between neighboring sampled values and the spatial autocorrelation between sampled values. When kriging, the variogram is used to describe this spatial correlation, and to compute the interpolation weights.

The empirical or sample variogram constructed from sample data depicts the rate at which the difference between sample values, expressed as a (semi)-variance, increases within increasing separation distance. Ideally, the empirical variogram shows a pattern of strong spatial relationship at relatively small separation distances – indicated by a relatively low variance that reflects a correspondingly high correlation between closely-spaced locations – that diminishes with increasing separation distance until the variance reaches an asymptotic value at which separation distance the relationship between sampled values is negligible. For purposes of kriging, the discontinuous empirical variogram that is obtained from the sample data is represented using one of a number of relatively simple functions that is "fit" to the empirical variogram, thereby guaranteeing that the resulting variogram model will always be mathematically valid and lead to a solvable system of kriging equations.

When undertaking indicator kriging, the indicator variogram describes how often two values separated by a distance *h* lie on the opposite sides of a defined threshold. As such, it quantifies the "lack" of spatial connectivity of values at opposing sides of defined thresholds. The empirical indicator variogram is calculated from the indicator-transformed sample data, and the indicator variogram model is identified by fitting one of the small number of common variogram functions to this indicator-transformed empirical variogram.

The most common variogram models are the linear, the spherical, and the exponential. The main parameters used to describe a single-structure model variogram are the nugget (n), which describes the variance at very small separation distances; the sill (s), which describes the asymptotic limit of the variance of the model variogram or no correlation limit; and the range (r) which describes the separation distance at which the variogram value is asymptotically or practically equivalent to the sill. The value ascribed to the sill does not alter the value of the estimate that is obtained at intermediate locations when kriging; however, it does alter the value of the kriging variance that is obtained at locations. Since kriging variances were not employed for any purpose in this study of the likely extent of RIM, the actual values ascribed to the sills are not of great importance, and emphasis was instead placed upon estimating and modeling the form of the variogram and the range-lengths in the horizontal and vertical directions.

4.2.1 Initial Variogram Models

The use of MIK to evaluate data across multiple thresholds as undertaken for the assessment of RIM at Areas 1 and 2 could employ variograms that are specific to each threshold, resulting in four potentially different variograms to represent one constituent (e.g., combined radium) across four thresholds. However, since a relatively small number of samples exceed the higher threshold values - preventing the development of an empirical variogram to be modeled - a single variogram model was used for all indictor thresholds and emphasis was placed on estimating the directional range-lengths for this single, horizontally-isotropic vertically-anisotropic spherical variogram model, as follows:

- The isotropic variogram range-length in the horizontal direction and the sill were estimated for Areas 1 and 2 separately from the complete set of combined thorium and combined radium sample data obtained from each Area, respectively.
- The initial range-length in the vertical direction was estimated from gamma response data obtained from selected borings: examples are presented for AC-23 for illustration purposes.

The horizontal and vertical empirical variograms and corresponding variogram models that were calculated and used to estimate the extent of RIM for Areas 1 and 2 in initial calculations completed in May 2016 to provide input to the FFS are depicted in Figure 8. On the basis of these initial empirical variograms and associated variogram models, the following parameters were specified for purposes of initial indicator kriging. In all cases, the variogram models are spherical and the nugget (i.e., the near-field variance) was assumed equal to zero:

- Area 1: horizontal range-length = 140 feet; vertical range-length = 10 feet; radium sill = 0.08, thorium sill = 0.045.
- Area 2: horizontal range-length = 200 feet; vertical range-length = 10 feet; radium sill = 0.04, thorium sill = 0.17.

The following are noted regarding the variograms depicted in Figure 8:

- Although the range-lengths of the horizontal and vertical variogram models were defined on the basis of different data types – i.e., the range-length of the horizontal variogram was defined from the radium and thorium sample data, whereas the range-length of the vertical variogram was defined from gamma counts – it is assumed that the sill is equivalent in all directions and is equal to the sill value that is obtained from the horizontal empirical variogram calculated from the radium and thorium sample data in each area, respectively.
- The variogram range length was assumed equal for the radium and thorium sample data within each Area, and was derived on the basis of a visual "fit" to empirical indicator variograms constructed for indicator-transformed values of combined radium and combined thorium corresponding only to the first concentration threshold (i.e., greater than 7.9 pCi/g but less than 52.9 pCi/g: Figure 8, "Threshold 1 Only") and also corresponding to all thresholds, simultaneously (Figure 8, "All Thresholds").

Results of these initial calculations, which were completed to provide timely input to the FFS, are provided in Section 7.

4.2.2 Updated Variogram Models

Following these initial calculations, additional work was undertaken to further evaluate the empirical vertical variogram and corresponding model using the compiled ensemble of available soft data. The objective of this effort was to identify a single most representative variogram model structure and range length based upon all available soft data. For this purpose, one-dimensional empirical variograms were calculated using all available vertical profile records for the five classes of soft data (i.e., GCPT data ["downholeGCPTPointData"]; recent downhole gamma ["borehole response"]; recent core gamma ["core response"]; recent core alpha ["core alpha"]; and recently-digitized gamma ["gamma-digitizedWLHoles"]). These one-dimensional empirical variograms were plotted individually, and then gathered together into each of the five available data classes. The resulting plots are depicted in Appendix C. The plots are graphically overlaid by auto-scaling the (semi-)variance (ordinate) axes to the maximum value for each location/data-class combination: as a result, this gives the appearance that all variograms rise to the same sill but at different range-lengths, whereas the sills actually differ substantially between borings and have not been normalized at this stage.

Following the preparation of these initial plots and their simple graphical overlay, each individual one-dimensional empirical variogram calculated as above was normalized by dividing by the average of the binned (semi-)variances for the corresponding location/data-class, resulting in all *normalized* empirical variograms reaching a similarly-valued "sill" generally at a value slightly larger than 1. For each of the five classes of soft data, a single ensemble average empirical variogram was then calculated by taking a weighted average of the normalized (semi-) variance at each lag distance, where the weight was provided by the number of data pairs. The five resulting ensemble average empirical one-dimensional (vertical) variograms are plotted in Figure 9 for Area 1 (top panel) and Area 2 (bottom panel): also shown in Figure 9 is a single spherical variogram model visually-fitted to the normalized ensemble empirical variograms for both Areas using a range-length of 3.5 feet. The sill value shown in Figure 9 is not instructive or meaningful since it represents a normalized quantity used for plotting purposes only.

On the basis of the multi-boring vertical empirical variograms plotted together by data class in Appendix C, and the variogram model visually fit to the weighted average of these empirical variograms normalized by their average binned (semi-)variance (Figure 9), updated estimates of the extent of RIM and associated calculations were made using the following revised variogram models for Areas 1 and 2 (in each case, using a spherical model variogram structure):

- Area 1: horizontal range-length = 140 feet; vertical range-length = 3.5 feet; radium sill = 0.08, thorium sill = 0.045.
- Area 2: horizontal range-length = 200 feet; vertical range-length = 3.5 feet; radium sill = 0.04, thorium sill = 0.17.

The results of these calculations are provided in Section 7, and compared to the initial calculations provided in May 2016.

4.3 Definition of Interpolation Grid

The interpolation grid for the kriging was defined to provide estimates of the presence or absence of RIM above each threshold concentration on a vertical and horizontal discretization suitable for evaluating partial excavation remedy alternatives based upon 40 CFR § 192.12, as follows:

> Remedial actions shall be conducted so as to provide reasonable assurance that, *as a result of residual radioactive materials from any designated processing site:*
>
> > (a) The concentration of radium-226 in land averaged over any area of **100 square meters** shall not exceed the background level by more than—
> >
> > (1) 5 pCi/g, averaged over the first 15 cm of soil below the surface, and
> >
> > (2) 15 pCi/g, averaged over **15 cm thick layers of soil** more than 15 cm below the surface.

Consistent with these regulations regarding management of radiologically-impacted soils, the interpolation grids are defined by square blocks of side-length 10 meters (32.8 feet) and of thickness 0.15 meters (0.5 feet). Two grids were defined, the first encompassing Area 1 and the second encompassing Area 2. In each case, the grid was initially defined to extend beyond the hard data sample locations and later in the analysis was expanded to extend beyond the estimated excavation footprint for the most voluminous (i.e., complete rad removal) alternative in order to calculate the base elevations and volumes of potential excavations. The dimensions of the two grids are listed below in units of feet, in terms of the number of grid cells in the easting, northing and vertical directions where nx is the number of columns in the grid, ny is the number of rows, and nz is the number of layers, respectively; the spacing in the easting direction (x-size), spacing in the northing direction (y-size), spacing in the vertical direction (z-size), and the location of the origin that lies at the lower left bottom layer of the 3D interpolation grid (x-min, y-min, z-min), as follows:

Area 1 grid: nx = 36, x-min = 515740, x-size = 32.8

ny = 38, y-min = 1068340, y-size = 32.8

nz = 230, z-min = 410, z-size = 0.5

Area 2 grid: nx = 53, x-min = 514090, x-size = 32.8

ny = 60, y-min = 1069080, y-size = 32.8

nz = 230, z-min = 410, z-size = 0.5

All kriging calculations and all subsequent post-processing calculations were undertaken using these grids and dimensions: i.e., the volumes of RIM and the volumes of clean soil (overburden and setback) required to be removed under the various complete or partial rad removal alternatives that are presented in later report sections were also determined on the basis of these grids. Given this, figures presented in this report that depict the extent of RIM or of any excavations also reflect this grid and are not "smoothed" for aesthetic purposes, because this would not accurately depict the outputs of the calculations.

4.4 Preparation of Calculation Inputs

At the completion of the data processing and other processing steps, the principal inputs to each MIK calculation were compiled as follows:

- Hard data - tabulated values of easting coordinate, northing coordinate, sample elevation, and combined result for either radium *or* thorium. The actual values were listed, together with the global univariate default CDF describing the estimated occurrence of radium *or* thorium below each threshold concentration.
- Soft data - tabulated values of easting coordinate, northing coordinate, measurement elevation and normalized response for one or more classes of soft data, pre-coded into a CDF approximately relating the soft data to the occurrence of radium *or* thorium below each threshold value.
- Grid definition – the geometry and discretization of the interpolation grid.
- Variogram – as detailed above, for these calculations a single variogram was assumed to apply within each Area for all indicator thresholds, for both combined radium and combined thorium.

4.5 Multiple Indicator Kriging

The IK3D program was then executed in order to calculate the approximate extent of RIM above each threshold concentration in each of the two Areas, resulting in several 3D estimates of the extent of RIM. It might be possible, on the basis of established radiological and geochemical relationships between radionuclides and the empirical relationships shown in Section 2.2, to combine the radium and thorium data prior to undertaking indicator kriging. However, for purposes of this analysis of RIM, and for consistency with the comparison of both thorium and radium to the concentration thresholds separately, radium and thorium were interpolated independently and their results combined to estimate the extent of RIM, as detailed in the following section. MIK was completed using point kriging for computational expediency since sample replicates were not preserved and a zero-valued short-range variance was assumed, although as noted in the assumptions and limitations section, block kriging could be implemented to evaluate the variance within individual blocks if an excavation alternative was to be selected.

Section 5
Post-Processing of Indicator Kriging Outputs

5.1 Overview

The primary outputs from each IK3D calculation (i.e., one for combined radium and one for combined thorium for each area) comprise a table four columns wide with a number of rows equal to ncol *times* nrow *times* nlay where ncol is the number of columns in the interpolation grid; nrow is the number of rows; and nlay is the number of layers. Each row in the table comprises the updated conditional CDF (CCDF) for the non-exceedence of the far corresponding threshold concentrations at that location in the interpolation grid. These values themselves are of little practical use without additional processing – as a result, the greatest effort was expended to develop a post-processing procedure and codes that implemented that procedure to provide outputs suitable for purposes of the FFS. These steps are detailed in the following sub-sections.

5.2 Post-Processing Steps

For each pair of calculations (i.e., combined radium and combined thorium) in each Area, post-processing of the two tabular output files produced by IK3D was completed as follows:

1. Combine the results from the separate radium and thorium analyses;
2. Set interpolated values to zero beyond practical extents and other surfaces;
3. Identify the presence of RIM;
4. Identify the top and bottom elevation of RIM at each grid location;
5. Calculate the volume of material exceeding each concentration threshold;
6. Estimate the volume of clean material that may require excavation (overburden and setback);
7. Calculate the bottom elevation of the excavation.

Outputs from these calculations were then used as the basis for excavation planning, material volume balance, final grading plans, and cost estimation described in the FFS. Each of these post-processing calculations is detailed in a subsection below.

5.2.1 <u>Combine Results of Radium and Thorium Indicator Kriging</u>

The results of the indicator kriging undertaken independently for the combined radium and combined thorium data were combined by identifying the "higher" of the two estimates obtained at each interpolation point within the kriging grid, and writing a single file representing the combined results. Since the contents of the output files written by IK3D at the conclusion of the kriging represent the cumulative probability of non-exceedance, the value that expresses the union of the extents of RIM at any interpolated location based upon the combined radium and combined thorium interpolations is actually the lower of the CCDF values obtained for either the combined radium or combined thorium at that location. This post processing is consistent with the interpretation of the thresholds as introduced in Section 2.3.

5.2.2 Set Interpolated Values to Zero beyond Practical Extents and Other Surfaces

The 3D interpolation grids described in the previous section extend in many areas above the land surface, below the base of the documented waste and laterally beyond the extent of each landfill area. Interpolated values that are above the land surface and beyond the lateral extents of each landfill are non-physical and result from extrapolation beyond the convex hull of the sample data. For this reason, cells of the interpolation grid that extend beyond these physical limits were flagged and not considered further in calculations of either RIM or non-RIM extent or volume, using the 2015 ground surface elevation DEM as the most suitable identifier of land surface elevation; and using computer aided design (CAD) drawings provided by Feezor as the most suitable identifier of the lateral limits of waste within each Area. Interpolated values that are below the documented base of the waste cannot be ruled out a-priori as not meaningful, and for this reason no lower interpolation limits were enforced in the post-processing of the indicator kriging results.

5.2.3 Identify the Presence of RIM

The presence or absence of RIM at any elevation at each row-column location within the interpolation grid was determined by reading through the 3D grid of combined (i.e., maximum of radium *or* thorium) interpolation results and determining whether the values of the interpolated CCDF are consistent with RIM being present at that cell at (i.e., above) each of the four concentration thresholds. For example: for the "best-estimate" calculations, RIM is determined as more-likely-than-not to be present if the value of the CCDF at that location for that concentration threshold is less than 0.5 - i.e., if the cumulative probability of *non*-exceedance for the corresponding threshold is less than 0.5, then the probability of exceedance is greater than 0.5 and consequently RIM is interpreted as more-likely-than-not to be present at that location. At the conclusion of this post-processing step, the interpolated extent of RIM at concentrations greater than each of the four thresholds can be further post-processed to obtain other necessary quantities and outputs.

5.2.4 Identify the Top and Bottom Elevation of RIM at Each Grid Cell

The top and bottom elevation of RIM at concentrations exceeding each of the four thresholds at any row-column location within the interpolation grid was determined by reading through the 3D grid of RIM extents (determined as described above) first from the top (i.e., layer 1) and next from the bottom, identifying the first instance of RIM, and recording the elevation of the node at that center of that interpolation cell. The resulting two, two-dimensional (2D) arrays for each concentration threshold in each area describe two surfaces between which the identified RIM at the corresponding concentration threshold lies.

This procedure only identifies the elevations of the uppermost (i.e., shallowest) and lowermost (i.e., deepest) interpolated occurrences of RIM at each row-column location in the kriging grid: intervening layers of the interpolation grid may not exhibit continuous RIM but may instead comprise a combination of intervals of RIM and of intervening non-RIM. As a result, the use of these upper and lower RIM surfaces alone to make a calculation of the volume of RIM would not be appropriate as it would tend to over-estimate the actual volume of RIM material, by incorporating intervening non-RIM intervals. Despite the fact that the intervening non-RIM does not contribute to the volume of RIM, for all practical purposes when considering an excavation remedy, the intervening non-RIM would have to be removed in order to access the RIM. In consideration of these factors, the subsequent post-processing steps were implemented to properly reflect the actual volumes of RIM present above each concentration threshold in a manner that accounts for intermittent intervening non-RIM intervals, and to also account for the volume of these intervening non-RIM intervals when determining the volume of non-RIM material that would require removal, handling and staging as part of an excavation remedy.

5.2.5 Estimate the Volume of RIM above Each Threshold

The volume of RIM present in each of Area 1 and Area 2 at concentrations exceeding each of the four thresholds was determined by reading through the 3D grid of RIM extents (determined as described above) and summing the number of interpolation grid cells exhibiting RIM above each threshold, and then multiplying each of the four sums thus obtained by the dimensions of each interpolation grid cell (i.e., 32.8 *x* 32.8 *x* 0.5 ≈ 540 cubic feet (or approximately 20 cubic yards) per cell). At the conclusion of this post-processing step, "best estimates" of the volume of RIM present within each Area at concentrations greater than each of the four thresholds are tabulated.

5.2.6 Estimate the Volume of Clean (non-RIM) Material to be Excavated

Should a complete or partial excavation remedy be implemented, it will be necessary to remove, handle, temporarily stage and possibly restore landfill material that is un-impacted by radionuclides but that overlies or surrounds RIM. This will be necessary for two reasons: first, because the material directly overlies and is intervening between intervals of RIM (referred to as clean overburden in this report); and second, to provide for safe excavation by maintaining required slope stability during excavation using appropriate setbacks (referred to as set-back in this report). The volume of clean non-RIM material that would need to be removed in order to access and safely excavate the RIM present above each threshold concentration was determined as follows:

- Vertical clean overburden: this comprises all interpolation cells that are identified as clean (i.e., "non-RIM" at the corresponding concentration threshold) via the indicator kriging that vertically overly the lowermost (i.e., deepest) occurrence of RIM at each interpolation grid row-column location, up to the most recent (2015) digital land surface.
- Clean set-back material: this comprises all interpolation cells that are identified as clean (i.e., "non-RIM" at the corresponding concentration threshold) that were not identified as vertical clean overburden and that have a node elevation that is above a safe set-back ratio of 3:1 (i.e., corresponding to three units of distance in the horizontal direction for each unit

of distance in the vertical direction) with respect to any interpolated cell that is identified as RIM at the corresponding threshold.

At the conclusion of this post-processing step, for each of the four concentration thresholds, for each Area of OU-1, each cell of the interpolation grid has been ascribed a numeric flag indicating whether the cell is designated as RIM, clean vertical overburden or clean setback, enabling the volumes of clean vertical overburden and clean setback to be totaled in a similar manner to that used to totalize the RIM volumes.

5.2.7 <u>Calculate the Bottom Elevation of the Excavation</u>

The bottom elevation for each excavation that would result from accessing and removing RIM present above each of the four threshold concentrations (i.e., the excavation base for each of the four excavation alternatives) was determined by reading through the 3D grid of numeric flags identifying RIM, vertical clean overburden and clean setback determined as described above from the bottom, identifying the first instance of material - which in all cases comprises either RIM or set-back material – that will require excavation, and recording the elevation of the node at the center of that interpolation cell. For each of the four concentration thresholds, in each of the two areas, the resulting 2D array of elevations describes the bottom surface of the excavation required to safely remove the material that is identified as RIM.

5.3 Summary Tables and Figures

The following tables and figures present the principal outputs from the indicator kriging and associated post-processing steps as detailed above:

- Plan-view 2D maps of the extent of RIM present at concentrations exceeding each of the four concentration thresholds in each Area;
- Plan-view 2D maps of the extent of excavation required to remove RIM identified as present at concentrations exceeding each of the four concentration thresholds in each Area;
- Tabulations of the "best-estimate" of the top-and-bottom elevations of the vertically-bounding occurrences of RIM at each boring location at concentrations exceeding each of the four concentration thresholds in each Area;
- Tabulations of the following estimated material volumes corresponding to the identified 3D extent of RIM at concentrations exceeding each of the four concentration thresholds in each Area of OU-1:
  - Volume of RIM
  - Volume of clean overburden material
  - Volume of clean set-back material
  - Total volume of material required for excavation for that removal alternative

Additional tables and figures were produced as output from supplemental calculations that were undertaken to evaluate the uncertainty associated with these estimated extents and volumes, as described in Section 7.

Section 6
Assumptions and Limitations

6.1 Overview

The work presented in this report was undertaken to estimate the extent of RIM, and associated extents and volumes of RIM and non-RIM material, in support of calculations required for the FFS. Caution is advised regarding the use of these results for any other purposes.

Among others, the assumptions and limitations summarized in this section underpin the calculations and influence the output of the calculations. The effect of some assumptions and limitations likely could be reduced through the collection of additional data or application of increasingly sophisticated methods of analysis; however, the effect of some assumptions and limitations may not be substantively reduced through these mechanisms since they are inherent to the methods used and to the use of such methods to interpolate sparse data sets for the purposes detailed in this report. Furthermore, there is some structure exhibited by the data – including areas of demonstrably "non-RIM" versus areas of demonstrably "RIM" that were all treated within a singular kriging exercise – that might benefit from further, separate, analyses. However, such an effort was not undertaken in this study.

6.2 Assumptions

The following assumptions, among others, underlie the methods used for the analysis and the application of these methods for the purposes presented in this report:

- The use of geostatistics is premised on the a-priori assumption that the data (or more precisely, their transform) exhibit intrinsic stationarity.
    - Application of statistical tests to evaluate stationarity can be difficult; however, visual inspection both of the data and of the results of the kriging can help reveal deviations from stationarity.
- The available hard sample data are representative of conditions in the subsurface within OU-1 Areas 1 and 2 at the scale of interest.
    - This assumption embodies several assumptions regarding sampling and measurement accuracy, spatial distribution, local scale variability, and so on.
- The use of a single, horizontally isotropic, variogram structure and parameterization for each Area for both radium and thorium is reasonable and representative.
    - The variograms used in Area 1 and Area 2 were based on an analysis of, and assumed to be representative of, all available empirical variograms; however, those empirical variograms do exhibit differences.
- The use of a single variogram model, as described above, across all concentration thresholds is representative:

  - The validity of this assumption cannot easily be tested due to the small number of samples that exhibit concentrations exceeding the higher thresholds. Although guidelines vary generally between 20 and 100 data locations, consensus tends to suggest that 30 or more locations is necessary to estimate a stable variogram.

- Gamma emissions are a reliable relative indicator of the presence and concentration of either radium *or* thorium in landfill material.
  - Although gamma emissions are often used to infer the presence and relative concentration of radium, they are used less often to infer the presence of thorium. Use of gamma for this purpose in this report is premised on the empirical correlations presented in this report.

- Application of the baseline-adjustment and normalization to the soft data renders the information provided by each of the five classes of soft data regarding the presence and relative concentration of radium *or* thorium comparable.
  - Alternative methods to process the soft data could be considered, such as principal component analysis (PCA), to normalize and combine the five classes of soft data into a single soft-data "signal".

- Use of the 0.50 selection criterion provides a best-estimate of extents and volumes.
  - This assumption was tested to some extent via the cross-validation analysis, but more rigorous testing of this assumption would require greater discretization of the CDF, particularly close to and surrounding the target intervals.

6.3 Limitations

The following limitations, among others, underlie the methods used for the analysis and the application of these methods for the purposes presented in this report:

- The MIK approach has been demonstrated to be robust with skewed data sets. However, there is some loss of information using MIK to discretize the sample data into a fairly small number of thresholds.
  - The edges of the RIM extent might be defined more precisely by discretizing the CDF more finely; however, this precision would likely not alter the estimated extents or volumes substantially, and might result in less stable estimation of extents.

- Point kriging was used for expediency; however, block kriging could be implemented and could provide information regarding the block-variance if sample replicates were preserved in the analysis and a non-zero-valued short-range variance was assumed.
  - Rigorous implementation of block kriging would necessitate a thorough evaluation of both sample accuracy and variability, and near-field (within-block) variability, to help define the nugget term.

- The cross-validation analysis could only be undertaken for the 7.9 pCi/g (CRR) case due to the smaller number of data available at concentrations exceeding the higher thresholds, but its results are assumed indicative of the predictive performance of MIK at the higher thresholds.

Section 7
Calculations Results

7.1 Overview

As outlined in the introduction, the objective of the analyses detailed in this report is to obtain a best estimate of the 3D extent and volume of material classified as RIM within each Area of OU-1 that is present at concentrations exceeding four thresholds; and, secondarily, to estimate the associated extent and volume of clean non-RIM that would require excavation to access and remove the RIM from each Area. A best estimate is required because costing, scheduling and many other aspects of potential remedial alternatives of necessity rest upon the RIM extents and volumes. Results of the best-estimate calculations are depicted in this section. However, presentation of a single best estimate without any indication of the uncertainty associated with that estimate that arises from underlying assumptions and limitations, and the possible presence of bias in the best estimate, would misrepresent the study. For this reason, the best-estimates of RIM extent and associated RIM and non-RIM volumes are supplemented by additional calculations to indicate a range of extents and volumes that is reasonably consistent with available data, and the presence and direction of any bias that may be present in the best-estimates.

The map-based figures presented in this Section depict estimated extents of RIM based upon the multiple indicator kriging analysis. For qualitative comparison purposes, each of the map-based figures also depicts the approximate extent of RIM at concentrations greater than 7.9 pCi/g (combined thorium *or* combined radium) as estimated by EMSI based upon visual inspection of the distribution of locations exhibiting and not exhibiting RIM at any depth within each Area of OU-1. Additional information is provided on the estimates of vertical and horizontal RIM extent as obtained via visual inspection in Section 7.2.2; however, these estimates of vertical and horizontal extent obtained via visual inspection were used only as a means of evaluating and corroborating the results obtained from the indicator kriging.

7.2 Calculations

7.2.1 Initial "Best-Estimate" Extent and Volume Calculations

The initial "best estimates" of the extent of RIM within Area 1 and Area 2 at concentrations exceeding the four concentration thresholds were obtained using:

- The combined radium and combined thorium data available through early May 2016;
- The processed gamma and alpha count "soft-data" encoded as described in Section 4;
- The initial horizontal and vertical variograms defined and presented in Section 4;
- A posterior CCDF selection criteria of 0.50 to identify RIM as present.

To facilitate timely completion of the updated RI and the FFS, the results of these initial estimates were provided to EMSI and others in May 2016. These results are presented in the figures and tables described below:

- Figure 10 depicts the estimated lateral extent of RIM within Area 1 as calculated in May 2016 using the initial data sets and variogram model for Area 1, for each of the four concentration thresholds: (a) > 7.9 pCi/g, (b) > 52.9 pCi/g but within 16 feet of the 2005 land surface, (c) > 500 pCi/g, and (d) > 1,000 pCi/g.
- Figure 11 depicts the estimated lateral extent of RIM within Area 2 as calculated in May 2016 using the initial data sets and variogram model for Area 2, for each of the four concentration thresholds: (a) > 7.9 pCi/g, (b) > 52.9 pCi/g but within 16 feet of the 2005 land surface, (c) > 500 pCi/g, and (d) > 1,000 pCi/g.
- Figure 12 depicts the estimated lateral extent of the excavations that would be required to remove the RIM that is depicted in Figure 10 for Area 1, for each of the four concentration thresholds: (a) > 7.9 pCi/g, (b) > 52.9 pCi/g but within 16 feet of the 2005 land surface, (c) > 500 pCi/g, and (d) > 1,000 pCi/g.
- Figure 13 depicts the estimated lateral extent of the excavations that would be required to remove the RIM that is depicted in Figure 11 for Area 2, for each of the four concentration thresholds: (a) > 7.9 pCi/g, (b) > 52.9 pCi/g but within 16 feet of the 2005 land surface, (c) > 500 pCi/g, and (d) > 1,000 pCi/g.

In addition, Table 1 depicts the estimated volumes of both RIM and non-RIM vertical overburden and set-back materials that would be required to be excavated in each of Area 1 and Area 2 based upon the initial calculations completed May 2016.

7.2.2 Updated "Best-Estimate" Extent and Volume Calculations

Following receipt of the final comprehensive project database in June 2016, the "best-estimate" calculations were updated and used to form the basis for supplemental calculations of the uncertainty in the extent and volume estimates. When the final database was obtained, the "best-estimate" calculations completed during May 2016 in support of the FFS were revisited, and the following changes made to obtain updated "best estimates":

1. Revisions to the vertical variogram as detailed in Section 4;
2. Updates to hard data inputs reflecting a small number of additional sample results;

Other aspects of the calculations remained unchanged, and the updated "best estimates" generally differed by single-digit percentages from the initial estimates obtained in early May.

The resulting updated "best estimates" of the presence and thickness of RIM exceeding the lowest concentration threshold – i.e., the complete rad removal concentration threshold of 7.9 pCi/g – are listed on Table 2 (RIM Intervals – Area 1: Best-Estimate) and Table 3 (RIM Intervals – Area 2: Best-Estimate) for comparison with thicknesses of RIM that were estimated by EMSI through visual inspection of both the radium and thorium sample data and the gamma and alpha counts obtained at each boring location. Comparison of the "best-estimate" interpolated thicknesses of RIM listed on Tables 2 and 3 with the values obtained via visual inspection (the latter provided by EMSI in July, 2016) generally shows good correspondence. In some instances, the interpolated thicknesses obtained via MIK are substantially greater, or substantially smaller, than the thicknesses estimated via visual inspection. However, inspection of these instances reveals that these differences often arise in a systematic manner from consistent and understandable differences in the approaches used. For example, visual inspection provides an estimate of RIM thickness that is specific to the individual boring in consideration, whereas MIK provides an estimate of RIM thickness that pertains to the location of the interpolation point within the interpolation grid cell that contains that boring in addition to potentially other borings. As such, the MIK estimate is a locally-weighted value at the interpolation node determined from the neighboring borings. In addition, the visual inspection estimate is independent of surrounding boreholes, whereas MIK explicitly considers the spatial correlation between neighboring borings both within and beyond the interpolation grid cell. Finally, systematic rules were followed in undertaking the visual inspection (as previously described by EMSI) regarding the use of gamma data and the strength of signal versus the posited thickness of RIM. In contrast, MIK combines the hard and soft data in a manner that can produce more variable patterns of RIM.

Consider, for example, the vicinity of boring 5-3 within Area 1. At this location, the top and bottom elevations of RIM determined using the kriging method suggest at first glance a single thick RIM interval, whereas visual inspection suggests that the borings in the vicinity of 5-3 exhibit localized tops and bottoms of multiple RIM intervals. In this particular area, an upper RIM interval is identified in all borings (5-3, 5-4, 5-5, 5-6) whereas only one boring (5-3) extends deep enough to provide information beneath the base of the neighboring borings (i.e., 5-4, 5-5 and 5-6). The combination of the vertical variogram and the absence of data at depth from the neighboring borings results in the kriging indicating that the deeper RIM interval is likely present at these neighboring borings below the depth at which they were terminated. In this particular instance, a shorter horizontal variogram range-length might lead to a different result; however, the range length seems fairly well supported by the hard data.

The interpolated thicknesses of RIM listed on Tables 2 and 3 are considered "best estimates" in the sense only that they were obtained through an objective application of the data-processing and interpolation techniques described earlier in this report to the data available at the time of calculation and represent the central-tendency of the output obtained from the kriging under these conditions. The uncertainty associated with this "best estimate", and the possibility of systematic bias in the estimate, are detailed in subsequent subsections. The "best estimates" of the volumes of RIM, plus clean (non-RIM) overburden and setback, are listed on Tables 4 and 5 together with additional estimates, the complete contents of which are detailed in section 7.3.

7.2.3 Additional Extent and Volume Calculations

To provide an indication of the potential range of uncertainty that is associated with the "best-estimates" of the extents and the volumes of RIM plus clean (non-RIM) overburden and setback, two additional sets of calculations were performed. The additional extent and volume calculations were obtained as described below. A larger number of additional calculations could be undertaken by varying additional assumptions or inputs, and such an analysis would provide for a more comprehensive assessment of uncertainty; however, the results of the additional calculations that were completed are considered sufficiently illustrative of the range of uncertainty for the purposes of this study. Therefore, in each of the calculations described below, the hard data (i.e., combined radium and combined thorium concentrations), the soft data (i.e., the processed and normalized gamma and alpha responses), the variograms, and the interpolation grids were unaltered.

7.2.3.1 Comparison of Prior and Posterior Univariate CDFs

First, an assessment of the Area-wide univariate posterior CCDF was completed. The best-estimate and the ranges on this best-estimate described above were obtained using a prior univariate CDF, assumed applicable to both Area 1 and Area 2, that was estimated based upon review of the sample data from both Area 1 and Area 2 when initially received. However, estimated volumes of RIM at each concentration threshold within Area 1 and Area 2, when combined with the estimated total volumes of waste material within Area 1 and Area 2, respectively, provide some information regarding the appropriateness of this prior univariate CDF. Estimates of two univariate CDFs – one applicable to Area 1 and one applicable to Area 2 – were made based upon the outputs of intermediate calculations of the volumes of RIM present in each area above the four threshold concentrations. To make these calculations, the criterion of identifying only RIM that lies *within 16-ft of the 2005 land surface* was not considered, to ensure that a complete volume estimate for locations exceeding the 52.9 pCi/g concentration threshold regardless of depth could be obtained.

Table 4 lists the initial univariate CDF and the posterior univariate CCDFs calculated from the RIM and non-RIM volumes determined for Area 1 and Area 2. Inspection of Table 4 and the inset plot indicates that the volume estimates for Area 1 and Area 2 present slightly different CDFs between the two areas and as such might be treated differently in the geostatistical analysis. However, Table 4 and the inset plot also suggest that the initial univariate CDF that was developed based solely upon the hard sample data regardless of geographic location was a reasonable estimate of the global CDF throughout OU-1. Given this result, no additional calculations were made using revised or updated input CDFs specific to each Area. Subsequent calculations to illustrate uncertainty were completed using the CDFs inputs as ascribed to the initial and updated best-estimate calculations.

7.2.3.2 Selection Criteria as Intervals on the “Best-Estimate”

The best-estimate of the extent and volume of RIM above each of the four thresholds, and all associated outputs, were obtained using a selection criterion of 0.5 when post-processing the posterior CCDF obtained at each interpolation point at the conclusion of the MIK. As detailed earlier in this report, in the simplest case (i.e., of a single threshold) a criterion of 0.5 can be interpreted as discriminating between locations that more-likely-than-not exceed the threshold and those that more-likely-than-not fall below the threshold. However, it is common in post-processing of stochastic calculations to illustrate the range of plausible outcomes from the calculations. For example, in trivial cases, the 0.5 selection criterion might be interpreted as the central tendency of a distribution about which selection criteria of 0.25 and 0.75 would describe approximately symmetric intervals. In non-trivial cases such as the RIM mapping for Areas 1 and 2 these intervals might be asymmetric, illustrating that there may be greater uncertainty in one direction (i.e., on one side of the best estimate) than the other. To illustrate the relative range of uncertainty associated with the "best-estimate" and the asymmetry of this uncertainty, the MIK calculations were post-processed using selection criteria of 0.25 and 0.75 for the posterior CCDF rather than the central-tendency value of 0.5. In doing so, the following result is expected:

- The selection criterion of 0.75 should result in larger estimates of extent and associated volumes than the selection criteria of 0.5, because the value of 0.75 describes the cumulative probability of non-exceedance at the corresponding concentration threshold, and hence corresponds with a probability of (1.0 - 0.75 =) 0.25 probability of exceeding the threshold: i.e., less certainty is needed in order to identify a location as comprising RIM, and this requirement for less certainty results in larger extents and volumes
- The selection criterion of 0.25 should result in smaller estimates of extent and associated volumes than the selection criteria of 0.5, because the value of 0.25 describes the cumulative probability of non-exceedance at the corresponding concentration threshold, and hence corresponds with a probability of (1.0 - 0.25 =) 0.75 probability of exceeding the threshold: i.e., more certainty is needed in order to identify a location as comprising RIM, and this requirement for greater certainty results in smaller extents and volumes

These results are compared to the best-estimate below.

7.2.4 Cross-Validation Analysis

The additional kriging calculations described in section 7.2.3 were undertaken to provide an indication of the uncertainty associated with the best-estimate, under the assumption that the best-estimate is an unbiased estimate where bias is assessed in terms of the predicted volumes of RIM and of non-RIM overburden and setback materials. As detailed earlier, although kriging is referred to as an unbiased estimator this unbiasedness is only in the sense that the mean estimation error should be zero, and there is no guarantee that the best estimates of the RIM extents and volumes are indeed unbiased.

To assess whether the best-estimates of extents and volumes obtained from the indicator kriging may exhibit a bias – and, the typical direction of any such bias – a single-point cross-validation (CV) or "leave-one-out" analysis was conducted. The CV analysis was completed to establish whether outputs from the indicator kriging tend to over-predict the occurrence of RIM at sampled locations, which for purposes of this study can be considered a false-positive; or tend to under-predict the occurrence of RIM at sampled locations, which for purposes of this study can be considered a false-negative, with the inference that any tendency to over-predict the presence of RIM will tend to result in over-estimates of associated RIM and non-RIM volumes, and vice-versa.

The CV analysis that was undertaken is related in purpose to a simplified receiver operating characteristic (ROC) calculation, which can help identify optimal models and discard suboptimal ones. A rigorous ROC analysis is implemented, for example, by varying a discriminating threshold (such as a concentration that distinguishes RIM from non-RIM) and plotting the true positive rate (TPR) against the false positive rate (FPR) at various threshold settings, or plotting the false negative rate (FNR, comprising missed detections) vs. the FPR, which is also referred to as a detection error tradeoff (DET) plot. To construct a comprehensive ROC or DET plot for the West Lake RIM analysis would, require that CV analyses be undertaken on the basis of a piecewise-continuous distribution of thresholds, so that the results could be used to identify the location along the CCDF that provides the best predictor or identify the selection criterion that minimizes error in the sense that it balances Type I and Type II errors.

For purposes of this assessment of RIM, however, the CV analysis was implemented solely to assess whether the 0.50 selection criterion provides a balance between the FNR and FPR, under the assumption that if FNR>FPR then the interpolated extents and volumes will tend to underestimate the true extents and volumes, whereas if FPR>FNR then the interpolated extents and volumes will tend to overestimate the true extents and volumes. Furthermore, due to the small number of sample results that exceed higher concentration thresholds, the CV analysis was only undertaken for the complete rad removal case, i.e., for the concentration threshold of 7.9 pCi/g. The CV analysis is undertaken using IK3D separately for combined radium and for combined thorium as follows:

- Modify the input files previously prepared for independent indicator kriging of the combined thorium and combined radium data sets for each of Area 1 and Area 2, to undertake a CV analysis rather than to interpolate to a grid (see Deutsch and Journel, 1992, for further explanation on using IK3D to undertake CV analyses)
  - The output from the CV calculation is not a gridded result but is a posterior CCDF at each sample location, that is obtained when the hard data available at that sample location has been removed from the input data set
- Tabulate the posterior CCDFs that are obtained from the CV analysis, together with the prior CDF that would be assumed based on the hard result available at each location

Outputs from the CV calculations could be viewed from two perspectives. First, the CV analysis could be interpreted strictly in terms of the prediction of the presence or absence of RIM at each location that was suppressed from the data set: i.e., if the sample at the suppressed location indicated a concentration below 7.9 pCi/g, and the CV predicts that the concentration more-likely-than-not falls below this threshold, then this would be considered a true result, whereas if the CV predicts that this threshold more-likely-than-not is exceeded, then this would be considered a false positive. This analysis provides a useful indication of any potential bias although, by focusing strictly on the assessment of RIM versus non-RIM it neglects subtle shifts in the CDF that could result in either an over- or under-prediction of RIM extent a at intermediate locations away from sampled locations where there is no knowledge of the "true" value for comparison. A second interpretation of the CV output would be to compare the posterior CCDF that was obtained from the CV calculation with the prior CDF assigned to the location based upon the data, as follows:

- Where the CV CCDF and the data derived CDF are equivalent, the indicator kriging is interpreted to have correctly identified the presence (or absence) of RIM. Collected together these comprise the true negatives and true positives (T(P+N))
- Where the CV CCDF suggests a greater likelihood of RIM than does the data derived CDF, the indicator kriging is interpreted to have resulted in a false positive (FP)

- Where the CV CCDF suggests a lesser likelihood of RIM than does the data derived CDF, the indicator kriging is interpreted to have resulted in a false negative (FN)

The FPR and FNR can be calculated by summing the FP and the FN, respectively. The latter evaluation of the CV analysis outputs is emphasized in this report, although conclusions reached regarding the presence and direction of prediction bias were very similar for both methods of evaluation, as described in Section 7.3.2.

7.3 Results

7.3.1 Extent and Volume Calculations

Figures 14 and 15 depict the updated best estimates of the lateral extent of RIM that exceed the four concentration thresholds within Areas 1 and 2, respectively. Figures 16 and 17 depict the updated best estimate of the lateral extent of the excavations that would be required to access and remove the RIM estimated as being present within Areas 1 and 2, respectively (as depicted in Figures 14 and 15).

Estimated volumes of RIM present above each of the four concentration thresholds, within each of Area 1 and Area 2, are listed on Table 5 and Table 6, respectively. The estimates included in these tables comprise the updated best estimate obtained using a selection criterion of 0.5 (as depicted in Figures 6 and 7), together with higher and lower intervals obtained using selection criteria of 0.25 and 0.75, respectively. The values listed on Table 5 and Table 6 are also presented in Figures 18 and 19 for Areas 1 and 2, respectively. Inspection of the entries in Tables 5 and 6, and their graphical representation in Figures 18 and 19, indicates that there may be a substantial range of uncertainty associated with the estimated volumes of RIM and non-RIM. This is not unexpected, given the volume of the data support within each Area of OU-1; the variability in sample results demonstrated by closely-spaced borings; and the relatively short variogram range-lengths when compared with the size of the interpolation domains (i.e., the size of Areas 1 and 2), among other factors. Figures 18 and 19 also indicate that the intervals used to illustrate uncertainty are approximately symmetric about the updated best estimate when plotted on a logarithmic scale which, combined with the results of the CV analysis described next, has implications for the design and costing of an excavation remedy alternative.

7.3.2 Cross-Validation Analysis

Tables 7 and 8 list the results of the CV analysis for Area 1 and Area 2, respectively, in terms of both counts and rates. Simple charts are included below the corresponding tables to graphically present the counts of the (a) number of true positives and negatives, designated T(P+N), (b) number of false positives, designated FP, and (c) number of false negatives, designated FN. These counts are then related to corresponding "rates" which for purposes here are simply the percentage of false negatives or false negative rate, FNR, and the percentage of false positives or false positive rate, FPR.

Inspection of Table 7 reveals that for Area 1, for both the combined radium and combined thorium analyses, the CV analysis suggests that although the T(P+N) represents the majority of the results and is in each case larger than the sum of FN plus FP, in both cases FNR is larger than FPR. This result indicates that the MIK results may tend to be biased in the sense that they under-estimate the extent of RIM, and consequently under-estimate the volume of RIM and the volume of non-RIM overburden and setback material that would require excavation under a complete or partial rad removal alternative for Area 1.

Inspection of Table 8 reveals that for Area 2, for both the combined radium and combined thorium analyses, the CV analysis suggests that in each case FNR is larger than FPR and furthermore that in both cases the sum of FNR plus FPR is larger than the T(P+N). This result indicates that the MIK results likely tend to be biased in the sense that they under estimate the extent of RIM, and consequently underestimate the volume of RIM and the volume of non-RIM overburden and setback material that would require excavation under a complete or partial rad removal alternative for Area 2. Furthermore, the result that the T(P+N) is less than the sum of FNR plus FPR suggests there may be greater sensitivity of the MIK results to the location and removal of hard sample data which is expected given that the number of samples per unit volume of waste material is on the order of 3 to 4 times smaller, on average, in Area 2 than it is in Area 1, which tends to lead to greater uncertainty in interpolated results.

Section 8
Discussion

The foregoing calculations present for both Areas 1 and 2 estimates of the extent and volume of RIM above four threshold concentrations; the volume of any non-RIM surrounding the RIM, that would be required to be removed to safely access and excavate the RIM; and the lateral extent of any necessary excavations. These results are summarized within CAD- and GIS-ready electronic files for use in subsequent calculations.

The extent and volume estimates are based upon interpolation of irregularly-spaced sample data that directly indicate the presence or absence of RIM, together with more spatially dense measurements of radiation counts that indirectly indicate the presence or absence of RIM. Numerous features of the RIM spatial distribution analysis result in uncertainty about the final extent and volume estimates made using indicator kriging. The sources of uncertainty can be broadly categorized as follows (this list is indicative and not comprehensive):

1. Hard sample data – including all components of variation in the sampling, handling, measurement and reporting procedures when obtaining sample results; local-scale variability (some of which might be incorporated within a nugget); the distribution of sample results in 3D space and potential for non-representativeness of boring locations; and any systematic differences in sample selection between field sampling events.

2. Soft activity data – all of the above, in addition to variability in the strength and linearity of the relationship between activity results and concentrations of radium and thorium which are of primary interest.

3. Representative volumes – the individual samples represent small volumes of RIM and non-RIM material on the order of decimeter scale that are used to estimate average values for blocks of landfill waste material on the order of 10-meter scale. This might be alleviated through the use of block kriging, which was not completed for computational expediency.

4. Interpolation approach and parameters – the simplifications inherent in transforming data into multiple indicators; the assumption of horizontal isotropy within both Areas; the development of a single variogram for each Area and assumption of Area-wide applicability of those variograms; uncertainty in the estimates of the variogram parameters (particularly the range length); and the assumption of applicability of a single variogram to all four concentration thresholds within each Area.

5. Delineation (discretization) – all extent and volume estimates were made on a 10m by 10m by 0.15m grid, for consistency with 40 CFR §192.12; however, no final decision has been made as to the scale upon which RIM should be assessed, or the degree to which it might be remediated. For example, at each threshold concentration, there might be a reasonable minimal soil volume (although this might vary with depth) that might be subject to

remediation, and that would constitute a more practical representative volume for the interpolation.

6. Excavation and disposal: the RIM volume estimates distinguish between RIM and non-RIM based on interpolation. The non-RIM includes intervening “clean” intervals that lie between the lowest and highest RIM intervals and overlying “clean” material above the highest RIM interval. Some portion of the intervening non-RIM has a high likelihood of becoming mixed with, and contaminated by, RIM during excavation (presumably, overlying non-RIM has a lower probability of this occurring). Thus, at least some of the intervening non-RIM is likely to end up categorized as and disposed of with RIM so that the actual amount of material handled and disposed of as RIM is very likely to be larger than the interpolated RIM volumes.

Finally, the use of geostatistics in this instance was premised on the a-priori determination that the data (or more precisely, their transform) can be considered to exhibit stationarity. The existence of stationarity is to some extent a modeling decision rather than a true state of affairs; however, it is possible that there may be departures from stationarity that lead to errors in RIM estimates.

As a result of the foregoing (among other sources of uncertainty), estimates of RIM presence and extent in some locations within each Area may be less certain than others. For example, densely-sampled areas that exhibit concentrations substantially above threshold concentrations may be accompanied by much less uncertainty than infrequently sampled areas that exhibit concentrations close to threshold concentrations, where there would be greater sensitivity to the above-listed sources of uncertainty. Cross-validation suggested that the indicator kriging results obtained using a 0.50 selection criterion may underestimate the extent of RIM. As such, the RIM volumes and extents and corresponding non-RIM volumes required for excavation as determined using 0.50 should be viewed as likely underestimates. The reader is recommended to base any conclusions on the 0.50 selection criterion as a theoretical “best estimate,” but recognize that the actual extents and volumes are more likely to be larger than this estimate than to be smaller than this estimate. Figures 20 and 21 depict the estimated extent of RIM within Area 1 and Area 2, respectively, for each of the four concentration thresholds. In each figure, each panel depicts the extents obtained using the three selection criteria (i.e., 0.25, 0.50 and 0.75), to aid the reader in visualizing the range of results. Based on the analyses presented herein, and accepting the assumptions, limitations and other factors contributing to uncertainty, the reader should assume that the true extents and volumes lie somewhere between the “best estimate” and the higher interval result (i.e., between 0.50 and 0.75).

Given the above, many cost associated with an excavation remedy would increase as the volume increases, although the increases may not scale linearly with increasing volume. To provide approximate extents to support costing of remedy alternatives, additional calculations were deemed unwarranted. However, additional analyses may be warranted if a complete or partial excavation remedy is selected, in order to refine the estimates in areas of greatest uncertainty; evaluate and mitigate bias through further discretization of the CDF; and, incorporate information on practical excavation lifts (thicknesses) and other implications for the volume of RIM to be handled. The framework now established for the geostatistical estimation of RIM extents and volumes could also help guide an incremental or other sampling program to field-verify RIM.

Section 9
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FIGURES

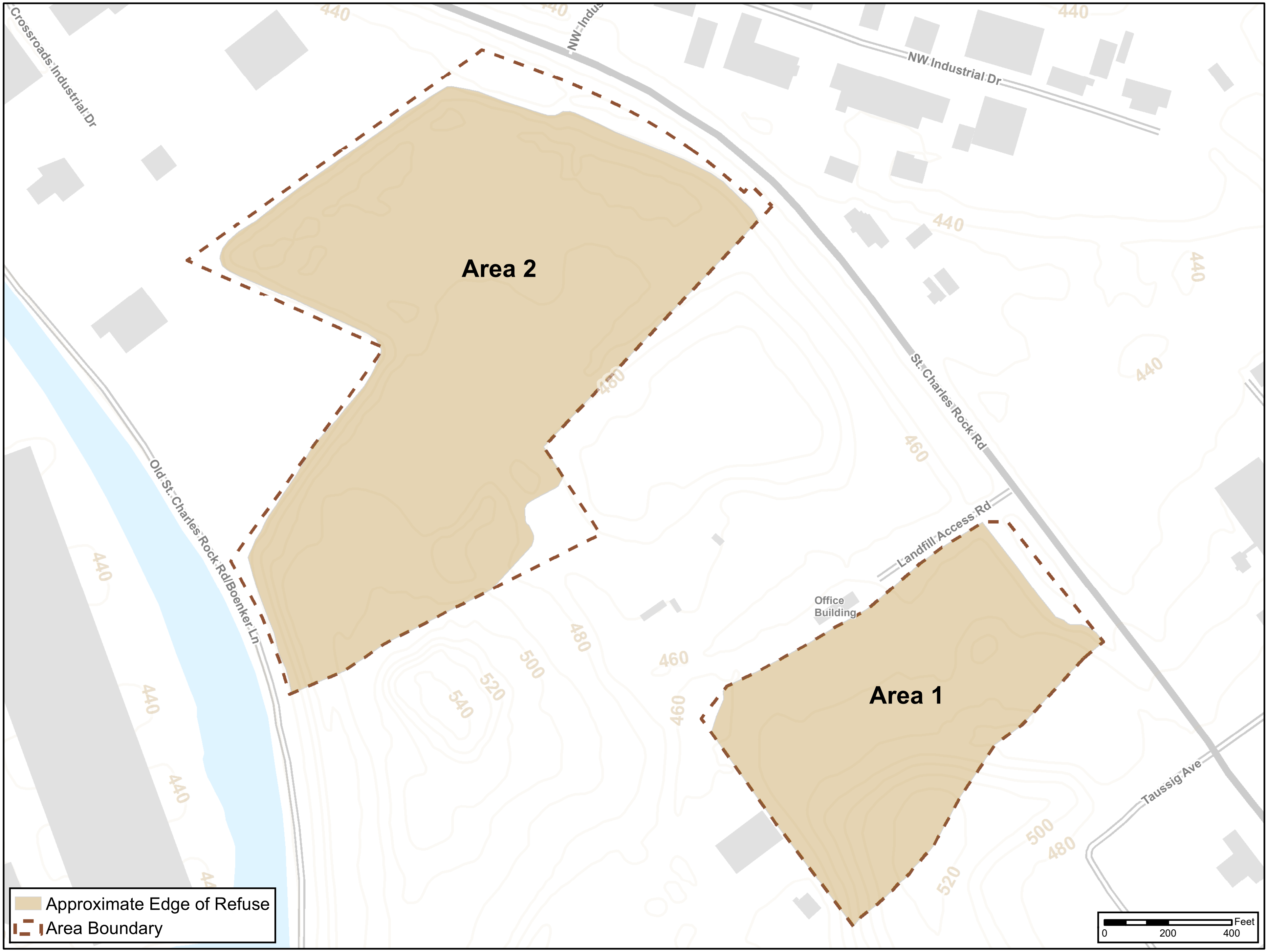


Figure 1 Site Location Depicting West Lake Operable Unit 1 (OU-1) Areas 1 and 2

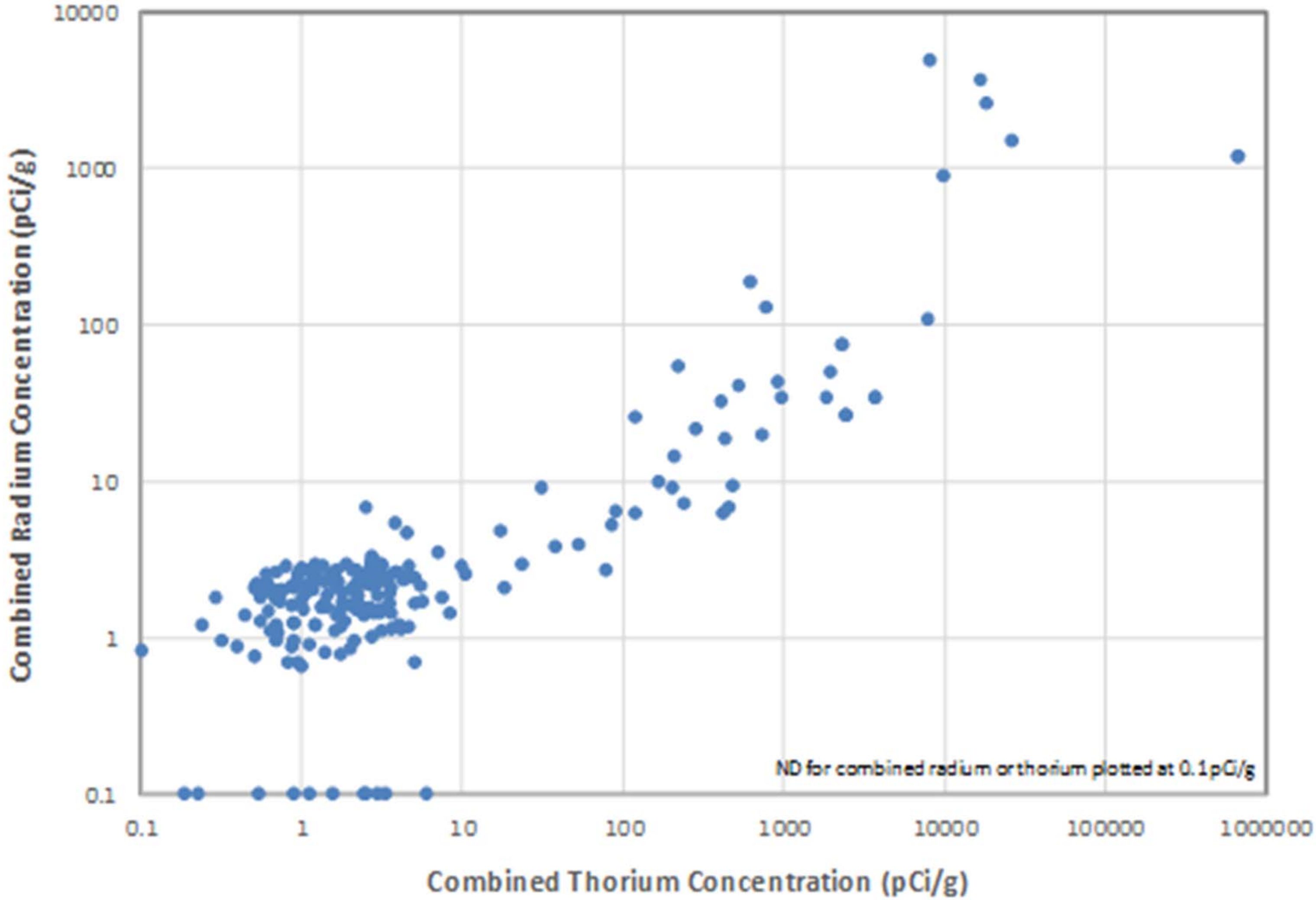


Figure 2 Scatter Plot, Area 1: Combined Radium vs Combined Thorium

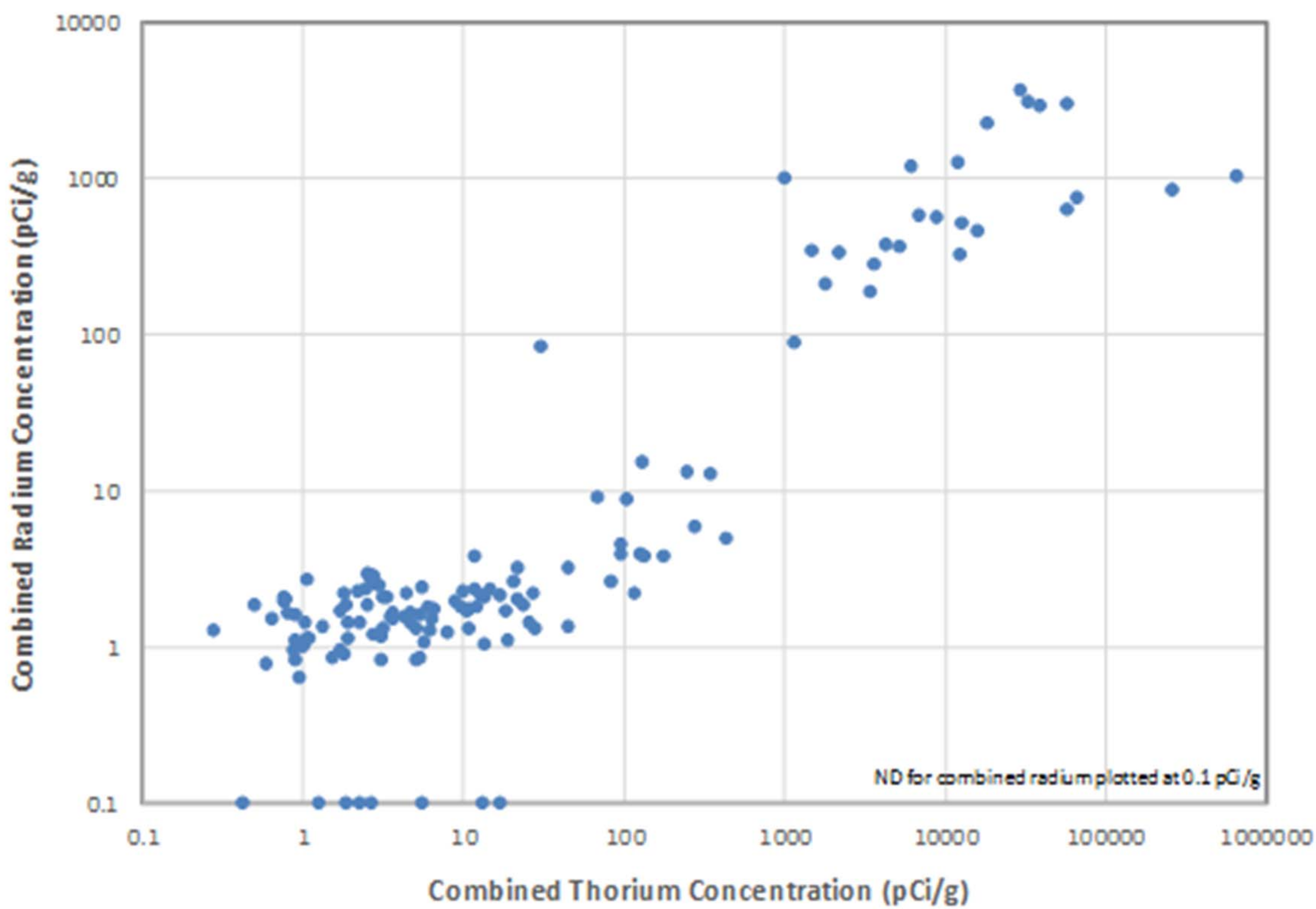
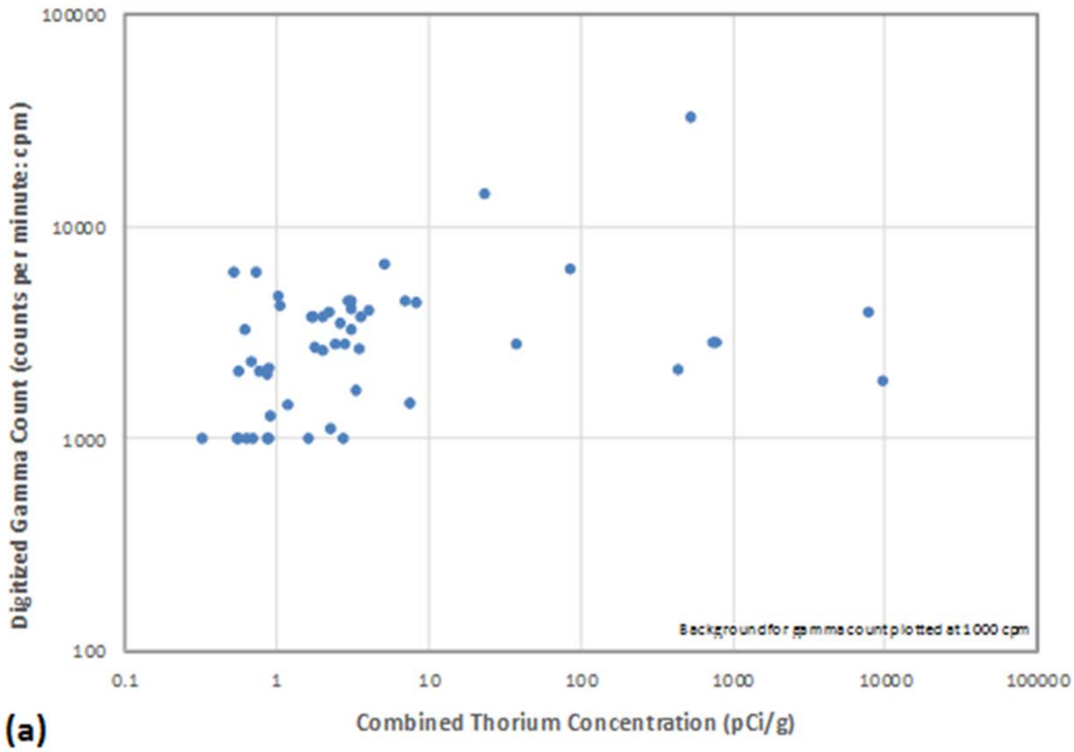
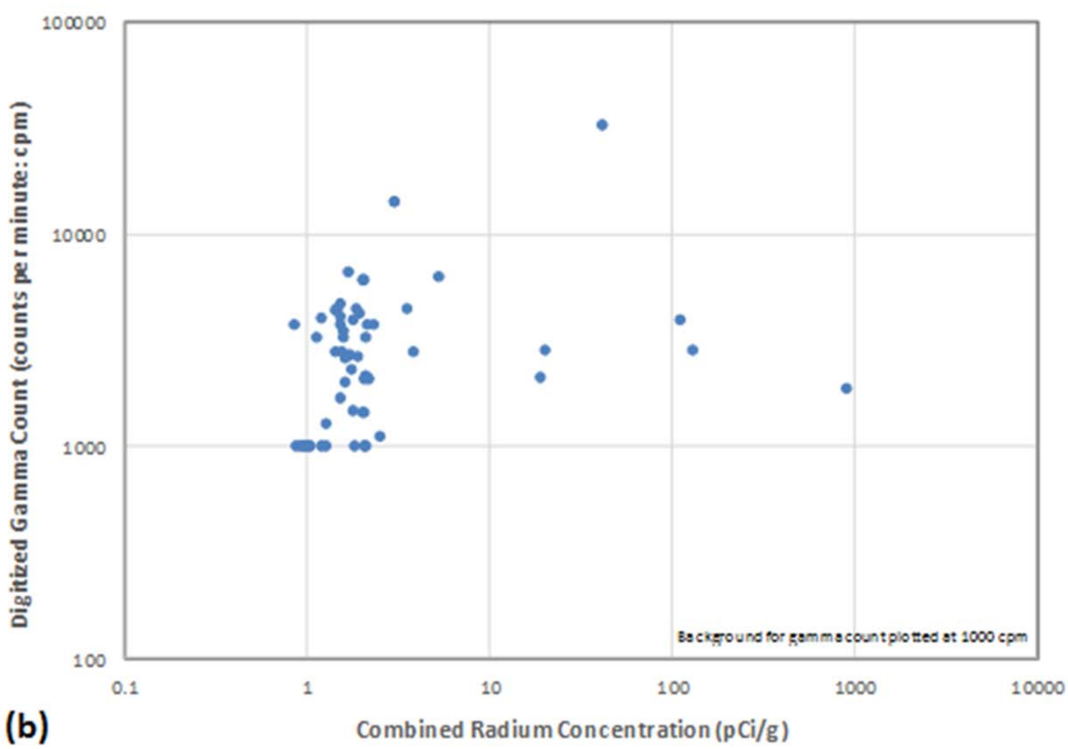


Figure 3 Scatter Plot, Area 2: Combined Radium vs Combined Thorium

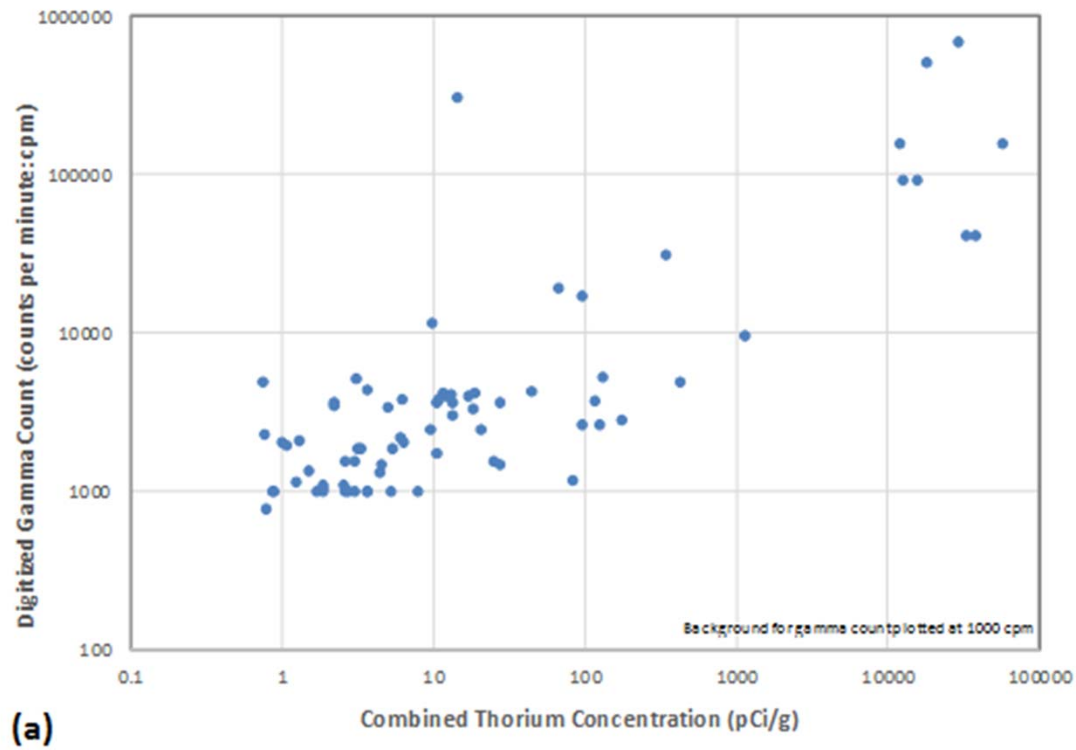


(a)



(b)

Figure 4 Scatter Plots, Area 1: (a) Combined Thorium vs Gamma, (b) Combined Radium vs Gamma



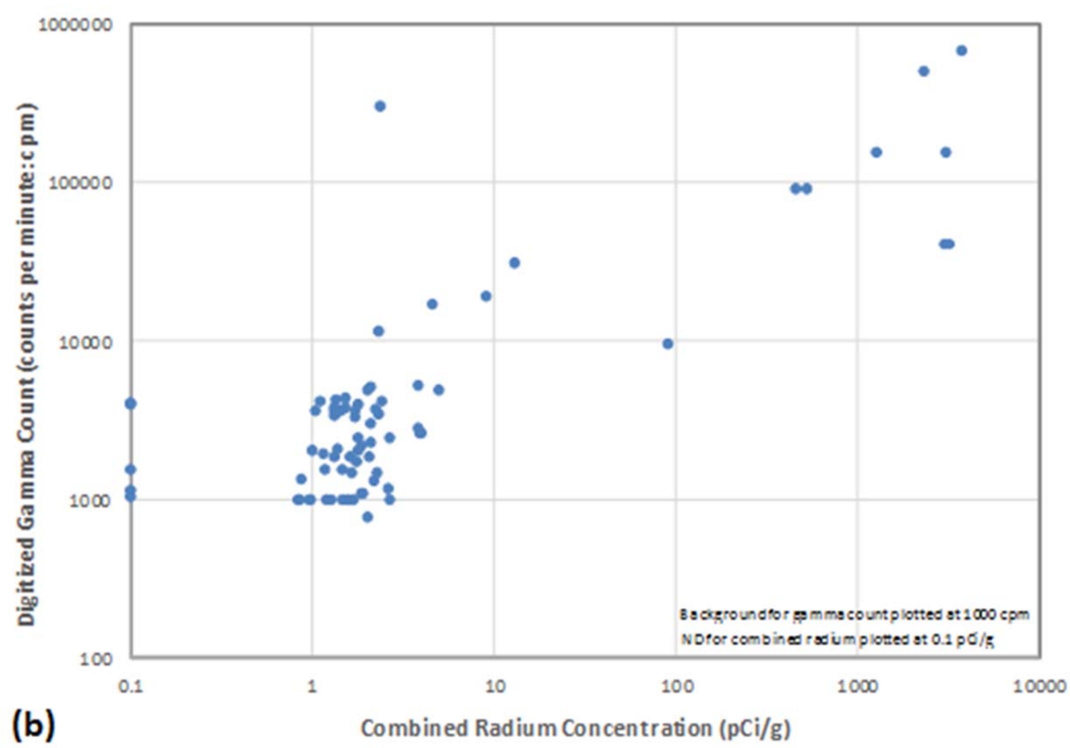


Figure 5 Scatter Plots, Area 2: (a) Combined Thorium vs Gamma, (b) Combined Radium vs Gamma

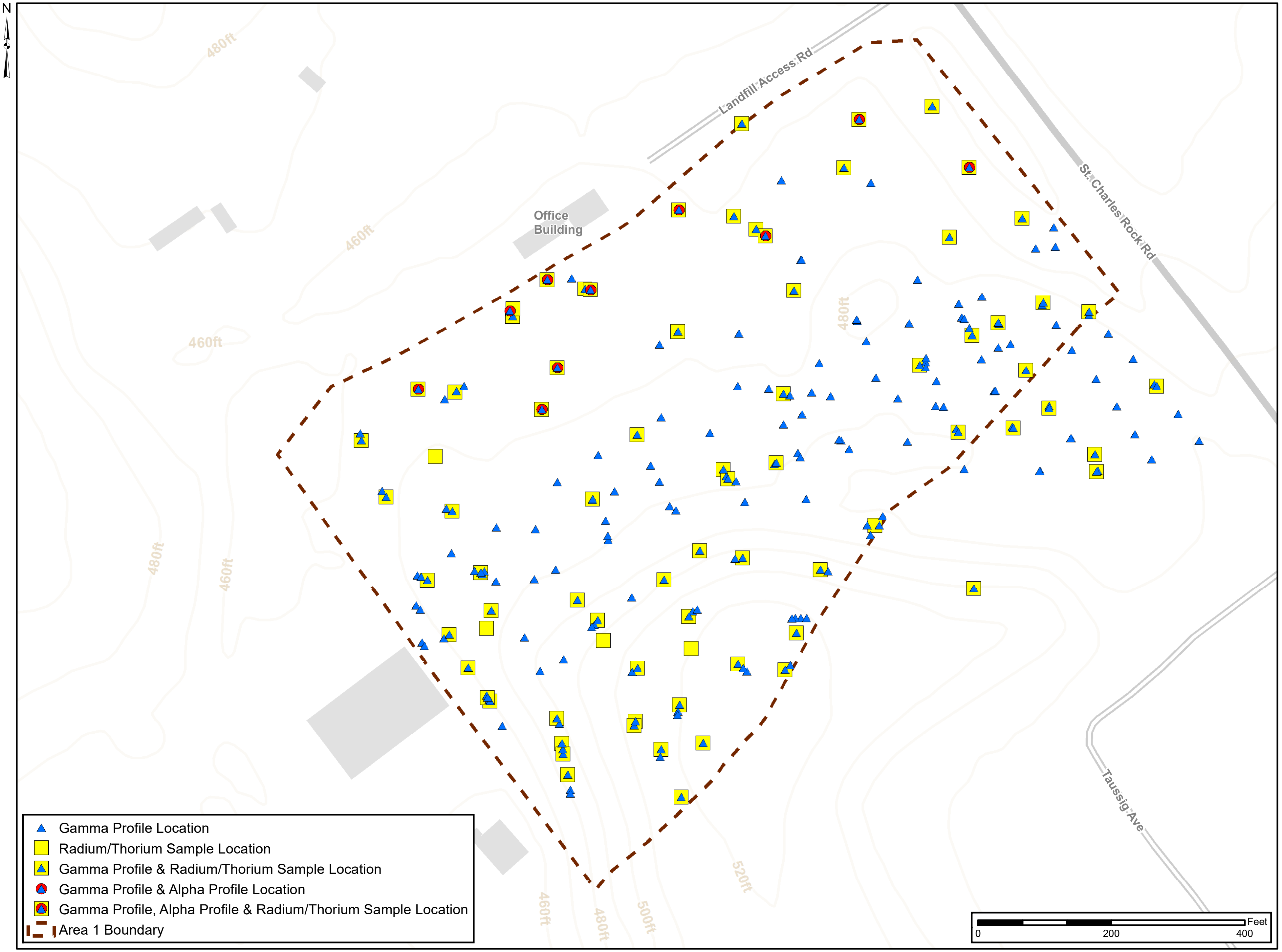


Figure 6 Area 1 Sample Locations

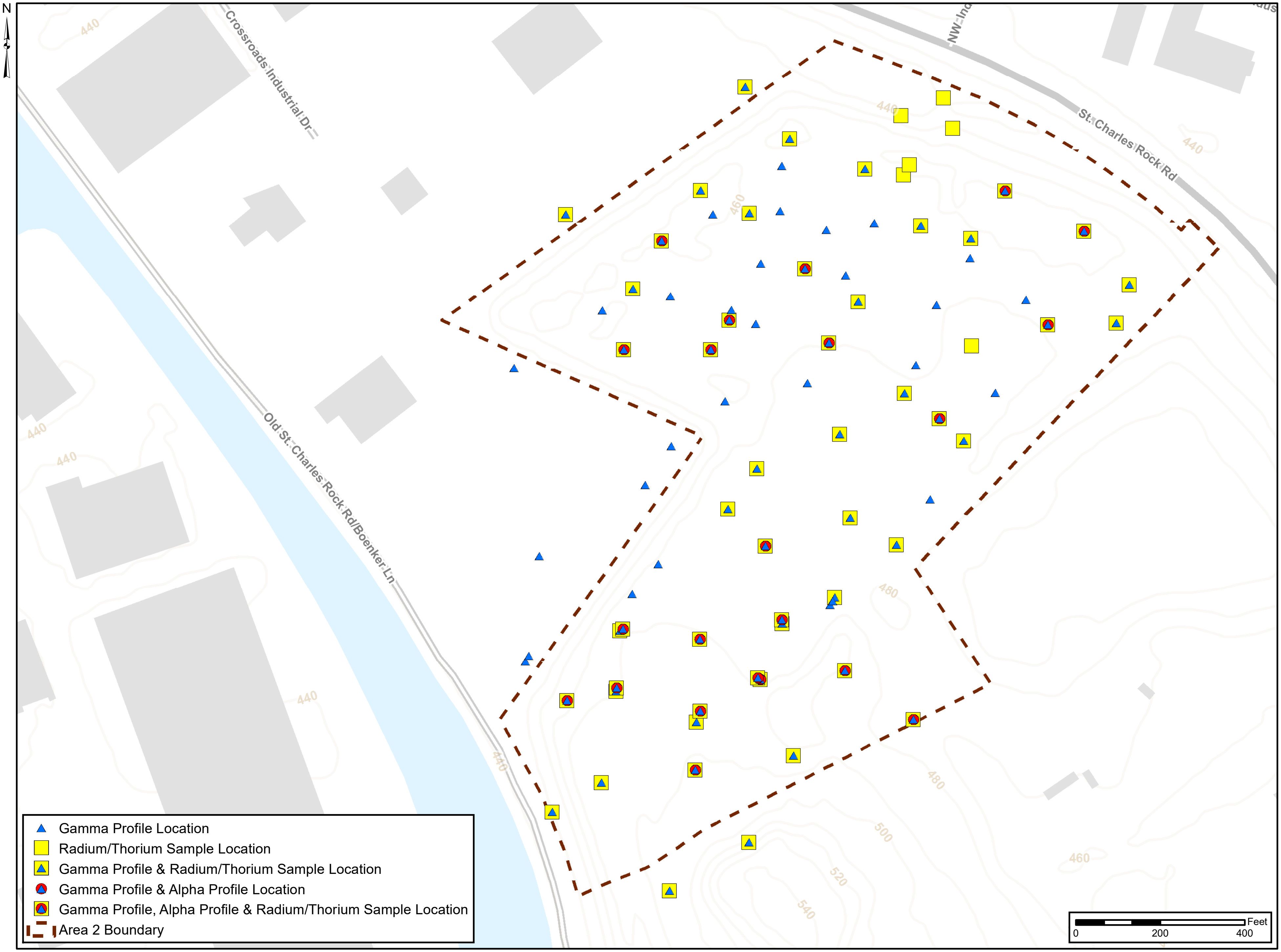


Figure 7 Area 2 Sample Locations

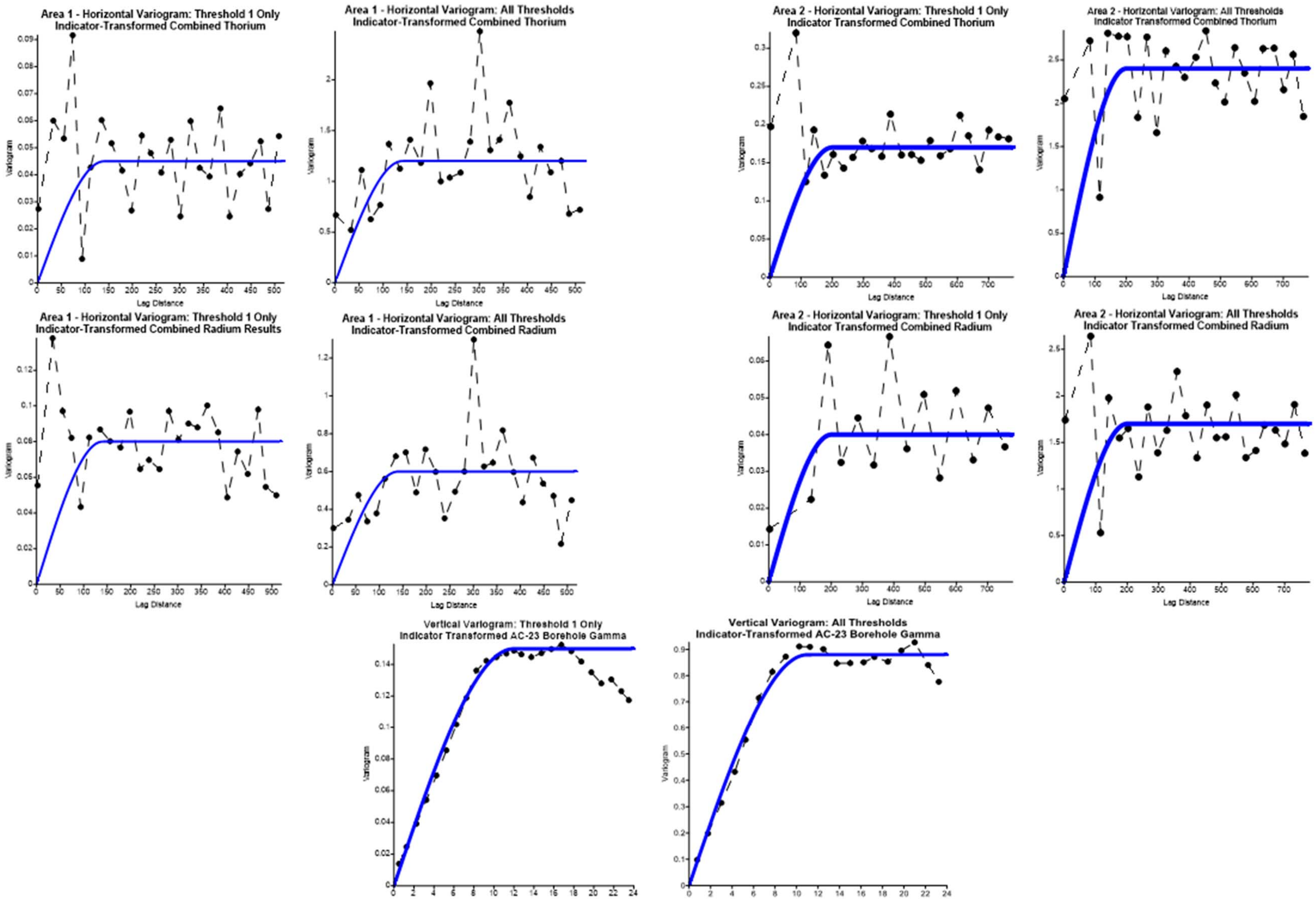
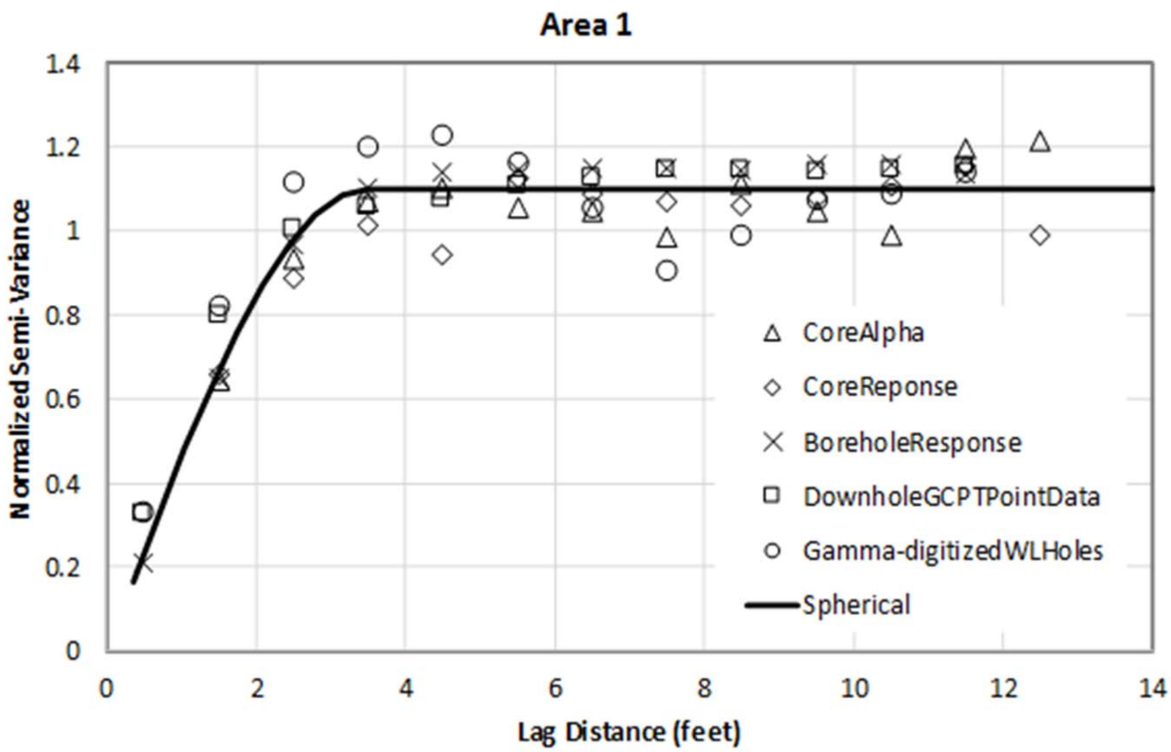


Figure 8 Initial Empirical and Modeled Horizontal and Vertical Variograms



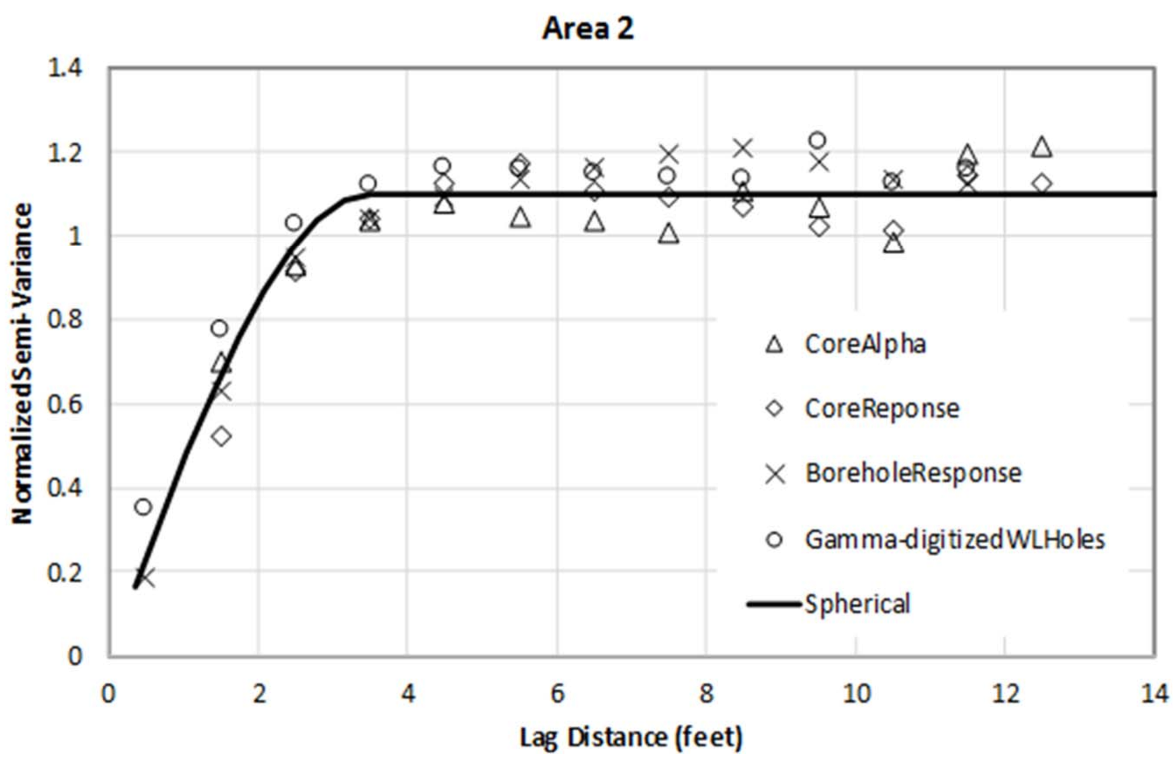


Figure 9 Updated Empirical and Modeled Vertical Variograms

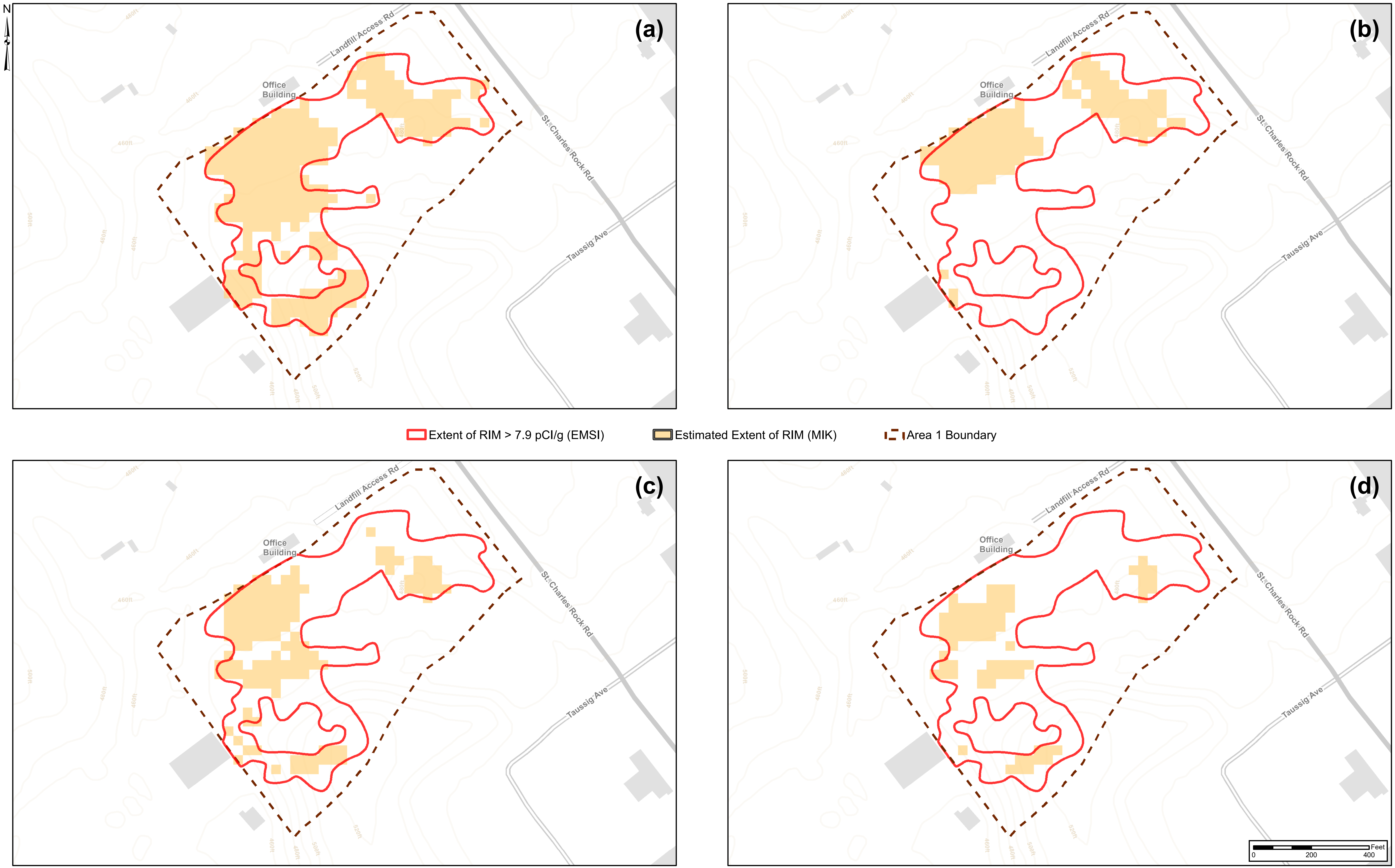


Figure 10 Estimated Lateral Extent of RIM, Area 1 - Initial Best Estimate: (a) > 7.9 pCi/g, (b) > 52.9 pCi/g within 16 ft of 2005 ground surface, (c) > 500 pCi/g, (d) > 1000 pCi/g

Figure 11 Estimated Lateral Extent of RIM, Area 2 - Initial Best Estimate: (a) > 7.9 pCi/g, (b) > 52.9 pCi/g within 16 ft of 2005 ground surface, (c) > 500 pCi/g, (d) > 1000 pCi/g

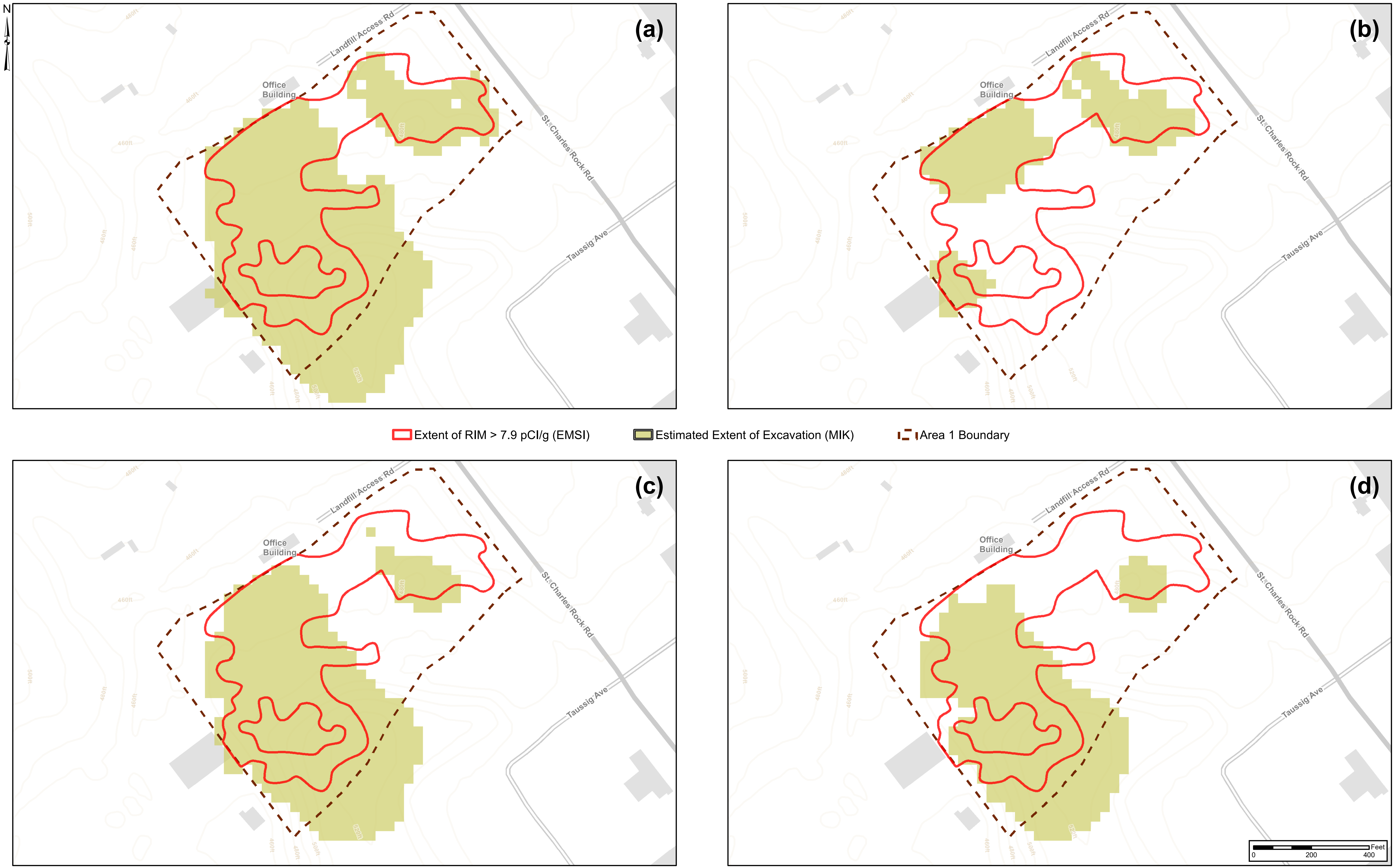


Figure 12 Estimated Lateral Extent of Excavation, Area 1 - Initial Best Estimate: (a) > 7.9 pCi/g, (b) > 52.9 pCi/g within 16 ft of 2005 ground surface, (c) > 500 pCi/g, (d) > 1000 pCi/g

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Figure 13 Estimated Lateral Extent of Excavation, Area 2 - Initial Best Estimate: (a) > 7.9 pCi/g, (b) > 52.9 pCi/g within 16 ft of 2005 ground surface, (c) > 500 pCi/g, (d) > 1000 pCi/g

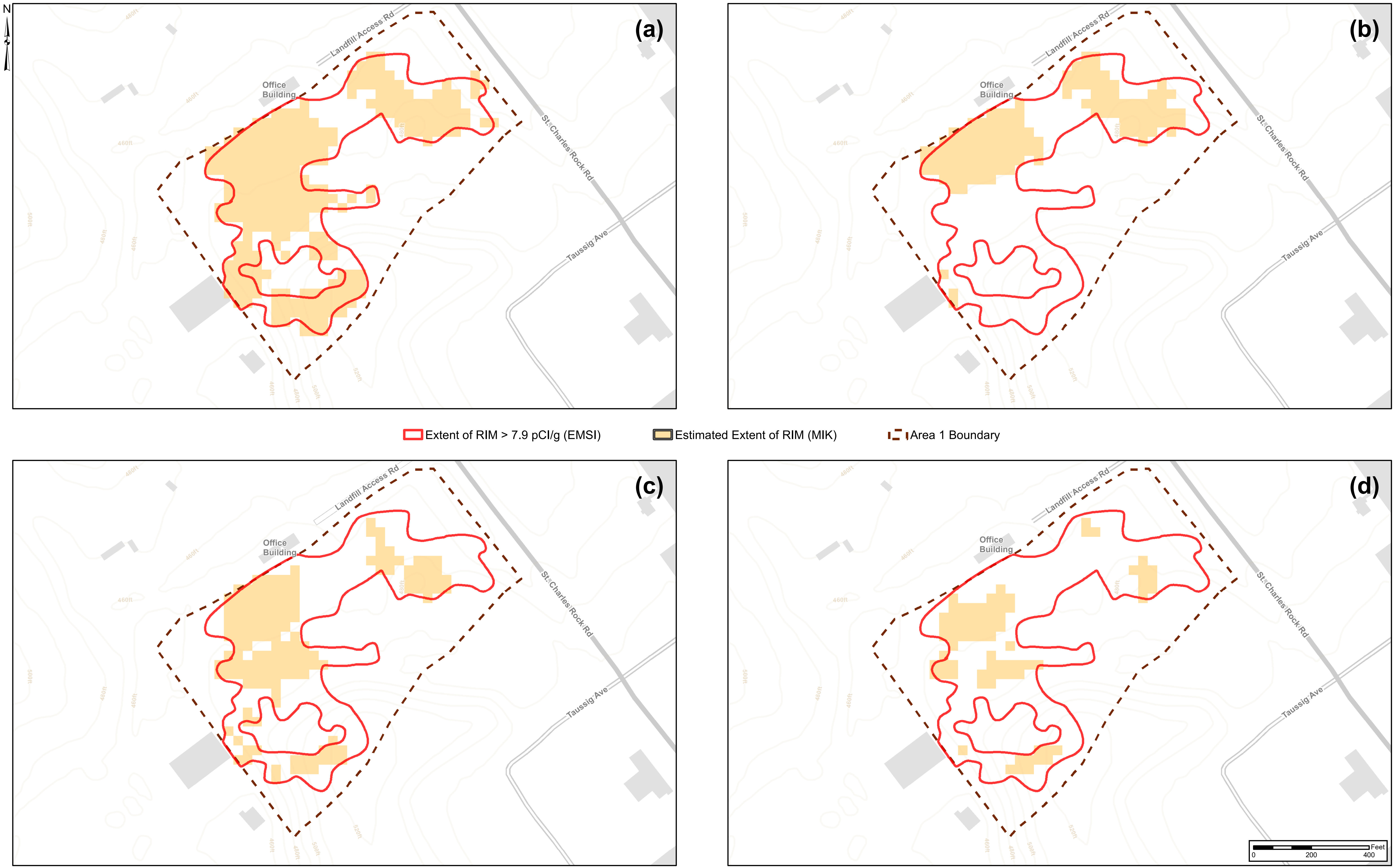


Figure 14 Estimated Lateral Extent of RIM, Area 1 - Updated Best Estimate: (a) > 7.9 pCi/g, (b) > 52.9 pCi/g within 16 ft of 2005 ground surface, (c) > 500 pCi/g, (d) > 1000 pCi/g

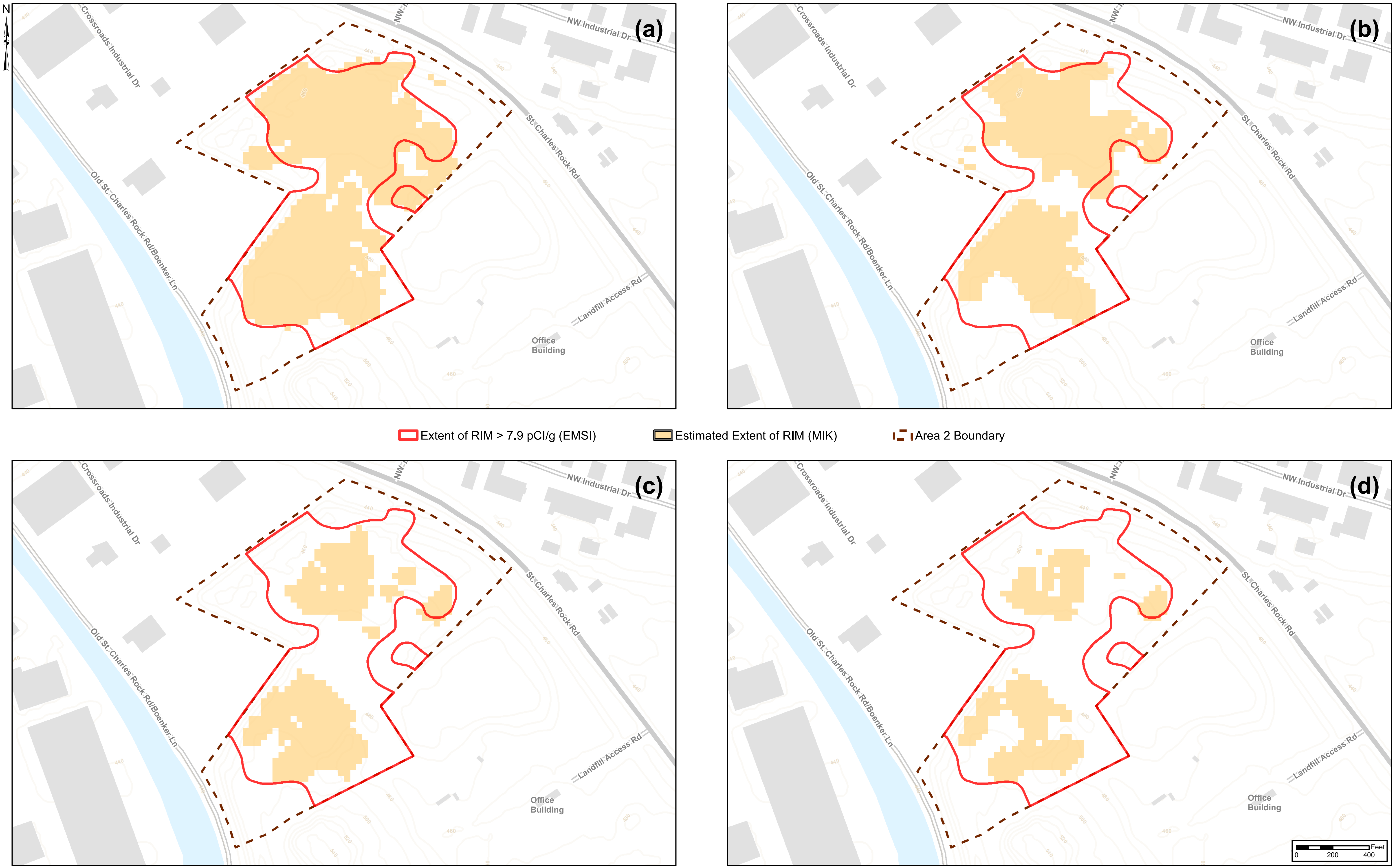


Figure 15 Estimated Lateral Extent of RIM, Area 2 - Updated Best Estimate: (a) > 7.9 pCi/g, (b) > 52.9 pCi/g within 16 ft of 2005 ground surface, (c) > 500 pCi/g, (d) > 1000 pCi/g

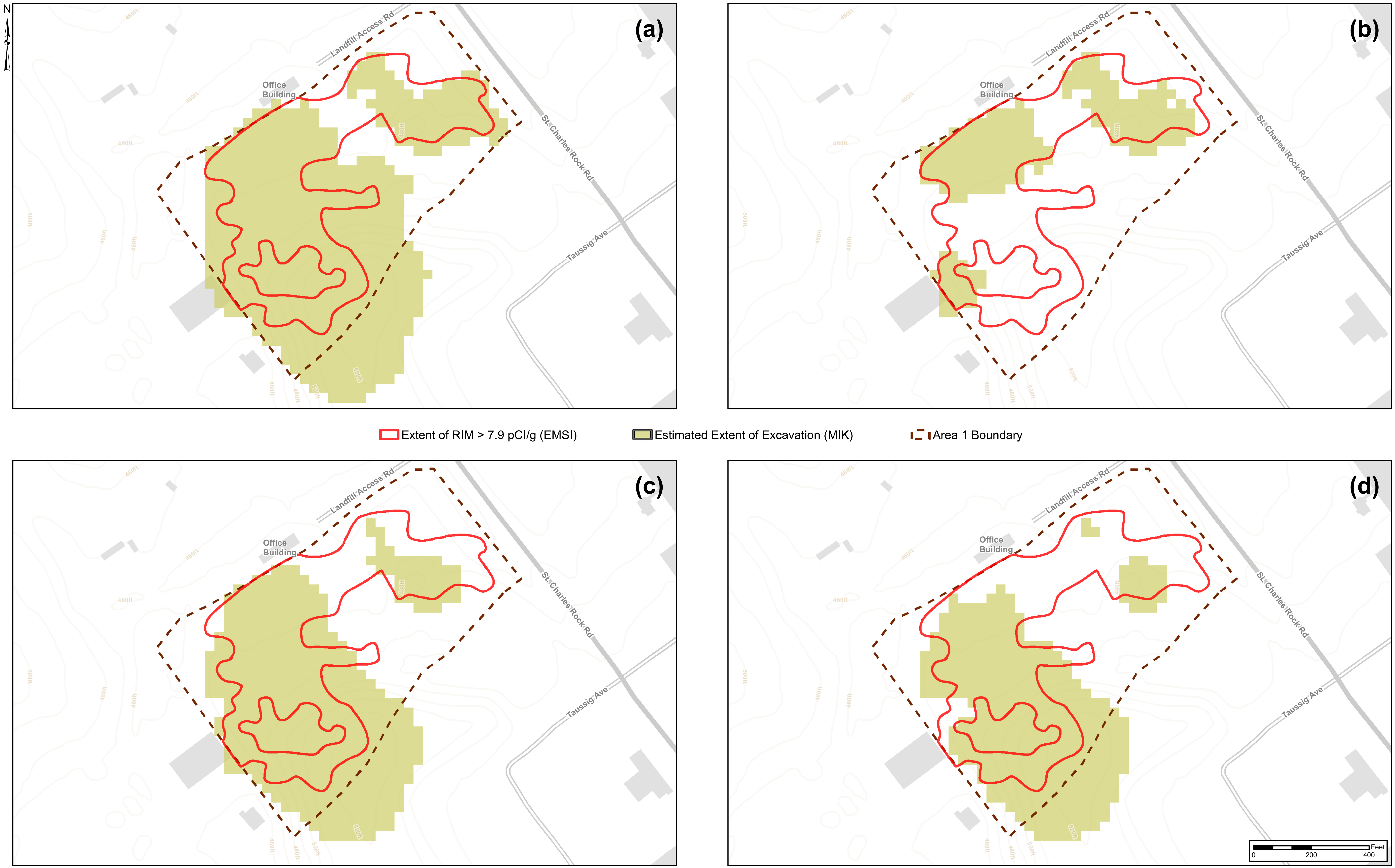


Figure 16 Estimated Lateral Extent of Excavation, Area 1 - Updated Best Estimate: (a) > 7.9 pCi/g, (b) > 52.9 pCi/g within 16 ft of 2005 ground surface, (c) > 500 pCi/g, (d) > 1000 pCi/g

Figure 17 Estimated Lateral Extent of Excavation, Area 2 - Updated Best Estimate: (a) > 7.9 pCi/g, (b) > 52.9 pCi/g within 16 ft of 2005 ground surface, (c) > 500 pCi/g, (d) > 1000 pCi/g

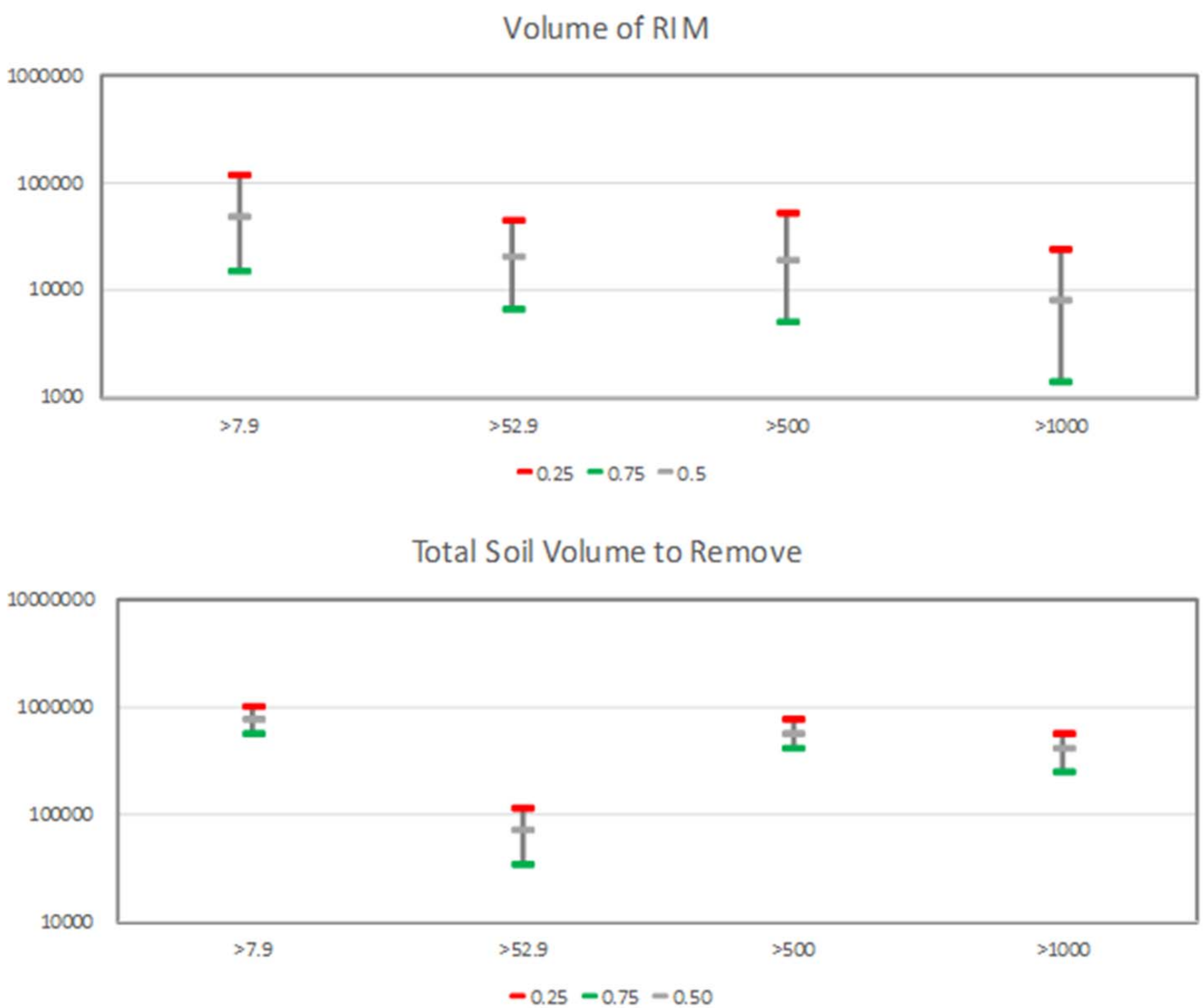


Figure 18 Estimated Material Volumes, Area 1: Updated Best-Estimate and Intervals

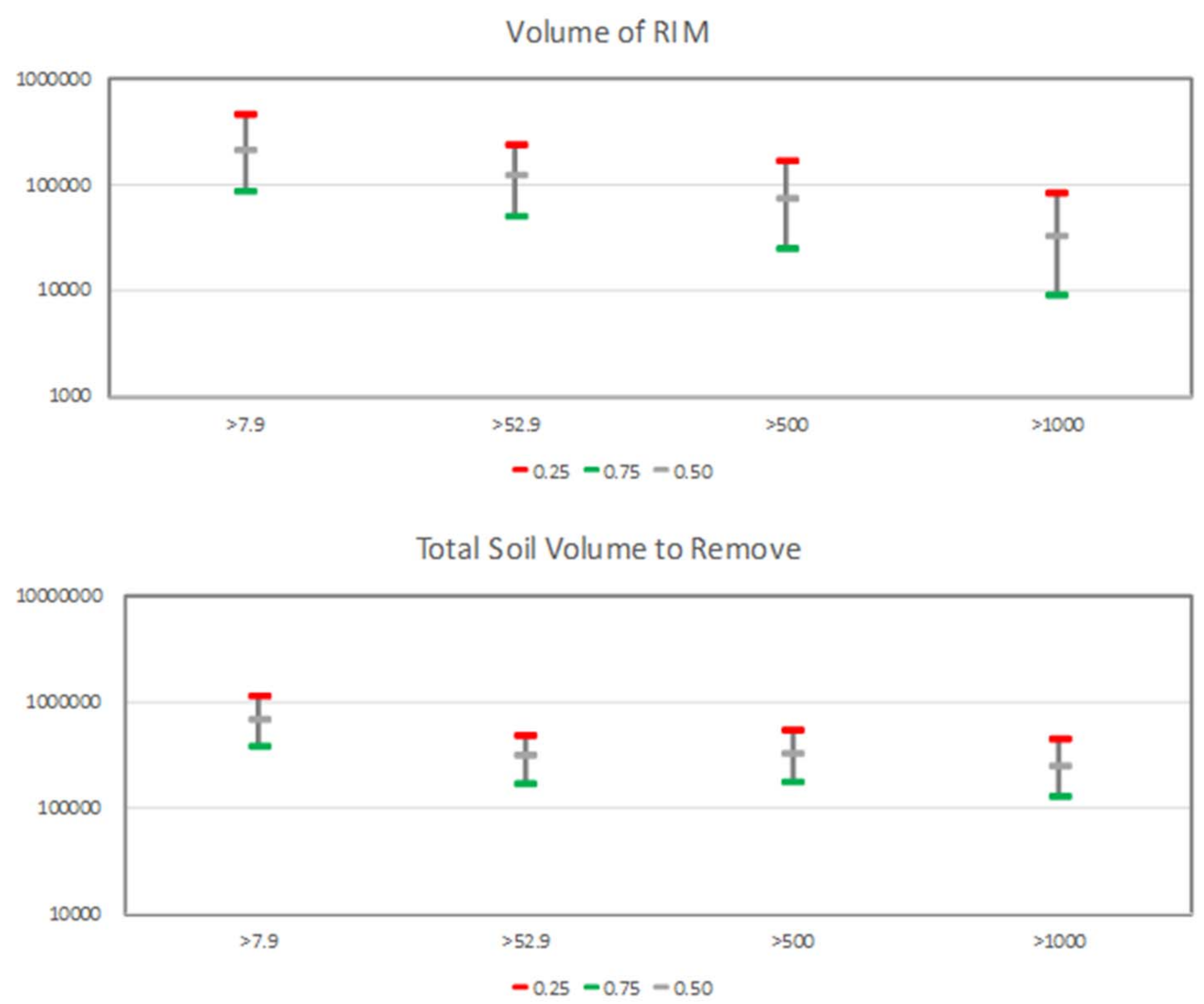


Figure 19 Estimated Material Volumes, Area 2: Updated Best-Estimate and Intervals

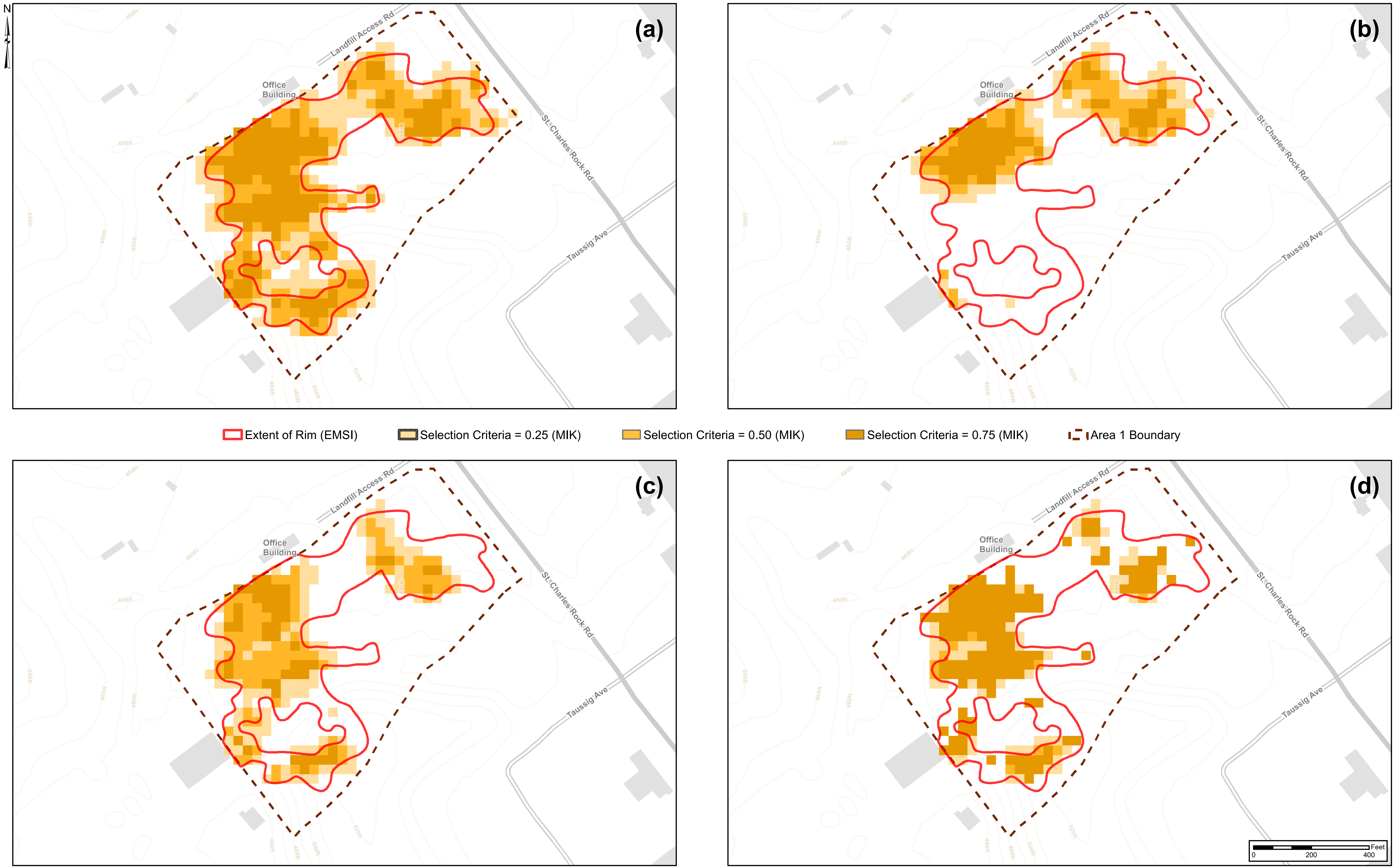


Figure 20 Estimated Lateral Extent of RIM, Area 1 - Updated Best Estimate and Intervals: (a) > 7.9 pCi/g, (b) > 52.9 pCi/g within 16 ft of 2005 ground surface, (c) > 500 pCi/g, (d) > 1000 pCi/g

Figure 21 Estimated Lateral Extent of RIM, Area 2 - Updated Best Estimate and Intervals: (a) > 7.9 pCi/g, (b) > 52.9 pCi/g within 16 ft of 2005 ground surface, (c) > 500 pCi/g, (d) > 1000 pCi/g

TABLES

Table 1

Estimated Material Volumes – Area 1 and Area 2: Initial Best-Estimates

Area 1					
Measure (cubic yd)	**>7.9**	**>52.9**	**>500**	**>1000**	**Comments**
Vol-RIM	46200	20800	18000	7110	RIM vol
Vol-VO	276000	37700	126000	70700	Vert. overburden vol
Vol-SB	426000	15100	432000	316000	Adnl setback vol
Total Vol	**749000**	**73600**	**576000**	**394000**	
Area 2					
Measure (cubic yd)	**>7.9**	**>52.9**	**>500**	**>1000**	**Comments**
Vol-RIM	220000	130000	72600	31100	RIM vol
Vol-VO	303000	142000	164000	124000	Vert. overburden vol
Vol-SB	190000	56600	97400	90000	Adnl setback vol
Total Vol	**713000**	**329000**	**334000**	**245000**	

Tabulated values are reported to three significant digits

Table 2

RIM Intervals - Area 1: Updated Best-Estimate

Boring	RIM Present?	Depth to Top of RIM Interval (ft)	Elevation Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval						Indicator Kriging Results			
							Downhole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium	Bilinear Interpolation		Interpolated Cell Value	
													Top-Interp	Bot-Interp	Top-Cell	Bot-Cell
GCPT 1-1	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 1-1A	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 1-2	Yes	23.5	448.2	25.2	446.5	1.7	X	NA	NA	NA	NA	NA	-10	-10	448.5	433
GCPT 2-1	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 2-2	No						-	NA	NA	NA	NA	NA	-10	-10	444	443.5
GCPT 2-2A	No						-	NA	NA	NA	NA	NA	-10	-10	442.5	442
GCPT 2-3	No						-	NA	NA	NA	NA	NA	442.5	439.8	442.5	440
GCPT 2-3A	Yes	35	441.6	36.8	439.8	1.8	X	NA	NA	NA	NA	NA	442.5	439.8	442.5	440
GCPT 2-2B	Yes	33.2	442.1	34.7	440.6	1.5	X	NA	NA	NA	NA	NA	-10	-10	442.5	442
GCPT 2-2C	Yes	31.8	443.5	32.7	442.6	0.9	X	NA	NA	NA	NA	NA	-10	-10	442.5	442
GCPT 2-4	No						-	NA	NA	NA	NA	NA	-10	-10	442.5	442
GCPT 3-1	No						-	NA	NA	NA	NA	NA	451.1	446.2	452	446.5
GCPT 3-1A	Yes	27	447.9	28.5	446.4	1.5	X	NA	NA	NA	NA	NA	451.1	446.2	452	446.5
GCPT 3-2	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 4-1	Yes	27.5	446.9	31	443.4	3.5	X	NA	NA	NA	NA	NA	447.2	443.7	447	443.5
GCPT 4-2	Yes	33.5	445.5	34.5	444.5	1	X	NA	NA	NA	NA	NA	-10	-10	446	444.5
GCPT 5-1	Yes	23.2	450.4	25.8	447.8	2.6	X	NA	NA	NA	NA	NA	450.9	440.8	451	447
GCPT 5-2	Yes	25.2	448.1	27	446.3	1.8	X	NA	NA	NA	NA	NA	448.1	441.6	448	446
GCPT 5-3	Yes	25.5	449.2	33	441.7	7.5	X	NA	NA	NA	NA	NA	448.7	421.2	449.5	421
GCPT 5-4	No						-	NA	NA	NA	NA	NA	-10	-10	424	422
GCPT 5-4A	No						-	NA	NA	NA	NA	NA	425.2	422.7	424	422
GCPT 5-5	Yes	30.1	446.6	34.4	442.3	4.3	X	NA	NA	NA	NA	NA	441.5	421.8	447.5	421.5
GCPT 5-6	Yes	25.5	449.2	29	445.7	3.5	X	NA	NA	NA	NA	NA	449.5	421.4	449.5	421.5
GCPT 6-2	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 6-3	Yes	27.2	446.8	28.8	445.2	1.6	X	NA	NA	NA	NA	NA	448.3	445.8	448	445.5
GCPT 6-4	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 6-5	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 6-6	Yes	26	449.2	29	446.2	3	X	NA	NA	NA	NA	NA	449.6	446.2	449.5	446
GCPT 7-1	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 7-2	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 7-3	No						-	NA	NA	NA	NA	NA	-10	-10	433.5	433
GCPT 8-1	Yes	27.5	452.2	30	449.7	2.5	X	NA	NA	NA	NA	NA	-10	-10	451	450
GCPT 9-1	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 9-2	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 9-3	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 9-3A	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCTP 9-4	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10

Table 2

RIM Intervals - Area 1: Updated Best-Estimate

Boring	RIM Present?	Depth to Top of RIM Interval (ft)	Elevation Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval						Indicator Kriging Results			
							Downhole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium	Bilinear Interpolation		Interpolated Cell Value	
													Top-Interp	Bot-Interp	Top-Cell	Bot-Cell
GCPT 10-1	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 10-2	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 10-3	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 10-3A	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 10-4	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 10-4A	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 11-1	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 11-2	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 11-3	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 11-4	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 12-1	Yes	22	457.4	24.9	454.5	2.9	X	NA	NA	NA	NA	NA	-10	-10	459	454
GCPT 12-2	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 12-3	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 12-4	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 12-5	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 12-6	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 13-1	Yes	15	455.9	16.3	454.6	1.3	X	NA	NA	NA	NA	NA	455.9	454.8	456	455
GCPT 13-2	No						-	NA	NA	NA	NA	NA	455.7	455	455.5	455
GCPT 13-2A	No						-	NA	NA	NA	NA	NA	-10	-10	455.5	455
GCPT 13-3	No						-	NA	NA	NA	NA	NA	-10	-10	455.5	455
GCPT 13-4	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 13-4S	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 13-5	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 13-5S	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 13-6	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 13-6S	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 13-7	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 13-7S	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 14-1	Yes	18.3	455.9	19.6	454.6	1.3	X	NA	NA	NA	NA	NA	456	454.8	456	455
GCPT 14-2	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 14-3	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 14-3S	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 14-4	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 14-5	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 14-5S	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 14-6	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 14-6S	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10

Table 2

RIM Intervals - Area 1: Updated Best-Estimate

Boring	RIM Present?	Depth to Top of RIM Interval (ft)	Elevation Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval						Indicator Kriging Results			
							Downhole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium	Bilinear Interpolation		Interpolated Cell Value	
													Top-Interp	Bot-Interp	Top-Cell	Bot-Cell
GCPT 14-7	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 15-1	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 15-2	No						-	NA	NA	NA	NA	NA	-10	-10	452.5	451.5
GCPT 15-3	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 15-4	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 15-5	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 15-6	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 15-7	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 15-8	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 16-1	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 16-2	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 16-3	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 16-4	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 16-5	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 16-6	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 16-7	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 16-8	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 1C-1	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 1C-1A	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 1C-2	No						-	NA	NA	NA	NA	NA	443.4	440.5	443.5	440.5
GCPT 1C-2R	Yes	29.6	442.9	32	440.5	2.4	X	NA	NA	NA	NA	NA	443.5	440.5	443.5	440.5
GCPT 1C-3	No						-	NA	NA	NA	NA	NA	-10	-10	441.5	441
GCPT 1C-4	No						-	NA	NA	NA	NA	NA	-10	-10	443.5	442.5
GPCT 1C-4R	Yes	43.4	442.6	44	442	0.6	X	NA	NA	NA	NA	NA	-10	-10	443.5	442.5
GCPT 1C-5	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 1C-5A	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 1C-6	Yes	21.4	447.4	23.2	445.6	1.8	X	NA	NA	NA	NA	NA	447.5	442.1	448	442
GCPT 1C-6T	Yes	22	446.9	24	444.9	2	X	NA	NA	NA	NA	NA	-10	-10	448	442
GCPT 1C-6T1	Yes	22.5	446.4	23.6	445.3	1.1	X	NA	NA	NA	NA	NA	-10	-10	448	442
GCPT 1C-7	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 1C-8	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 1C-9	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 1C-10	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT 1C-11	No						-	NA	NA	NA	NA	NA	-10	-10	446	443.5
GCPT 1C-12	Yes	55.7	444.4	57	443.1	1.3	X	NA	NA	NA	NA	NA	-10	-10	446	443
GCPT 1C-13	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT-108	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10

Table 2

RIM Intervals - Area 1: Updated Best-Estimate

Boring	RIM Present?	Depth to Top of RIM Interval (ft)	Elevation Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval						Indicator Kriging Results			
							Downhole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium	Bilinear Interpolation		Interpolated Cell Value	
													Top-Interp	Bot-Interp	Top-Cell	Bot-Cell
GCPT-111A	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
GCPT-119	No						-	NA	NA	NA	NA	NA	-10	-10	433.5	433
GCPT-28A	Yes	24.2	456.3	25.6	454.9	1.4	X	NA	NA	NA	NA	NA	-10	-10	458	454.5
GCPT-36	Yes	7.8	457.2	8.8	456.2	1	X	NA	NA	NA	NA	NA	458.5	456	458.5	456
GCPT-25	Yes	7.3	458	9.8	455.5	2.5	X	NA	NA	NA	NA	NA	458.9	454.8	459	454.5
PVC-25R	Yes	8.3	457	10.9	454.4	2.6	X	NA	NA	NA	NA	NA	458.9	454.8	459	454.5
1D-1	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
1D-2	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
1D-3	Yes	25.5	446.6	29.5	442.6	4	X	NA	NA	NA	NA	NA	447	442.5	447	442.5
1D-4	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
1D-5	Yes	54.1	433.5	56.2	431.4	2.1	X	NA	NA	NA	NA	NA	435	433.3	433.5	432
1D-6	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
1D-7	Yes	80.2	432.6	85.5	427.3	5.3	X	NA	NA	NA	NA	NA	449.1	418.9	432.5	419
1D-8	Yes	74.7	442.5	75.6	441.6	0.9	X	NA	NA	NA	NA	NA	-10	-10	442.5	442
1D-8A	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
1D-9	No						-	NA	NA	NA	NA	NA	464	423	465	423
1D-9A	No						-	NA	NA	NA	NA	NA	459.6	423.4	465	423
1D-10	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
1D-11	No						-	NA	NA	NA	NA	NA	438.5	436.8	438.5	437
1D-11A	No						-	NA	NA	NA	NA	NA	438.4	436.9	438.5	437
1D-12	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
1D-13	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
1D-13A	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
1D-13B	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
1D-13C	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
1D-14	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
1D-15	Yes	89.4	427.3	89.7	427	0.3	X	NA	NA	NA	NA	NA	431.7	426.4	432	426.5
1D-16	Yes	46	438.8	48	436.8	2	X	NA	NA	NA	NA	NA	436.5	434.8	437.5	435
1D-16A	Yes	49.7	435.5	49.9	435.3	0.2	X	NA	NA	NA	NA	NA	435.8	434.1	437.5	435
1D-17	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
1D-17A	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
1D-18	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
1D-18A	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
1-2	No						-	-	NA	-	-	-	440	433.8	433.5	433
2-2	No						-	-	NA	-	-	-	-10	-10	442.5	442
5-3	Yes	26	448.4	34	440.4	8	X	X	NA	X	X	X	448.8	421.2	449.5	421
5-3	Yes	49	425.4	53?	421.4?	4?	X	-	NA	-	-	-	448.8	421.2	449.5	421

Table 2

RIM Intervals - Area 1: Updated Best-Estimate

Boring	RIM Present?	Depth to Top of RIM Interval (ft)	Elevation Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval						Indicator Kriging Results			
							Downhole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium	Bilinear Interpolation		Interpolated Cell Value	
													Top-Interp	Bot-Interp	Top-Cell	Bot-Cell
8-1	No						-	-	NA	-	-	-	-10	-10	451	450
12-5	No						-	-	NA	-	-	-	-10	-10	-10	-10
13-3	No						-	-	NA	-	-	-	-10	-10	-10	-10
13-6	No						-	-	NA	-	-	-	-10	-10	-10	-10
14-2	No						-	-	NA	-	-	-	-10	-10	-10	-10
14-4	No						-	-	NA	-	-	-	-10	-10	-10	-10
14-5	No						-	-	NA	-	-	-	-10	-10	-10	-10
14-7	No						-	-	NA	-	-	-	-10	-10	-10	-10
15-2	Yes	22	454.5	27	449.5	5	-	-	NA	-	X	-	-10	-10	452.5	451.5
16-3	No						-	-	NA	-	-	-	-10	-10	-10	-10
16-6	No						-	-	NA	-	-	-	-10	-10	-10	-10
1C-6	Yes	20	449.2	27	442.2	7	X	-	NA	X	X	-	447.3	442.2	448	442
WL-119	Yes	31.5	447.7	33	446.2	1.5	X	-	NA	-	-	-	-10	-10	433.5	433
1-2-Geoprobe	No						NA	NA	NA	-	-	-	-10	-10	448.5	433
2-2-Geoprobe	Yes	30	445.25	34	441.25	4	NA	NA	NA	X	X	-	-10	-10	442.5	442
2-3-Geoprobe	Yes	33	443.459	38	438.459	5	NA	NA	NA	X	X	-	442.5	439.8	442.5	440
8-1B-Geoprobe	No						NA	NA	NA	-	-	-	-10	-10	451	450
1C-12-Geoprobe	No						NA	NA	NA	-	-	-	-10	-10	446	443
1C-12B-Geoprobe	Yes	54	445.723	56	443.723	2	NA	NA	NA	-	X	-	446	443	446	443
1C-12C-Geoprobe	Yes	53	447.161	58	442.161	5	NA	NA	NA	X	X	-	446	443.1	446	443
1C-2RA-Geoprobe	No						NA	NA	NA	-	-	-	443.9	440.6	443.5	440.5
1C-4R-Geoprobe	No						NA	NA	NA	-	-	-	-10	-10	443.5	442.5
1C-4RB-Geoprobe	No						NA	NA	NA	-	-	-	-10	-10	443.5	442.5
1C-6T1-Geoprobe	No						NA	NA	NA	-	-	-	-10	-10	446	442.5
WL-119-Geoprobe	No						NA	NA	NA	-	-	-	-10	-10	433.5	433
WL-119B-Geoprobe	No						NA	NA	NA	-	-	-	-10	-10	433.5	433
WL-119C-Geoprobe	No						NA	NA	NA	-	-	-	-10	-10	433.5	433
1D-1S	No						-	-	-	-	-	-	-10	-10	-10	-10
1D-2S	No						-	-	-	-	-	-	-10	-10	-10	-10
1D-3S	Yes	23	449.3	31	441.3	8	X	X	X	X	X	-	447.2	442.5	447	442.5
1D-4S	No						-	-	-	-	-	-	-10	-10	-10	-10
1D-5S	Yes	51	436.8	56	431.8	5	X	X	X	X	X	-	435.9	433.9	437	434.5
1D-6S	No						-	-	-	-	-	-	-10	-10	-10	-10
1D-7S	Yes	76	437.3	93	420.3	17	X	X	X	X	X	-	459.7	418.9	495.5	419
1D-8S	Yes	72	444.7	74	442.7	2	X	-	-	-	-	-	-10	-10	-10	-10
1D-9S	Yes	70	448.9	72.5	446.4	2.5	X	-	-	-	-	-	463.4	423	465	423
1D-9S	Yes	82	436.9	96	422.9	14	X	X	X	X	X	-	463.4	423	465	423

Table 2

RIM Intervals - Area 1: Updated Best-Estimate

Boring	RIM Present?	Depth to Top of RIM Interval (ft)	Elevation Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval						Indicator Kriging Results			
							Downhole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium	Bilinear Interpolation		Interpolated Cell Value	
													Top-Interp	Bot-Interp	Top-Cell	Bot-Cell
1D-10S	No						-	-	-	-	-	-	-10	-10	-10	-10
1D-11S	Yes	82	440.3	86	436.3	4	X	X	X	X	X	-	438.4	436.7	438.5	436.5
1D-12S	No						-	-	-	-	-	-	-10	-10	-10	-10
1D-13S	No						-	-	-	-	-	-	-10	-10	-10	-10
1D-14S	No						-	-	-	-	-	-	-10	-10	-10	-10
1D-15S	Yes	83.5	432.6	86	430.1	2.5	X	X	X	X	X	-	432.1	427.2	432	426.5
1D-16S	Yes	49.5	436.1	51.5	434.1	2	X	X	X	X	X	-	434.8	433.3	433.5	432
1D-17S	No						-	-	-	-	-	-	-10	-10	-10	-10
1D-18S	No						-	-	-	-	-	-	-10	-10	-10	-10
1D-19S	No						-	-	-	-	-	-	-10	-10	424.5	423.5
1D-20S	No						-	-	-	-	-	-	-10	-10	-10	-10
WL-101-MH	No						-	NA	NA	-	-	-	-10	-10	-10	-10
WL-102-MH	Yes	0	462.8	6	456.8	6	X	NA	NA	-	-	-	460.5	458.5	460.5	458.5
WL-103-MH	Yes	9	441.9	11	439.9	2	-	NA	NA	-	X	-	-10	-10	442	440.5
WL-104-MH	No						-	NA	NA	-	-	-	-10	-10	-10	-10
WL-105A-MH	Yes	5.5	461.7	12	455.2	6.5	X	NA	NA	X	X	-	463.6	455.7	465	456
WL-105B-MH	Yes	5.5	460.5	10.5	455.5	5	X	NA	NA	-	-	-	462.6	457.2	464	460
WL-105C-MH	Yes	2	463.7	5	460.7	3	X	NA	NA	-	-	-	463.5	459.2	464	460
WL-106A-MH	Yes	0	462.8	6	456.8	6	-	NA	NA	X	X	X	462.4	461.2	463	462
WL-106-MH	Yes	1	464.4	5.5	459.9	4.5	X	NA	NA	-	-	-	461.8	456.9	461.5	459.5
WL-107-MH	No						-	NA	NA	-	-	-	-10	-10	-10	-10
WL-108-MH	No						-	NA	NA	-	-	-	-10	-10	-10	-10
WL-109A-MH	No						-	NA	NA	-	-	-	-10	-10	-10	-10
WL-109B-MH	No						-	NA	NA	-	-	-	-10	-10	-10	-10
WL-109C-MH	No						-	NA	NA	-	-	-	-10	-10	-10	-10
WL-109D-MH	No						-	NA	NA	-	-	-	-10	-10	-10	-10
WL-110-MH	No						-	NA	NA	-	-	-	-10	-10	-10	-10
WL-111-MH	No						-	NA	NA	-	-	-	-10	-10	-10	-10
WL-112-MH	Yes	4	463.6	7	460.6	3	X	NA	NA	-	X	-	461.5	460.5	461.5	460.5
WL-113-MH	Yes	3	464	5	462	2	X	NA	NA	-	-	-	-10	-10	-10	-10
WL-114-MH	Yes	0	468.3	6	462.3	6	X	NA	NA	X	X	X	-10	-10	-10	-10
WL-115-MH	No						-	NA	NA	-	-	-	-10	-10	-10	-10
WL-116-MH	No						-	NA	NA	-	-	-	-10	-10	-10	-10
WL-117-MH	Yes	3	464.6	11	456.6	8	X	NA	NA	-	X	-	457.3	456	457	456
WL-118-MH	Yes	0	465.8	7	458.8	7	X	NA	NA	X	X	-	-10	-10	457	455.5
WL-119-MH	No						-	NA	NA	-	-	-	-10	-10	433.5	433
WL-120-MH	No						-	NA	NA	-	-	-	-10	-10	-10	-10

Table 2

RIM Intervals - Area 1: Updated Best-Estimate

Boring	RIM Present?	Depth to Top of RIM Interval (ft)	Elevation Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval						Indicator Kriging Results			
							Downhole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium	Bilinear Interpolation		Interpolated Cell Value	
													Top-Interp	Bot-Interp	Top-Cell	Bot-Cell
WL-121-MH	No						-	NA	NA	-	-	-	-10	-10	-10	-10
WL-122-MH	No						-	NA	NA	-	-	-	-10	-10	-10	-10
WL-123-MH	No						-	NA	NA	-	-	-	442.2	439.2	442.5	439.5
WL-124-MH	No						-	NA	NA	-	-	-	-10	-10	461.5	457
PVC-24-MH	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
PVC-25-MH	Yes	7	460.7	11	456.7	4	X	NA	NA	-	-	-	459	454.8	459	454.5
PVC-26-MH	Yes	3	462.2	10	455.2	7	X	NA	NA	-	-	-	459.5	456.5	459.5	456.5
PVC-27-MH	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
PVC-28-MH	Yes	12	461.1	17	456.1	5	X	NA	NA	-	-	-	-10	-10	458	454.5
PVC-36-MH	Yes	6	460.8	9.5	457.3	3.5	X	NA	NA	-	-	-	-10	-10	-10	-10
PVC-37-MH	No						-	NA	NA	NA	NA	NA	458.5	456	458.5	456
PVC-38-MH	Yes	0	470.5	15	455.5	15	X	NA	NA	-	-	-	-10	-10	-10	-10
PVC-41-MH	No						-	NA	NA	NA	NA	NA	471.3	456.4	471.5	456.5
NRC-29	No						-	NA	NA	NA	NA	NA	-10	-10	-10	-10
AC-1a	Yes	4.5	462.2	22	444.7	17.5	X	X	X	X	X	X	461	427.5	461	427.5
AC-1b	Yes	29	437.7	32	434.7	3	-	X	X	X	X	-	461	427.5	461	427.5
AC-1c	Yes	35	431.7	41	425.7	6	X	-	-	-	-	-	461	427.5	461	427.5
AC-2Ba	Yes	2	464.2	6.5	459.7	4.5	X	-	-	-	-	-	456.3	454.5	456.5	454.5
AC-2Bb	Yes	9.5	456.7	13.5	452.7	4	X	X	X	X	X	-	456.3	454.5	456.5	454.5
AC-3a	Yes	0	466.4	19	447.4	19	X	X	X	X	X	X	466.9	427.3	467	427.5
AC-3b	Yes	32.5	433.9	39.5	426.9	7	X	-	-	-	-	-	466.9	427.3	467	427.5
AC-4B	No						-	-	-	-	-	-	-10	-10	-10	-10
AC-5	No						-	-	-	-	-	-	-10	-10	-10	-10
AC-6	No						-	-	-	-	-	-	-10	-10	-10	-10
AC-7	Yes	0.5	461	5	456.5	4.5	X	-	-	-	-	-	-10	-10	460.5	460
WL-102-CT	No						-	-	X	-	-	-	460.5	458.3	460.5	458.5
WL-106A-CT	Yes	2	461.8	12	451.8	10	X	X	X	X	X	-	461.7	454.8	461.5	452
WL-114-CT	Yes	2	465.4	6	461.4	4	-	X	-	-	-	-	-10	-10	-10	-10

amsl = above mean sea level   cpm = counts per minute

Notes: NA - Data were not collected or are otherwise not available.

X - Data support the presence of RIM in the indicated interval

'- Data do not indicate the presence of RIM at this location/interval

Table 3

RIM Intervals – Area 2: Updated Best-Estimate

Boring	RIM Present?	Depth to Top of RIM Interval (ft)	Elevation Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval						Indicator Kriging Results			
							Downhole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium	Bilinear Interpolation		Interpolated Cell Value	
													Top-Interp	Bot-Interp	Top-Cell	Bot-Cell
AC-8	No	None	None	None	None	None	-	-	-	-	-	-	-10	-10	-10	-10
AC-9	No	None	None	None	None	None	-	-	-	-	-	-	-10	-10	-10	-10
AC-10	Yes	11	456.676	14	453.676	3	-	-	-	-	X	-	456	455	456	455
AC-11	No	NA	NA	NA	NA	NA	-	-	-	-	-	-	456.3	444	456.5	444
AC-12	Yes	1	458.587	5	454.587	4	X	X	-	-	X	-	457.6	456	457.5	456
AC-13	Yes	14	454.089	24	444.089	10	X	X	X	X	X	-	453.5	446.5	453.5	446.5
AC-14	No	None	None	None	None	None	-	-	-	-	-	-	-10	-10	-10	-10
AC-15	No	None	None	None	None	None	-	-	-	-	-	-	-10	-10	-10	-10
AC-16	Yes	10	458.212	30	438.212	20	X	X	X	X	X	X	459.5	438.5	459.5	438.5
AC-17	No	None	None	None	None	None	-	-	-	-	-	-	465.5	461.5	465.5	461.5
AC-18	Yes	0	469.529	15	454.529	15	X	X	X	X	X	X	470.2	457.7	470.5	458
AC-19	Yes	0	477.185	14	463.185	14	X	X	X	X	X	X	475.5	466.5	475.5	466.5
AC-20	Yes	19	469.976	29	459.976	10	X	X	X	X	X	X	470.4	462	470.5	462
AC-21	Yes	8	469.569	33	444.569	25	X	X	X	X	X	X	468	446	468	446
AC-21A	Yes	6	471.393	17	460.393	11	X	X	X	X	X	X	468	446	468	446
AC-22	Yes	16	467.275	20	463.275	4	X	X	X	X	X	-	466.5	463.5	466.5	463.5
AC-23	Yes	17	469.548	29	457.548	12	X	X	X	X	X	X	467.3	461.1	467	461.5
AC-24	Yes	0	477.384	17	460.384	17	X	X	X	X	X	X	478.2	445.1	477	428.5
AC-24	Yes	42.5	434.884	46	431.384	3.5	X	-	-	NA	NA	NA	478.2	445.1	477	428.5
AC-25	Yes	20	459.445	22.5	456.945	2.5	X	-	-	NA	NA	NA	483	467.7	483	475.5
AC-26A	Yes	2.5	470.686	6	467.186	3.5	X	X	X	X	X	-	-10	-10	469.5	467.5
AC-26A	Yes	36	437.186	39	434.186	3	-	-	-	-	X	-	-10	-10	469.5	467.5
WL-209-CT	Yes	0	467.546	12	455.546	12	X	X	X	X	X	X	467.1	442.8	467	442.5
WL-234-CT	Yes	1	479.017	22	458.017	21	X	X	X	X	X	X	478.3	459.3	478	459
WL-207	No	None	None	None	None	None	-	NA	NA	-	-	-	-10	-10	-10	-10
WL-208	Yes	0	474.8	10	464.8	10	-	NA	NA	-	X	-	474.2	465	474	465
WL-209	Yes	0	467.4	11	456.4	11	X	NA	NA	X	X	X	467	444.4	467	442.5
WL-209	Yes	24	443.4	26	441.4	2	-	NA	NA	-	X	-	467	444.4	467	442.5
WL-210	Yes	0	477.8	16.5	461.3	16.5	X	NA	NA	X	X	X	477.6	435.9	477	428.5
WL-210	Yes	39	438.8	49.5	428.3	10.5	X	NA	NA	-	X	-	477.6	435.9	477	428.5
WL-211	Yes	0	475.3	13	462.3	13	X	NA	NA	X	X	-	474.2	465	476	465
WL-212	Yes	8	464.9	12	460.9	4	-	NA	NA	-	X	-	464.9	462.6	464	462.5
WL-213	Yes	0	472.3	6	466.3	6	-	NA	NA	-	X	-	467.6	467	467.5	467
WL-214	Yes	4	464.5	6	462.5	2	-	NA	NA	-	X	-	465	442.5	465	442.5
WL-214	Yes	24	444.5	26	442.5	2	-	NA	NA	-	X	-	465	442.5	465	442.5
WL-215	No	NA	NA	NA	NA	NA	NA	NA	NA	-	-	-	-10	-10	-10	-10
WL-216A	Yes	0	477.4	10	467.4	10	X	NA	NA	X	X	-	475.2	471.8	475	472
WL-216B	No	None	None	None	None	None	-	NA	NA	-	-	-	475.6	471.5	475	472

Table 3

RIM Intervals – Area 2: Updated Best-Estimate

Boring	RIM Present?	Depth to Top of RIM Interval (ft)	Elevation Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval						Indicator Kriging Results			
							Downhole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium	Bilinear Interpolation		Interpolated Cell Value	
													Top-Interp	Bot-Interp	Top-Cell	Bot-Cell
WL-216C	Yes	0	477.6	8	469.6	8	X	NA	NA	NA	NA	NA	476	471.1	476	471
WL-217	Yes	9	465.7	11	463.7	2	-	NA	NA	-	X	-	465	464	465	464
WL-218	No	None	None	None	None	None	-	NA	NA	-	-	-	-10	-10	-10	-10
WL-219	No	None	None	None	None	None	-	NA	NA	-	-	-	-10	-10	-10	-10
WL-220	No	None	None	None	None	None	-	NA	NA	-	-	-	-10	-10	-10	-10
WL-221	No	None	None	None	None	None	-	NA	NA	-	-	-	-10	-10	-10	-10
WL-222	Yes	0	457.8	7	450.8	7	-	NA	NA	-	X	-	460.1	452.5	460	452.5
WL-223	Yes	1	461.2	7.5	454.7	6.5	X	NA	NA	-	X	-	460	456.4	460	456.5
WL-224	No	None	None	None	None	None	-	NA	NA	-	-	-	-10	-10	-10	-10
WL-225	No	None	None	None	None	None	-	NA	NA	-	-	-	-10	-10	-10	-10
WL-226	Yes	0	467.5	22	445.5	22	X	NA	NA	-	X	-	464.8	446.1	465	446
WL-227	Yes	4	458	6	456	2	-	NA	NA	-	X	-	455.5	454	455.5	454
WL-228	No	None	None	None	None	None	-	NA	NA	-	-	-	-10	-10	-10	-10
WL-229	No	None	None	None	None	None	-	NA	NA	-	-	-	-10	-10	-10	-10
WL-230	Yes	0	463.3	6	457.3	6	X	NA	NA	-	X	-	458.5	457	458.5	457
WL-231	Yes	3	461.8	11	453.8	8	X	NA	NA	-	X	-	459.5	452.5	459.5	452.5
WL-233	Yes	17	472.2	31	458.2	14	X	NA	NA	-	X	-	470.1	458.4	470.5	458
WL-234	Yes	0	480	21	459	21	X	NA	NA	X	X	X	478.8	459.4	478	459.5
WL-235	Yes	0	481.1	1	480.1	1	-	NA	NA	-	X	-	483	463.2	483	457
WL-235	Yes	20.5	460.6	24.5	456.6	4	X	NA	NA	-	-	-	483	463.2	483	457
WL-236	No	None	None	None	None	None	-	NA	NA	-	-	-	-10	-10	-10	-10
WL-237	No	None	None	None	None	None	-	NA	NA	NA	NA	NA	-10	-10	-10	-10
WL-238	Yes	1	465.2	10.5	455.7	9.5	X	NA	NA	NA	NA	NA	463.4	456.5	463.5	456.5
WL-239	No	None	None	None	None	None	-	NA	NA	-	-	-	-10	-10	-10	-10
WL-240	No	None	None	None	None	None	-	NA	NA	NA	NA	NA	-10	-10	-10	-10
WL-241	Yes	1	468.6	9.5	460.1	8.5	X	NA	NA	X	X	-	465.5	461	465.5	461
WL-242	Yes	0	NA	3	NA	3	NA	NA	NA	-	X	-	462	455.9	462	456.5
WL-243	Yes	0	NA	2	NA	2	NA	NA	NA	-	X	-	462.2	454.6	462	456.5
WL-244	Yes	0	NA	1	NA	1	NA	NA	NA	-	X	-	-10	-10	-10	-10
WL-245	No	None	None	None	None	None	NA	NA	NA	-	-	-	-10	-10	-10	-10
WL-246	No	None	None	None	None	None	NA	NA	NA	-	-	-	-10	-10	-10	-10
PVC-4	Yes	0	469.91	5.5	464.41	5.5	X	NA	NA	X	NA	X	467	453.5	466.5	455.5
PVC-4	Yes	11	458.91	13	456.91	2	X	NA	NA	-	NA	NA	467	453.5	466.5	455.5
PVC-5	Yes	1	463.99	7	457.99	6	X	NA	NA	-	NA	NA	458.5	450	458.5	450
PVC-5	Yes	9.5	455.49	14.5	450.49	5	X	NA	NA	-	NA	NA	458.5	450	458.5	450
PVC-6	Yes	0	466.08	16	450.08	16	X	NA	NA	X	NA	-	460.8	443.5	461	443.5
PVC-6	Yes	19	447.08	22.5	443.58	3.5	X	NA	NA	NA	NA	NA	460.8	443.5	461	443.5
PVC-7	Yes	0	470.99	7	463.99	7	X	NA	NA	NA	NA	NA	467.9	445.9	468	446.5

Table 3

RIM Intervals – Area 2: Updated Best-Estimate

Boring	RIM Present?	Depth to Top of RIM Interval (ft)	Elevation Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval						Indicator Kriging Results			
							Downhole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium	Bilinear Interpolation		Interpolated Cell Value	
													Top-Interp	Bot-Interp	Top-Cell	Bot-Cell
PVC-7	Yes	17	453.99	22	448.99	5	X	NA	NA	NA	NA	NA	467.9	445.9	468	446.5
PVC-8	Yes	0	471.41	1.5	469.91	1.5	X	NA	NA	-	NA	NA	471.6	470.2	471.5	470
PVC-9	Yes	1	469.92	6.5	464.42	5.5	X	NA	NA	X	NA	-	465.5	463.2	465.5	463.5
PVC-10	Yes	0	473.75	7	466.75	7	X	NA	NA	X	NA	NA	468.1	454.5	467.5	454.5
PVC-10	Yes	7	466.75	13	460.75	6	X	NA	NA	X	NA	X	468.1	454.5	467.5	454.5
PVC-11B	Yes	0	475.87	10.5	465.37	10.5	X	NA	NA	X	NA	X	470.5	457.3	472.5	459
PVC-12	Yes	0.5	467.82	5.5	462.82	5	X	NA	NA	NA	NA	NA	462.5	459.3	462.5	459.5
PVC-13	No	None	None	None	None	None	-	NA	NA	NA	NA	NA	-10	-10	-10	-10
PVC-18	No	None	None	None	None	None	-	NA	NA	-	NA	NA	-10	-10	-10	-10
PVC-19	Yes	6	463.55	10.5	459.05	4.5	X	NA	NA	X	NA	-	464.5	454.8	464.5	454.5
PVC-20	Yes	0	466.65	4	462.65	4	X	NA	NA	X	NA	NA	462.5	460.5	462.5	460.5
PVC-33	Yes	1.5	464.81	3.5	462.81	2	X	NA	NA	NA	NA	NA	459.4	458.5	459.5	458.5
PVC-34	Yes	0	463.31	3	460.31	3	X	NA	NA	NA	NA	NA	460.6	456.5	460.5	456.5
PVC-35	Yes	0.5	466.61	8	459.11	7.5	X	NA	NA	NA	NA	NA	463.5	457	463.5	457
PVC-39	Yes	1.5	465.17	4	462.67	2.5	X	NA	NA	NA	NA	NA	462	444.4	462	439
PVC-40	Yes	0.5	466.59	5	462.09	4.5	X	NA	NA	NA	NA	NA	460.5	453	460.5	453
NRC-2	Yes	15	467.25	18	464.25	3	X	NA	NA	NA	NA	NA	475.5	460.6	478	459.5
NRC-3	Yes	0	476	3	473	3	X	NA	NA	NA	NA	NA	466.8	465	466.5	465
NRC-16	Yes	0	485.5	19 +	< 466.5	19 +	X	NA	NA	NA	NA	NA	466.7	462.7	466.5	462.5
NRC-17	Yes	20	467.5	21	466.5	1	X	NA	NA	NA	NA	NA	467.2	458.9	467	458
NRC-21	Yes	0	474	2	472	2	X	NA	NA	NA	NA	NA	474.9	462.5	475	463
NRC-21	Yes	5	469	12	462	7	X	NA	NA	NA	NA	NA	474.9	462.5	475	463
NRC-21	Yes	14	460	16	458	2	X	NA	NA	NA	NA	NA	474.9	462.5	475	463
NRC-22	Yes	0	486.5	2	484.5	2	X	NA	NA	NA	NA	NA	468.1	459.3	468.5	457.5
NRC-22	Yes	8	478.5	17	469.5	9	X	NA	NA	NA	NA	NA	468.1	459.3	468.5	457.5
NRC-22	Yes	18	468.5	25 +	< 461.5	7 +	X	NA	NA	NA	NA	NA	468.1	459.3	468.5	457.5
NRC-30	No	None	None	None	None	None	-	NA	NA	NA	NA	NA	465.5	457.9	459	458
NRC-31	No	None	None	None	None	None	-	NA	NA	NA	NA	NA	-10	-10	-10	-10
NRC-32	Yes	0	473	2	471	2	X	NA	NA	NA	NA	NA	476	464.3	476	462.5

amsl = above mean sea level cpm = counts per minute

Notes: NA - Data were not collected or are otherwise not available.

X - Data support the presence of RIM in the indicated interval

'- Data do not indicate the presence of RIM at this location/interval

Table 4

Prior and Posterior Univariate CDFs for Area 1 and Area 2

Area 1 - The total volume of waste in Area 1 is approximately **1,031,000** cubic yards

Measure (cubic yd)	>7.9	>52.9	>500	>1000
Vol-RIM	48200	39200	18700	7930
Vol-VO	306000	270000	142000	75600
Vol-SB	435000	431000	410000	331000

Category	Prior CDF	Posterior CDF	Cubic Yd
<7.9	90.0%	95.3%	983000
<52.9	93.0%	96.2%	992000
<500	96.0%	98.2%	1010000
<1000	99.0%	99.2%	1020000
TOTAL	**100.0%**	**100.0%**	**1030000**

Area 2 - The total volume of waste in Area 2 is approximately **1,443,000** cubic yards

Measure (cubic yd)	>7.9	>52.9	>500	>1000
Vol-RIM	213000	161000	73900	32400
Vol-VO	314000	230000	163000	127000
Vol-SB	164000	105000	92200	89500

Category	Prior CDF	Posterior CDF	Cubic Yd
<7.9	90.0%	85.3%	1230000
<52.9	93.0%	88.9%	1280000
<500	96.0%	94.9%	1370000
<1000	99.0%	97.8%	1410000
TOTAL	**100.0%**	**100.0%**	**1440000**

CDF = Cumulative Distribution Function
Tabulated values are reported to three significant digits

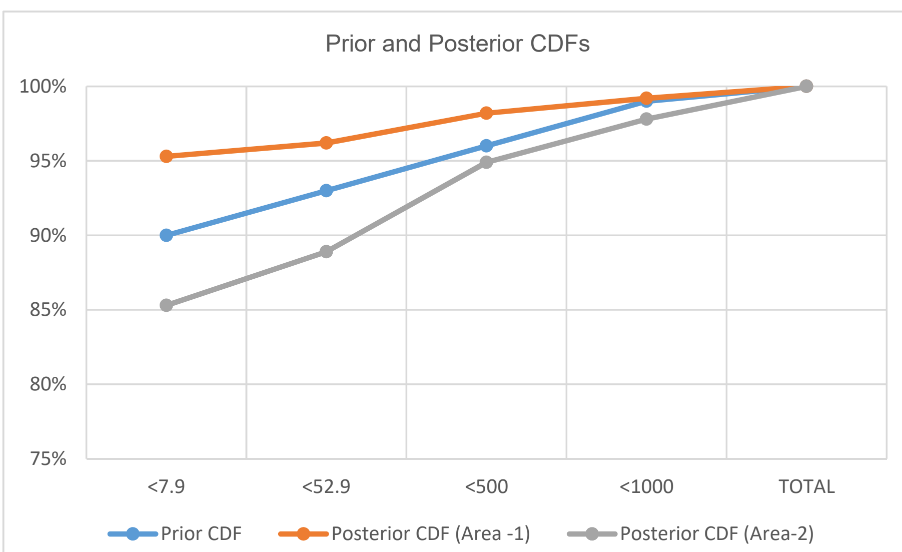


Table 5

Estimated Material Volumes – Area 1: Updated Best-Estimate and Intervals

0.5					
Measure (cubic yd)	**>7.9**	**>52.9**	**>500**	**>1000**	**Comments**
Vol-RIM	48200	20900	18700	7930	RIM vol
Vol-VO	306000	39100	142000	75600	Vert. overburden vol
Vol-SB	435000	12900	410000	331000	Adnl setback vol
Total Vol	**789000**	**72900**	**570000**	**414000**	
0.25					
Measure (cubic yd)	**>7.9**	**>52.9**	**>500**	**>1000**	**Comments**
Vol-RIM	120000	45400	51700	23900	RIM vol
Vol-VO	502000	51200	285000	174000	Vert. overburden vol
Vol-SB	416000	17600	432000	364000	Adnl setback vol
Total Vol	**1040000**	**114000**	**769000**	**562000**	
0.75					
Measure (cubic yd)	**>7.9**	**>52.9**	**>500**	**>1000**	**Comments**
Vol-RIM	15000	6610	5080	1420	RIM vol
Vol-VO	129000	18900	48900	18700	Vert. overburden vol
Vol-SB	423000	8450	357000	233000	Adnl setback vol
Total Vol	**568000**	**33900**	**411000**	**253000**	

Tabulated values are reported to three significant digits

Table 6

Estimated Material Volumes – Area 2: Updated Best-Estimate and Intervals

0.5					
Measure (cubic yd)	**>7.9**	**>52.9**	**>500**	**>1000**	**Comments**
Vol-RIM	213000	124000	73900	32400	RIM vol
Vol-VO	314000	141000	163000	127000	Vert. overburden vol
Vol-SB	164000	48900	92200	89500	Adnl setback vol
Total Vol	**690000**	**315000**	**329000**	**249000**	
0.25					
Measure (cubic yd)	**>7.9**	**>52.9**	**>500**	**>1000**	**Comments**
Vol-RIM	462000	244000	172000	85300	RIM vol
Vol-VO	381000	173000	255000	234000	Vert. overburden vol
Vol-SB	306000	69600	128000	126000	Adnl setback vol
Total Vol	**1150000**	**487000**	**555000**	**445000**	
0.75					
Measure (cubic yd)	**>7.9**	**>52.9**	**>500**	**>1000**	**Comments**
Vol-RIM	86000	50400	25300	9110	RIM vol
Vol-VO	177000	84200	72700	49200	Vert. overburden vol
Vol-SB	124000	34700	77800	72000	Adnl setback vol
Total Vol	**387000**	**169000**	**176000**	**130000**	

Tabulated values are reported to three significant digits

Table 7

Cross-Validation Summary - Area 1

	Radium		**Thorium**	
	Count	***Rate***	***Count***	***Rate***
FP	13	7.2%	18	9.9%
T(P+N)	116	64.1%	110	60.8%
FN	47	26.0%	50	27.6%
UNK	5	2.8%	3	1.7%

FP - False Positives

T(P+N) - True Positives and Negatives

FN - False Negatives

UNK - Unkriged Locations

Tabulated values are reported to three significant digits

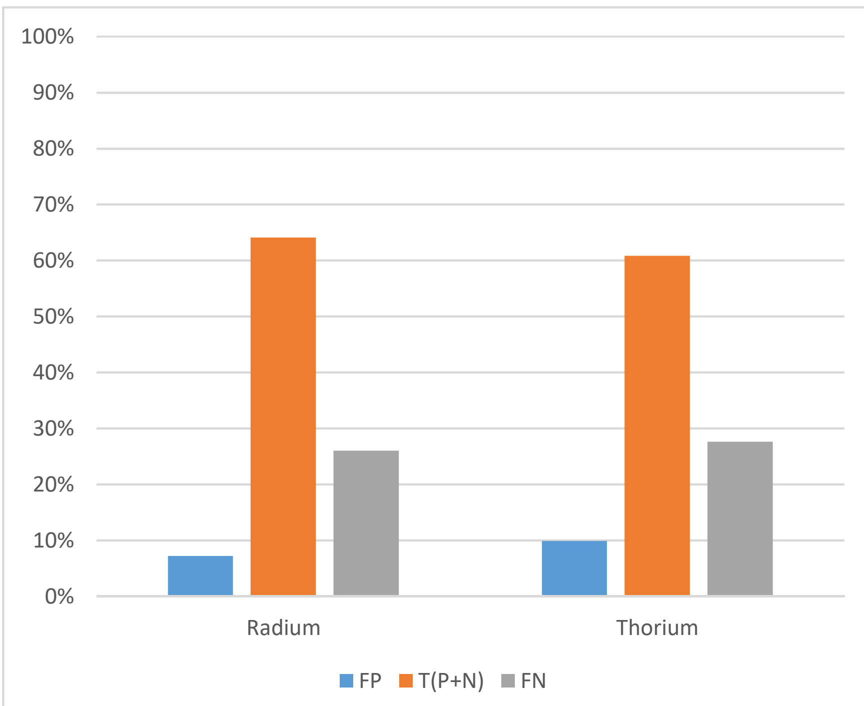


Table 8

Cross-Validation Summary - Area 2

	Radium		Thorium	
	Count	*Rate*	*Count*	*Rate*
FP	40	29.4%	35	25.7%
T(P+N)	28	20.6%	34	25.0%
FN	55	40.4%	55	40.4%
UNK	13	9.6%	12	8.8%

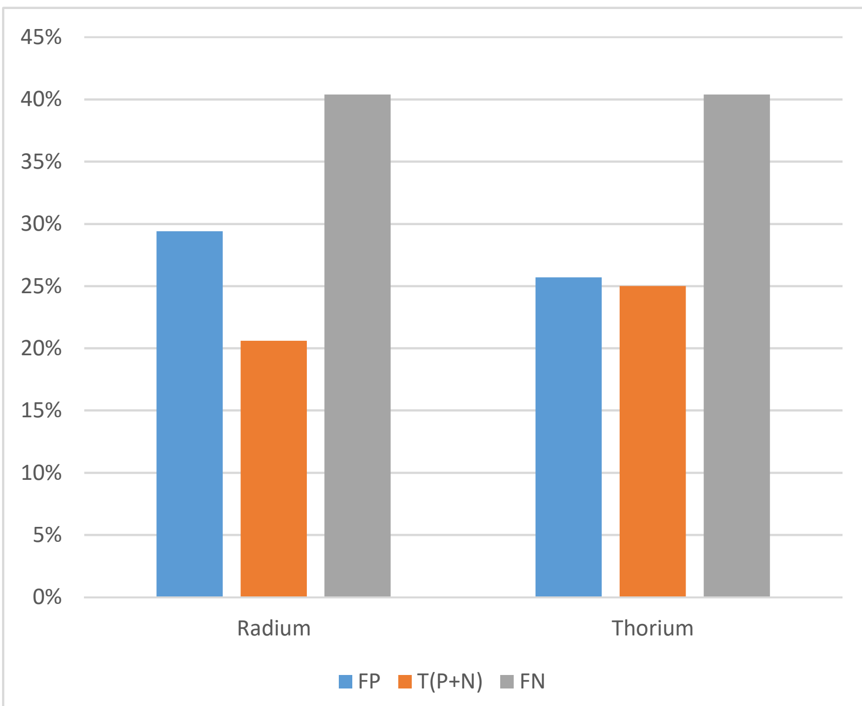
FP - False Positives

T(P+N) - True Positives and Negatives

FN - False Negatives

UNK - Unkriged Locations

Tabulated values are reported to three significant digits



APPENDICES

Appendix A

Tables of Radium and Thorium Sample Results

Table A-1

Complete Radium and Thorium Sample Results – Area 1

Sample Designation	Upper Sample Depth (feet)	Lower Sample Depth (feet)	Units	Radium-226					Radium-228					Combined Radium 226 + 228		Combined Radium relative to 7.9 pCi/g Unrestricted Use Criteria	Thorium-230					Thorium-232					Combined Thorium 230 + 232		Combined Thorium relative to 7.9 pCi/g Unrestricted Use Criteria
				Result	Final Q	CSU[1]	CV	MDA	Result	Final Q	CSU[1]	CV	MDA				Result	Final Q	CSU[1]	CV	MDA	Result	Final Q	CSU[1]	CV	MDA			
McLaren/Hart RI Data																													
WL-101	5	5	pCi/g	1.04		0.22		0.33	0.95	U			0.95	1.52	*	Less than Criteria	2.18		0.57		0.07	0.89				0.07	3.07		Less than Criteria
WL-101	20	20	pCi/g	0.91		0.19		0.35	1.08	U			1.08	1.45	*	Less than Criteria	1.63		0.57		0.23	1.45		0.53		0.19	3.08		Less than Criteria
WL-102	5	5	pCi/g	1.17		0.22		0.26	0.99	U			0.99	1.67	*	Less than Criteria	4.18		1.02		0.23	0.90		0.38		0.14	5.08		Less than Criteria
WL-102	15	15	pCi/g	0.98		0.23		0.35	1.07	U			1.07	1.52	*	Less than Criteria	1.68		0.58		0.3	1.64		0.56		0.2	3.32		Less than Criteria
WL-103	5	5	pCi/g	1.17		0.26		0.34	1.19	U			1.19	1.77	*	Less than Criteria	1.42		0.51		0.22	0.78		0.36		0.17	2.20		Less than Criteria
WL-103	10	10	pCi/g	0.81		0.34		0.53	1.26	U			1.26	1.44	*	Less than Criteria	7.52		1.65		0.16	0.77				0.09	8.29		Exceeds Criteria
WL-104	5	5	pCi/g	0.78		0.18		0.30	0.84	U			0.84	1.20	*	Less than Criteria	3.08		0.85		0.21	0.94		0.41		0.19	4.02		Less than Criteria
WL-104	20	20	pCi/g	0.39		0.19		0.34	0.92	U			0.92	0.85	*	Less than Criteria	1.26		0.47		0.21	0.77		0.35		0.14	2.03		Less than Criteria
WL-105	10	10	pCi/g	40.8		2.1		0.6	1.59	U			1.59	41.6	*	Exceeds Criteria	522		95		0.09	4.34		2.62		1.36	526		Exceeds Criteria
WL-105	30	30	pCi/g	0.99		0.23		0.34	1.18	U			1.18	1.58	*	Less than Criteria	1.59		0.56		0.31	1.04		0.42		0.15	2.63		Less than Criteria
WL-106	0	0	pCi/g	906		37		2	5.86	U			5.86	909	*	Exceeds Criteria	9,700		1,800		11.8	35.2				11.2	9,735		Exceeds Criteria
WL-106	5	5	pCi/g	18.8		1.3		0.4	1.42				1.07	20.2		Exceeds Criteria	731		135		0.21	3.22				0.2	734		Exceeds Criteria
WL-106 DUP (F)	5	5	pCi/g	128		6		1.0	2.69	U			2.69	129	*	Exceeds Criteria	766		142		0.14	4.71				0.12	771		Exceeds Criteria
WL-106	25	25	pCi/g	1.26		0.25		0.4	1.18	U			1.18	1.85	*	Less than Criteria	2.38		0.55		0.14	0.56				0.09	2.94		Less than Criteria
WL-106 DUP (F)	25	25	pCi/g	2.92		0.35		0.31	1.16	U			1.16	3.50	*	Less than Criteria	6.49		1.37		0.12	0.47				0.09	6.96		Less than Criteria
WL-107	5	5	pCi/g	0.80		0.21		0.29	0.91		0.38		0.68	1.71		Less than Criteria	0.89		0.34		0.13	0.89		0.34		0.09	1.78		Less than Criteria
WL-107	51	51	pCi/g	0.71		0.21		0.36	0.98	U			0.98	1.20	*	Less than Criteria	0.56		0.27		0.15	0.14		0.12		0.09	0.70		Less than Criteria
WL-107 DUP (L)	51	51	pCi/g	0.42		0.2		0.38	1.11	U			1.11	0.98	*	Less than Criteria	0.67		0.33		0.23	0.22		0.17		0.13	0.89		Less than Criteria
WL-108	5	5	pCi/g	0.95		0.25		0.37	1.34	U			1.34	1.62	*	Less than Criteria	1.21		0.42		0.16	0.79		0.32		0.12	2.00		Less than Criteria
WL-109	5	5	pCi/g	0.90		0.21		0.31	1.18		0.4		0.62	2.08		Less than Criteria	0.67		0.3		0.13	0.21		0.16		0.11	0.88		Less than Criteria
WL-109	50	50	pCi/g	0.95		0.21		0.30	1.36		0.48		0.71	2.31		Less than Criteria	1.1		0.36		0.2	0.58		0.25		0.21	1.7		Less than Criteria
WL-109 DUP (L)	50	50	pCi/g	1.36		0.37		0.56	1.51	U			1.51	2.12	*	Less than Criteria	2.43		0.71		0.26	1.13				0.12	3.56		Less than Criteria
WL-110	5	5	pCi/g	0.87		0.25		0.40	1.27	U			1.27	1.51	*	Less than Criteria	0.66		0.35		0.23	0.37		0.25		0.16	1.03		Less than Criteria
WL-110	50	50	pCi/g	1.01		0.21		0.31	1.02	U			1.02	1.52	*	Less than Criteria	0.87		0.29		0.12	0.87		0.28		0.08	1.74		Less than Criteria
WL-111	0	0	pCi/g	0.91		0.22		0.33	1.05	U			1.05	1.44	*	Less than Criteria	2.12		0.72		0.29	0.68		0.36		0.20	2.80		Less than Criteria
WL-111	5	5	pCi/g	0.61		0.21		0.42	1.02	U			1.02	1.12	*	Less than Criteria	2.76		0.90		0.77	0.70	U	0.39		0.70	3.11	*	Less than Criteria
WL-111 DUP (L)	5	5	pCi/g	0.91		0.23		0.41	1.36	U			1.36	1.59	*	Less than Criteria													
WL-111	51	51	pCi/g	0.48		0.18		0.33	1.10	U			1.10	1.03	*	Less than Criteria	2.47		1.26		0.79	0.58	U	0.49		0.58	2.76	*	Less than Criteria
WL-111 DUP (L)	51	51	pCi/g	0.51		0.22		0.35	1.01	U			1.01	1.02	*	Less than Criteria													
WL-112	0	0	pCi/g	1.32		0.24		0.41	1.18	U			1.18	1.91	*	Less than Criteria	2.67		0.76		0.25	0.84		0.34		0.19	3.51		Less than Criteria
WL-112	5	5	pCi/g	4.66		0.46		0.42	1.20	U			1.20	5.26	*	Less than Criteria	84.4		15.8		1.9	1.56	U	0.81		1.56	85.2	*	Exceeds Criteria
WL-112	42	42	pCi/g	0.76		0.20		0.34	1.31		0.44		0.58	2.07		Less than Criteria	0.92		0.44		0.42	0.68		0.37		0.3	1.60		Less than Criteria
WL-113	5	5	pCi/g	0.97		0.08		0.06	1.06		0.14		0.13	2.03		Less than Criteria	0.33		0.15		0.11	0.19		0.11		0.08	0.52		Less than Criteria
WL-113 DUP (F)	5	5	pCi/g	1.06		0.08		0.06	0.98		0.13		0.13	2.04		Less than Criteria	0.58		0.23		0.15	0.15		0.11		0.08	0.73		Less than Criteria
WL-113	10	10	pCi/g	1.53		0.15		0.12	0.98		0.22		0.24	2.51		Less than Criteria	2.21		0.52		0.13	0.08		0.07		0.08	2.29		Less than Criteria
WL-114	0	0	pCi/g	109		5		0.9	2.50	U			2.50	110	*	Exceeds Criteria	7,850		1,470		0.92	18.1		4.6		0.78	7,868		Exceeds Criteria
WL-114	5	5	pCi/g	2.59		0.17		0.06	0.39		0.12		0.16	2.98		Less than Criteria	23.2		4.9		0.4	0.26	U	0.22		0.26	23.3	*	Exceeds Criteria
WL-114 DUP (L)	5	5	pCi/g	2.54		0.14		0.07	0.46		0.12		0.15	3.00		Less than Criteria													
WL-114	15	15	pCi/g	0.98		0.08		0.07	1.04		0.15		0.14	2.02		Less than Criteria	1.08		0.46		0.28	0.2	U	0.14		0.2	1.18	*	Less than Criteria
WL-114 DUP (L)	15	15	pCi/g	0.97		0.08		0.07	1.08		0.17		0.15	2.05		Less than Criteria													
WL-115	5	5	pCi/g	1.00		0.08		0.06	0.93		0.13		0.12	1.93		Less than Criteria	0.84		0.29		0.18	0.21		0.13		0.11	1.05		Less than Criteria
WL-115	40	40	pCi/g	0.58		0.05		0.05	0.69		0.1		0.10	1.27		Less than Criteria	0.29		0.16		0.12	0.27		0.15		0.09	0.56		Less than Criteria
WL-116	0	0	pCi/g	0.94		0.21		0.33	1.19	U			1.19	1.54	*	Less than Criteria	1.94		0.69		0.52	0.52		0.34		0.46	2.46		Less than Criteria
WL-116	5	5	pCi/g	1.11		0.08		0.06	0.94		0.13		0.14	2.05		Less than Criteria	0.51		0.21		0.13	0.25		0.14		0.04	0.76		Less than Criteria
WL-116 DUP (F)	5	5	pCi/g	1.18		0.13		0.13	1.0		0.2		0.28	2.2		Less than Criteria	0.35		0.17		0.11	0.21		0.13		0.07	0.56		Less than Criteria
WL-116	10	10	pCi/g	1.00		0.07		0.05	0.76		0.11		0.11	1.76		Less than Criteria	0.36		0.2		0.21	0.33		0.18		0.13	0.69		Less than Criteria
WL-117	10	10	pCi/g	3.15		0.19		0.07	0.64		0.14		0.16	3.79		Less than Criteria	36.58		7.4		0.13	1		0.35		0.12	38		Exceeds Criteria
WL-117	25	25	pCi/g	0.62		0.06		0.05	0.64		0.12		0.12	1.26		Less than Criteria	0.7		0.28		0.15	0.2		0.14		0.12	0.9		Less than Criteria

Table A-1

Complete Radium and Thorium Sample Results – Area 1

Sample Designation	Upper Sample Depth (feet)	Lower Sample Depth (feet)	Units	Radium-226					Radium-228					Combined Radium 226 + 228		Combined Radium relative to 7.9 pCi/g Unrestricted Use Criteria	Thorium-230					Thorium-232					Combined Thorium 230 + 232		Combined Thorium relative to 7.9 pCi/g Unrestricted Use Criteria
				Result	Final Q	CSU[1]	CV	MDA	Result	Final Q	CSU[1]	CV	MDA				Result	Final Q	CSU[1]	CV	MDA	Result	Final Q	CSU[1]	CV	MDA			
WL-118	5	5	pCi/g	18.4		1		0.3	0.73	U			0.73	18.8	*	Exceeds Criteria	425		87		2.5	10.3		3.5		2.22	435		Exceeds Criteria
WL-118	10	10	pCi/g	1.31		0.1		0.05	0.49		0.09		0.14	1.80		Less than Criteria	7.19		1.88		0.2	0.35		0.23		0.2	7.54		Less than Criteria
WL-119	5	5	pCi/g	0.89		0.07		0.06	0.73		0.12		0.12	1.62		Less than Criteria	0.6		0.28		0.22	0.26		0.17		0.13	0.9		Less than Criteria
WL-119	50	50	pCi/g	0.46		0.05		0.04	0.41		0.09		0.10	0.87		Less than Criteria	0.67		0.35		0.41	0.41	U	0.26		0.41	0.88	*	Less than Criteria
WL-119 DUP (L)	50	50	pCi/g	0.48		0.05		0.06	0.44		0.1		0.12	0.92		Less than Criteria													
WL-119 DUP (F)	50	50	pCi/g	0.45		0.05		0.06	0.50		0.10		0.12	0.95		Less than Criteria	0.22		0.13		0.11	0.1		0.08		0.09	0.3		Less than Criteria
WL-120	5	5	pCi/g	1.00		0.09		0.07	1.08		0.15		0.16	2.08		Less than Criteria	0.48		0.18		0.12	0.14		0.09		0.09	0.62		Less than Criteria
WL-120	50	50	pCi/g	0.92		0.1		0.11	0.91		0.21		0.22	1.83		Less than Criteria	0.32		0.19		0.15	0.23		0.16		0.13	0.55		Less than Criteria
WL-120 DUP (F)	50	50	pCi/g	1.07		0.09		0.09	1.04		0.18		0.17	2.11		Less than Criteria	0.38		0.19		0.21	0.25		0.15		0.15	0.63		Less than Criteria
WL-121	0	0	pCi/g	7.28	U			7.28	2.14	U			2.14	Non-detect	*	Non-detect	1.57		0.36		0.1	0.87		0.23		0.09	2.44		Less than Criteria
WL-122	0	0	pCi/g	5.44	U			5.44	1.69	U			1.69	Non-detect	*	Non-detect	1.93		0.43		0.12	1.02		0.26		0.1	2.95		Less than Criteria
WL-123	0	0	pCi/g	5.98	U			5.98	1.82	U			1.82	Non-detect	*	Non-detect	1.45		0.34		0.07	1.06		0.27		0.05	2.51		Less than Criteria
WL-124	0	0	pCi/g	5.22	U			5.22	1.79	U			1.79	Non-detect	*	Non-detect	2.16		0.49		0.07	1.16		0.3		0.07	3.32		Less than Criteria
Phase 1C data (and Cotter samples from Core of Phase 1C borings)																													
FEEBRI14-5.012-013	12	13	pCi/g	1.24		0.22	0.14	0.29	1.22		0.28	0.23	0.48	2.46		Less than Criteria	1.66		0.48	0.01	0.08	1.19		0.36	0.10	0.10	2.86		Less than Criteria
FEEBRI14-5.060-061	60	61	pCi/g	1.31	J	0.29	0.24	0.50	1.43	J	0.45	0.34	0.73	2.74		Less than Criteria	1.03		0.32	0.01	0.06	1.12		0.33	0.08	0.09	2.15		Less than Criteria
FEEBRIS 12-5.002-003	2	3	pCi/g	1.22		0.16	0.07	0.15	0.88		0.17	0.14	0.29	2.09		Less than Criteria	1.27		0.35	0.01	0.07	0.94		0.27	0.11	0.07	2.21		Less than Criteria
FEEBRIS 12-5.012-013	12	13	pCi/g	1.15		0.19	0.10	0.21	1.10		0.24	0.16	0.34	2.25		Less than Criteria	1.72		0.49	0.01	0.08	0.87		0.29	0.14	0.07	2.59		Less than Criteria
FEEBRIS 13-3.019-020	19	20	pCi/g	1.50		0.23	0.14	0.30	1.39	J	0.36	0.27	0.56	2.89		Less than Criteria	3.41		0.85	0.01	0.07	1.20		0.36	0.14	0.08	4.61		Less than Criteria
FEEBRIS 13-3.029-030	29	30	pCi/g	0.39	UJ	0.31	0.24	0.50	0.73	J	0.37	0.31	0.68	1.11	*	Less than Criteria	0.79		0.26	0.00	0.06	0.81		0.25	0.11	0.08	1.60		Less than Criteria
FEEBRIS 14-2.019-020	19	20	pCi/g	1.31		0.18	0.09	0.20	1.33		0.22	0.19	0.40	2.64		Less than Criteria	2.76		0.70	0.01	0.07	1.05		0.32	0.14	0.08	3.81		Less than Criteria
FEEBRIS 14-2.029-031	29	31	pCi/g	1.19		0.19	0.11	0.23	1.14		0.21	0.14	0.31	2.33		Less than Criteria	1.52		0.43	0.01	0.07	1.36		0.38	0.13	0.06	2.88		Less than Criteria
FEEBRIS 14-4.005-006	5	6	pCi/g	0.90		0.14	0.08	0.17	0.68		0.13	0.21	0.44	1.59		Less than Criteria	1.29		0.39	0.01	0.08	1.10		0.34	0.15	0.09	2.39		Less than Criteria
FEEBRIS 14-4.028-029	28	29	pCi/g	0.82		0.20	0.14	0.29	0.84	J	0.24	0.23	0.51	1.66		Less than Criteria	2.08		0.55	0.00	0.09	1.46		0.39	0.13	0.06	3.54		Less than Criteria
FEEBRIS 14-7.013-014	13	14	pCi/g	0.90		0.15	0.19	0.39	0.48		0.16	0.15	0.32	1.38		Less than Criteria	1.54		0.49	0.04	0.14	0.89		0.32	0.18	0.11	2.43		Less than Criteria
FEEBRIS 14-7.039-040	39	40	pCi/g	1.32		0.23	0.16	0.33	0.99	J	0.30	0.29	0.61	2.31		Less than Criteria	1.80		0.54	0.03	0.14	1.26		0.40	0.17	0.10	3.05		Less than Criteria
FEEBRIS 15-2.024-025	24	25	pCi/g	4.78		0.51	0.15	0.31	1.48	J	0.29	0.29	0.60	6.26		Less than Criteria	115.62		23.75	0.02	0.09	1.84		0.46	0.14	0.10	117.5		Exceeds Criteria
FEEBRIS 15-2.043-044	43	44	pCi/g	1.40		0.20	0.12	0.24	1.42		0.25	0.16	0.35	2.82		Less than Criteria	1.36		0.44	0.02	0.11	1.33		0.42	0.17	0.08	2.69		Less than Criteria
FEEBRIS 16-3.006-007	6	7	pCi/g	1.36		0.24	0.14	0.28	1.61		0.32	0.22	0.46	2.98		Less than Criteria	1.86		0.53	0.02	0.11	1.30		0.39	0.15	0.08	3.16		Less than Criteria
FEEBRIS 16-3.011-012	11	12	pCi/g	1.17		0.19	0.10	0.21	1.67		0.23	0.16	0.34	2.84		Less than Criteria	1.77		0.52	0.01	0.09	1.37		0.41	0.15	0.08	3.14		Less than Criteria
FEEBRIS 16-3.011-012D	11	12	pCi/g	1.27		0.19	0.10	0.21	1.25		0.26	0.20	0.43	2.52		Less than Criteria	1.86		0.57	0.03	0.13	1.62		0.50	0.19	0.12	3.47		Less than Criteria
FEEBRIS 16-6.006-007	6	7	pCi/g	1.36		0.21	0.11	0.24	1.41		0.26	0.17	0.37	2.77		Less than Criteria	1.67		0.46	0.00	0.06	1.23		0.35	0.13	0.06	2.90		Less than Criteria
FEEBRIS 16-6.021-022	21	22	pCi/g	0.93		0.15	0.09	0.05	1.26		0.21	0.18	0.37	2.19		Less than Criteria	1.41		0.41	0.00	0.09	1.50		0.41	0.13	0.06	2.91		Less than Criteria
FEEBRIS01-2.008-009	8	9	pCi/g	1.38		0.20	0.11	0.22	1.31	J	0.22	0.24	0.50	2.69		Less than Criteria	0.68		0.25	0.02	0.10	0.38		0.17	0.10	0.10	1.05		Less than Criteria
FEEBRIS01-2.018-019	18	19	pCi/g	1.32		0.20	0.09	0.19	1.34		0.25	0.20	0.43	2.65		Less than Criteria	0.62		0.22	0.00	0.08	0.34		0.15	0.07	0.05	0.96		Less than Criteria
FEEBRIS01-2.020-021	20	21	pCi/g	1.22		0.22	0.13	0.27	1.05		0.25	0.23	0.50	2.28		Less than Criteria	0.84		0.27	0.01	0.06	0.57		0.20	0.07	0.08	1.41		Less than Criteria
FEEBRIS01-2.022-023	22	23	pCi/g	0.23	UJ	0.33	0.27	0.58	0.44	UJ	0.41	0.39	0.90	Non-detect	*	Non-detect	0.13		0.08	0.00	0.07	0.06	U	0.06	0.06	0.07	0.19	*	Less than Criteria
FEEBRIS01-2.023-024	23	24	pCi/g	1.35		0.32	0.19	0.40	1.21	J	0.43	0.38	0.81	2.56		Less than Criteria	0.94		0.30	0.01	0.07	0.56		0.21	0.07	0.08	1.51		Less than Criteria
FEEBRIS01-2.024-025	24	25	pCi/g	1.36		0.20	0.10	0.21	1.13		0.20	0.16	0.34	2.50		Less than Criteria	3.41		0.84	0.01	0.09	1.34		0.38	0.08	0.06	4.74		Less than Criteria
FEEBRIS01-2.028-029	28	29	pCi/g	0.61		0.16	0.12	0.24	0.35	U	0.20	0.23	0.50	0.97	*	Less than Criteria	1.38		0.46	0.02	0.12	0.71		0.29	0.15	0.15	2.10		Less than Criteria
FEEBRIS01-2.033-034	33	34	pCi/g	0.62		0.13	0.09	0.18	0.26	U	0.19	0.16	0.33	0.88	*	Less than Criteria	0.28		0.12	0.00	0.06	0.11	U	0.07	0.06	0.05	0.39	*	Less than Criteria
FEEBRIS01-2.038-039	38	39	pCi/g	1.02		0.19	0.11	0.24	0.95	J	0.32	0.47	0.76	1.97		Less than Criteria	0.28		0.13	0.01	0.06	0.29		0.13	0.07	0.06	0.57		Less than Criteria
FEEBRIS01-2.038-039D	38	39	pCi/g	1.05		0.25	0.16	0.34	1.20	J	0.42	0.40	0.84	2.25		Less than Criteria	0.40		0.16	0.02	0.08	0.13	U	0.08	0.07	0.06	0.53	*	Less than Criteria
FEEBRIS01-2.039-040	39	40	pCi/g	4.98		0.48	0.12	0.25	1.28	J	0.37	0.35	0.71	6.26		Less than Criteria	416.66	QJ	123.32	0.05	0.80	5.23	QJ	2.46	0.81	0.72	421.9		Exceeds Criteria
FEEBRIS01-2.040-041	40	41	pCi/g	0.39		0.10	0.08	0.16	0.44		0.17	0.15	0.32	0.83		Less than Criteria	0.06	U	0.06	0.02	0.08	0.05	U	0.05	0.07	0.05	Non-Detect	*	Non-detect
FEEBRIS02-2.005-006	5	6	pCi/g	0.99		0.16	0.10	0.20	1.14		0.19	0.10	0.22	2.14		Less than Criteria	1.24		0.39	0.03	0.12	0.89		0.29	0.09	0.08	2.13		Less than Criteria
FEEBRIS02-2.019-020	19	20	pCi/g	0.96		0.20	0.13	0.28	0.84		0.27	0.19	0.41	1.79		Less than Criteria	0.16		0.08	0.01	0.06	0.13	U	0.08	0.07	0.08	0.29	*	Less than Criteria
FEEBRIS02-2.020-021	20	21	pCi/g	0.32	U	0.18	0.17	0.36	0.66	UJ	0.41	0.36	0.80	Non-detect	*	Non-detect	0.66		0.22	0.00	0.07	0.46		0.17	0.08	0.08	1.12		Less than Criteria
FEEBRIS02-2.021-022	21	22	pCi/g	1.17		0.21	0.11	0.23	1.44	J	0.28	0.27	0.56	2.62		Less than Criteria	1.36		0.40	0.01	0.08	1.25		0.36	0.08	0.06	2.61		Less than Criteria

Table A-1

Complete Radium and Thorium Sample Results – Area 1

Sample Designation	Upper Sample Depth (feet)	Lower Sample Depth (feet)	Units	Radium-226					Radium-228					Combined Radium 226 + 228		Combined Radium relative to 7.9 pCi/g Unrestricted Use Criteria	Thorium-230					Thorium-232					Combined Thorium 230 + 232		Combined Thorium relative to 7.9 pCi/g Unrestricted Use Criteria
				Result	Final Q	CSU[1]	CV	MDA	Result	Final Q	CSU[1]	CV	MDA				Result	Final Q	CSU[1]	CV	MDA	Result	Final Q	CSU[1]	CV	MDA			
FEEBRIS02-2.022-023	22	23	pCi/g	1.31	J	0.37	0.31	0.65	1.54	J	0.44	0.36	0.78	2.85		Less than Criteria	0.69		0.23	0.01	0.06	0.68		0.22	0.07	0.05	1.37		Less than Criteria
FEEBRIS02-2.022-023D	22	23	pCi/g	1.51		0.24	0.12	0.25	1.33	J	0.27	0.24	0.50	2.84		Less than Criteria	0.57		0.19	0.01	0.05	0.44		0.16	0.06	0.07	1.00		Less than Criteria
FEEBRIS02-2.031-032GP	31	32	pCi/g	13.77	J	1.28	0.25	0.52	0.79	UJ	0.58	0.47	0.98	14.56	*	Exceeds Criteria	205.53		43.37	0.01	0.04	1.39		0.33	0.04	0.04	206.9		Exceeds Criteria
FEEBRIS02-3.034-035GP	34	35	pCi/g	3.23		0.52	0.39	0.19	1.64	J	0.49	0.98	1.95	4.86		Less than Criteria	16.79		3.42	0.01	0.04	0.26		0.09	0.04	0.04	17.04		Exceeds Criteria
FEEBRIS02-3.035-036GP	35	36	pCi/g	21.08	J	2.06	0.49	1.02	0.45	UJ	0.78	0.59	1.25	21.53	*	Exceeds Criteria	281.62		53.20	0.00	0.03	2.60		0.49	0.03	0.02	284.2		Exceeds Criteria
FEEBRIS05-3.025-026	25	26	pCi/g	1.28		0.21	0.12	0.25	1.13		0.20	0.22	0.47	2.41		Less than Criteria	4.63		1.01	0.01	0.06	0.43		0.15	0.06	0.05	5.07		Less than Criteria
FEEBRIS05-3.025-026D	25	26	pCi/g	5.32		0.56	0.21	0.42	1.09	J	0.35	0.29	0.62	6.41		Less than Criteria	88.92		18.01	0.00	0.07	0.82		0.25	0.07	0.06	89.7		Exceeds Criteria
FEEBRIS05-3.028-029	28	29	pCi/g	1,487.21	J	121.47	5.09	10.21	19.82	QJ	6.41	5.36	10.81	1,507		Exceeds Criteria	25,825	QJ	7,538	1.45	17.70	202.82	QJ	78.56	15.40	15.53	26,028		Exceeds Criteria
FEEBRIS05-3.029-030	29	30	pCi/g	5.60		0.55	0.12	0.25	1.19	J	0.28	0.30	0.63	6.79		Less than Criteria	444	QJ	97.72	0.25	1.12	6.76	QJ	2.48	1.51	0.92	450		Exceeds Criteria
FEEBRIS05-3.029-030D	29	30	pCi/g	0.44		0.12	0.09	0.18	0.36	U	0.21	0.21	0.44	0.80	*	Less than Criteria	0.94		0.31	0.01	0.08	0.45		0.19	0.08	0.10	1.38		Less than Criteria
FEEBRIS05-3.033-034	33	34	pCi/g	32.62	J	2.44	0.46	0.93	1.96	J	0.43	0.44	0.90	34.58		Exceeds Criteria	1,815	QJ	559	0.54	4.54	14.41	QJ	8.16	3.69	4.00	1,829		Exceeds Criteria
FEEBRIS08-1.028-029	28	29	pCi/g	1.27		0.21	0.23	0.47	0.88	J	0.19	0.30	0.64	2.15		Less than Criteria	1.81		0.46	0.02	0.08	0.88		0.26	0.07	0.05	2.69		Less than Criteria
FEEBRIS08-1.040-041	40	41	pCi/g	1.49		0.22	0.13	0.20	1.59		0.27	0.21	0.44	3.08		Less than Criteria	1.57		0.46	0.01	0.09	1.31		0.38	0.09	0.08	2.88		Less than Criteria
FEEBRIS08-1.044-045	44	45	pCi/g	1.29		0.28	0.20	0.42	1.43	J	0.44	0.36	0.76	2.72		Less than Criteria	77.76		16.93	0.01	0.06	0.48		0.19	0.08	0.06	78.2		Exceeds Criteria
FEEBRIS08-1B.028-029GP	28	29	pCi/g	0.96	J	0.19	0.27	0.55	0.48	UJ	0.33	0.27	0.59	1.44	*	Less than Criteria	3.42		0.84	0.02	0.07	0.15		0.08	0.05	0.05	3.57		Less than Criteria
FEEBRIS08-1B.028-029GP-D	28	29	pCi/g	1.73		0.34	0.23	0.48	0.83	J	0.37	0.38	0.82	2.56		Less than Criteria	10.39	Q	2.65	0.01	0.07	0.19		0.11	0.07	0.07	10.6		Exceeds Criteria
FEEBRIS08-1B.029-030GP	29	30	pCi/g	0.58		0.15	0.06	0.14	0.13	U	0.20	0.16	0.36	0.71	*	Less than Criteria	0.81		0.24	0.01	0.05	0.13		0.07	0.05	0.05	0.93		Less than Criteria
FEEBRIS1-2.023-024GP	23	24	pCi/g	1.45		0.26	0.17	0.35	1.27	J	0.33	0.26	0.55	2.72		Less than Criteria	1.09		0.29	0.00	0.03	0.54		0.16	0.04	0.04	1.63		Less than Criteria
FEEBRIS1-2.028-029GP	28	29	pCi/g	0.85		0.24	0.16	0.33	0.23	UJ	0.29	0.24	0.53	1.08	*	Less than Criteria	0.64		0.19	0.01	0.04	0.06	U	0.05	0.04	0.04	0.70	*	Less than Criteria
FEEBRIS13-6.021-022	21	22	pCi/g	1.42		0.22	0.11	0.22	1.24	J	0.25	0.61	0.78	2.66		Less than Criteria	2.75		0.68	0.02	0.10	1.21		0.34	0.08	0.07	3.95		Less than Criteria
FEEBRIS13-6.021-022D	21	22	pCi/g	1.26		0.19	0.11	0.22	1.10		0.21	0.14	0.30	2.35		Less than Criteria	1.40		0.39	0.00	0.08	1.11		0.32	0.07	0.08	2.51		Less than Criteria
FEEBRIS13-6.039-040	39	40	pCi/g	1.16		0.18	0.10	0.21	1.34		0.24	0.15	0.32	2.50		Less than Criteria	1.38		0.43	0.02	0.11	0.97		0.32	0.13	0.14	2.35		Less than Criteria
FEEBRIS1C-12.048-049GP	48	49	pCi/g	1.46	J	0.39	0.29	0.60	1.48	J	0.65	0.61	1.29	2.94		Less than Criteria	1.74		0.52	0.02	0.08	0.14	U	0.10	0.12	0.12	1.88	*	Less than Criteria
FEEBRIS1C-12.049-050GP	49	50	pCi/g	1.53		0.24	0.11	0.23	1.01	J	0.33	0.30	0.62	2.54		Less than Criteria	0.43		0.16	0.00	0.04	0.17		0.09	0.05	0.04	0.60		Less than Criteria
FEEBRIS1C-12B.053-054GP	53	54	pCi/g	1.14		0.29	0.20	0.41	0.63	UJ	0.38	0.32	0.70	1.77	*	Less than Criteria	0.66		0.23	0.02	0.08	0.34		0.14	0.06	0.06	0.99		Less than Criteria
FEEBRIS1C-12B.054-055GP	54	55	pCi/g	1.86		0.26	0.12	0.25	1.02		0.26	0.20	0.43	2.88		Less than Criteria	9.41		2.17	0.00	0.04	0.39		0.14	0.05	0.04	9.80		Exceeds Criteria
FEEBRIS1C-12C.055-056GP	55	56	pCi/g	31.01	J	2.47	0.51	1.04	1.25	UJ	0.67	0.60	1.23	32.25	*	Exceeds Criteria	398.76		91.99	0.00	0.04	2.19		0.55	0.06	0.04	401.0		Exceeds Criteria
FEEBRIS1C-2RA.028-029GP	28	29	pCi/g	2.17		0.34	0.14	0.18	1.16	J	0.52	0.42	0.90	3.32		Less than Criteria	2.47		0.53	0.00	0.03	0.27		0.09	0.03	0.02	2.73		Less than Criteria
FEEBRIS1C-4R.046-047GP	46	47	pCi/g	1.74		0.23	0.10	0.20	0.65		0.19	0.20	0.43	2.39		Less than Criteria	4.45		1.10	0.01	0.06	0.08	U	0.06	0.06	0.05	4.53	*	Less than Criteria
FEEBRIS1C-4RB.046-047GP	46	47	pCi/g	1.20		0.19	0.11	0.24	0.66		0.24	0.23	0.49	1.86		Less than Criteria	2.03		0.61	0.01	0.06	0.18	U	0.11	0.07	0.08	2.21	*	Less than Criteria
FEEBRIS1C-6TI.022-023GP	22	23	pCi/g	1.45		0.20	0.12	0.16	0.84		0.21	0.17	0.36	2.29		Less than Criteria	0.39		0.14	0.00	0.03	0.21		0.09	0.04	0.05	0.60		Less than Criteria
FEEBRISIC-6.019-020	19	20	pCi/g	1.40		0.19	0.11	0.23	1.13		0.23	0.18	0.37	2.54		Less than Criteria	1.29		0.38	0.01	0.06	1.71		0.45	0.08	0.06	3.00		Less than Criteria
FEEBRISIC-6.024-025	24	25	pCi/g	2.65		0.29	0.09	0.19	1.28		0.24	0.23	0.48	3.94		Less than Criteria	51.01		10.82	0.01	0.07	1.43		0.40	0.09	0.09	52.4		Exceeds Criteria
FEEBRISIC-6.025-026	25	26	pCi/g	7.04	J	0.94	0.34	0.71	0.13	UJ	0.63	0.46	1.01	7.17	*	Less than Criteria	239.82		52.04	0.01	0.09	1.09		0.33	0.09	0.07	240.9		Exceeds Criteria
FEEBRISIC-6.026-027	26	27	pCi/g	8.79	J	0.95	0.30	0.62	0.43	UJ	0.71	0.57	1.20	9.22	*	Exceeds Criteria	201.96		39.97	0.00	0.05	0.88		0.25	0.06	0.07	202.8		Exceeds Criteria
FEEBRISWL-119.001-002	1	2	pCi/g	1.19		0.18	0.09	0.19	0.77		0.15	0.15	0.31	1.96		Less than Criteria	0.45		0.19	0.01	0.07	0.30		0.14	0.08	0.07	0.76		Less than Criteria
FEEBRISWL119.005-006	5	6	pCi/g	1.35		0.19	0.09	0.19	1.39		0.23	0.17	0.37	2.75		Less than Criteria	1.38		0.38	0.01	0.08	1.29		0.34	0.07	0.06	2.67		Less than Criteria
FEEBRISWL-119.009-010	9	10	pCi/g	1.31		0.21	0.10	0.21	1.26	J	0.28	0.25	0.53	2.57		Less than Criteria	0.55		0.20	0.01	0.06	0.40		0.16	0.07	0.05	0.95		Less than Criteria
FEEBRISWL-119.009-010D	9	10	pCi/g	1.41		0.21	0.12	0.24	1.32		0.24	0.20	0.42	2.72		Less than Criteria	0.58		0.19	0.01	0.05	0.52		0.17	0.05	0.06	1.10		Less than Criteria
FEEBRISWL-119.020-021	20	21	pCi/g	1.08		0.19	0.14	0.28	1.11		0.24	0.23	0.49	2.18		Less than Criteria	0.49		0.18	0.01	0.07	0.42		0.16	0.07	0.07	0.91		Less than Criteria
FEEBRISWL-119.034-035GP	34	35	pCi/g	1.28	J	0.32	0.24	0.51	1.36	J	0.43	0.43	0.91	2.64		Less than Criteria	0.38		0.13	0.01	0.05	0.31		0.11	0.04	0.04	0.69		Less than Criteria
FEEBRISWL-119.040-041	40	41	pCi/g	0.51		0.17	0.15	0.31	0.88		0.22	0.19	0.41	1.39		Less than Criteria	0.31		0.15	0.00	0.09	0.13	U	0.09	0.09	0.08	0.44	*	Less than Criteria
FEEBRISWL-119.041-042	41	42	pCi/g	1.39		0.23	0.13	0.28	1.24	J	0.26	0.36	0.75	2.63		Less than Criteria	0.63		0.22	0.01	0.06	0.57		0.20	0.07	0.06	1.20		Less than Criteria
FEEBRISWL119.051-052	51	52	pCi/g	0.40		0.09	0.07	0.04	0.52		0.12	0.10	0.22	0.92		Less than Criteria	0.57		0.32	0.07	0.25	0.55		0.30	0.19	0.18	1.12		Less than Criteria
FEEBRISWL-119B.038-039GP	38	39	pCi/g	1.57		0.33	0.23	0.48	1.44	J	0.37	0.38	0.81	3.01		Less than Criteria	0.65		0.19	0.01	0.05	0.56		0.16	0.05	0.05	1.20		Less than Criteria
FEEBRISWL-119C.043-044GP	43	44	pCi/g	1.31		0.20	0.13	0.27	0.98		0.21	0.16	0.35	2.30		Less than Criteria	3.03		0.68	0.00	0.04	0.40		0.13	0.04	0.04	3.44		Less than Criteria
FEEBRISWL-119C.045-046GP	45	46	pCi/g	0.87		0.18	0.16	0.34	0.32	U	0.25	0.21	0.46	1.19	*	Less than Criteria	4.20	Q	1.37	0.01	0.10	0.46		0.23	0.11	0.10	4.67		Less than Criteria

Table A-1

Complete Radium and Thorium Sample Results – Area 1

Sample Designation	Upper Sample Depth (feet)	Lower Sample Depth (feet)	Units	Radium-226					Radium-228					Combined Radium 226 + 228		Combined Radium relative to 7.9 pCi/g Unrestricted Use Criteria	Thorium-230					Thorium-232					Combined Thorium 230 + 232		Combined Thorium relative to 7.9 pCi/g Unrestricted Use Criteria
				Result	Final Q	CSU[1]	CV	MDA	Result	Final Q	CSU[1]	CV	MDA				Result	Final Q	CSU[1]	CV	MDA	Result	Final Q	CSU[1]	CV	MDA			
Phase 1D data (and Cotter samples from Core of Phase 1D borings)																													
FEEBRIS1D-01.007-009	7	9	pCi/g	1.08	U	0.20	1.66	0.28	0.95		0.23	0.27	0.57	2.04	*	Less than Criteria	1.65	J+	0.45	0.08	0.08	0.39	J	0.16	0.01	0.07	2.05		Less than Criteria
FEEBRIS1D-01.024-027	24	27	pCi/g	1.11	U	0.28	1.56	0.44	0.47	J	0.32	0.28	0.62	1.58	*	Less than Criteria	1.21	J+	0.34	0.07	0.07	0.11	J	0.08	0.01	0.06	1.31		Less than Criteria
FEEBRIS1D-02.020-023	20	23	pCi/g	1.26		0.18	1.24	0.30	1.12		0.30	0.26	0.54	2.38		Less than Criteria	0.84	J+	0.25	0.05	0.05	0.45	J	0.16	0.00	0.05	1.29		Less than Criteria
FEEBRIS1D-02.027-030	27	30	pCi/g	1.14	U	0.23	1.51	0.34	1.05		0.35	0.27	0.58	2.19	*	Less than Criteria	0.68	J+	0.24	0.07	0.06	0.18	J	0.11	0.01	0.07	0.87		Less than Criteria
FEEBRIS1D-02.036-037	36	37	pCi/g	1.01	U	0.30	1.66	0.45	0.85	J	0.45	0.40	0.86	1.86	*	Less than Criteria	0.72	J+	0.26	0.08	0.08	0.70	J	0.25	0.01	0.08	1.42		Less than Criteria
FEEBRIS1D-03.028-029	28	29	pCi/g	188.12	J+	14.14	20.89	3.24	2.14	U	3.05	2.33	4.76	190.26	*	Exceeds Criteria	615.58	J+	127.85	0.08	0.09	4.07		0.92	0.01	0.0636	620		Exceeds Criteria
FEEBRIS1D-03.041-043	41	43	pCi/g	1.22	U	0.23	1.33	0.32	0.74		0.25	0.20	0.45	1.97	*	Less than Criteria	1.59	J+	0.43	0.07	0.07	0.21	J	0.11	0.00	0.07	1.80		Less than Criteria
FEEBRIS1D-03.041-043 FD	41	43	pCi/g	0.41	U	0.22	1.50	0.57	0.29	J	0.32	0.26	0.58	0.70	*	Less than Criteria	0.73	J+	0.24	0.06	0.06	0.10	J	0.07	0.00	0.07	0.83		Less than Criteria
FEEBRIS1D-4.061-062	61	62	pCi/g	1.25	U	0.20	1.31	0.21	1.15		0.27	0.23	0.50	2.40	*	Less than Criteria	1.84	J	0.62	0.18	0.18	1.47	J	0.51	0.01	0.15	3.31		Less than Criteria
FEEBRIS1D-4.064-065	64	65	pCi/g	0.86		0.15	0.77	0.21	0.70		0.18	0.15	0.32	1.56		Less than Criteria	0.77	J	0.25	0.09	0.11	0.66	J	0.22	0.04	0.12	1.43		Less than Criteria
FEEBRIS1D-5.051-052	51	52	pCi/g	53.91		4.27	7.67	0.75	1.35		0.65	0.70	1.45	55.25		Exceeds Criteria	216.29	J	42.31	0.06	0.05	1.94	J	0.45	0.01	0.06	218		Exceeds Criteria
FEEBRIS1D-5.063-064	63	64	pCi/g	1.06	U	0.18	1.18	0.21	0.84		0.22	0.22	0.471	1.90	*	Less than Criteria	0.45		0.19	0.07	0.09	0.19	J	0.11	0.01	0.09	0.65		Less than Criteria
FEEBRIS1D-6.080-081	80	81	pCi/g	0.59	U	0.22	1.05	0.36	1.11		0.25	0.23	0.50	1.70	*	Less than Criteria	0.42		0.19	0.13	0.14	0.31		0.16	0.05	0.14	0.73		Less than Criteria
FEEBRIS1D-6.085-086	85	86	pCi/g	0.50	U	0.13	1.09	0.20	0.47		0.22	0.23	0.49	0.97	*	Less than Criteria	0.50	J	0.19	0.08	0.07	0.19	J	0.11	0.01	0.07	0.69		Less than Criteria
FEEBRIS1D-7.084-085	84	85	pCi/g	3,630.35		242.46	104.91	11.74	31.85		9.45	8.29	16.66	3,662.19		Exceeds Criteria	16,702.67		3,436.82	20.91	23.01	178.26		53.11	8.73	22.59	16,881		Exceeds Criteria
FEEBRIS1D-7.093-094	93	94	pCi/g	1.50		0.28	1.37	0.22	0.61		0.31	0.23	0.51	2.11		Less than Criteria	18.03		4.29	0.10	0.10	0.38		0.19	0.02	0.12	18.40		Exceeds Criteria
FEEBRIS1D-8.075-076	75	76	pCi/g	4.54		0.47	1.77	0.40	0.94		0.27	0.24	0.50	5.48		Less than Criteria	3.54	J	0.93	0.13	0.15	0.24	J	0.16	0.02	0.13	3.77		Less than Criteria
FEEBRIS1D-8.090-091	90	91	pCi/g	0.51	U	0.10	0.69	0.13	0.69		0.18	0.17	0.36	1.19	*	Less than Criteria	0.99	J	0.36	0.12	0.116	0.75	J	0.25	0.01	0.07	1.74		Less than Criteria
FEEBRIS1D-09.078-079	78	79	pCi/g	0.21	U	0.25	2.37	0.43	0.16	U	0.44	0.33	0.74	Non-detect	*	Non-detect	0.34	J+	0.15	0.07	0.07	0.19	J	0.11	0.01	0.07	0.53		Less than Criteria
FEEBRIS1D-09.088-089	88	89	pCi/g	40.20	J	9.94	4.59	1.05	3.58	U	2.31	0.49	4.24	43.78	*	Exceeds Criteria	905.57	J+	180.92	0.24	0.289	3.76	J	1.08	0.10	0.376	909.3		Exceeds Criteria
FEEBRIS1D-09.099-100	99	100	pCi/g	0.66	U	0.10	1.25	0.166	0.48		0.13	0.21	0.29	1.14	*	Less than Criteria	3.41	J+	0.82	0.07	0.08	0.19	J	0.11	0.01	0.08	3.60		Less than Criteria
FEEBRIS1D-10.046-049	46	49	pCi/g	1.34	U	0.24	1.43	0.34	1.58		0.29	0.25	0.54	2.92	*	Less than Criteria	0.46	J	0.17	0.06	0.06	0.33	J	0.13	0.00	0.05	0.79		Less than Criteria
FEEBRIS1D-10.074-076	74	76	pCi/g	0.81	U	0.20	1.14	0.26	0.66		0.23	0.19	0.43	1.47	*	Less than Criteria	0.31		0.13	0.06	0.06	0.32		0.13	0.01	0.06	0.62		Less than Criteria
FEEBRIS1D-11.085-086	85	86	pCi/g	24.40	J+	1.86	2.84	0.55	1.10		0.44	0.39	0.80	25.50		Exceeds Criteria	119.05	J+	24.07	0.06	0.07	1.35		0.34	0.00	0.05	120.4		Exceeds Criteria
FEEBRIS1D-11.087-088	87	88	pCi/g	0.73	U	0.13	0.96	0.17	0.68		0.18	0.14	0.29	1.42	*	Less than Criteria	1.38	J+	0.36	0.05	0.06	0.26	J	0.11	0.00	0.04	1.64		Less than Criteria
FEEBRIS1D-12.061-062	61	62	pCi/g	0.58	U	0.47	2.50	0.74	-0.37	U	0.67	0.36	0.86	Non-detect	*	Non-detect	0.73	J+	0.24	0.07	0.06	0.16	J	0.10	0.00	0.06	0.89		Less than Criteria
FEEBRIS1D-12.074-075	74	75	pCi/g	1.02	U	0.18	1.58	0.23	1.09		0.23	0.19	0.40	2.11	*	Less than Criteria	0.35	J+	0.14	0.05	0.04	0.17	J	0.09	0.01	0.06	0.51		Less than Criteria
FEEBRIS1D-13.085-086	85	86	pCi/g	1.17	U	0.19	1.56	0.28	1.11		0.25	0.25	0.52	2.28	*	Less than Criteria	0.62	J+	0.21	0.06	0.06	0.52	J	0.18	0.00	0.06	1.13		Less than Criteria
FEEBRIS1D-13.093-094	93	94	pCi/g	4.22		0.37	1.48	0.28	0.46	J	0.21	0.20	0.358	4.68		Less than Criteria	4.27	J+	0.97	0.11	0.07	0.26	J	0.15	0.01	0.06	4.54		Less than Criteria
FEEBRIS1D-14.054-056	54	55	pCi/g	0.40	U	0.30	2.37	0.53	0.14	U	0.51	0.38	0.85	Non-detect	*	Non-detect	0.21	J+	0.10	0.07	0.08	0.02	UJ	0.05	0.03	0.09	0.23	*	Less than Criteria
FEEBRIS1D-14.082-084	82	84	pCi/g	1.31	U	0.27	1.52	0.14	0.87		0.32	0.49	1.03	2.18	*	Less than Criteria	0.74	J+	0.24	0.06	0.05	0.34	J	0.14	0.01	0.06	1.08		Less than Criteria
FEEBRIS1D-15.077-080	77	80	pCi/g	0.70	U	0.19	1.03	0.30	0.49		0.21	0.26	0.55	1.20	*	Less than Criteria	0.20	J+	0.10	0.05	0.06	0.04	J	0.06	0.04	0.09	0.24		Less than Criteria
FEEBRIS1D-15.085-086	85	86	pCi/g	8.82	J+	0.85	2.85	0.48	0.24	U	0.42	0.32	0.68	9.06	*	Exceeds Criteria	30.86	J+	6.16	0.05	0.05	0.31	J	0.12	0.01	0.06	31.17		Exceeds Criteria
FEEBRIS1D-16.050-051	50	51	pCi/g	33.46		2.76	5.55	0.84	0.98		0.65	0.74	1.52	34.44		Exceeds Criteria	971.46	J	198.37	0.06	0.05	6.45	J	1.31	0.01	0.07	977.92		Exceeds Criteria
FEEBRIS1D-16.059-061	59	61	pCi/g	0.58	U	0.21	1.21	0.30	0.66		0.34	0.33	0.70	1.24	*	Less than Criteria	0.61		0.23	0.08	0.07	0.28		0.14	0.01	0.08	0.89		Less than Criteria
FEEBRIS1D-16.059-061 FD	59	61	pCi/g	0.52	U	0.17	1.20	0.23	0.59		0.28	0.27	0.59	1.11	*	Less than Criteria	0.37		0.24	0.21	0.23	0.27		0.18	0.01	0.13	0.64		Less than Criteria
FEEBRIS1D-17.030-031	30	31	pCi/g	0.38	U	0.21	1.46	0.40	0.39	J	0.41	0.35	0.75	0.77	*	Less than Criteria	0.35	J+	0.15	0.06	0.06	0.15	J	0.09	0.01	0.07	0.51		Less than Criteria
FEEBRIS1D-17.033-036	33	36	pCi/g	0.75	U	0.26	1.54	0.19	0.41	J	0.36	0.32	0.70	1.16	*	Less than Criteria	4.00	J+	0.97	0.08	0.07	0.18	J	0.12	0.04	0.13	4.18		Less than Criteria
FEEBRIS1D-18.013-014	13	14	pCi/g	0.76	U	0.16	1.24	0.20	0.31	J	0.16	0.12	0.27	1.07	*	Less than Criteria	0.56	J+	0.20	0.06	0.05	0.16	J	0.09	0.01	0.06	0.71		Less than Criteria
FEEBRIS1D-18.038-041	38	41	pCi/g	0.52	U	0.20	1.58	0.53	0.26	U	0.35	0.29	0.63	Non-detect	*	Non-detect	5.97	J+	1.38	0.07	0.07	0.05	J	0.06	0.00	0.06	6.03		Less than Criteria
FEEBRIS1D-18.044-046	44	46	pCi/g	1.34		0.21	1.33	0.22	1.40		0.27	0.25	0.52	2.74		Less than Criteria	1.29	J+	0.38	0.07	0.06	0.78	J	0.26	0.00	0.09	2.07		Less than Criteria
FEEBRIS1D-19.061-063	61	63	pCi/g	1.17	U	0.32	2.31	0.429	1.23		0.50	0.46	0.973	2.40	*	Less than Criteria	1.08	J	0.35	0.09	0.08	0.54	J	0.22	0.01	0.09	1.62		Less than Criteria
FEEBRIS1D-19.061-063 FD	61	63	pCi/g	1.28	J+	0.18	1.20	0.20	1.08		0.24	0.27	0.55	2.36		Less than Criteria	0.70		0.24	0.09	0.10	0.24	J	0.13	0.02	0.10	0.94		Less than Criteria
FEEBRIS1D-20.080-081	80	81	pCi/g	0.71	U	0.10	0.75	0.04	0.08	J	0.10	0.08	0.17	0.80	*	Less than Criteria	1.36	J	0.59	0.23	0.27	0.38	J	0.28	0.04	0.28	1.73		Less than Criteria
FEEBRIS1D-20.080-081 FD	80	81	pCi/g	0.83	U	0.13	0.91	0.12	0.05	U	0.15	0.12	0.26	Non-detect	*	Non-detect	1.43		0.51	0.14	0.14	0.14	J	0.12	0.01	0.10	1.57		Less than Criteria
FEEBRIS1D-20.089-090	89	90	pCi/g	1.33	U	0.19	1.44	0.22	1.15		0.23	0.20	0.42	2.47	*	Less than Criteria	1.43		0.49	0.14	0.11	1.20		0.42	0.02	0.15	2.63		Less than Criteria

Table A-1

Complete Radium and Thorium Sample Results – Area 1

Sample Designation	Upper Sample Depth (feet)	Lower Sample Depth (feet)	Units	Radium-226					Radium-228					Combined Radium 226 + 228		Combined Radium relative to 7.9 pCi/g Unrestricted Use Criteria	Thorium-230					Thorium-232					Combined Thorium 230 + 232		Combined Thorium relative to 7.9 pCi/g Unrestricted Use Criteria
				Result	Final Q	CSU[1]	CV	MDA	Result	Final Q	CSU[1]	CV	MDA				Result	Final Q	CSU[1]	CV	MDA	Result	Final Q	CSU[1]	CV	MDA			
Area 1 Additional Borings																													
FEEBRISAC-1.010-011	10	11	pCi/g	4,926.29		342.65	139.45	28.69	14.76	U	20.68	15.54	31.25	4,941	*	Exceeds Criteria	7,908	J+	1,823	8.73	11.06	257.04		69.58	5.04	15.70	8,165		Exceeds Criteria
FEEBRISAC-1.030-031	30	31	pCi/g	49.46		3.87	5.65	0.99	0.98	J	0.77	0.57	1.17	50.4		Exceeds Criteria	1,946		436.40	0.10	0.11	10.16		2.21	0.00	0.06	1,956		Exceeds Criteria
FEEBRISAC-2B.010-012	10	12	pCi/g	8.95		0.83	2.16	0.38	0.56	J	0.32	0.39	0.80	9.5		Exceeds Criteria	472.18		110.55	0.08	0.09	2.91		0.74	0.01	0.08	475.08		Exceeds Criteria
FEEBRISAC-2B.023-026	23	26	pCi/g	0.98	U	0.26	1.65	0.41	1.27		0.36	0.37	0.79	2.25	*	Less than Criteria	1.79		0.47	0.07	0.08	0.77		0.23	0.01	0.07	2.56		Less than Criteria
FEEBRISAC-3.005-006	5	6	pCi/g	2,599.36		183.37	112.63	20.25	6.28	U	15.98	12.01	24.24	2,606	*	Exceeds Criteria	17,784	J+	3,962	8.73	11.27	514.88		120.66	2.57	12.02	18,299		Exceeds Criteria
FEEBRISAC-3.044-045	44	45	pCi/g	0.40	U	0.20	1.07	0.31	0.26	J	0.31	0.25	0.55	0.66	*	Less than Criteria	0.59		0.20	0.06	0.07	0.39		0.15	0.01	0.06	0.98		Less than Criteria
FEEBRISAC-4B.013-014	13	14	pCi/g	0.62	U	0.36	1.96	0.63	0.91		0.41	0.47	1.03	1.53	*	Less than Criteria	1.96		0.51	0.06	0.05	0.24		0.11	0.00	0.05	2.20		Less than Criteria
FEEBRISAC-4B.032-033	32	33	pCi/g	1.01	U	0.16	1.12	0.23	1.16		0.19	0.12	0.26	2.17	*	Less than Criteria	4.62	J	1.03	0.06	0.06	0.92	J	0.25	0.01	0.05	5.54		Less than Criteria
FEEBRISAC-4B.032-033 FD	32	33	pCi/g	0.96	U	0.14	0.99	0.16	1.20		0.23	0.21	0.44	2.16	*	Less than Criteria	1.38	J	0.40	0.06	0.06	0.90		0.28	0.00	0.07	2.27		Less than Criteria
FEEBRISAC-5.011-012	11	12	pCi/g	1.11	U	0.16	1.17	0.19	1.27		0.23	0.16	0.34	2.38	*	Less than Criteria	3.28		0.81	0.06	0.06	1.04	J	0.30	0.01	0.06	4.32		Less than Criteria
FEEBRISAC-5.025-026	25	26	pCi/g	0.80	U	0.13	0.94	0.17	0.84		0.18	0.14	0.30	1.65	*	Less than Criteria	1.20		0.31	0.05	0.05	1.03		0.26	0.00	0.03	2.24		Less than Criteria
FEEBRISAC-6.013-016	13	16	pCi/g	1.05	U	0.14	1.28	0.24	1.21		0.21	0.17	0.35	2.26	*	Less than Criteria	0.97		0.31	0.08	0.08	1.25		0.36	0.01	0.08	2.22		Less than Criteria
FEEBRISAC-6.023-026	23	26	pCi/g	0.60	U	0.11	0.88	0.12	0.70		0.16	0.14	0.29	1.30	*	Less than Criteria	1.36	J	0.37	0.07	0.07	0.50	J	0.17	0.01	0.06	1.86		Less than Criteria
FEEBRISAC-7.022-023	22	23	pCi/g	1.20	U	0.22	1.26	0.30	1.40		0.24	0.30	0.63	2.60	*	Less than Criteria	1.45		0.38	0.05	0.05	1.23		0.32	0.00	0.05	2.68		Less than Criteria
FEEBRISAC-7.032-033	32	33	pCi/g	0.73	U	0.21	1.36	0.32	0.90		0.33	0.31	0.66	1.63	*	Less than Criteria	0.86		0.29	0.07	0.07	0.50		0.20	0.03	0.11	1.37		Less than Criteria
Cotter Borings																													
WL102CTA.002-003	2	3	pCi/g	1.03		0.147	0.029	0.073	0.137	U	0.25	0.2	0.422	1.17	*	Less than criteria	5.81	J+	0.423	0.01	0.023	0.826	J	0.159	0.0071	0.0371	6.64		Less than criteria
WL-102-CT-A	4	5	pCi/g	0.581	J+	0.269	0.34	0.143	0.122	UJ	0.43	0.76	0.346	0.703	*	Less than criteria	4.43	J+	0.378	0.05	0.013	0.577		0.136	0.0448	0.0104	5.01		Less than criteria
WL-102-CT-A DUP	4	5	pCi/g	6.75	J+	0.577	0.258	0.111	0.054	UJ	0.24	0.42	0.193	6.80	*	Less than criteria	1.82	J+	0.235	0.05	0.016	0.681		0.144	0.05	0.0138	2.50		Less than criteria
WL102CTA.022-023	22	23	pCi/g	1.41		0.19	0.033	0.085	1.11		0.32	0.19	0.418	2.52		Less than criteria	1.75	J+	0.236	0.01	0.024	1.23		0.198	0.0103	0.0444	2.98		Less than criteria
WL106ACT.004-006	4	6	pCi/g	18		0.611	0.029	0.073	0.767		0.29	0.19	0.401	19		Exceeds criteria	401	J+	3.58	0.01	0.048	1.14		0.19	0.0073	0.0238	402		Exceeds criteria
WL-106A-CT	10	12	pCi/g	9.64	J+	0.685	0.28	0.123	0.271	UJ	0.31	0.51	0.234	9.91	*	Exceeds criteria	165	J+	2.6	0.07	0.021	0.831	J	0.184	0.0491	0.0093	166		Exceeds criteria
WL-114-CT	7	8	pCi/g	0.981	J+	0.225	0.18	0.074	0.739		0.34	0.51	0.236	1.720		Less than criteria	4.78	J+	0.404	0.04	0.008	0.885		0.175	0.0568	0.0157	5.67		Less than criteria
WL114CT.032-033	32	33	pCi/g	0.458		0.104	0.032	0.08	0.512		0.25	0.17	0.365	0.970		Less than criteria	0.635	J+	0.138	0.02	0.053	0.47		0.118	0.0068	0.0357	1.11		Less than criteria
Cotter Samples from Core of Non-Cotter Borings																													
1-2-CT	39	40	pCi/g	0.72	J+	0.222	0.244	0.105	0.506	UJ	0.34	0.53	0.247	1.23	*	Less than criteria	0.855	J+	0.164	0.04	0.01	0.348		0.104	0.033	0.0048	1.203		Less than criteria
1C-6-CT	25	27	pCi/g	26.7	J+	1.16	0.209	0.086	0.293	U	0.33	0.54	0.247	27.0	*	Exceeds criteria	2,450	J+	95.6	2.79	1.18	2.78	U	3.21	2.78	1.17	2,453	*	Exceeds criteria
1D-16-CT	46	47	pCi/g	2.74	J+	0.369	0.258	0.113	0.324	U	0.28	0.46	0.21	3.06	*	Less than criteria	1.84	J+	0.235	0.02	0.007	0.854		0.16	0.036	0.0069	2.69		Less than criteria
1D-7-CT	83	84	pCi/g	1200	J+	9.25	0.286	0.116	4.94	J	0.49	0.36	0.166	1,205		Exceeds criteria	678,000	J+	15,300	475	109	847	J	538	256	108	678,847		Exceeds criteria
5-3-CT-A	28	30	pCi/g	33.7	J+	1.23	0.19	0.079	0.574	J	0.35	0.55	0.255	34.3		Exceeds criteria	3,660	J+	143	7.71	1.76	7.17	U	6.99	9.12	2.48	3,667	*	Exceeds criteria
5-3-CT-B	33	34	pCi/g	73.9	J+	1.8	0.197	0.082	0.397	U	0.3	0.47	0.217	74.3	*	Exceeds criteria	2,310	J+	158	8.12	3.42	0.449	U	6.25	17.7	4.81	2,310	*	Exceeds criteria

Notes:

Modified after original tables provided by Engineering Management Support Inc. (EMSI).

NDE = gamma log not deep enough   No Log = no log from RI investigation exists   * Indicates that result for one of the two isotopes was non-detect   Final Q = final qualifier   CSU1 = combined standard uncertainty (+/- sigma for McLaren/Hart samples)   CV = critical value   MDA= minimum detectable activity

[yellow highlight] indicates that combined value is greater than the unrestricted use criteria established by EPA.

J = The analyte was analyzed for, and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the environmental sample.

J+ = Same as J qualification but with an indication of positive bias in the sample concentration.

U = The analyte was analyzed for and is not present above the level of the associated value. The associated numerical value indicates the approximate concentration necessary to detect the analyte in the sample.

For McLaren/Hart RI Soil Boring Data:

- In calculated combined Ra and combined Th values, if of the the results was <MDA, one-half of the MDA was used in the calculation and the combined value was noted with an *. If both values were <MDA, combined results reported as "Non-detect".
- In calculated combined U values, if one or two of the the results was <MDA, one-half of the MDA was used in the calculation and the combined value was noted with an *. If all three values were <MDA, combined results reported as "Non-detect".

Table A-2

Complete Radium and Thorium Sample Results – Area 2

Sample Designation	Upper Sample Depth (feet)	Lower Sample Depth (feet)	Units	Radium-226					Radium-228					Combined Radium 226 + 228		Combined Radium relative to 7.9 pCi/g Unrestricted Use Criteria	Thorium-230					Thorium-232					Combined Thorium 230 + 232		Combined Thorium relative to 7.9 pCi/g Unrestricted Use Criteria
				Result	Final Q	CSU[1]	CV	MDA	Result	Final Q	CSU[1]	CV	MDA				Result	Final Q	CSU[1]	CV	MDA	Result	Final Q	CSU[1]	CV	MDA			
McLaren/Hart RI Data																													
WL-207	5	5	pCi/g	0.93	U			0.93	1.59	U			1.59	Non-detect	*	Non-detect	1.21		0.70		0.54	1.42		0.75		0.39	2.63		Less than criteria
WL-207 DUP (L)	5	5	pCi/g	0.68		0.18		0.24	0.97	U			0.97	1.17	*	Less than criteria	1.12		0.88		0.88	1.92		1.16		0.59	3.04		Less than criteria
WL-207	10	10	pCi/g	0.76		0.22		0.33	1.10	U			1.10	1.31	*	Less than criteria	1.78		1.43		1.45	1.37		1.22		1.17	3.15		Less than criteria
WL-208	5	5	pCi/g	3.26		0.32		0.37	0.68		0.46		0.66	3.94		Less than criteria	123		23		0.10	1.43		0.42		0.08	124.4		Exceeds criteria
WL-208 DUP (L)	5	5	pCi/g	3.40		0.34		0.38	1.03	U			1.03	3.92	*	Less than criteria	94.9		17		0.23	0.82		0.32		0.14	95.7		Exceeds criteria
WL-208	9	9	pCi/g	1.35		0.23		0.25	0.74	U			0.74	1.72	*	Less than criteria	10.07		2		0.07	0.36		0.16		0.07	10.43		Exceeds criteria
WL-209	0	0	pCi/g	3,720		142		10	21.34	U			21.34	3,731	*	Exceeds criteria	29,240		5,290		0.10	127		23		0.09	29,367		Exceeds criteria
WL-209	5	5	pCi/g	2,970		123		7	16.34	U			16.34	2,978	*	Exceeds criteria	38,280		7,750		40.2	138		60		32.2	38,418		Exceeds criteria
WL-209 DUP (F)	5	5	pCi/g	3,140		116		5	16.7		9.3		11.3	3,157		Exceeds criteria	32,680		6,420		29.0	180		65		20.2	32,860		Exceeds criteria
WL-209	25	25	pCi/g	0.85		0.18		0.29	0.92	U			0.92	1.31	*	Less than criteria	26.9		5.4		0.12	0.71		0.27		0.05	27.6		Exceeds criteria
WL-209 DUP (F)	25	25	pCi/g	0.62		0.2		0.27	0.85	U			0.85	1.05	*	Less than criteria	12.85		3.7		0.72	0.84	U	0.53		0.84	13.27	*	Exceeds criteria
WL-210	0	0	pCi/g	2,280		89		4	9.55	U			9.55	2,285	*	Exceeds criteria	18,190		3,510		15.1	59.2		23.2		17.5	18,249		Exceeds criteria
WL-210	5	5	pCi/g	520		26		3	6.72	U			6.72	523	*	Exceeds criteria	12,400		2,140		0.14	106		19		0.06	12,506		Exceeds criteria
WL-210 DUP (F)	5	5	pCi/g	458		20		2	4.66	U			4.66	460	*	Exceeds criteria	15,610		2,700		0.11	120		21		0.06	15,730		Exceeds criteria
WL-210	40	40	pCi/g	0.68		0.18		0.31	0.83	U			0.83	1.10	*	Less than criteria	18.2		3.3		0.12	0.37		0.17		0.08	18.6		Exceeds criteria
WL-210 DUP (F)	40	40	pCi/g	1.66		0.4		0.59	1.45	U			1.45	2.39	*	Less than criteria	10.8		2.2		0.1	0.82		0.28		0.07	11.6		Exceeds criteria
WL-211	5	5	pCi/g	8.52		0.58		0.33	1.15	U			1.15	9.10	*	Exceeds criteria	66.11		11.8		0.15	1.38		0.35		0.08	67.5		Exceeds criteria
WL-211	25	25	pCi/g	0.42		0.19		0.31	0.85	U			0.85	0.85	*	Less than criteria	4.97		1.04		0.16	0.32		0.16		0.08	5.29		Less than criteria
WL-212	5	5	pCi/g	1.26		0.4		0.46	1.16	U			1.16	1.84	*	Less than criteria	5.73		1.2		0.10	0.29		0.14		0.08	6.02		Less than criteria
WL-212	10	10	pCi/g	1.77		0.24		0.28	0.90	U			0.90	2.22	*	Less than criteria	116		20		0.23	0.9		0.29		0.13	117		Exceeds criteria
WL-213	0	0	pCi/g	1.00		0.26		0.37	0.90	U			0.90	1.45	*	Less than criteria	24.2		4.7		0.2	1.11		0.41		0.20	25.3		Exceeds criteria
WL-213	5	5	pCi/g	1.26		0.23		0.27	0.92	U			0.92	1.72	*	Less than criteria	17.29		3.4		0.16	0.89		0.3		0.15	18.18		Exceeds criteria
WL-213	25	25	pCi/g	0.93		0.33		0.52	1.49	U			1.49	1.68	*	Less than criteria	3.13		0.75		0.05	0.52		0.21		0.07	3.65		Less than criteria
WL-214	5	5	pCi/g	0.95		0.18		0.22	0.81	U			0.81	1.36	*	Less than criteria	44.4		7.8		0.21	0.41		0.2		0.14	44.8		Exceeds criteria
WL-214	25	25	pCi/g	0.52	U			0.52	0.89	U			0.89	Non-detect	*	Non-detect	12.8		2.5		0.18	0.36		0.19		0.12	13.2		Exceeds criteria
WL-215	0	0	pCi/g	0.70		0.20		0.29	0.73	U			0.73	1.07	*	Less than criteria	5.35		1.14		0.07	0.31		0.15		0.07	5.66		Less than criteria
WL-216	5	5	pCi/g	88.4		5.2		0.9	2.21	U			2.21	89.5	*	Exceeds criteria	1,131				0.93	3.05		1.45		0.81	1,134		Exceeds criteria
WL-216	25	25	pCi/g	1.03		0.21		0.39	1.62		0.44		0.54	2.65		Less than criteria	1.46		0.46		0.17	1.17		0.39		0.1	2.63		Less than criteria
WL-217	5	5	pCi/g	0.60		0.21		0.31	0.81	U			0.81	1.01	*	Less than criteria	0.96		0.3		0.13	0.085	U	0.005		0.085	1.00	*	Less than criteria
WL-217	10	10	pCi/g	1.27		0.24		0.29	1.04	U			1.04	1.79	*	Less than criteria	8.95		1.90		0.12	0.72		0.31		0.11	9.67		Exceeds criteria
WL-218	0	0	pCi/g	1.06		0.19		0.24	0.82		0.38		0.66	1.88		Less than criteria	1.77		0.57		0.14	0.77		0.32		0.07	2.54		Less than criteria
WL-218	5	5	pCi/g	0.85		0.20		0.41	1.01		0.48		0.70	1.86		Less than criteria	1.19		0.43		0.14	0.67		0.3		0.12	1.86		Less than criteria
WL-218	40	40	pCi/g	0.68		0.23		0.43	1.16	U			1.16	1.26	*	Less than criteria	7.27		1.51		0.1	0.58		0.25		0.09	7.85		Less than criteria
WL-219	5	5	pCi/g	1.12		0.26		0.33	1.17		0.59		0.77	2.29		Less than criteria	1.07		0.4		0.15	1.12		0.42		0.14	2.19		Less than criteria
WL-219	10	10	pCi/g	0.62		0.22		0.41	1.04	U			1.04	1.14	*	Less than criteria	0.64		0.25		0.08	0.44		0.2		0.07	1.08		Less than criteria
WL-220	5	5	pCi/g	0.81		0.23		0.36	1.22	U			1.22	1.42	*	Less than criteria	1.53		0.46		0.11	0.69		0.27		0.10	2.22		Less than criteria
WL-220	25	25	pCi/g	0.78		0.24		0.38	1.25		0.38		0.56	2.03		Less than criteria	0.56		0.27		0.11	0.22		0.16		0.1	0.78		Less than criteria
WL-221	5	5	pCi/g	0.75		0.2		0.34	1.12	U			1.12	1.31	*	Less than criteria	4.28		0.94		0.24	0.7		0.28		0.24	5.0		Less than criteria
WL-221	35	35	pCi/g	0.33	U			0.33	1.09	U			1.09	Non-detect	*	Non-detect	1.24		0.41		0.16	0.63		0.27		0.14	1.87		Less than criteria
WL-222	0	0	pCi/g	2.94		0.59		0.53	1.75	U			1.75	3.82	*	Less than criteria	131		25		0.19	1.31		0.40		0.2	132		Exceeds criteria
WL-222	5	5	pCi/g	1.80		0.26		0.29	0.83		0.44		0.70	2.63		Less than criteria	81.4		15.4		0.76	1.3		0.38		0.17	82.7		Exceeds criteria

Table A-2

Complete Radium and Thorium Sample Results – Area 2

Sample Designation	Upper Sample Depth (feet)	Lower Sample Depth (feet)	Units	Radium-226					Radium-228					Combined Radium 226 + 228		Combined Radium relative to 7.9 pCi/g Unrestricted Use Criteria	Thorium-230					Thorium-232					Combined Thorium 230 + 232		Combined Thorium relative to 7.9 pCi/g Unrestricted Use Criteria
				Result	Final Q	CSU[1]	CV	MDA	Result	Final Q	CSU[1]	CV	MDA				Result	Final Q	CSU[1]	CV	MDA	Result	Final Q	CSU[1]	CV	MDA			
WL-222	30	30	pCi/g	0.82		0.39		0.60	1.27	U			1.27	1.46	*	Less than criteria	0.88		0.32		0.21	1.0		0.3		0.15	1.9		Less than criteria
WL-223	5	5	pCi/g	1.73		0.27		0.30	1.14	U			1.14	2.30	*	Less than criteria	9.16		1.97		0.12	0.64		0.3		0.12	9.80		Exceeds criteria
WL-223	22	22	pCi/g	0.52		0.19		0.33	0.88	U			0.88	0.96	*	Less than criteria	0.68		0.28		0.12	0.18		0.13		0.1	0.86		Less than criteria
WL-224	5	5	pCi/g	0.84		0.21		0.28	1.23		0.47		0.67	2.07		Less than criteria	2.85		1.31		1.15	0.91	U	0.49		0.91	3.31	*	Less than criteria
WL-224	35	35	pCi/g	1.00		0.22		0.37	1.19		0.41		0.90	2.19		Less than criteria	4.08		1.71		0.84	0.62	U	0.42		0.62	4.39	*	Less than criteria
WL-225	5	5	pCi/g	1.07		0.27		0.40	1.18	U			1.18	1.66	*	Less than criteria	2.84		1.44		1.32	1.76		1.07		0.62	4.60		Less than criteria
WL-225	35	35	pCi/g	0.51	U			0.51	1.50	U			1.50	Non-detect	*	Non-detect	0.91		0.91		0.23	0.33		0.17		0.16	1.24		Less than criteria
WL-226	10	10	pCi/g	1.4		0.27		0.34	0.95		0.46		0.82	2.4		Less than criteria	14.1		4		1.1	0.85	U	0.51		0.85	14.5	*	Exceeds criteria
WL-226	20	20	pCi/g	3.26		0.44		0.40	1.12	U			1.12	3.82	*	Less than criteria	173		31		1.0	0.85	U	0.68		0.85	173	*	Exceeds criteria
WL-227	5	5	pCi/g	1.32		0.22		0.29	1.35		0.43		0.73	2.67		Less than criteria	20.4		4.7		0.9	0.53	U	0.52		0.53	20.7	*	Exceeds criteria
WL-227	40	40	pCi/g	0.43		0.18		0.24	0.79	U			0.79	0.83	*	Less than criteria	2.78		1.32		0.94	0.55	U	0.53		0.55	3.06	*	Less than criteria
WL-228	5	5	pCi/g	0.79		0.20		0.30	1.29		0.41		0.62	2.08		Less than criteria	2.72		1.45		1.05	0.79	U	0.34		0.79	3.12	*	Less than criteria
WL-228	15	15	pCi/g	0.64		0.25		0.37	1.12	U			1.12	1.20	*	Less than criteria	2.13		0.76		0.46	0.62		0.39		0.37	2.75		Less than criteria
WL-229	5	5	pCi/g	1.15		0.28		0.70	1.24	U			1.24	1.77	*	Less than criteria	4.97		1.89		0.97	1.47		0.97		0.89	6.44		Less than criteria
WL-229	20	20	pCi/g	0.38		0.19		0.34	0.96	U			0.96	0.86	*	Less than criteria	1.17		0.89		1.02	0.69	U	0.58		0.69	1.52	*	Less than criteria
WL-230	5	5	pCi/g	1.67		0.26		0.34	1.16	U			1.16	2.25	*	Less than criteria	26.8		6.4		1.3	0.87	U	0.63		0.87	27.2	*	Exceeds criteria
WL-230	35	35	pCi/g	0.53		0.22		0.36	0.89	U			0.89	0.98	*	Less than criteria	1.33		0.98		1.25	0.75	U	0.29		0.75	1.71	*	Less than criteria
WL-231	0	0	pCi/g	0.91		0.22		0.29	0.92	U			0.92	1.37	*	Less than criteria	1.21		0.39		0.20	0.19	U	0.1		0.19	1.31	*	Less than criteria
WL-231	5	5	pCi/g	4.06		0.37		0.28	1.02	U			1.02	4.57	*	Less than criteria	94.5		17.4		1.0	1.11		0.85		0.83	95.6		Exceeds criteria
WL-231	10	10	pCi/g	1.37		0.24		0.40	0.75	U			0.75	1.75	*	Less than criteria	10.2		3.0		1.4	0.87	U	0.28		0.87	10.6	*	Exceeds criteria
WL-233	27	27	pCi/g	4.44		0.46		0.38	1.11	U			1.11	5.00	*	Less than criteria	427		80		0.70	1.19		0.83		0.56	428		Exceeds criteria
WL-233	30	30	pCi/g	0.79		0.20		0.41	1.05	U			1.05	1.32	*	Less than criteria	9.93		2.72		0.9	0.82		0.64		0.49	10.75		Exceeds criteria
WL-234	10	10	pCi/g	3,060		116		4	14.5		7.9		10.3	3,075		Exceeds criteria	57,300		19,300		238	240	U	173		240	57,420	*	Exceeds criteria
WL-234 DUP (F)	10	10	pCi/g	1,260		49		3	6.62	U			6.62	1,263	*	Exceeds criteria	12,000		3,670		116	98.7	U	84.6		98.7	12,049	*	Exceeds criteria
WL-234	20	20	pCi/g	0.66	U			0.66	1.25	U			1.25	Non-detect	*	Non-detect	16.2		3.2		0.04	0.67		0.23		0.07	16.9		Exceeds criteria
WL-234 DUP (F)	20	20	pCi/g	1.18		0.26		0.39	1.23	U			1.23	1.80	*	Less than criteria	11.3		2.2		0.5	0.85		0.43		0.38	12.2		Exceeds criteria
WL-235	0	0	pCi/g	0.90		0.21		0.32	1.19		0.45		0.56	2.09		Less than criteria	12.4		2.48		0.13	1.03		0.31		0.10	13.4		Exceeds criteria
WL-235	5	5	pCi/g	0.74		0.46		0.56	1.58	U			1.58	1.53	*	Less than criteria	3.21		1.45		1.16	0.83	U	0.38		0.83	3.63	*	Less than criteria
WL-235	30	30	pCi/g	1.09		0.25		0.43	0.93	U			0.93	1.56	*	Less than criteria	3.15		1.43		1.0	0.94	U	0.28		0.94	3.62	*	Less than criteria
WL-236	5	5	pCi/g	1.03		0.23		0.34	1.00	U			1.00	1.53	*	Less than criteria	5.92		1.49		0.97	0.69	U	0.46		0.69	6.27	*	Less than criteria
WL-236	35	35	pCi/g	1.01		0.24		0.35	1.23	U			1.23	1.63	*	Less than criteria	4.9		1.33		1.01	1.02	U	0.63		1.02	5.4	*	Less than criteria
WL-239	5	5	pCi/g	0.96		0.11		0.10	1.13		0.19		0.17	2.09		Less than criteria	0.5		0.2		0.12	0.26		0.13		0.07	0.8		Less than criteria
WL-239	25	25	pCi/g	0.90		0.08		0.06	0.72		0.13		0.12	1.62		Less than criteria	0.58		0.26		0.25	0.31		0.17		0.14	0.89		Less than criteria
WL-241	5	5	pCi/g	12.9		0.54		0.1	0.24	U			0.24	13.0	*	Exceeds criteria	343		66		0.11	3.84		0.9		0.05	347		Exceeds criteria
WL-241	15	15	pCi/g	1.04		0.09		0.07	0.96		0.16		0.16	2.00		Less than criteria	0.57		0.21		0.13	0.18		0.11		0.08	0.75		Less than criteria
WL-242	0	0	pCi/g	1.57		0.26		0.51	0.77	U			0.77	1.96	*	Less than criteria	8.63		2.62		0.76	0.34	U			0.34	8.80	*	Exceeds criteria
WL-242	2	2	pCi/g	2.42		0.45		0.59	1.57	U			1.57	3.21	*	Less than criteria	21.3		5.3		1.11	0.75	U	0.58		0.75	21.7	*	Exceeds criteria
WL-243	0	0	pCi/g	4.78		0.44		0.33	1.13		0.54		0.84	5.91		Less than criteria	265		50		0.22	6.73		1.36		0.15	272		Exceeds criteria
WL-244	0	0	pCi/g	1.54		0.22		0.33	1.05	U			1.05	2.07	*	Less than criteria	20.8		4.1		0.71	0.78		0.68		0.65	21.6		Exceeds criteria
WL-245	0	0	pCi/g	0.95		0.26		0.34	1.20	U			1.20	1.55	*	Less than criteria	3.92		0.93		0.16	0.38		0.2		0.11	4.30		Less than criteria
WL-246	0	0	pCi/g	1.04		0.26		0.37	1.07	U			1.07	1.58	*	Less than criteria	2.91		0.82		0.3	0.63		0.31		0.15	3.54		Less than criteria

Table A-2

Complete Radium and Thorium Sample Results – Area 2

Sample Designation	Upper Sample Depth (feet)	Lower Sample Depth (feet)	Units	Radium-226					Radium-228					Combined Radium 226 + 228		Combined Radium relative to 7.9 pCi/g Unrestricted Use Criteria	Thorium-230					Thorium-232					Combined Thorium 230 + 232		Combined Thorium relative to 7.9 pCi/g Unrestricted Use Criteria
				Result	Final Q	CSU[1]	CV	MDA	Result	Final Q	CSU[1]	CV	MDA				Result	Final Q	CSU[1]	CV	MDA	Result	Final Q	CSU[1]	CV	MDA			
A2 Additional Borings (and Cotter samples from A2 Additional Borings)																													
FEEBRISAC-8.024-026	24	26	pCi/g	1.21	U	0.30	2.79	0.34	1.32		0.34	0.22	0.49	2.52	*	Less than criteria	2.17	J+	0.54	0.06	0.07	0.75	J+	0.23	0.01	0.06	2.93		Less than criteria
FEEBRISAC-8.035-036	35	36	pCi/g	0.70	U	0.13	0.92	0.16	0.43		0.13	0.10	0.22	1.14	*	Less than criteria	0.71	J+	0.26	0.07	0.08	0.35	J+	0.16	0.02	0.09	1.07		Less than criteria
FEEBRISAC-9.025-028	25	28	pCi/g	0.90	U	0.18	1.12	0.26	0.97		0.22	0.17	0.36	1.86	*	Less than criteria	0.37	J	0.15	0.06	0.07	0.13	J	0.09	0.03	0.09	0.50		Less than criteria
FEEBRISAC-9.025-028 FD	25	28	pCi/g	0.73	U	0.19	1.42	0.34	0.80		0.23	0.19	0.42	1.53	*	Less than criteria	0.41	J	0.14	0.04	0.04	0.23		0.10	0.00	0.04	0.64		Less than criteria
FEEBRISAC-9.032-033	32	33	pCi/g	1.02	U	0.31	2.01	0.17	0.70	J	0.49	0.42	0.90	1.72	*	Less than criteria	0.85		0.25	0.04	0.05	0.85		0.24	0.01	0.06	1.70		Less than criteria
FEEBRISAC-10.012-013	12	13	pCi/g	1.66		0.22	1.17	0.23	0.48		0.21	0.17	0.37	2.15		Less than criteria	12.19	J+	3.02	0.10	0.12	0.37	J+	0.17	0.05	0.13	12.6		Exceeds criteria
FEEBRISAC-10.026-028	26	28	pCi/g	0.77	U	0.14	1.09	0.18	0.66		0.16	0.10	0.22	1.44	*	Less than criteria	0.62	J+	0.19	0.05	0.05	0.41	J+	0.14	0.01	0.05	1.03		Less than criteria
FEEBRISAC-11.008-009	8	9	pCi/g	0.57	U	0.23	1.89	0.44	0.13	U	0.35	0.27	0.61	Non-detect	*	Non-detect	0.29	J	0.12	0.05	0.05	0.14	J	0.08	0.01	0.05	0.42		Less than criteria
FEEBRISAC-11.017-019	17	19	pCi/g	0.95	U	0.18	1.22	0.24	0.72		0.23	0.22	0.47	1.67	*	Less than criteria	0.49	J	0.16	0.06	0.07	0.30	J	0.12	0.03	0.08	0.79		Less than criteria
FEEBRISAC-12.002-004	2	4	pCi/g	2.85		0.28	1.19	0.19	0.36		0.16	0.17	0.35	3.21		Less than criteria	43.95	J	10.91	0.09	0.10	0.41	J	0.19	0.01	0.09	44.4		Exceeds criteria
FEEBRISAC-12.010-011	10	11	pCi/g	0.88	U	0.15	0.93	0.17	0.58		0.17	0.17	0.35	1.46	*	Less than criteria	4.44	J	0.96	0.06	0.07	0.23	J	0.10	0.01	0.06	4.68		Less than criteria
FEEBRISAC-13.020-022	20	22	pCi/g	8.46		0.90	3.78	0.78	0.33	U	0.54	0.42	0.91	8.78	*	Exceeds criteria	104	J+	20.72	0.04	0.05	0.66	J+	0.18	0.00	0.04	105		Exceeds criteria
FEEBRISAC-13.031-033	31	33	pCi/g	0.68	U	0.37	2.02	0.56	-0.03	U	0.17	0.44	0.98	Non-detect	*	Non-detect	2.01	J+	0.46	0.05	0.05	0.21	J+	0.09	0.02	0.06	2.21		Less than criteria
FEEBRISAC-14.013-014	13	14	pCi/g	0.71	U	0.32	3.18	0.81	0.05	U	0.58	0.43	0.96	Non-detect	*	Non-detect	2.99	J	1.26	0.47	0.60	2.57	J	1.12	0.03	0.42	5.56		Less than criteria
FEEBRISAC-14.025-026	25	26	pCi/g	0.28	U	0.08	0.77	0.17	0.55		0.13	0.09	0.20	0.84	*	Less than criteria	0.48	J	0.17	0.05	0.05	0.40	J	0.15	0.01	0.05	0.89		Less than criteria
FEEBRISAC-15.026-027	26	27	pCi/g	0.66	U	0.18	1.53	0.32	0.62		0.27	0.21	0.45	1.28	*	Less than criteria	0.18		0.08	0.04	0.04	0.09	J	0.06	0.00	0.04	0.27		Less than criteria
FEEBRISAC-15.032-034	32	34	pCi/g	0.56	U	0.18	1.05	0.27	0.35	J	0.29	0.25	0.55	0.91	*	Less than criteria	1.45	J	0.39	0.06	0.06	0.34	J	0.14	0.01	0.06	1.79		Less than criteria
FEEBRISAC-15.032-034 FD	32	34	pCi/g	0.31	U	0.12	0.59	0.20	0.33	J	0.16	0.15	0.32	0.64	*	Less than criteria	0.44	J	0.16	0.06	0.06	0.50	J	0.17	0.01	0.07	0.94		Less than criteria
FEEBRISAC-16.019-020	19	20	pCi/g	554		39.48	20.98	4.76	13.81		2.52	2.57	5.18	568		Exceeds criteria	8,710		1,811	6.23	7.84	43.68		17.25	2.11	9.28	8,753		Exceeds criteria
FEEBRISAC-16.022-023	22	23	pCi/g	358		23.76	13.03	1.71	8.01		1.40	1.35	2.71	366		Exceeds criteria	5,166	J	1,048	6.75	6.74	30.48	J	14.03	2.93	10.25	5,197		Exceeds criteria
FEEBRISAC-16.022-023 FD	22	23	pCi/g	317		24.70	25.03	4.34	10.62		3.50	4.32	8.28	327		Exceeds criteria	12,250	J	2,514	7.26	7.52	68.71	J	22.88	1.93	9.12	12,319		Exceeds criteria
FEEBRISAC-16.029-030	29	30	pCi/g	1.17		0.19	1.16	0.26	0.97		0.21	0.17	0.35	2.14		Less than criteria	15.91	J	3.84	0.08	0.08	1.07	J	0.34	0.02	0.09	16.98		Exceeds criteria
FEEBRISAC-17.008-010	8	10	pCi/g	0.83		0.14	0.82	0.08	0.32	J	0.20	0.17	0.38	1.16		Less than criteria	1.61	J	0.56	0.11	0.11	0.30	J	0.17	0.01	0.10	1.91		Less than criteria
FEEBRISAC-17.032-033	32	33	pCi/g	0.39	U	0.18	1.30	0.34	0.39	J	0.27	0.25	0.55	0.78	*	Less than criteria	0.45	J+	0.16	0.07	0.08	0.14	J+	0.08	0.04	0.09	0.59		Less than criteria
FEEBRISAC-18.002-005	2	5	pCi/g	206	J	13.96	12.52	2.17	8.16		1.44	1.50	3.03	215		Exceeds criteria	1,752	J+	368	7.28	7.73	22.98	J+	11.52	0.34	5.38	1,775		Exceeds criteria
FEEBRISAC-18.002-005 FD	2	5	pCi/g	333	J	22.18	17.29	1.66	9.19		1.62	1.30	2.62	343		Exceeds criteria	2,167	J+	449	6.71	6.65	31.21	J+	13.66	0.55	6.05	2,199		Exceeds criteria
FEEBRISAC-18.010-011	10	11	pCi/g	184		14.82	19.11	2.97	6.53		2.39	2.06	4.17	190		Exceeds criteria	3,414	J+	743	7.26	7.18	22.48	J+	12.60	3.61	11.46	3,436		Exceeds criteria
FEEBRISAC-19.005-006	5	6	pCi/g	1,005		66.26	19.31	2.47	8.07		1.99	1.70	3.41	1,013		Exceeds criteria	976	J+	201	5.63	5.29	9.76	J+	6.73	0.29	4.61	986		Exceeds criteria
FEEBRISAC-19.036-037	36	37	pCi/g	1.20		0.18	1.13	0.24	1.17		0.21	0.19	0.41	2.37		Less than criteria	1.39	J+	0.38	0.06	0.06	1.07	J+	0.30	0.01	0.05	2.46		Less than criteria
FEEBRISAC-20.023-024	23	24	pCi/g	580		38.54	18.16	3.74	8.43		1.74	2.00	4.02	588		Exceeds criteria	6,737	J+	1,397	7.63	8.09	40.44	J+	16.57	1.51	8.50	6,777		Exceeds criteria
FEEBRISAC-20.047-049	47	49	pCi/g	1.33		0.20	1.05	0.25	1.55		0.25	0.19	0.40	2.88		Less than criteria	1.54	J+	0.38	0.04	0.04	1.06	J+	0.27	0.01	0.04	2.60		Less than criteria
FEEBRISAC-20.047-049 FD	47	49	pCi/g	1.40	U	0.37	2.67	0.46	1.56		0.44	0.40	0.86	2.95	*	Less than criteria	1.32	J+	0.34	0.05	0.05	1.20	J+	0.30	0.02	0.07	2.52		Less than criteria
FEEBRISAC-21.012-013	12	13	pCi/g	272		18.78	27.10	3.26	8.48		2.28	2.37	4.82	280		Exceeds criteria	3491	J+	788	6.81	10.58	136.70		41.32	0.87	8.75	3,628		Exceeds criteria
FEEBRISAC-21.030-032	30	32	pCi/g	1.11	U	0.32	2.34	0.44	0.75		0.35	0.50	1.04	1.86	*	Less than criteria	22.62	J+	4.71	0.12	0.10	1.17	J+	0.39	0.01	0.10	23.79		Exceeds criteria
FEEBRISAC-21.040-042	40	42	pCi/g	0.80	U	0.12	1.07	0.18	0.49		0.18	0.16	0.35	1.29	*	Less than criteria	5.61	J+	1.21	0.04	0.04	0.53	J+	0.16	0.00	0.05	6.14		Less than criteria
FEEBRISAC-21A.013-014	13	14	pCi/g	376		30.43	51.89	7.58	6.84	J	6.11	4.74	9.69	383		Exceeds criteria	4,112	J+	908	7.61	9.60	101.67	J	32.57	2.37	11.09	4,214		Exceeds criteria
FEEBRISAC-21A.047-048	47	48	pCi/g	1.55		0.20	1.07	0.20	1.01		0.21	0.17	0.36	2.55		Less than criteria	1.96	J+	0.48	0.05	0.05	0.87	J	0.24	0.01	0.05	2.82		Less than criteria
FEEBRISAC-22.018-019	18	19	pCi/g	14.77		1.17	2.89	0.40	0.58	J	0.36	0.30	0.63	15.36		Exceeds criteria	128.54		26.34	0.05	0.06	0.69		0.20	0.02	0.07	129		Exceeds criteria
FEEBRISAC-22.041-042	41	42	pCi/g	1.26	U	0.36	1.87	0.63	1.65		0.55	0.51	1.09	2.90	*	Less than criteria	1.58		0.40	0.04	0.04	1.13		0.29	0.00	0.04	2.72		Less than criteria
FEEBRISAC-23.023-024	23	24	pCi/g	344		24.34	22.56	3.52	1.51	U	3.11	2.34	4.74	346	*	Exceeds criteria	1,458	J+	314	8.57	9.68	12.66	J+	9.39	3.27	10.78	1471		Exceeds criteria
FEEBRISAC-23.067-068	67	68	pCi/g	0.47	U	0.10	0.61	0.15	0.38		0.12	0.14	0.29	0.84	*	Less than criteria	4.77	J+	1.10	0.05	0.06	0.33	J+	0.13	0.01	0.06	5.11		Less than criteria

Table A-2

Complete Radium and Thorium Sample Results – Area 2

Sample Designation	Upper Sample Depth (feet)	Lower Sample Depth (feet)	Units	Radium-226					Radium-228					Combined Radium 226 + 228		Combined Radium relative to 7.9 pCi/g Unrestricted Use Criteria	Thorium-230					Thorium-232					Combined Thorium 230 + 232		Combined Thorium relative to 7.9 pCi/g Unrestricted Use Criteria
				Result	Final Q	CSU[1]	CV	MDA	Result	Final Q	CSU[1]	CV	MDA				Result	Final Q	CSU[1]	CV	MDA	Result	Final Q	CSU[1]	CV	MDA			
FEEBRISAC-24.004-005	4	5	pCi/g	1,188		78.28	21.06	3.17	9.53		2.22	1.87	3.75	1,198		Exceeds criteria	6,029	J+	902	7.36	6.86	54.15	J+	18.45	0.38	5.97	6,083		Exceeds criteria
FEEBRISAC-24.014-015	14	15	pCi/g	56.22		4.19	7.60	1.50	29.12		2.34	1.83	3.70	85.35		Exceeds criteria	20.50	J+	4.72	0.26	0.22	10.05	J+	2.27	0.11	0.37	30.55		Exceeds criteria
FEEBRISAC-24.039-041	39	41	pCi/g	1.08	U	0.26	2.46	0.39	1.11		0.44	0.37	0.79	2.19	*	Less than criteria	0.99	J+	0.28	0.05	0.04	0.80	J+	0.22	0.00	0.04	1.79		Less than criteria
FEEBRISAC-24.047-048	47	48	pCi/g	0.51	U	0.26	1.74	0.39	0.60		0.29	0.23	0.52	1.11	*	Less than criteria	0.56	J+	0.19	0.05	0.05	0.35	J+	0.14	0.00	0.06	0.90		Less than criteria
FEEBRISAC-25.037-038	37	38	pCi/g	1.25	U	0.20	1.53	0.28	1.50		0.27	0.19	0.41	2.75	*	Less than criteria	0.79	J+	0.22	0.05	0.05	0.27	J+	0.11	0.02	0.07	1.07		Less than criteria
FEEBRISAC-25.043-045	43	45	pCi/g	1.27	U	0.21	1.74	0.24	1.19		0.29	0.23	0.50	2.46	*	Less than criteria	4.52	J+	1.00	0.05	0.05	1.03	J+	0.27	0.01	0.05	5.55		Less than criteria
FEEBRISAC-26A.004-005	4	5	pCi/g	12.48		1.48	4.14	0.74	0.94	J	0.62	0.52	1.09	13.42		Exceeds criteria	245.54	J+	58.15	0.06	0.06	2.09		0.57	0.01	0.08	248		Exceeds criteria
FEEBRISAC-26A.037-038	37	38	pCi/g	2.41		0.28	1.38	0.26	1.40		0.30	0.26	0.54	3.81		Less than criteria	10.09	J+	2.30	0.05	0.05	1.49		0.39	0.00	0.05	11.58		Exceeds criteria
Cotter Borings																													
WL-209-CT	1	3	pCi/g	882	J+	4.87	0.15	0.066	5.48	J	0.49	0.35	0.16	887		Exceeds criteria	1,470,000	J+	19,600	363	82.9	1,150		556	361	82.5	1,471,150		Exceeds criteria
WL-209-CT DUP	1	3	pCi/g	855	J+	4.86	0.14	0.057	4.57	J	0.45	0.35	0.161	860		Exceeds criteria	256,000	J+	7,560	308	70.5	420	J	305	166	70.1	256,420		Exceeds criteria
WL209CT.009-010	9	10	pCi/g	460	J	3.84	0.08	0.185	45	J	1.37	0.19	0.416	505		Exceeds criteria	9330	J+	121	0.51	2.18	5.51	J	2.96	0.36	1.88	9,336		Exceeds criteria
WL209CT.021-023	21	23	pCi/g	0.756	J	0.14	0.05	0.11	0.23	J	0.24	0.18	0.39	0.99		Less than criteria	0.799	J+	0.162	0.01	0.05	0.629		0.142	0.01	0.024	1.428		Less than criteria
WL209CT.021-023 FD	21	23	pCi/g	0.59		0.12	0.04	0.088	0.418	J	0.23	0.15	0.337	1.01		Less than criteria	0.792	J+	0.158	0.02	0.055	0.656		0.143	0.01	0.038	1.448		Less than criteria
WL209CT.026-027	26	27	pCi/g	0.493	J	0.12	0.05	0.107	0.546	J	0.24	0.16	0.344	1.039		Less than criteria	0.547	J+	0.13	0.01	0.043	0.462		0.119	0.01	0.037	1.009		Less than criteria
WL-234-CT	8	10	pCi/g	1,040	J+	8.62	0.26	0.102	3.82	J	0.46	0.4	0.184	1,044		Exceeds criteria	644,000	J+	9,870	113	47.8	662		321	208	47.6	644,662		Exceeds criteria
WL-234-CT DUP	8	10	pCi/g	757	J+	7	0.24	0.096	1.92	J	0.35	0.38	0.173	759		Exceeds criteria	65,500	J+	2,850	267	87.4	202	J	165	170	38.9	65,702		Exceeds criteria
WL234CT.018-019	18	19	pCi/g	110	J	1.6	0.05	0.117	0.633	J	0.25	0.16	0.348	111		Exceeds criteria	4290	J+	81.5	0.5	2.17	3.81	J	2.44	0.24	1.64	4,294		Exceeds criteria
WL234CT.044-045	44	45	pCi/g	0.992		0.15	0.03	0.084	0.39	J	0.22	0.15	0.33	1.38		Less than criteria	1.18	J+	0.194	0.01	0.038	0.976		0.175	0.01	0.024	2.16		Less than criteria
Cotter Samples from Core of Non-Cotter Borings																													
WL-210-CT (AC-24)	4	5	pCi/g	633	J+	4.06	0.12	0.051	1.5	J	0.31	0.37	0.173	635		Exceeds criteria	57,000	J+	2,070	104	23.8	318	J	157	103	23.6	57,318		Exceeds criteria
AC24-WL210CT.045-046	45	46	pCi/g	0.489		0.11	0.03	0.078	0.248	J	0.22	0.16	0.355	0.737		Less than criteria	0.517	J+	0.127	0.01	0.037	0.2		0.079	0.01	0.023	0.7		Less than criteria
AC25-WL235CT.021-022	21	22	pCi/g	0.994		0.16	0.04	0.102	0.674		0.27	0.17	0.372	1.668		Less than criteria	4.24	J+	0.362	0.01	0.043	1.02		0.177	0.01	0.037	5.26		Less than criteria

Notes:

Modified after original tables provided by Engineering Management Support Inc. (EMSI).

NDE = gamma log not deep enough   No Log = no log from RI investigation exists   * Indicates that result for one of the two isotopes was non-detect   Final Q = final qualifier   CSU1 = combined standard uncertainty (+/- sigma for McLaren/Hart samples)   CV = critical value   MDA= minimum detectable activity

[highlighted cell] indicates that combined value is greater than the unrestricted use criteria established by EPA

J = The analyte was analyzed for, and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the environmental sample.

J+ = Same as J qualification but with an indication of positive bias in the sample concentration.

U = The analyte was analyzed for and is not present above the level of the associated value. The associated numerical value indicates the approximate concentration necessary to detect the analyte in the sample.

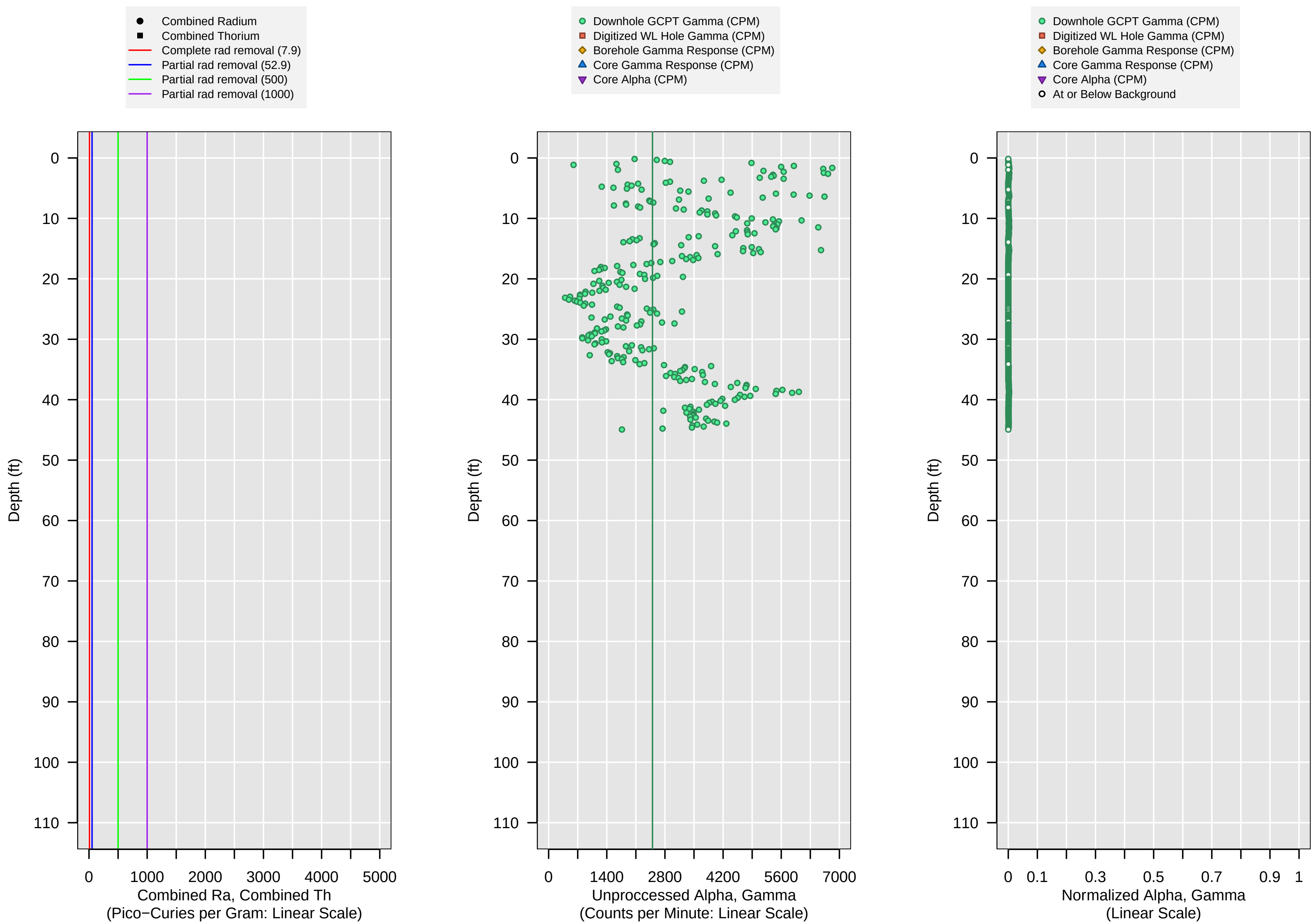
For McLaren/Hart RI Soil Boring Data:

- In calculated combined Ra and combined Th values, if of the the results was <MDA, one-half of the MDA was used in the calculation and the combined value was noted with an *. If both values were <MDA, combined results reported as "Non-detect".
- In calculated combined U values, if one or two of the the results was <MDA, one-half of the MDA was used in the calculation and the combined value was noted with an *. If all three values were <MDA, combined results reported as "Non-detect".

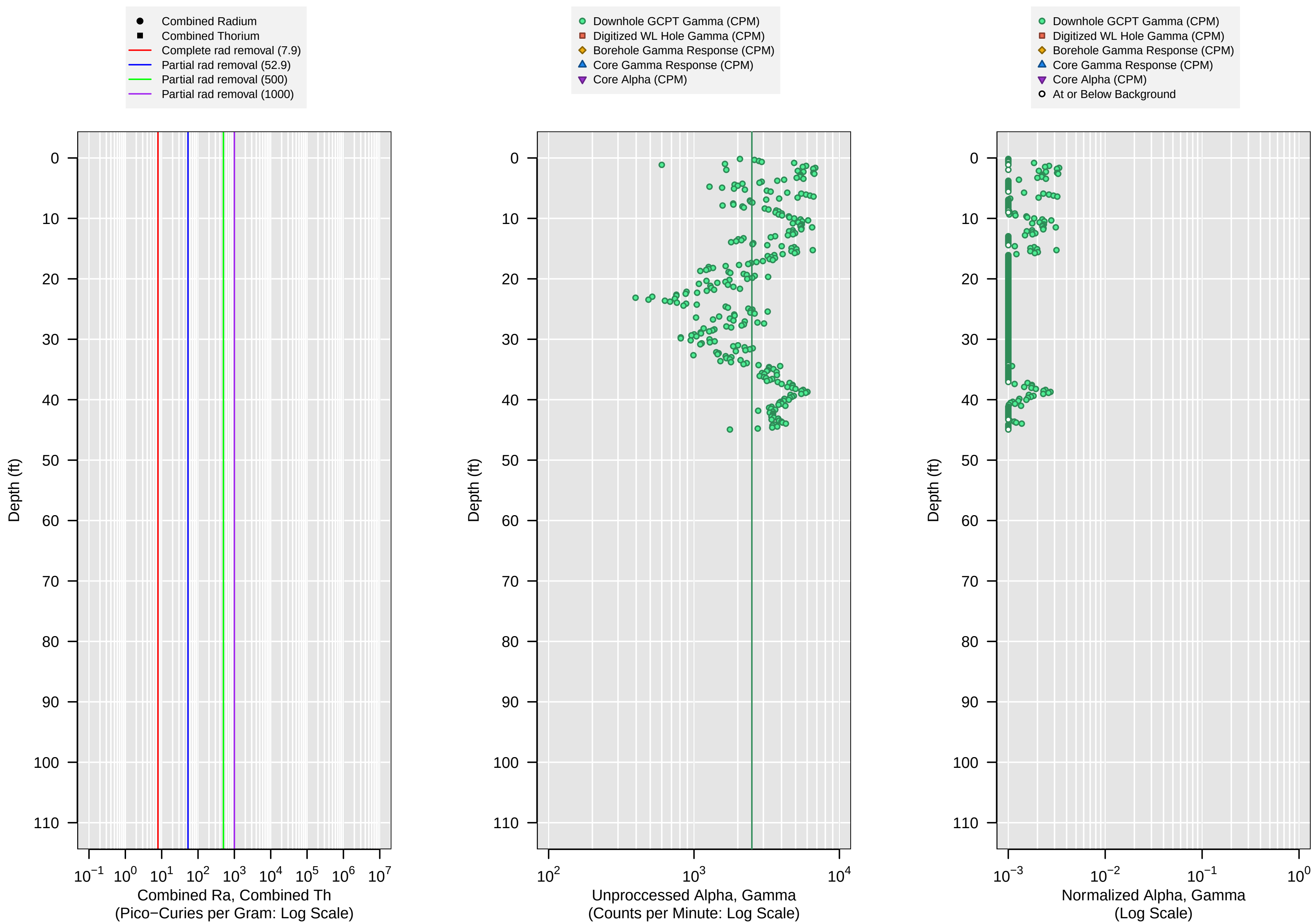
Appendix B

Vertical Profiles of Combined Radium and Combined Thorium Results together with Unprocessed and Processed Gamma and Alpha Responses

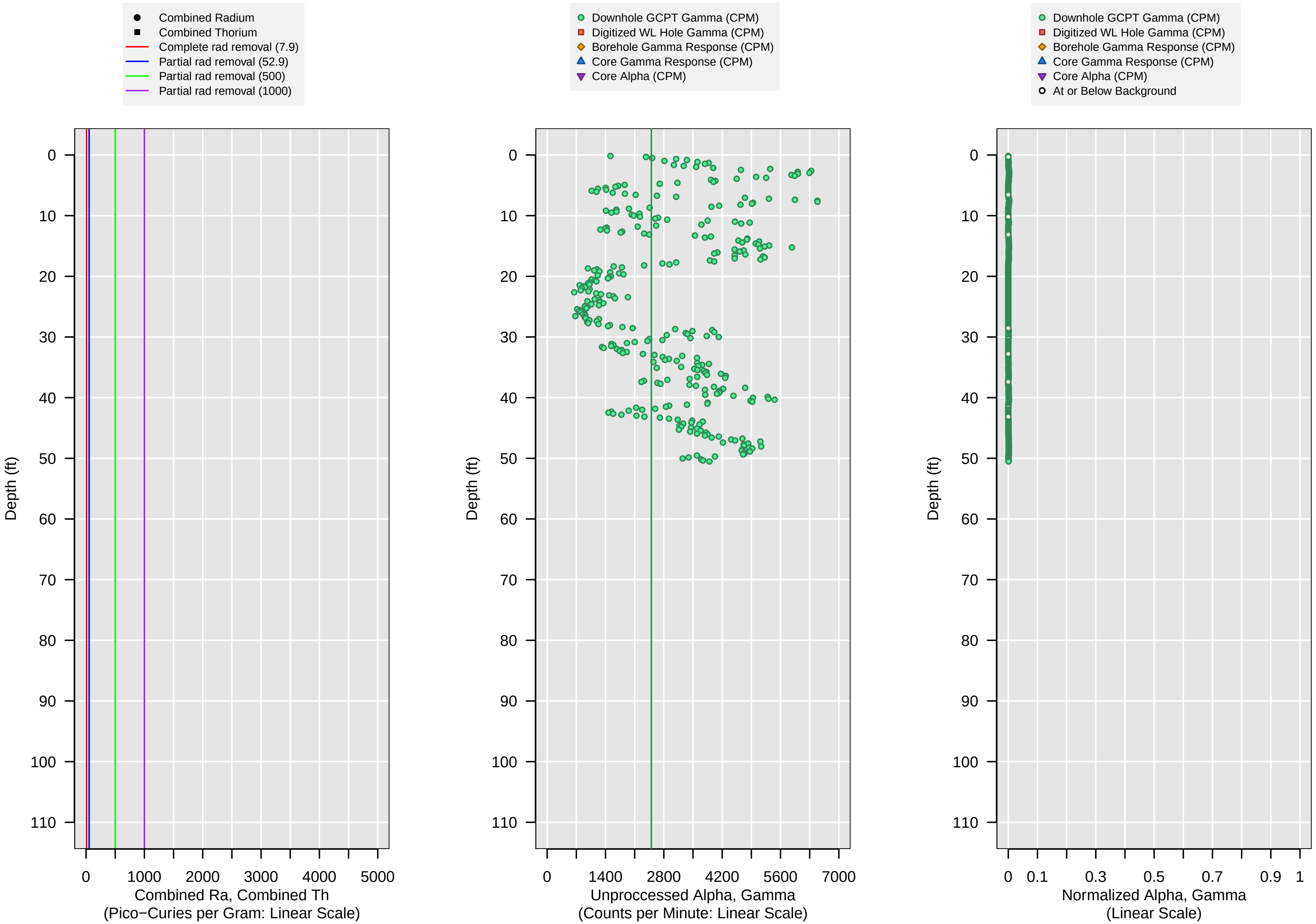
GCPT−10−1


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1400
2800
4200
5600
7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

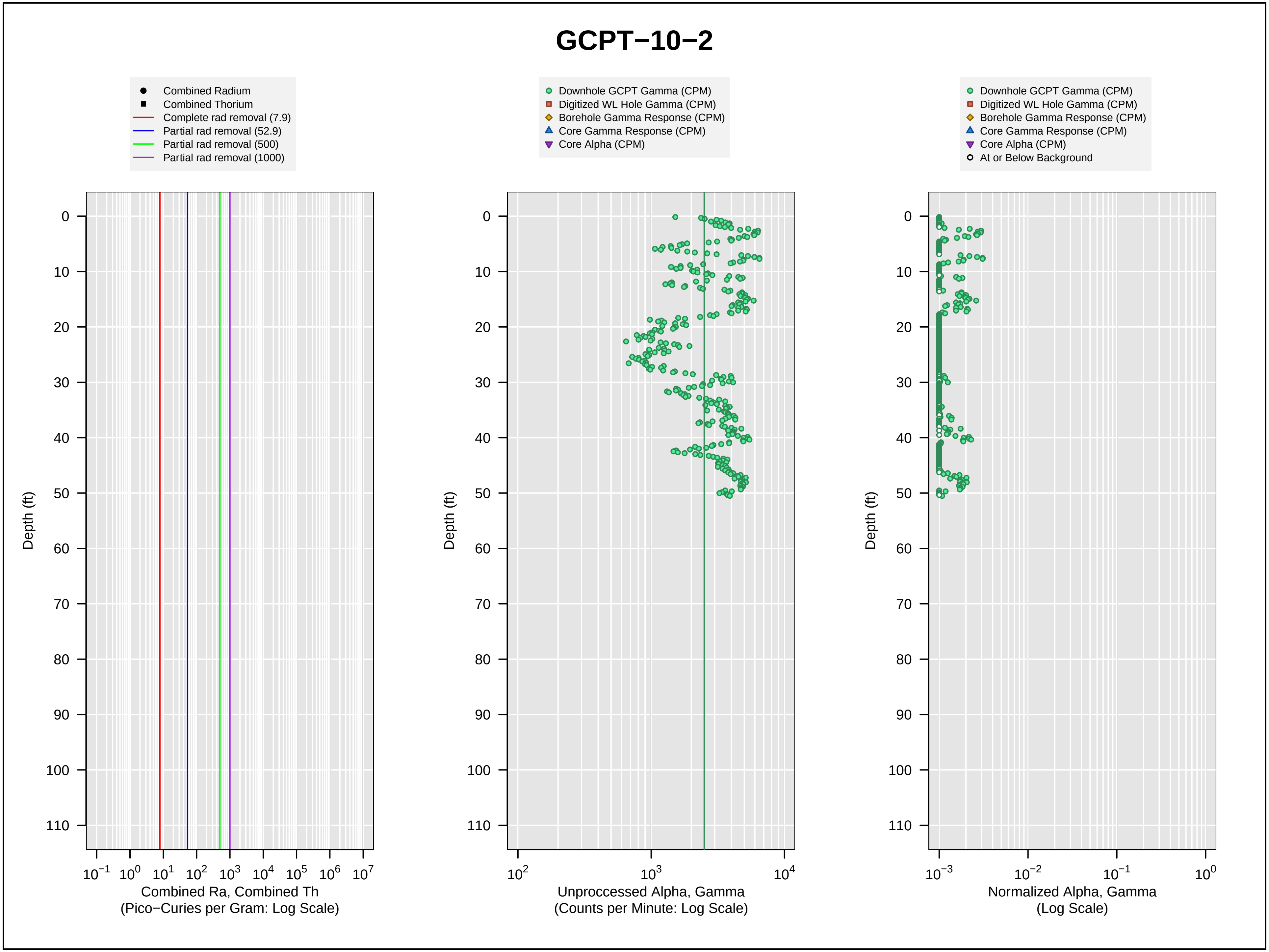
GCPT−10−1


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

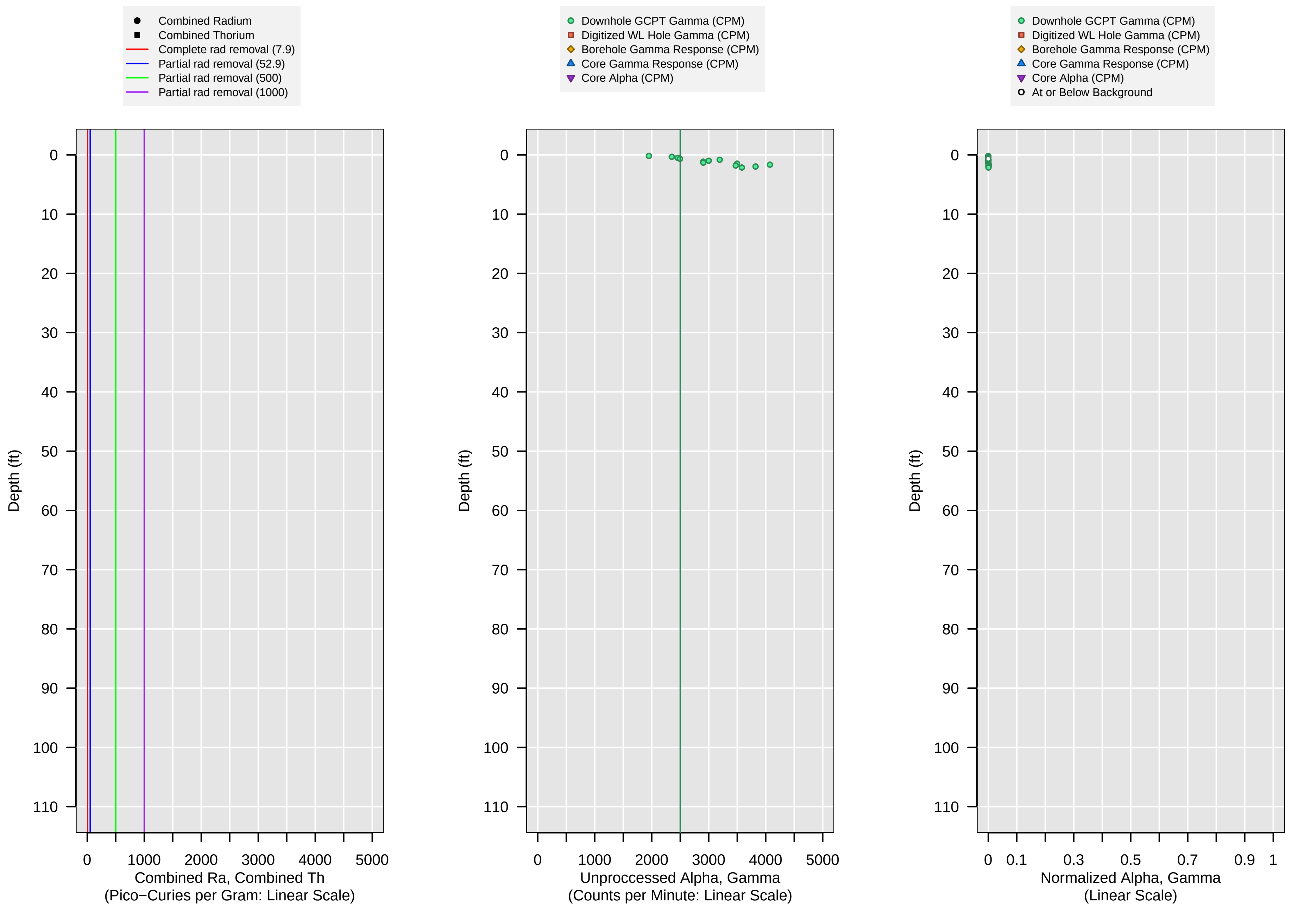
GCPT−10−2



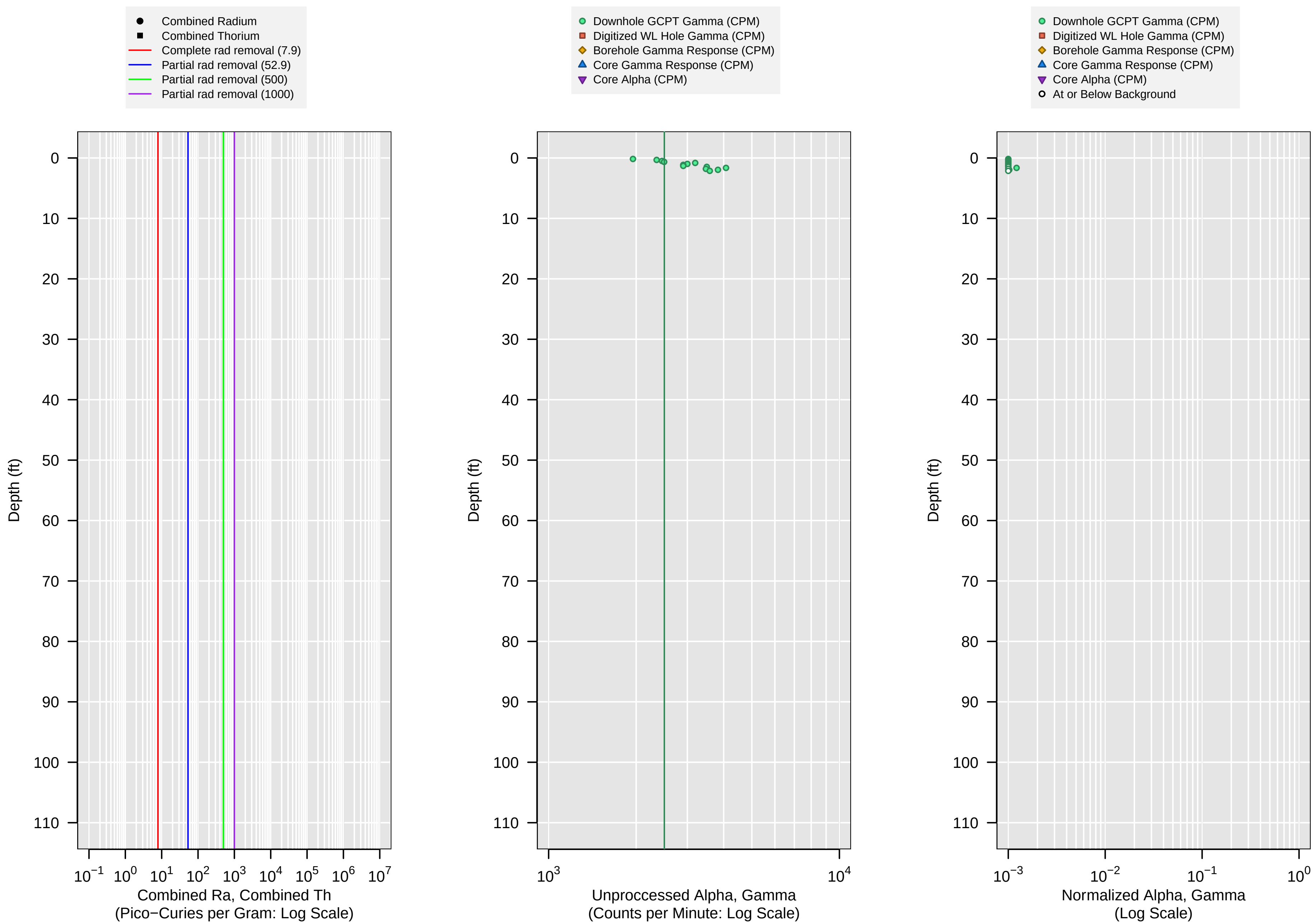
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1400
2800
4200
5600
7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)


GCPT−10−2
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

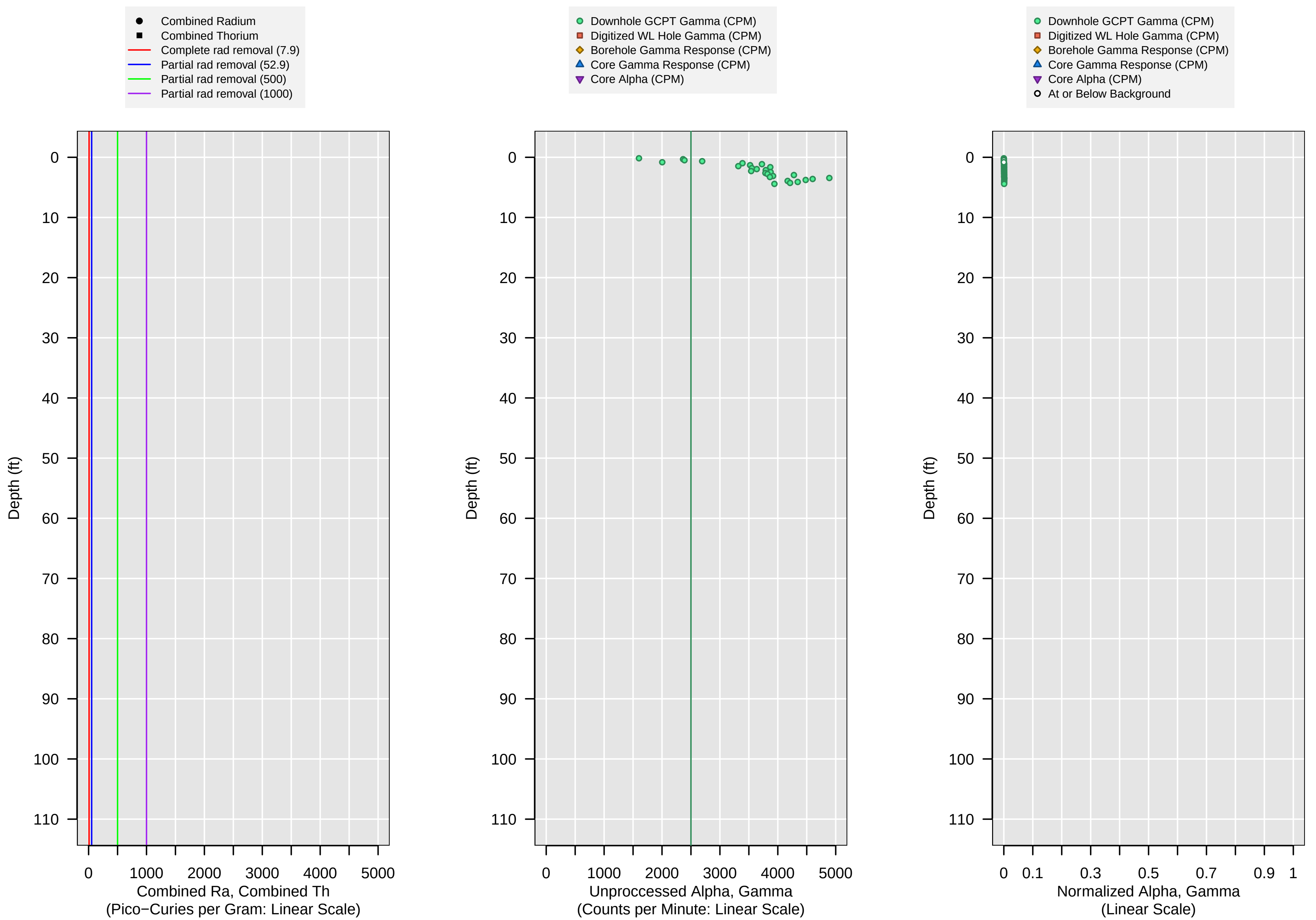
GCPT−10−3


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

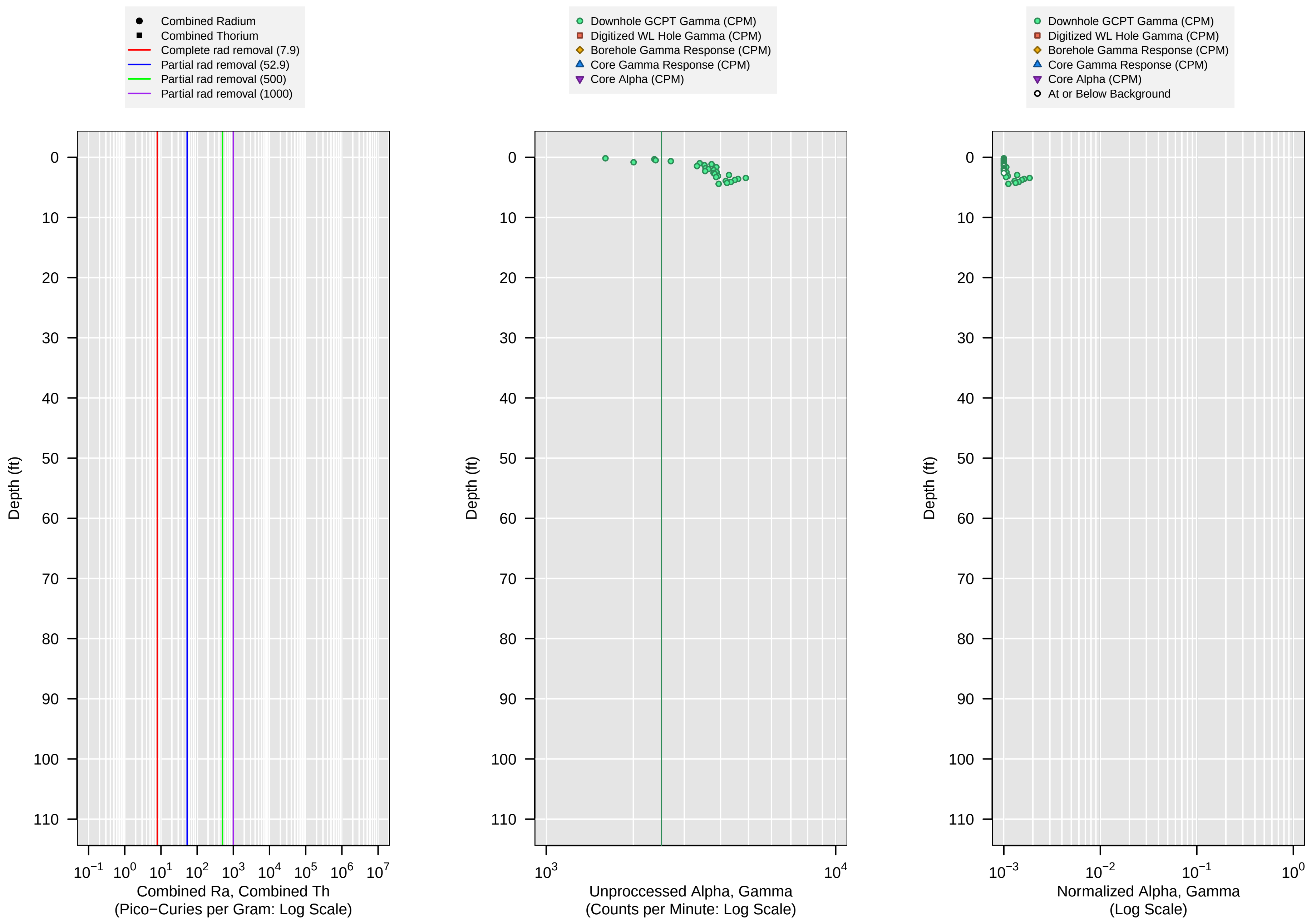
GCPT−10−3

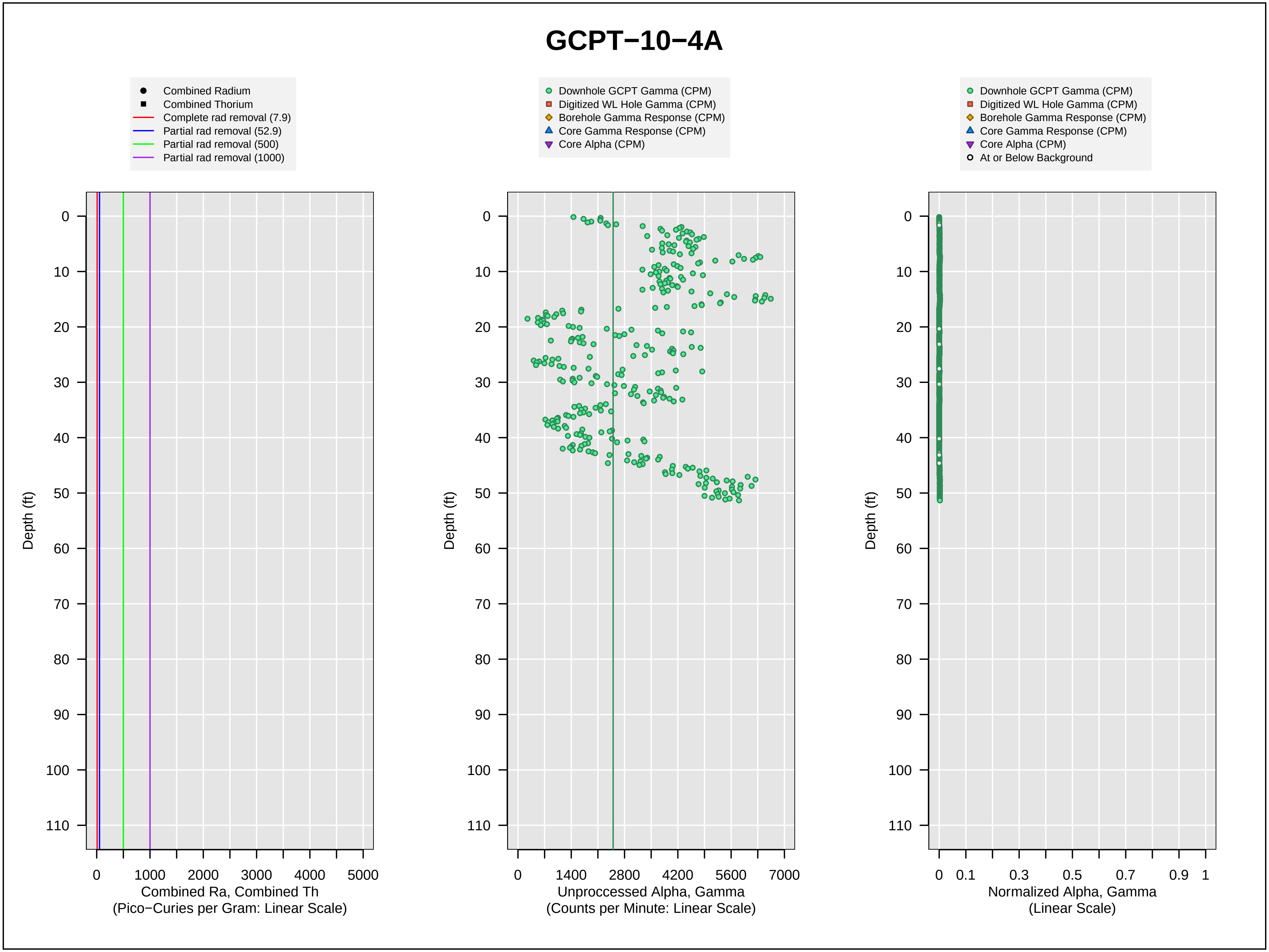

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−10−3A

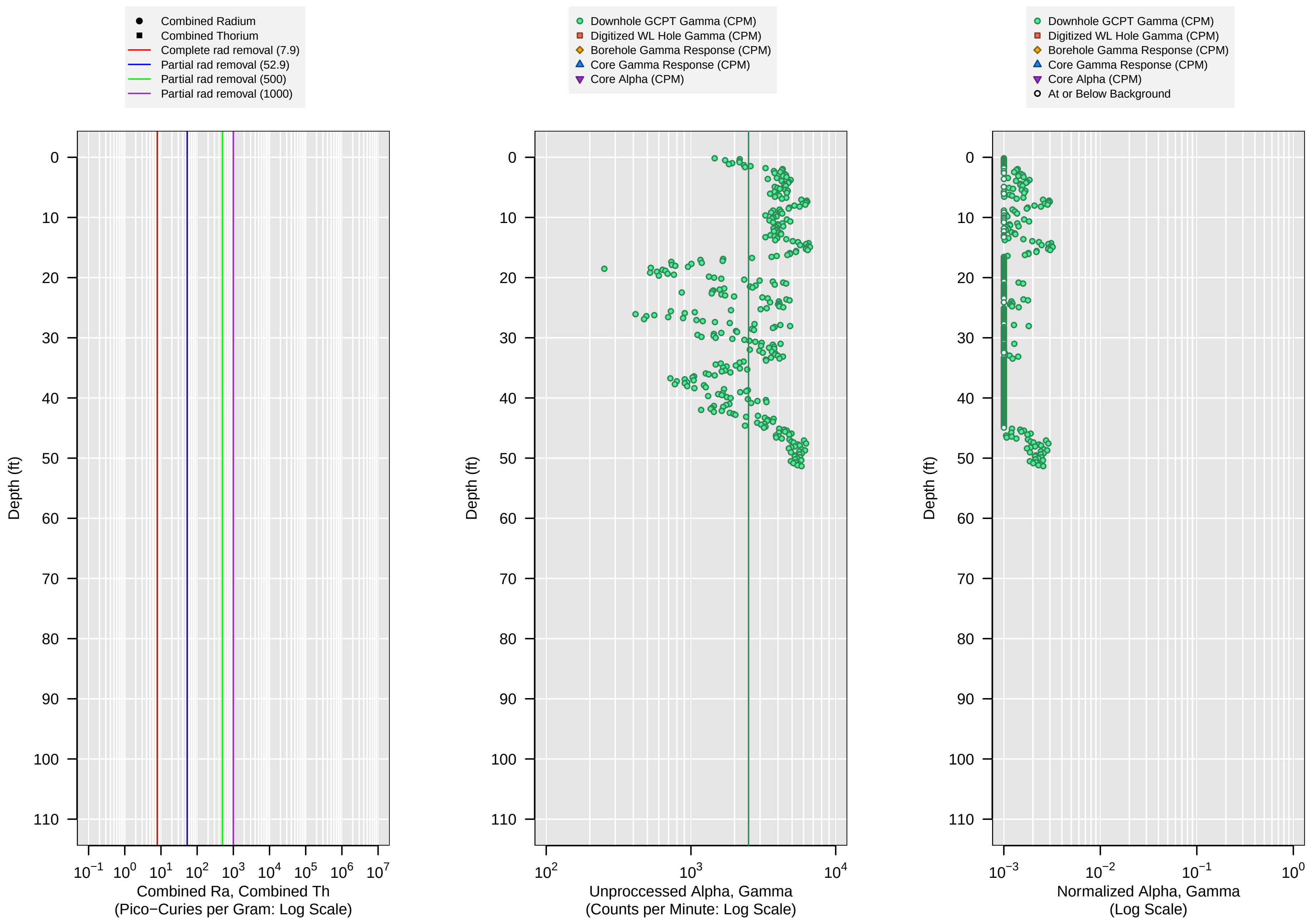

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−10−3A

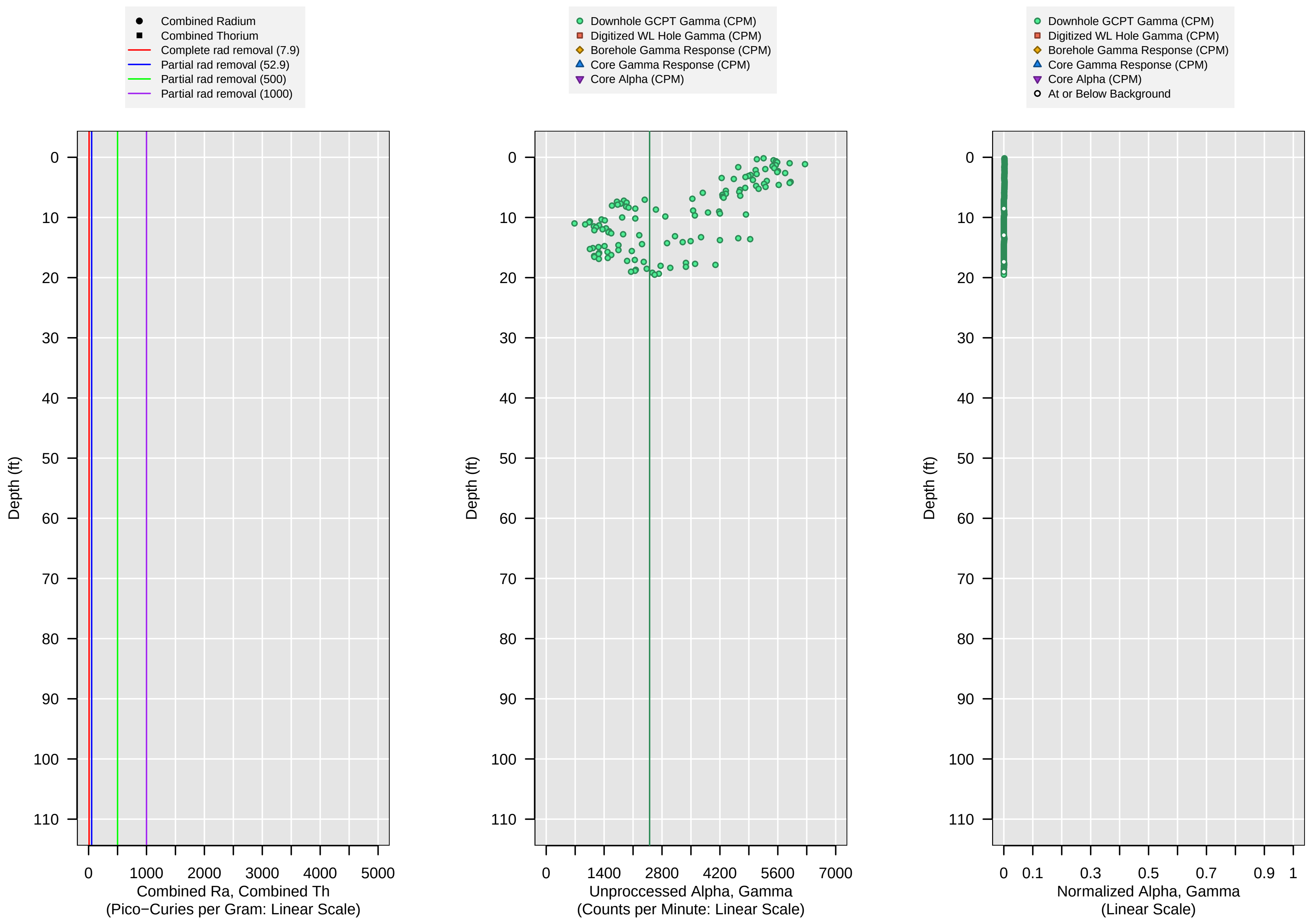

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)


GCPT−10−4A
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

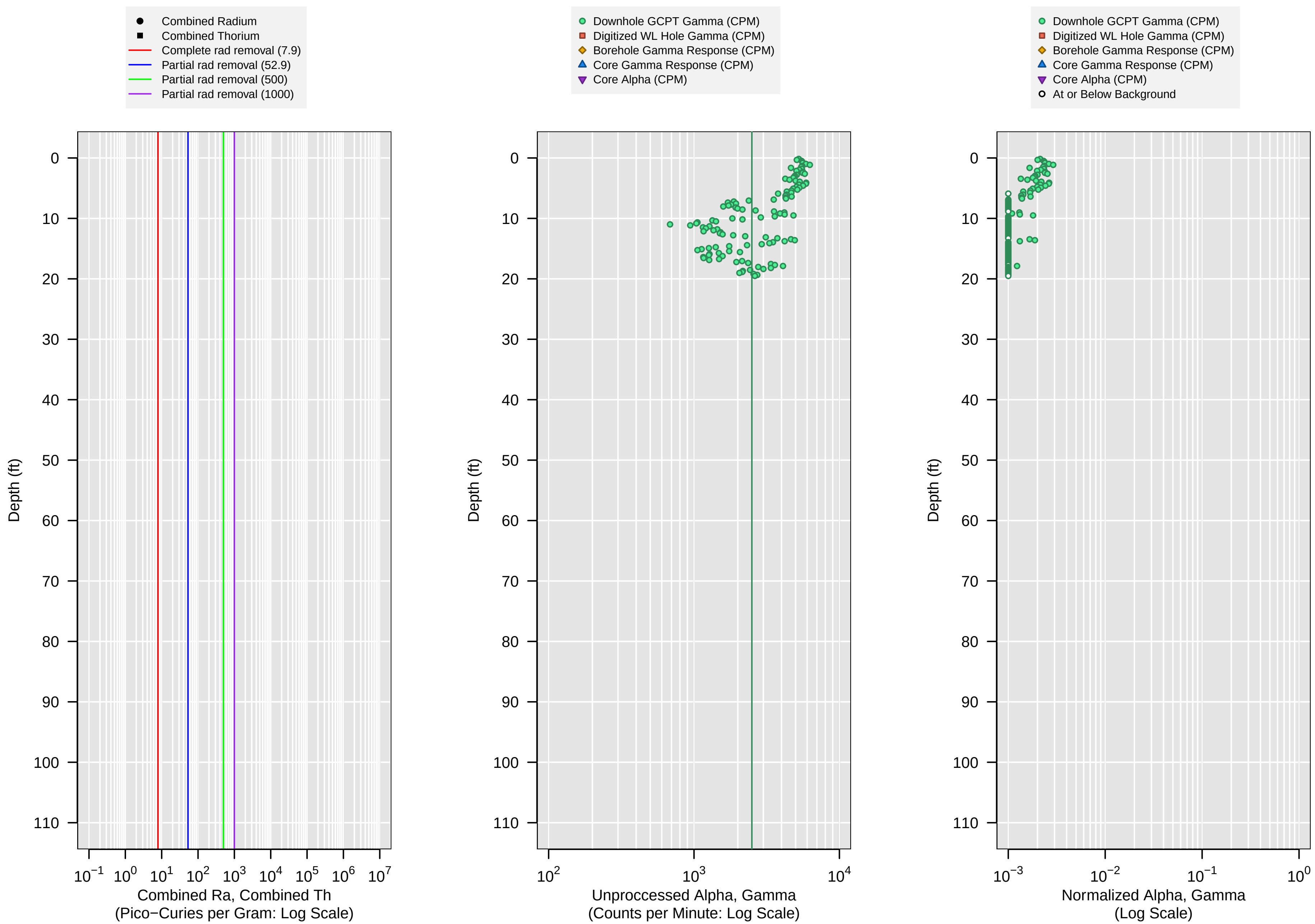
GCPT−10−4A


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{-1} 10^{0} 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6} 10^{7}
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
10^{2} 10^{3} 10^{4}
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
10^{-3} 10^{-2} 10^{-1} 10^{0}
Normalized Alpha, Gamma
(Log Scale)

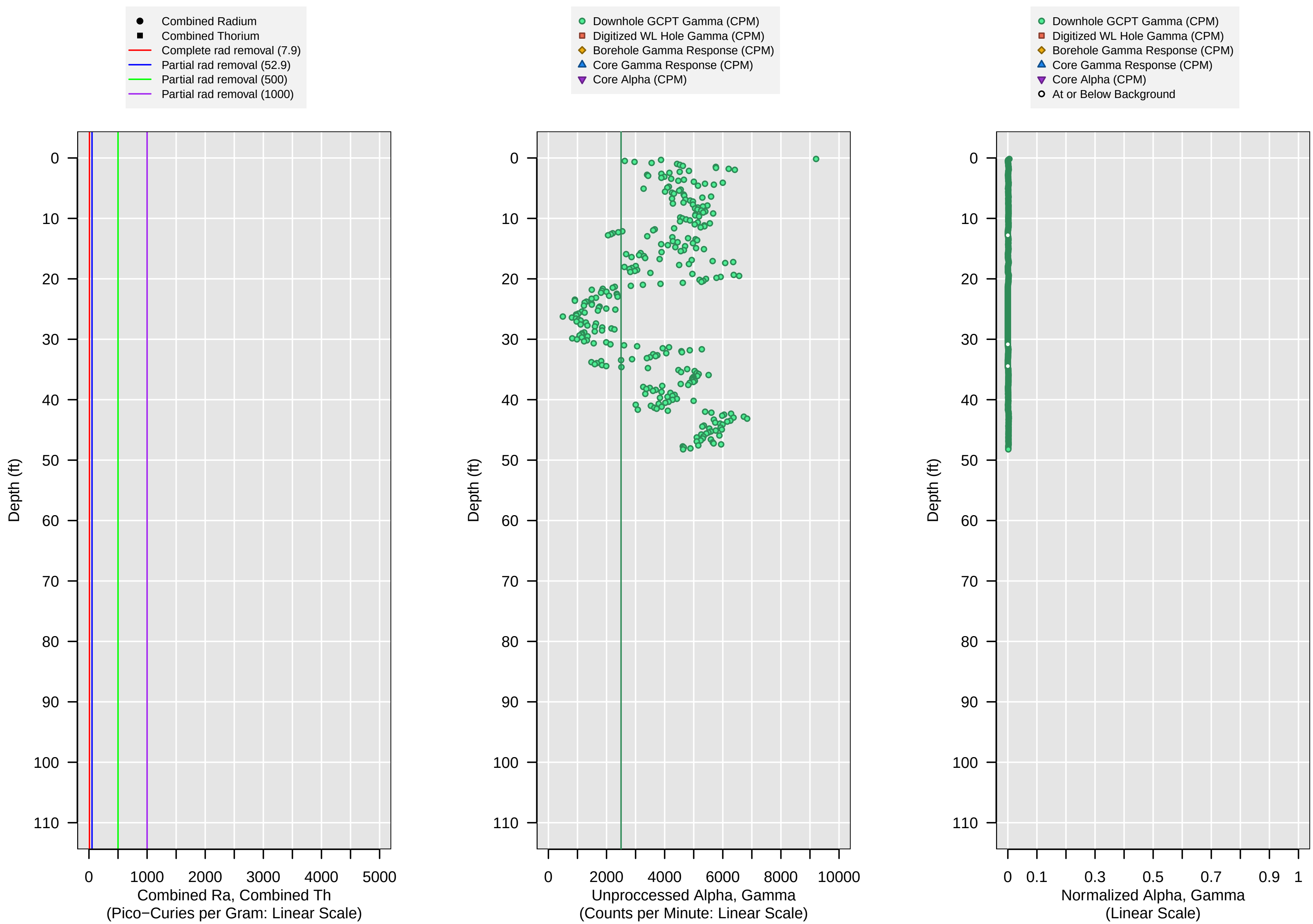
GCPT−1−1


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Linear Scale)

GCPT−1−1

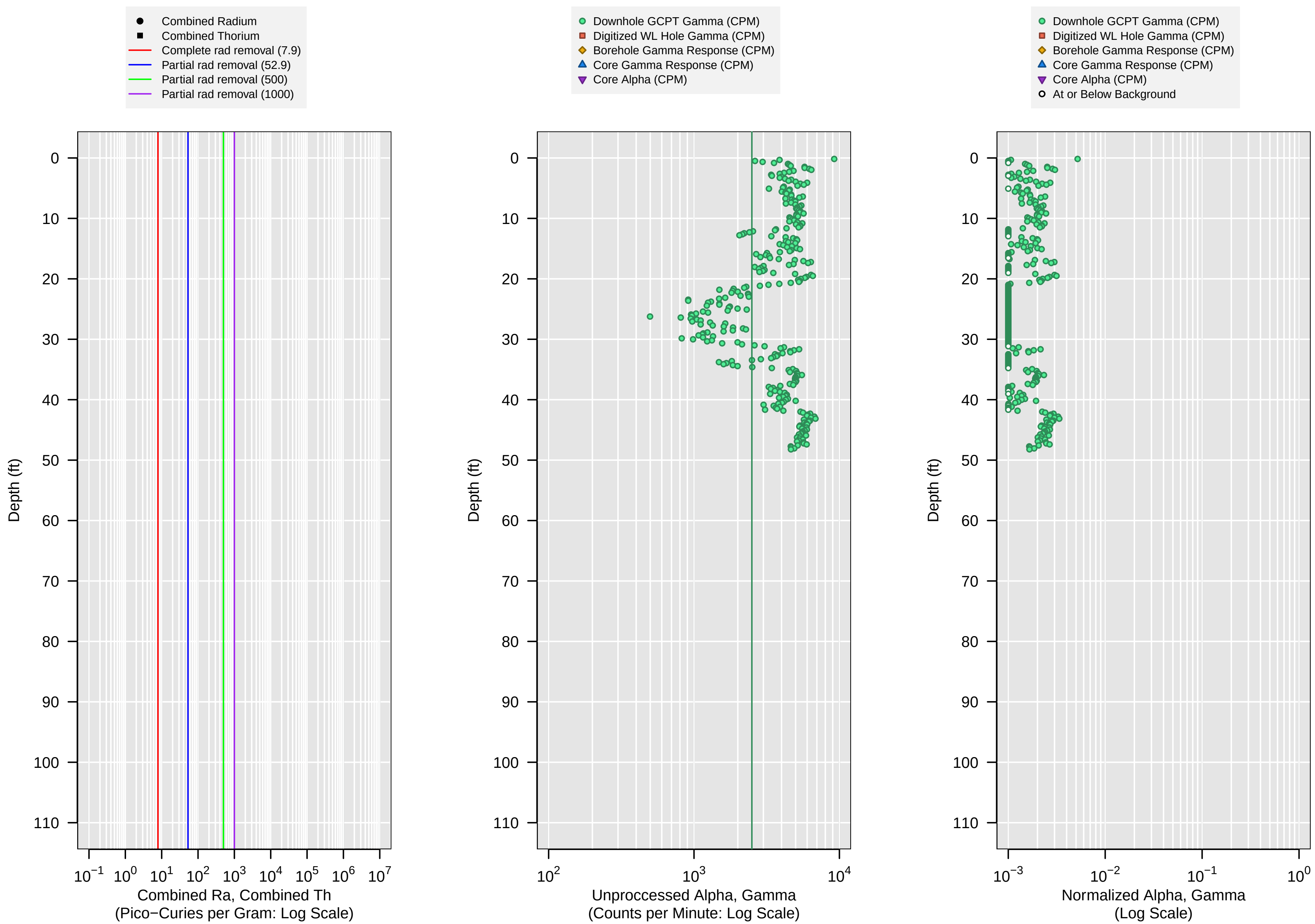

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{-1} 10^{0} 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6} 10^{7}
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
10^{2} 10^{3} 10^{4}
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
10^{-3} 10^{-2} 10^{-1} 10^{0}
Normalized Alpha, Gamma
(Log Scale)

GCPT−11−1

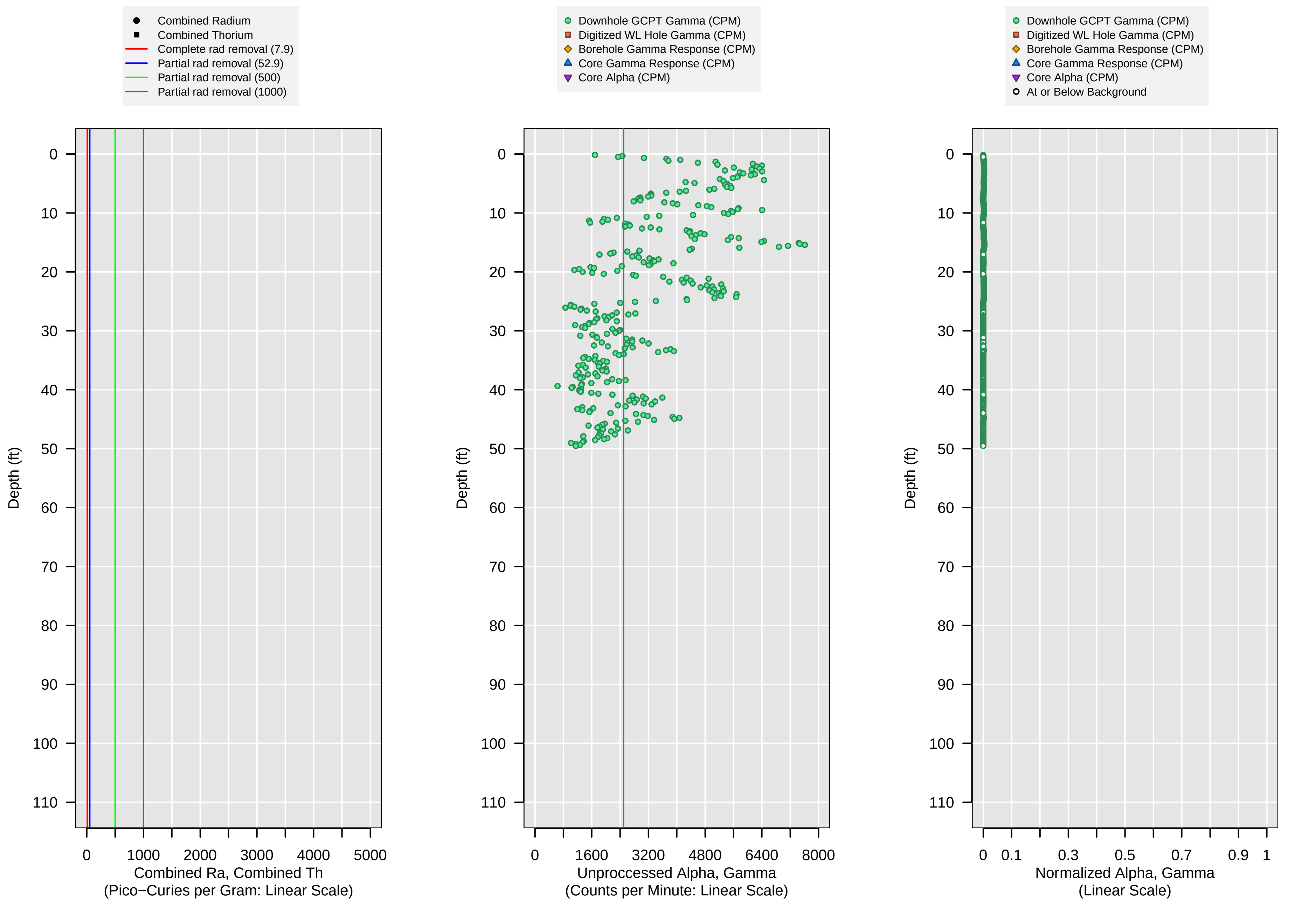

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

S.S. PAPADOPULOS & ASSOCIATES, INC.

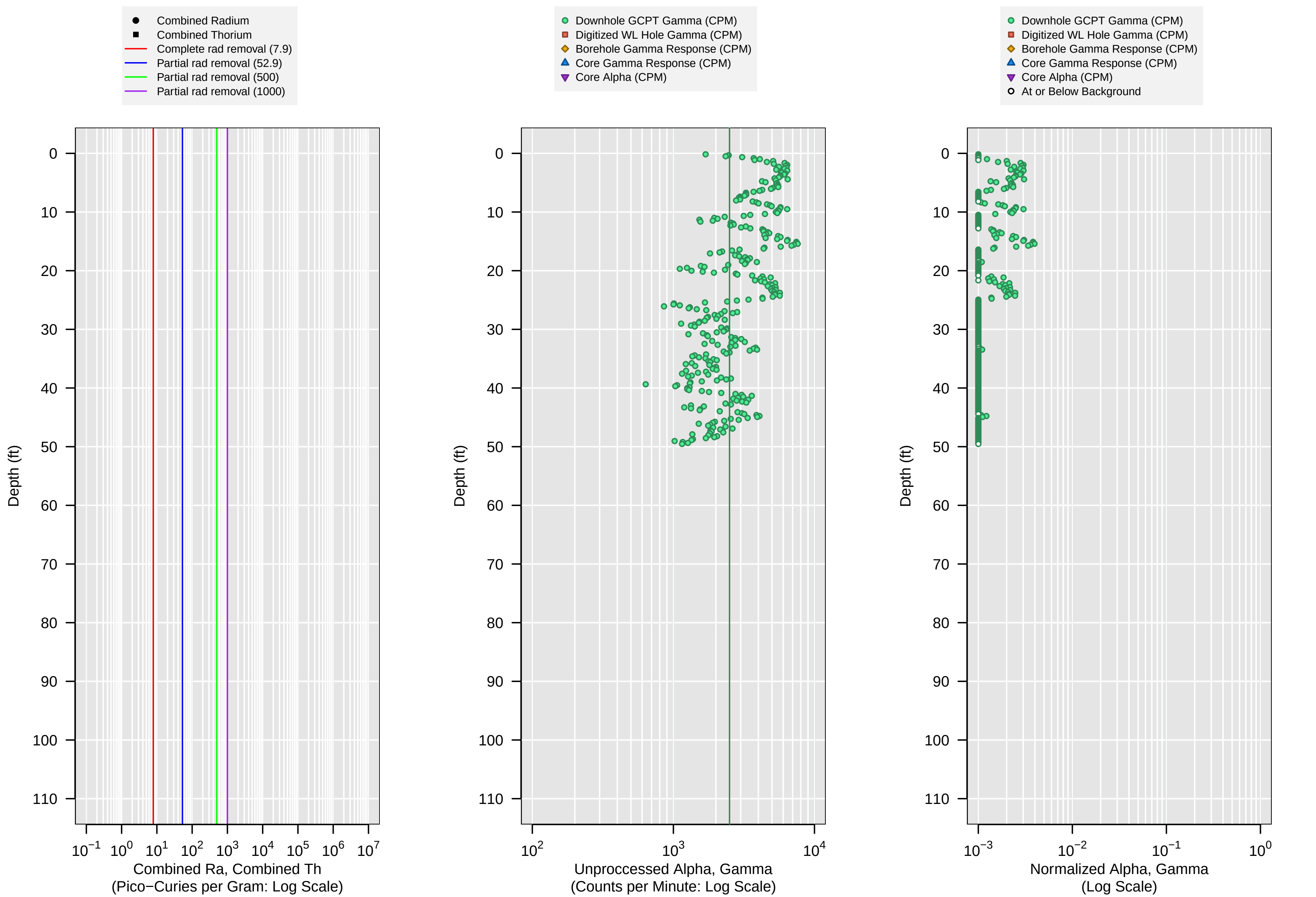
GCPT−11−1



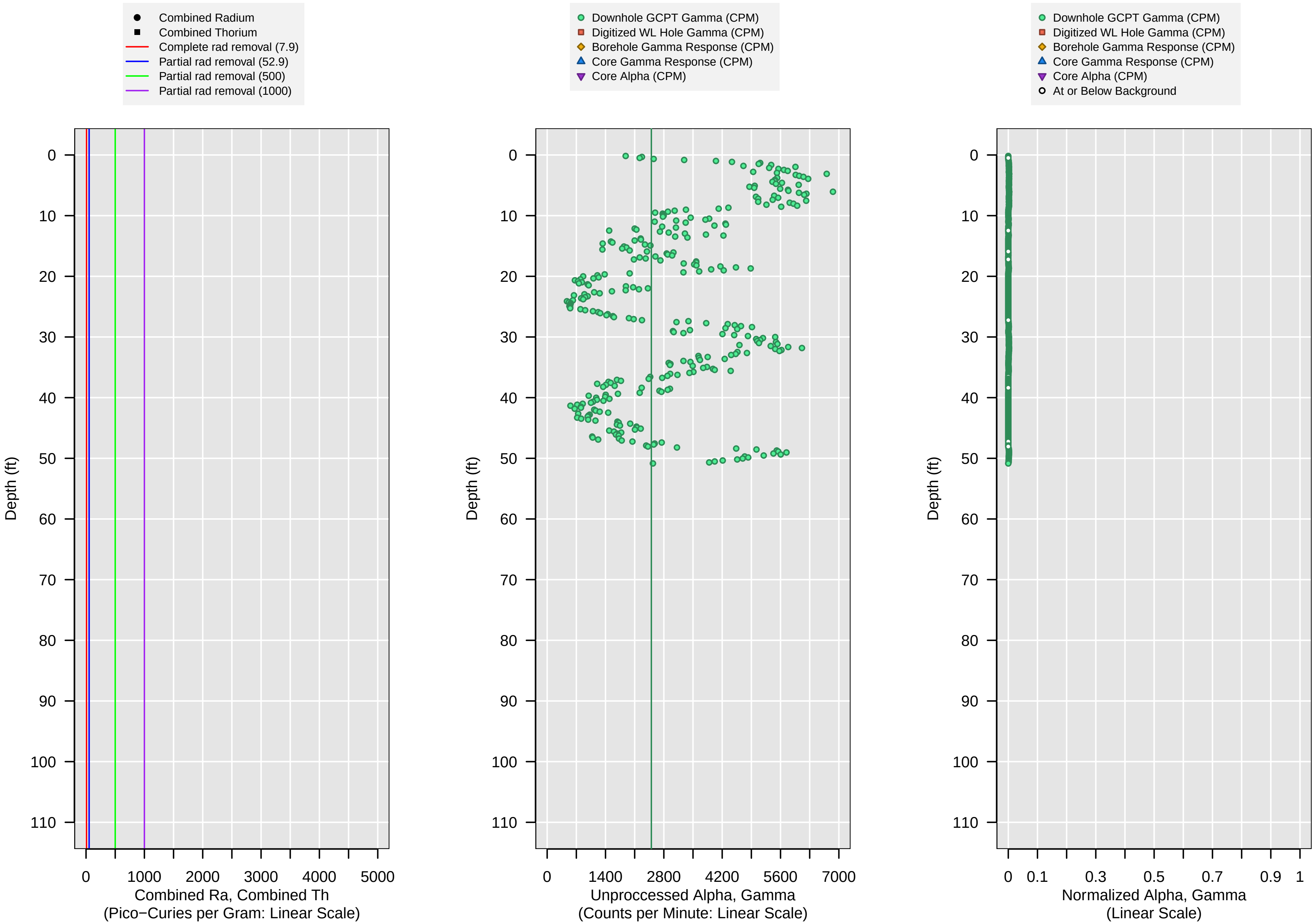
GCPT−11−2


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

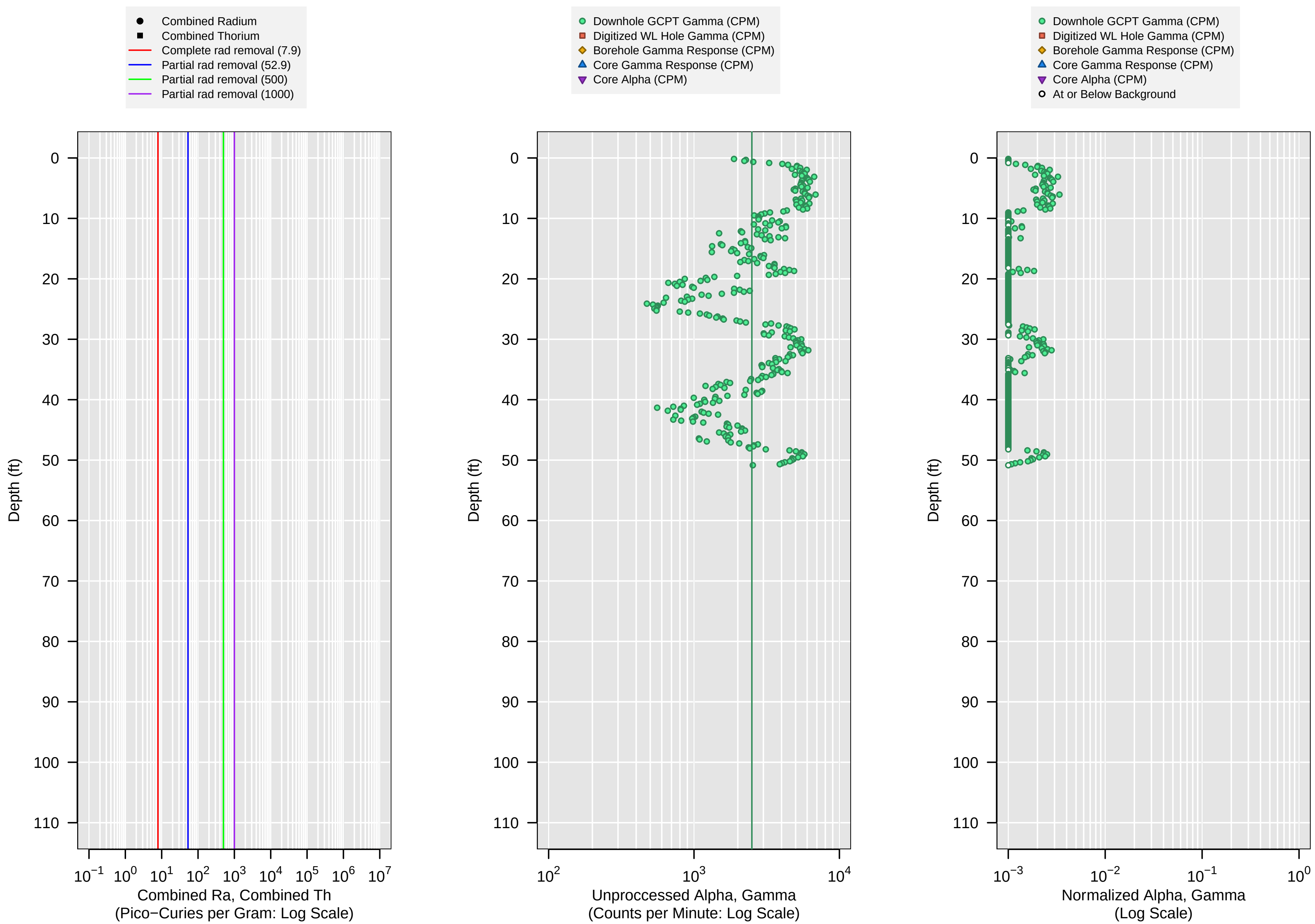
GCPT−11−2

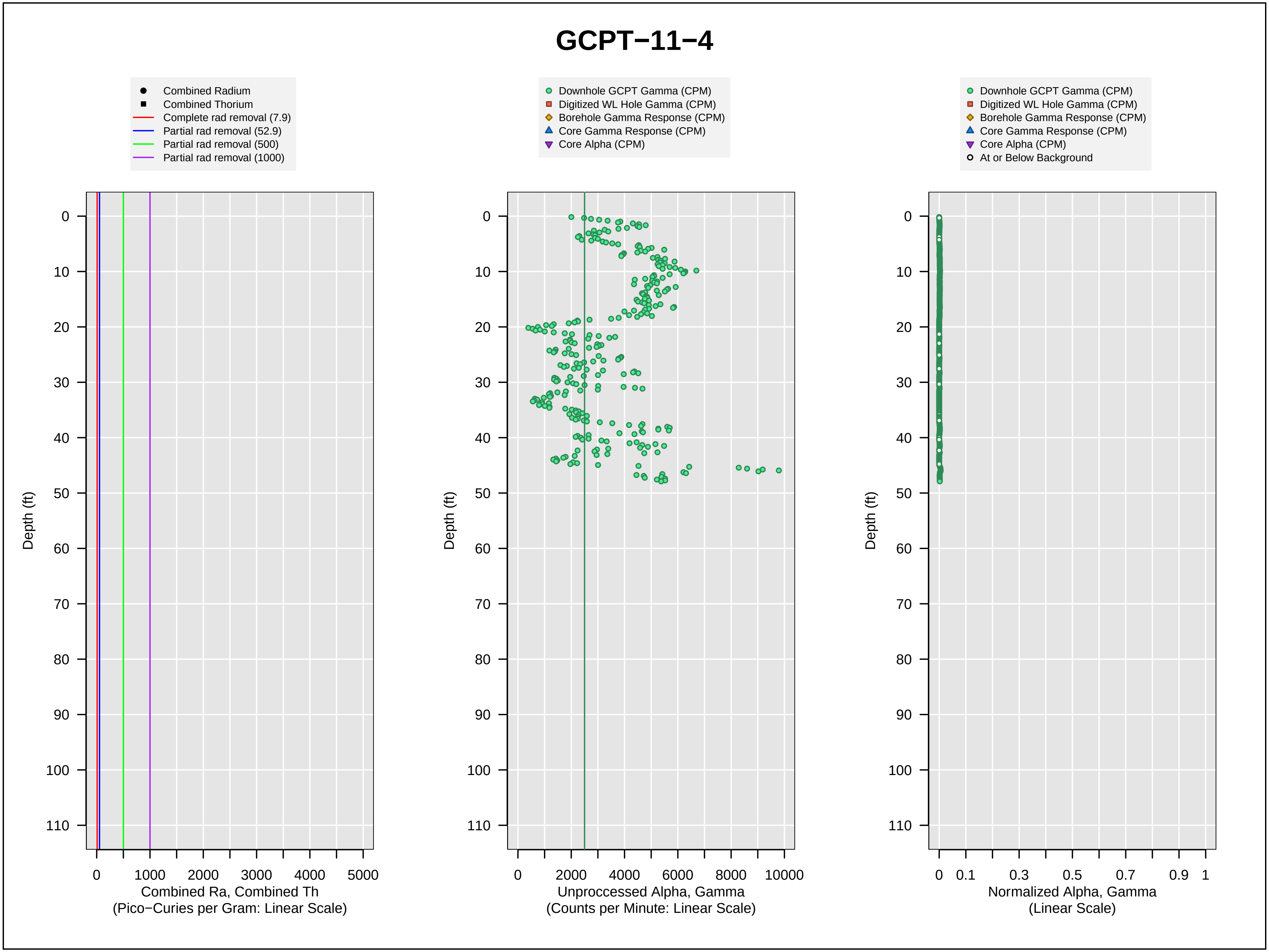

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−11−3


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

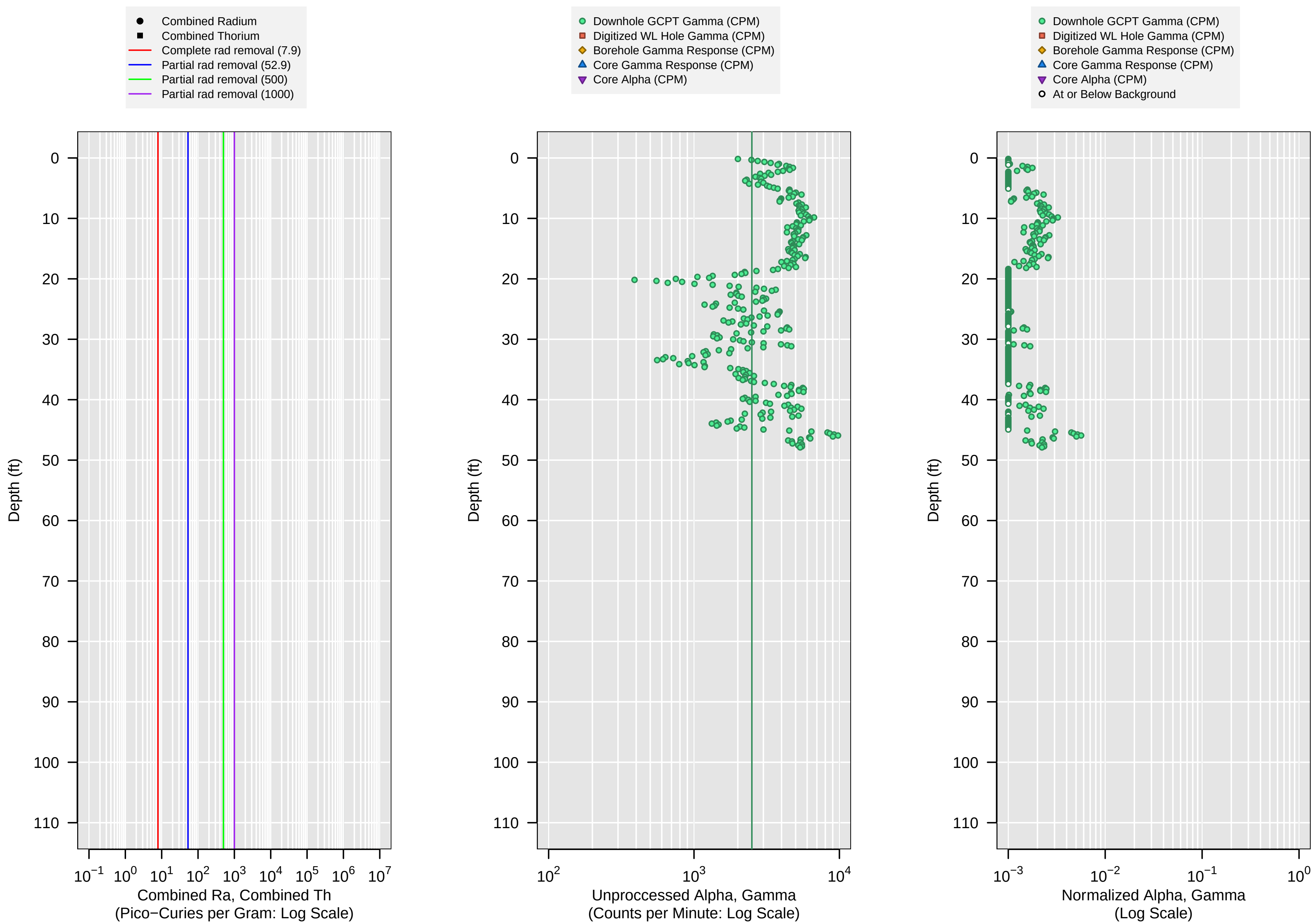
GCPT−11−3


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)



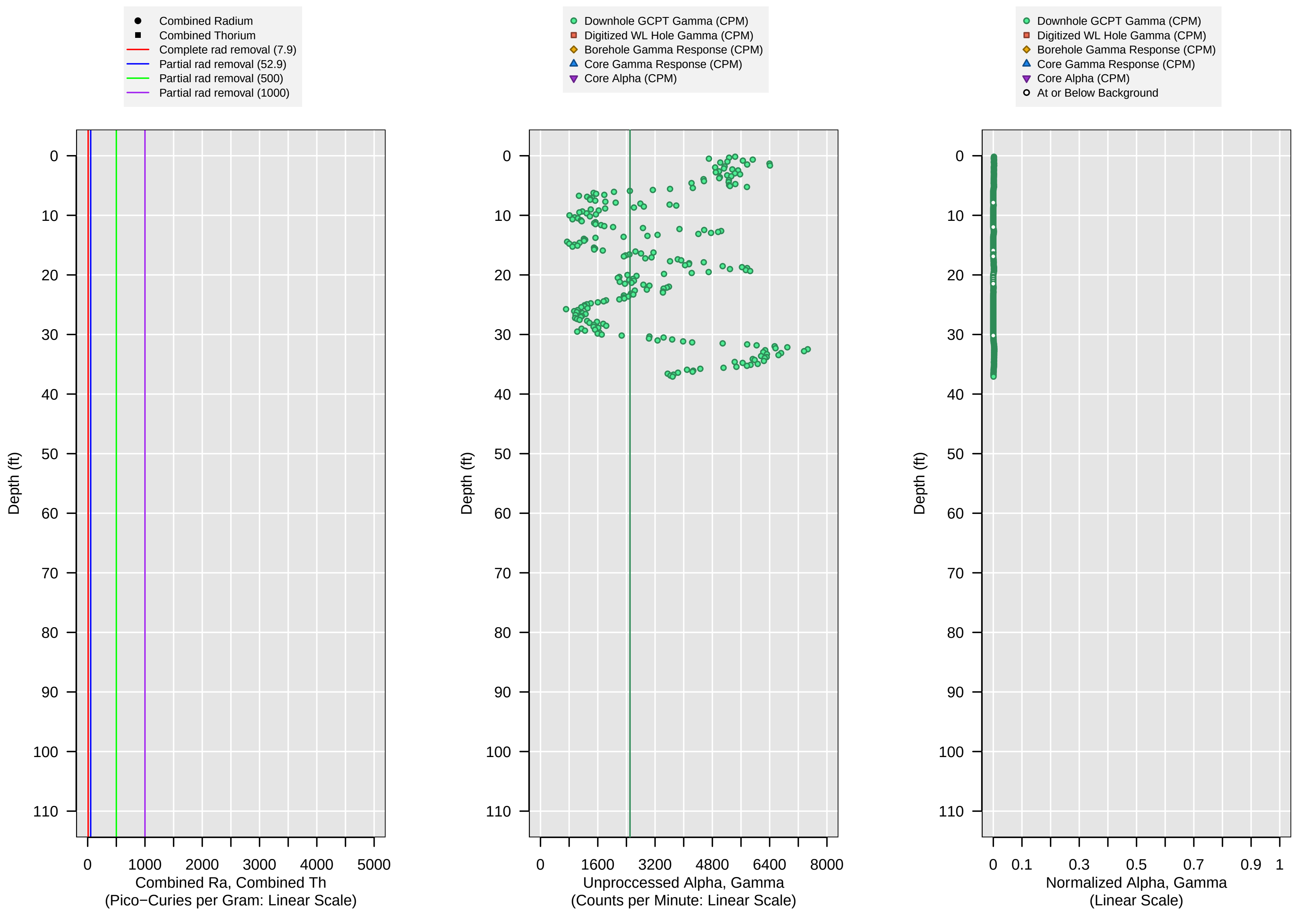
GCPT−11−4
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Normalized Alpha, Gamma
(Linear Scale)

GCPT−11−4

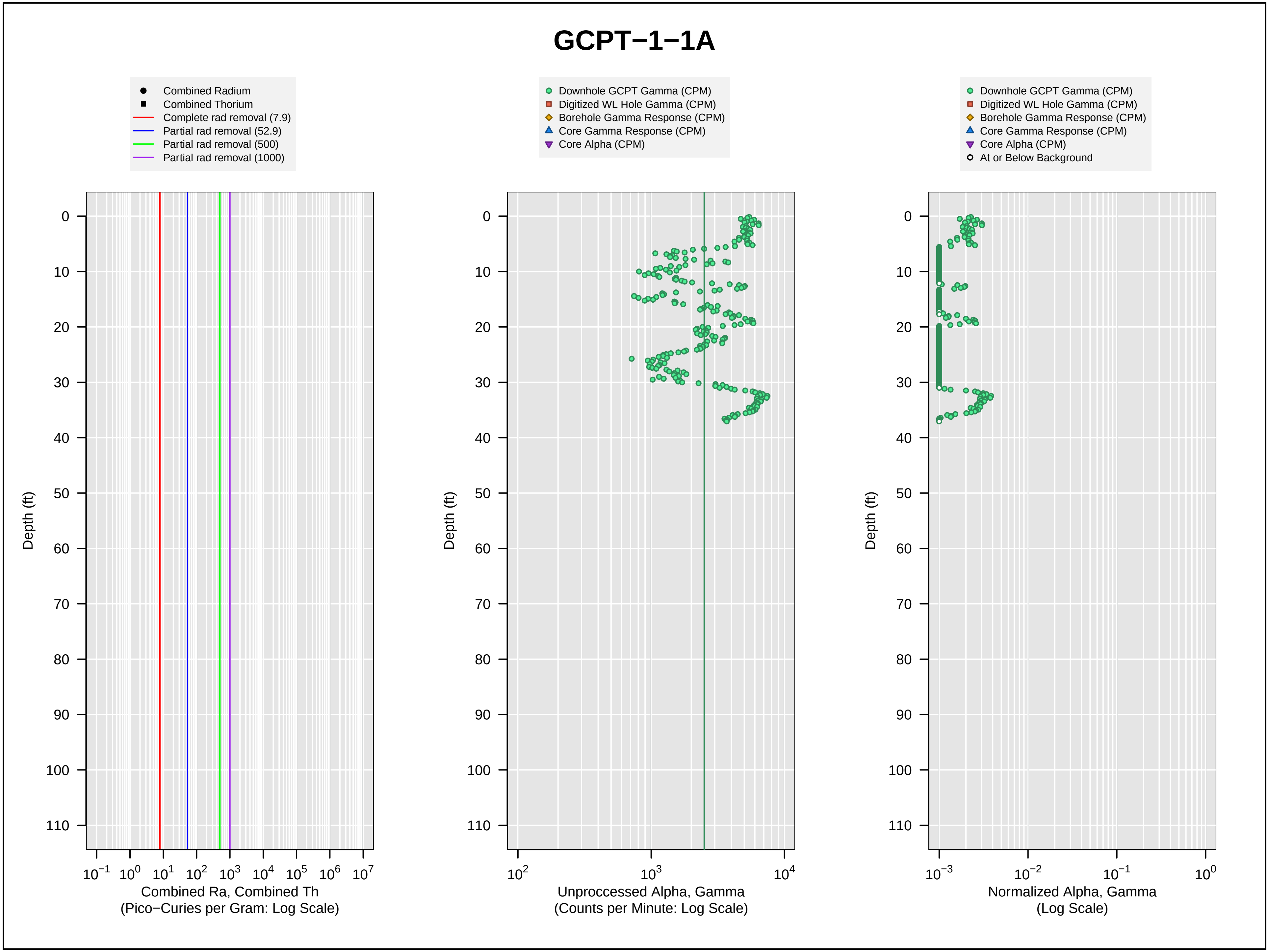


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

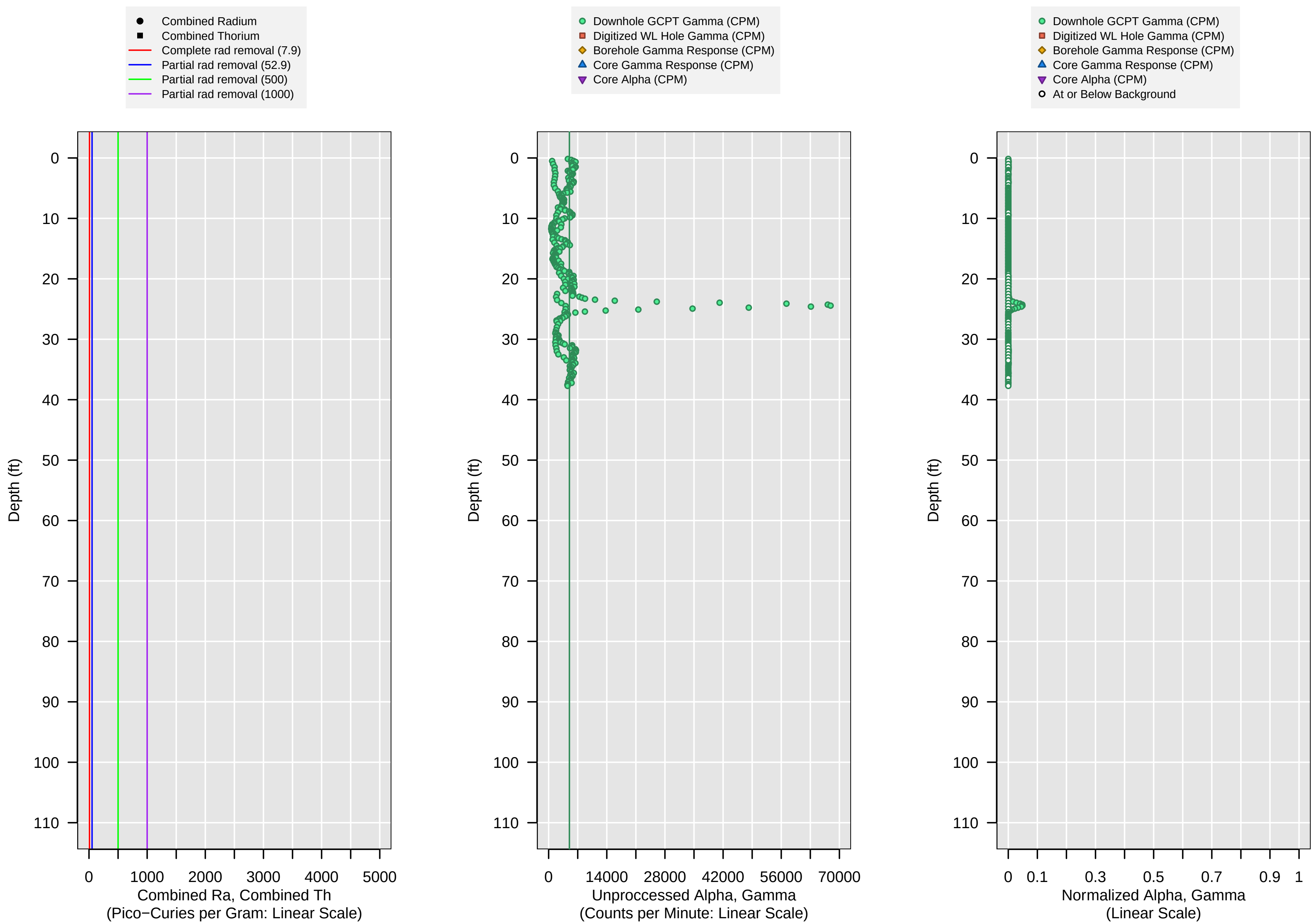
GCPT−1−1A

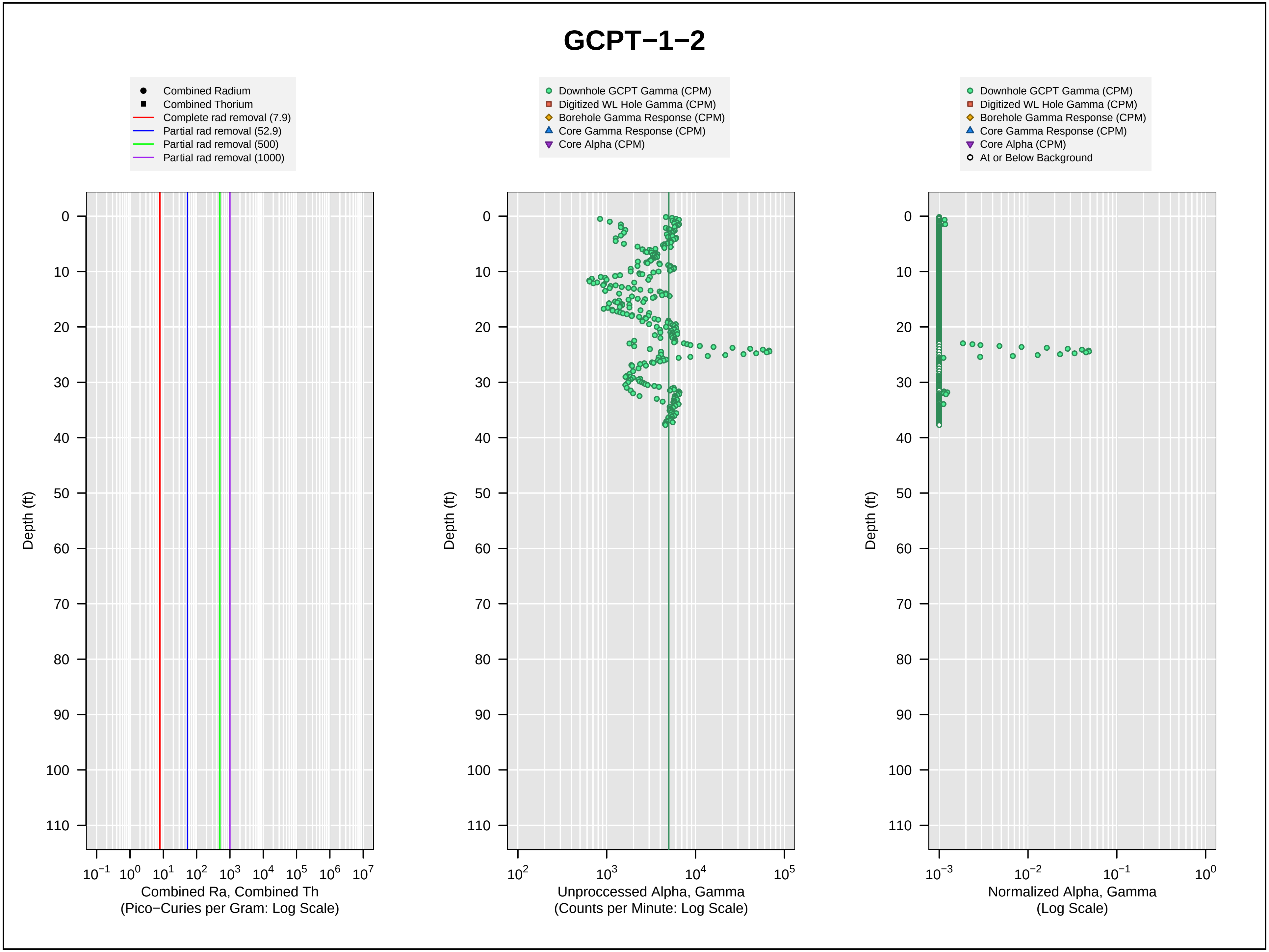


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

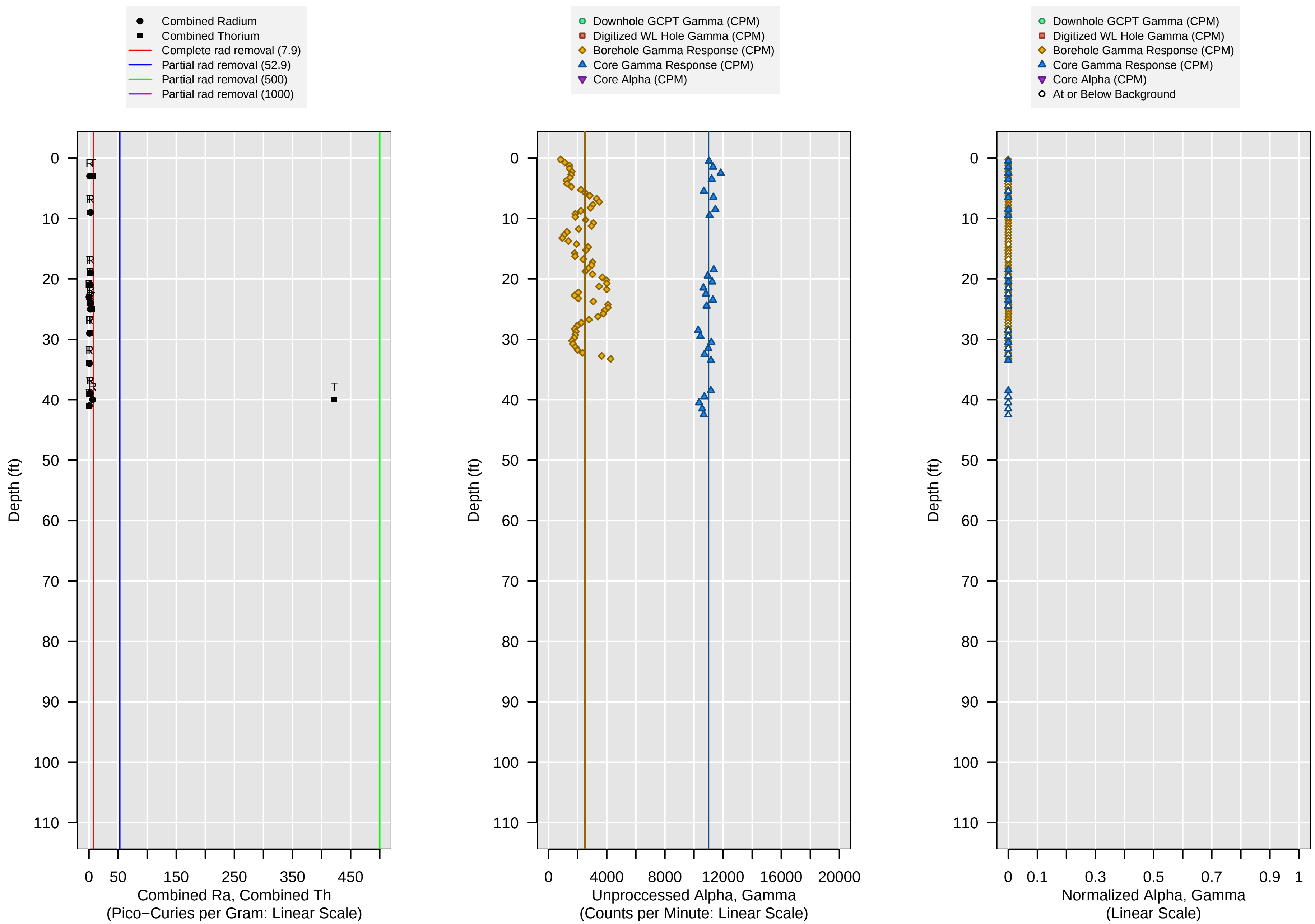

GCPT−1−1A
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−1−2


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

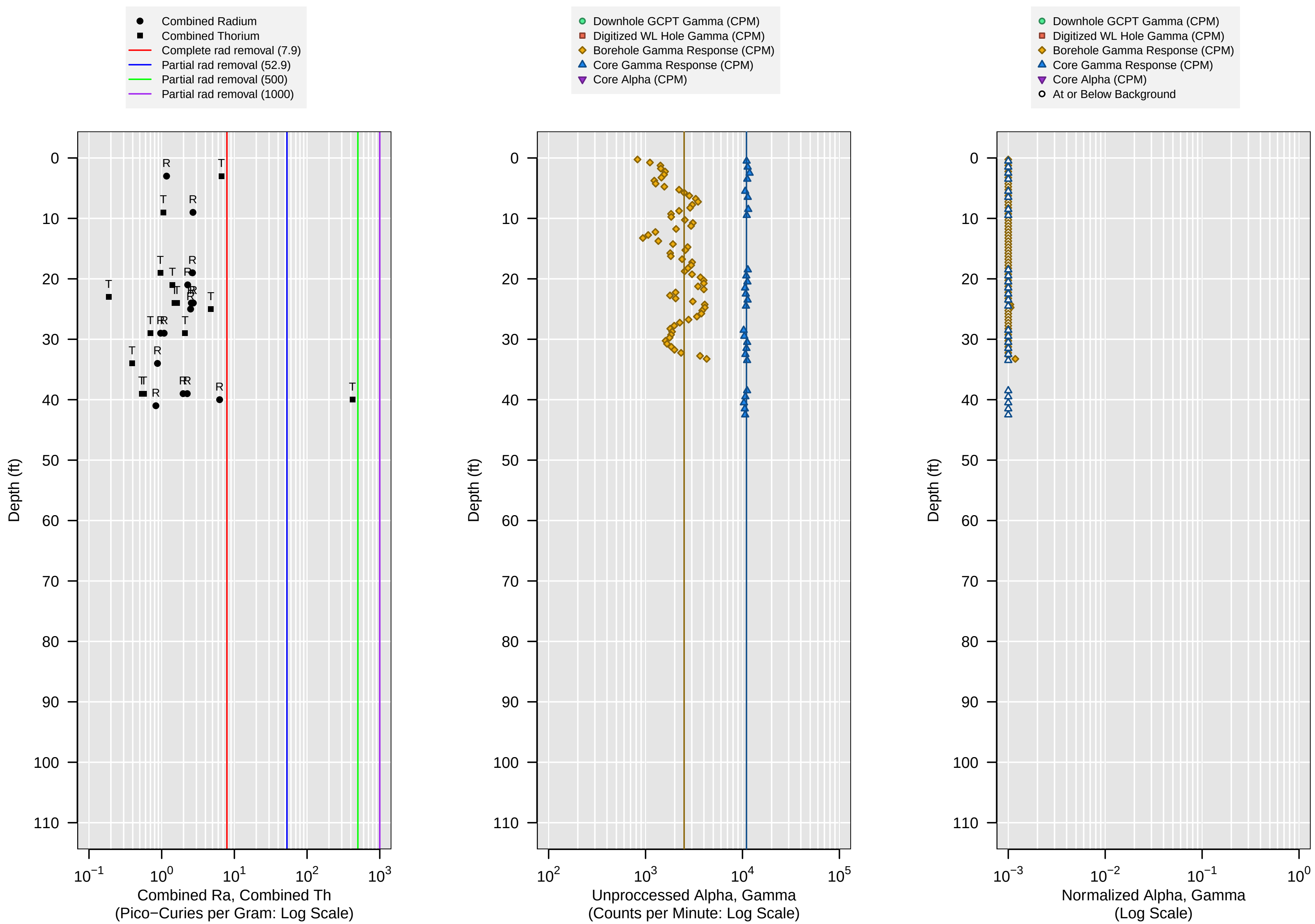

GCPT−1−2
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

Sonic−1−2

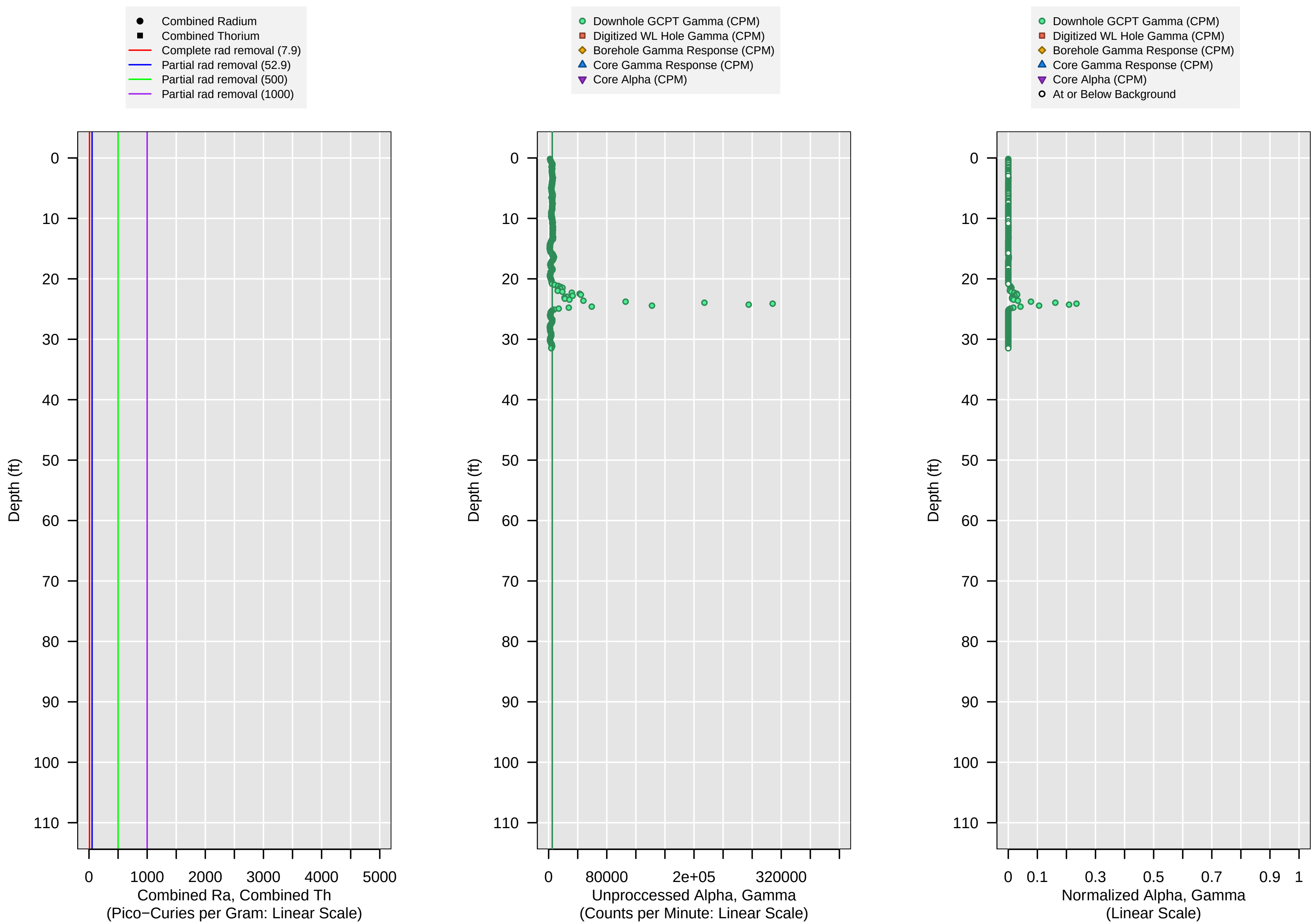


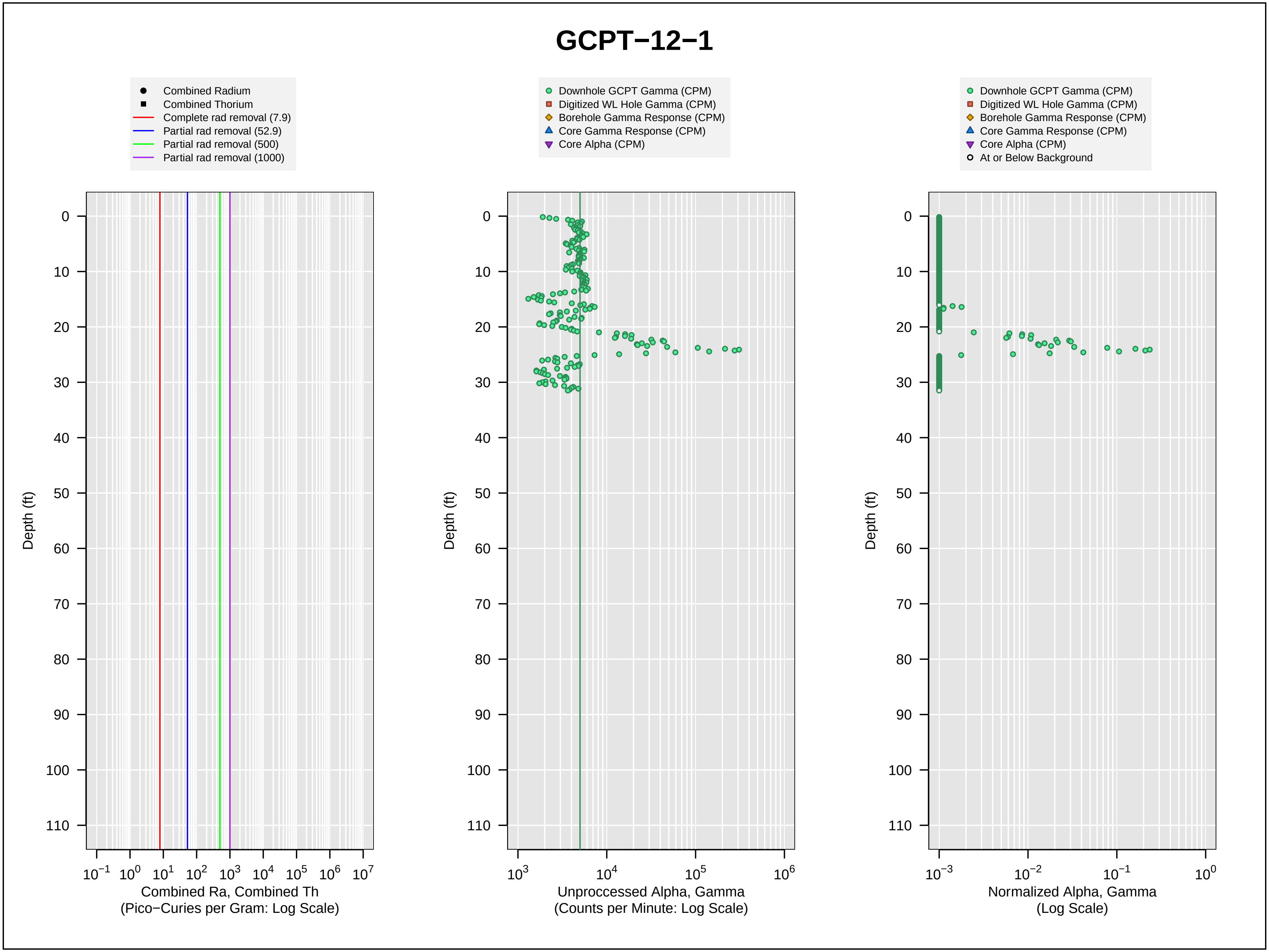
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

Sonic−1−2

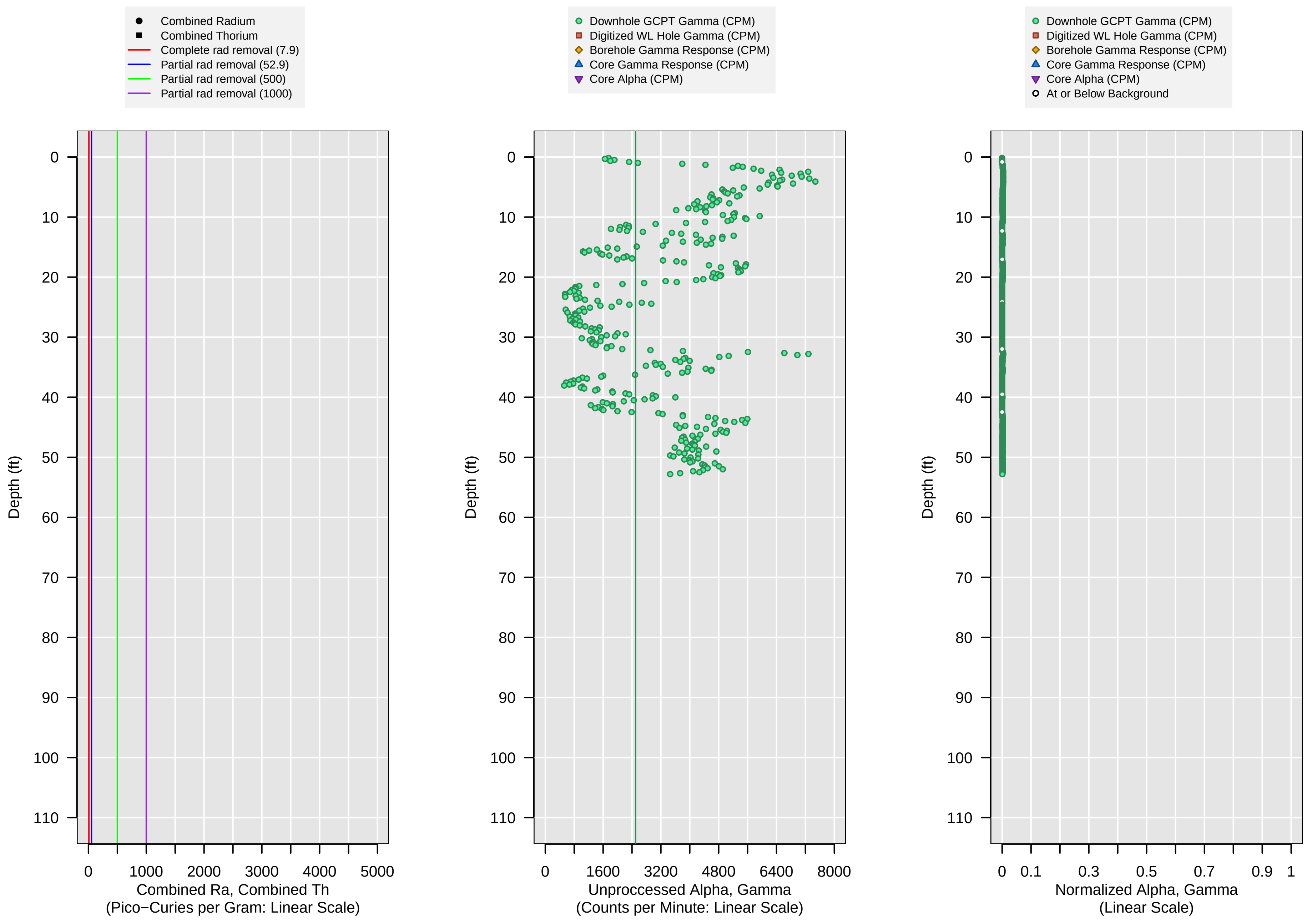

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−12−1


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

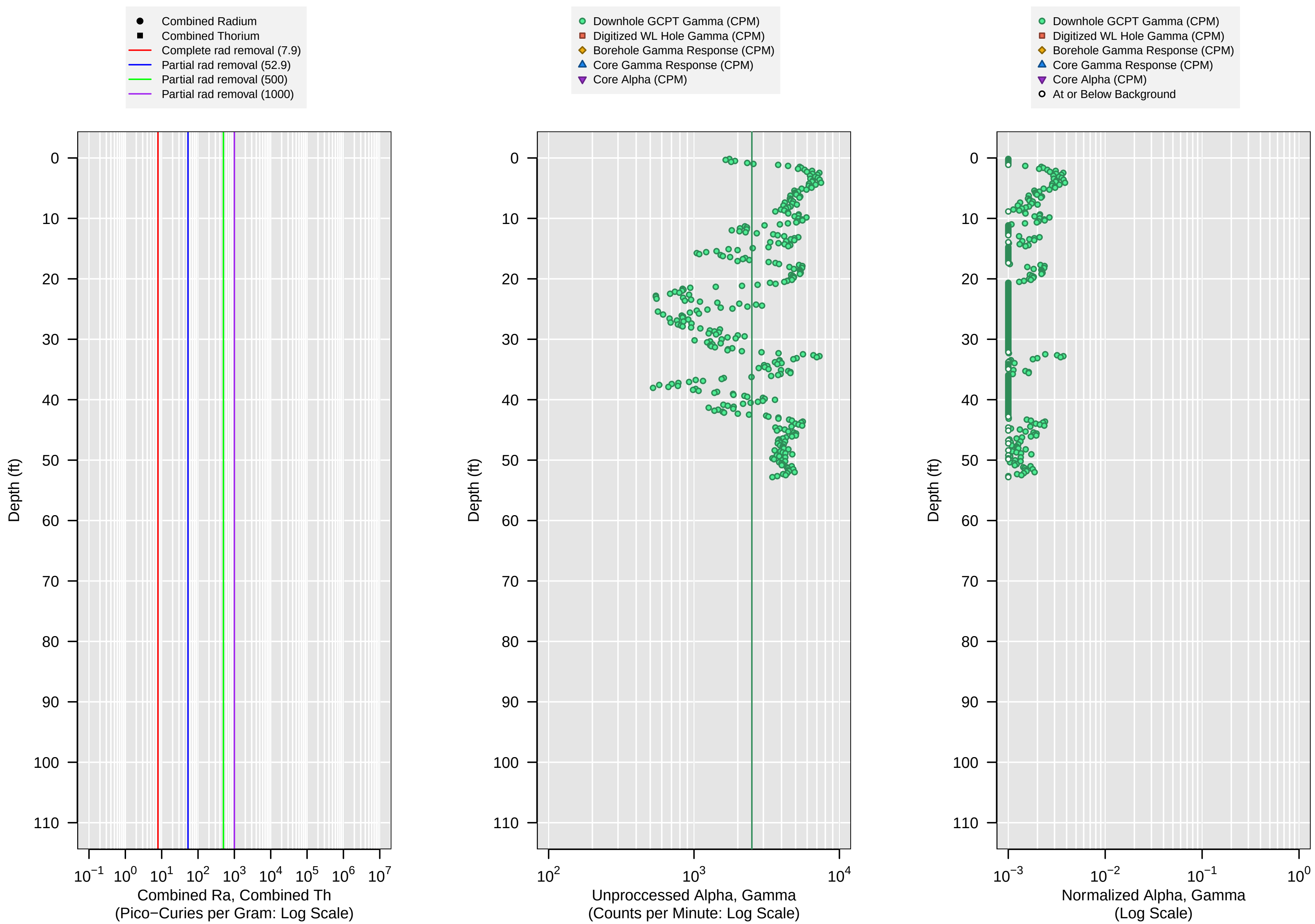

GCPT−12−1
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−12−3



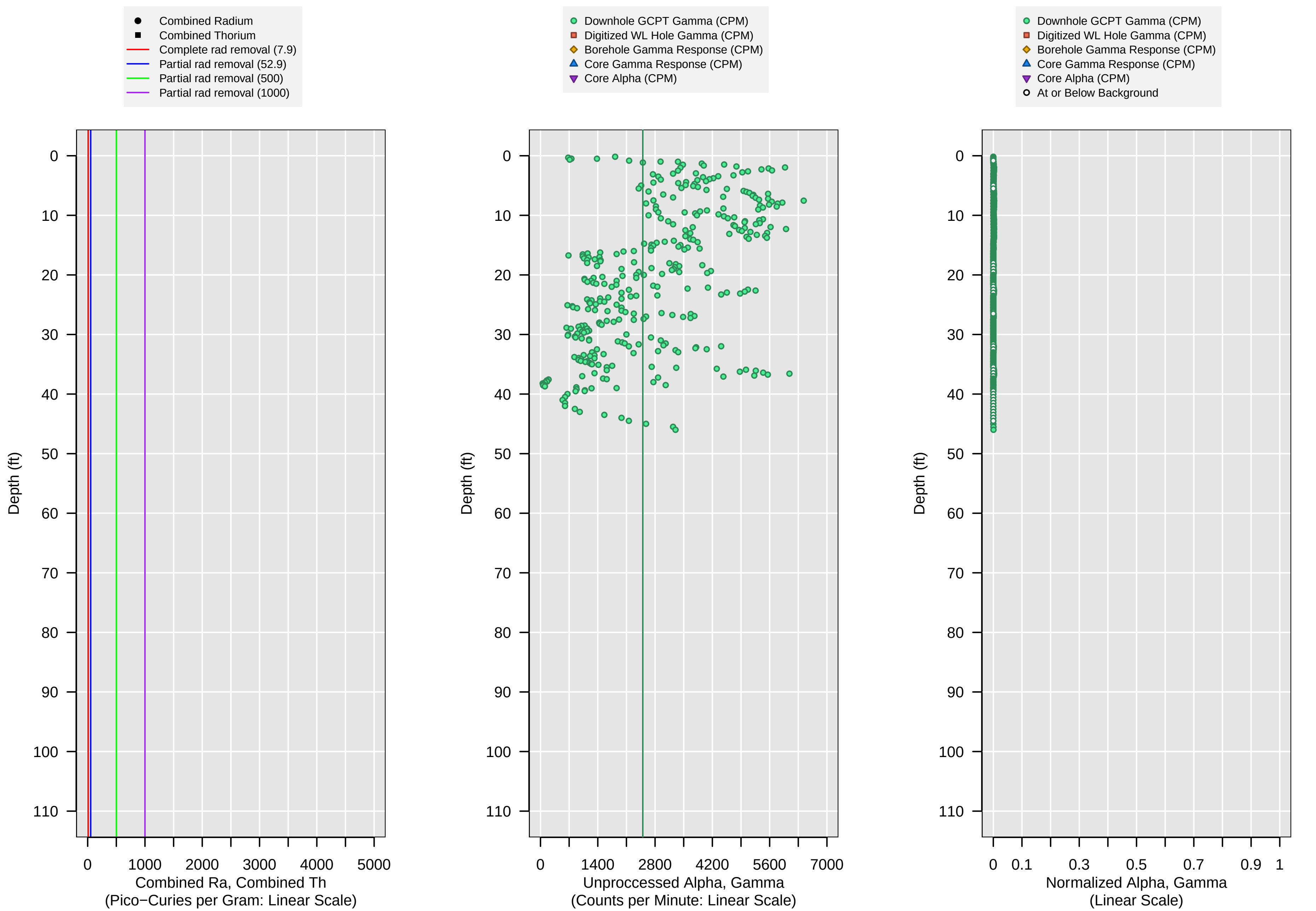
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−12−3



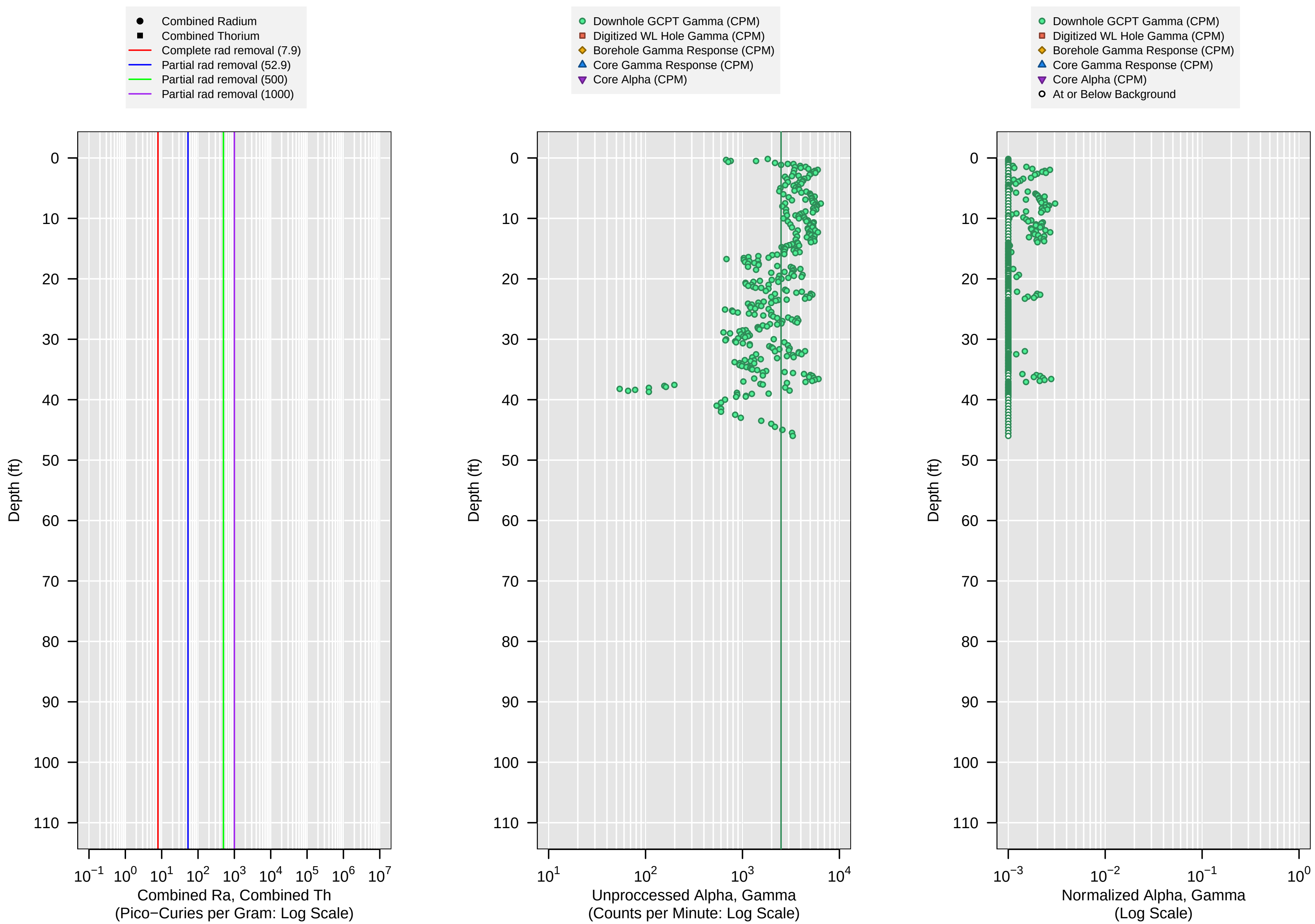
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

GCPT−12−5



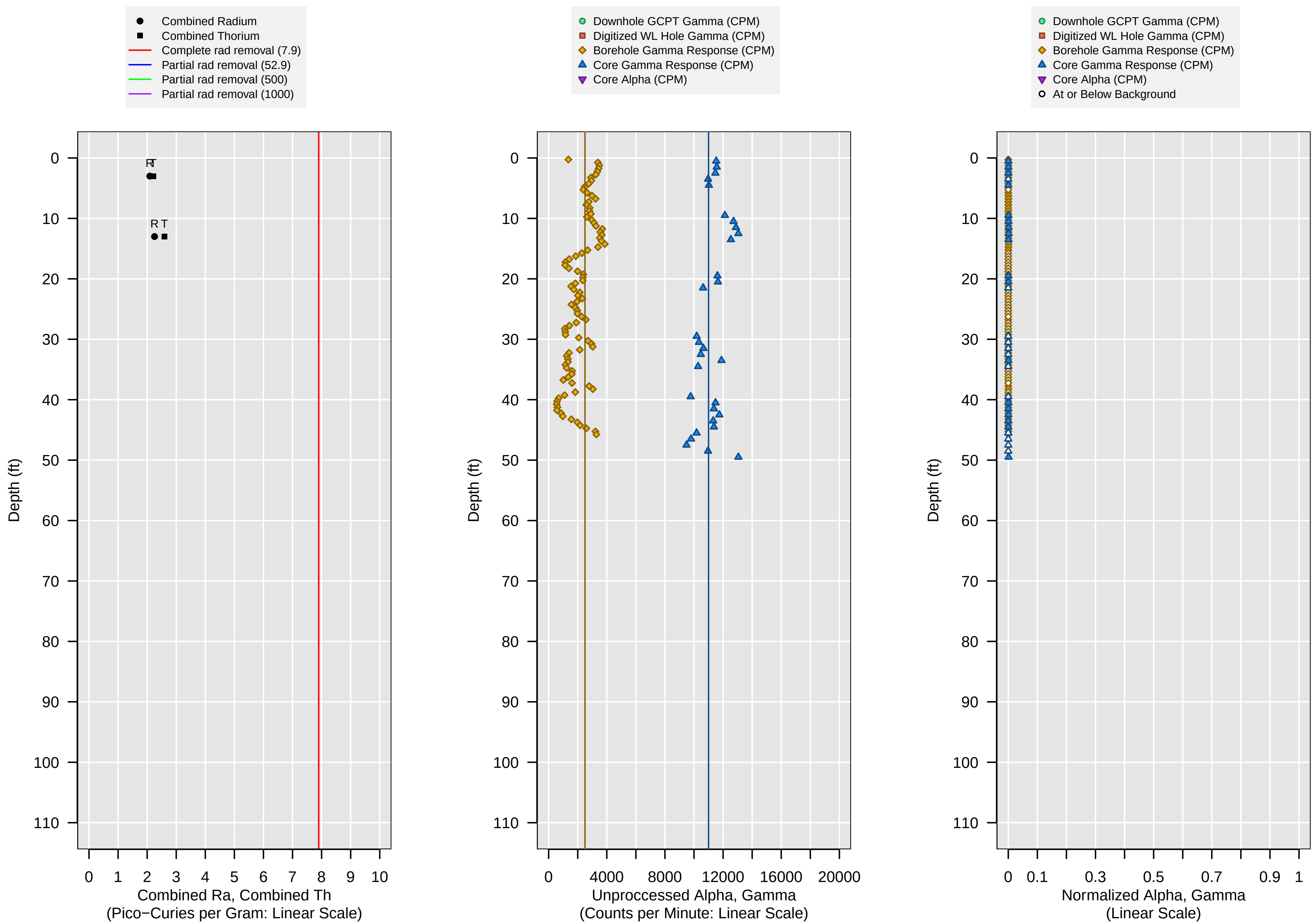
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
1400
2800
4200
5600
7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

GCPT−12−5

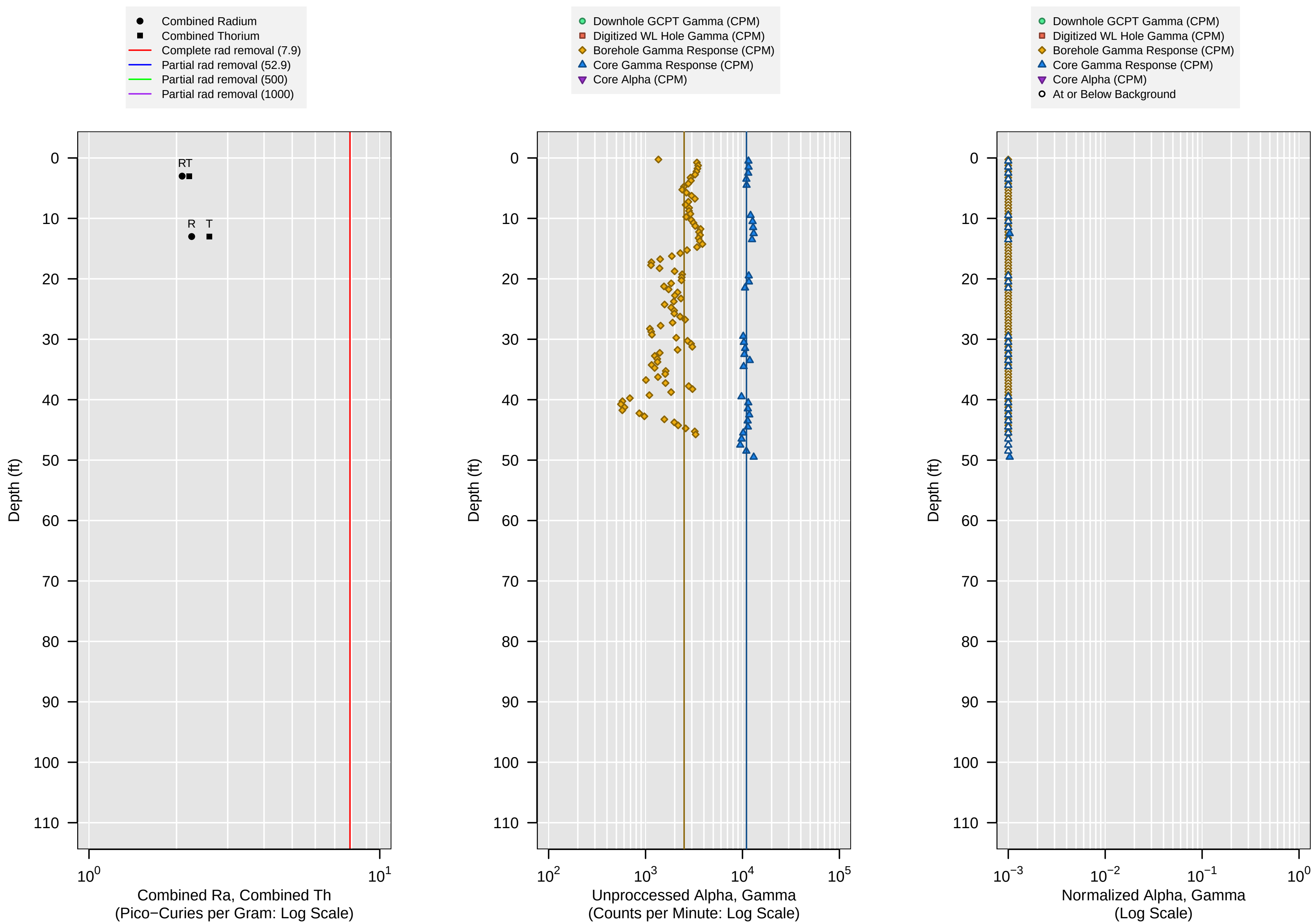


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

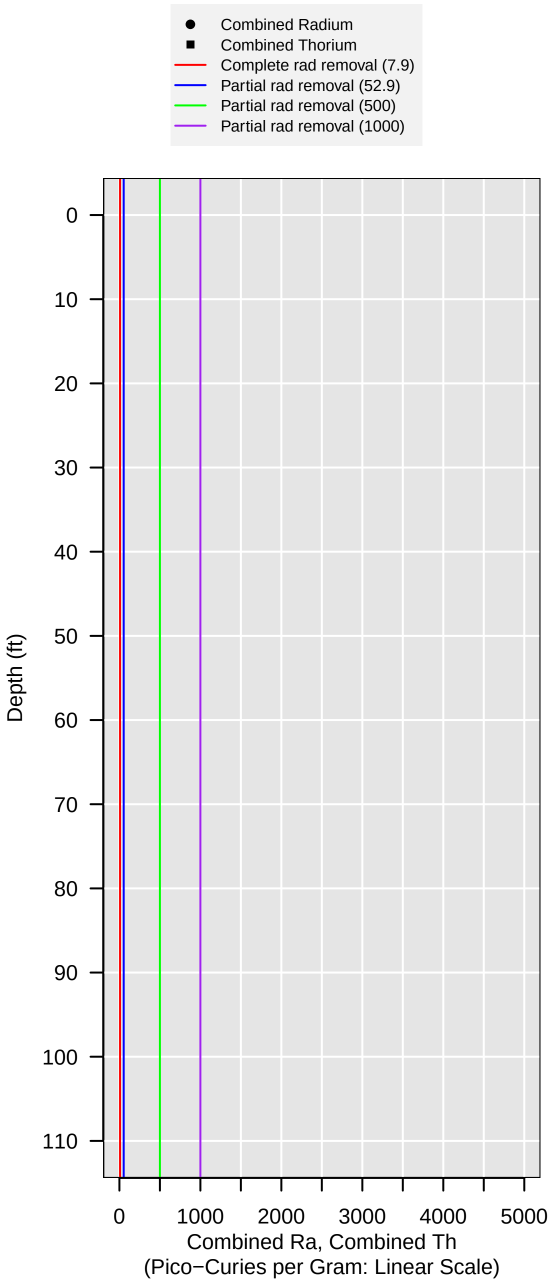
Sonic−12−5

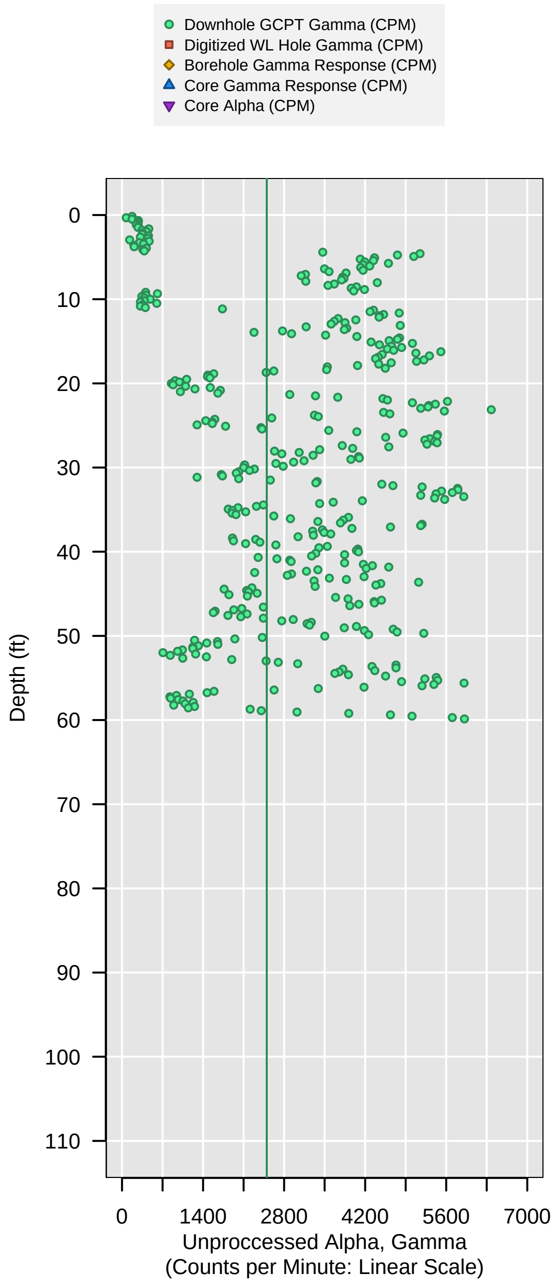

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

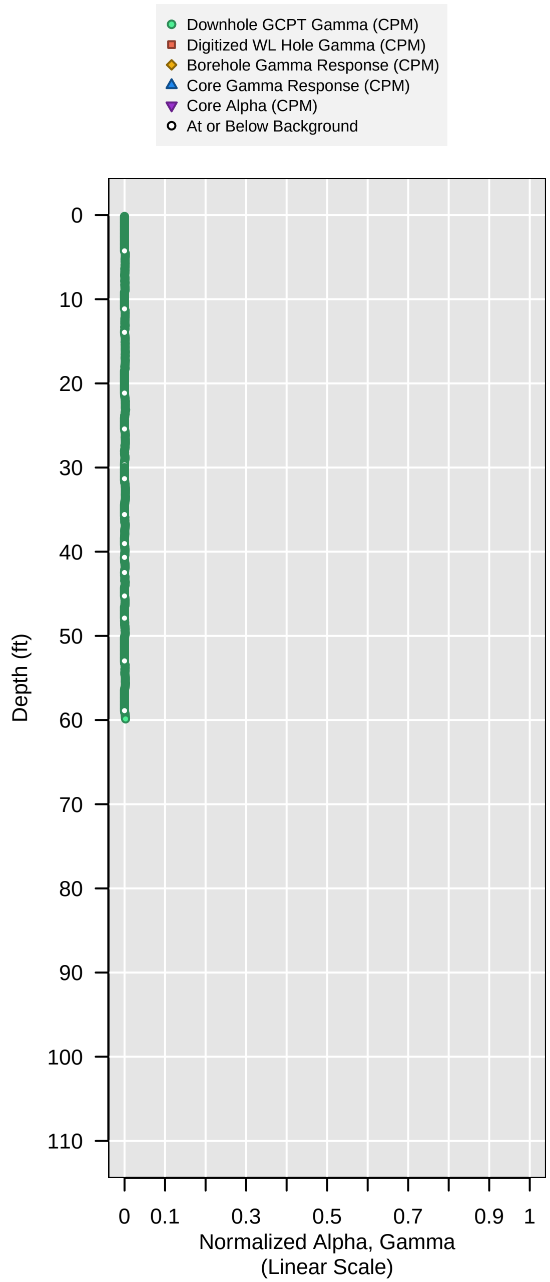
Sonic−12−5

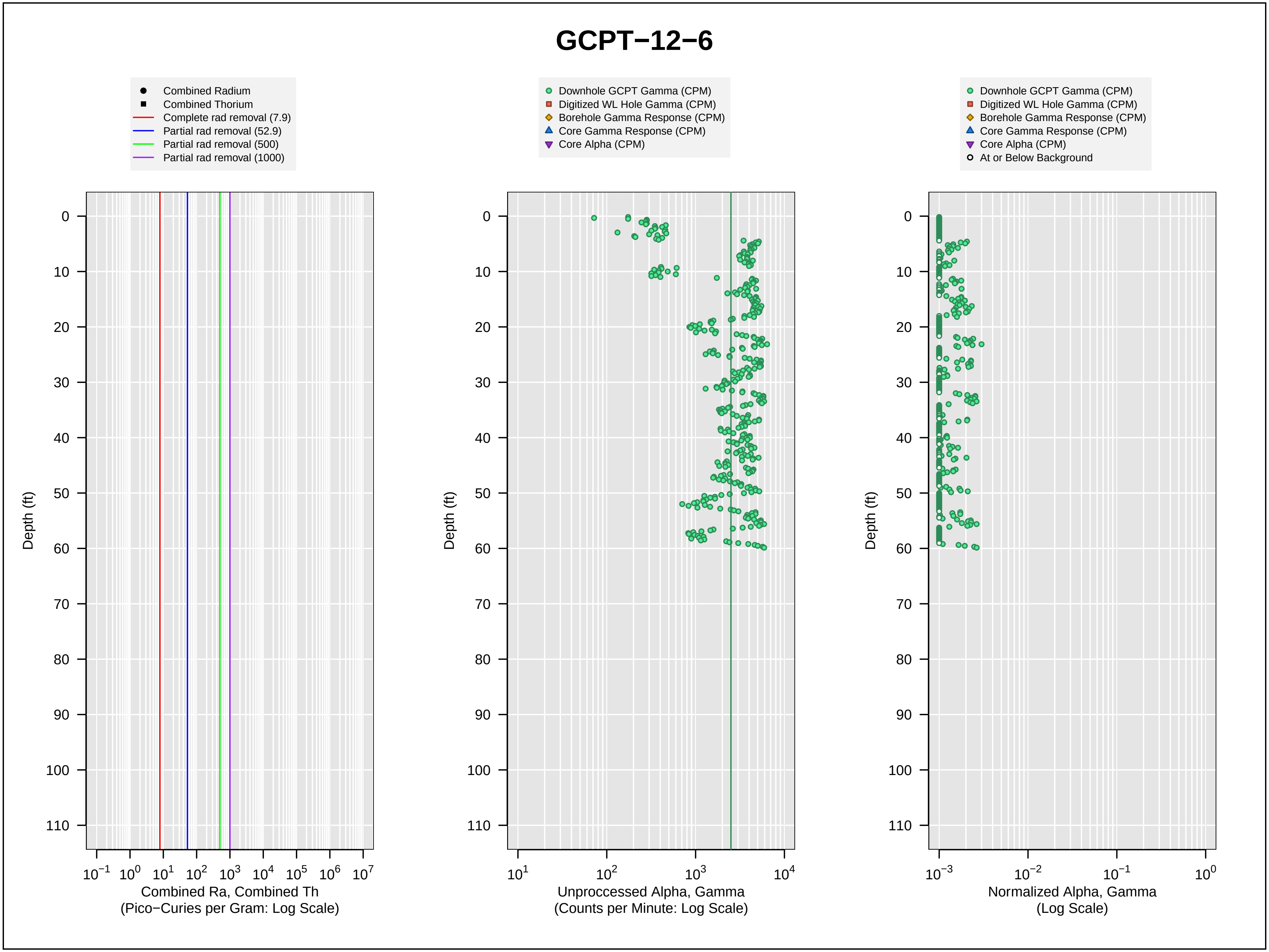

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
RT
R T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−12−6

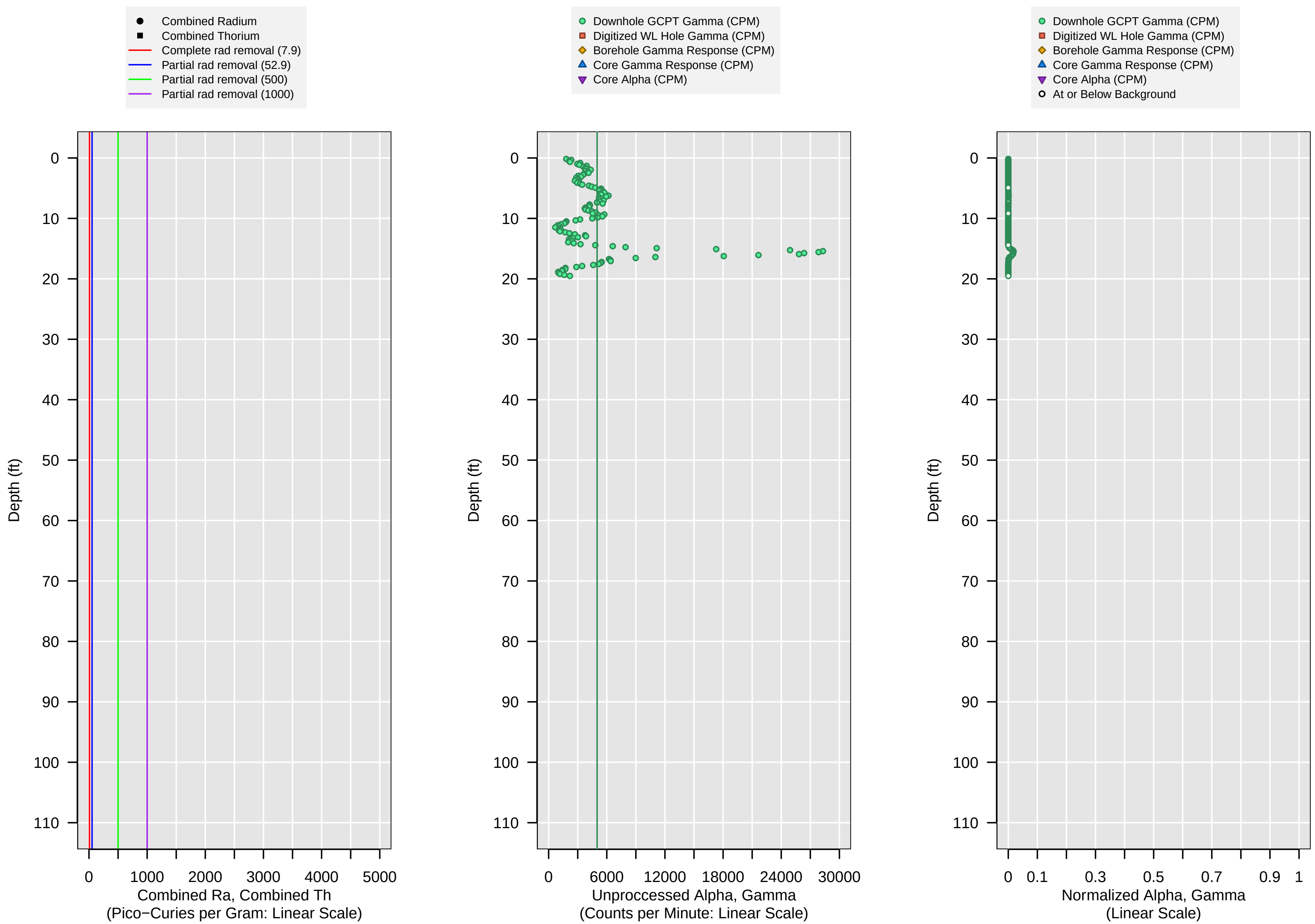

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
1400
2800
4200
5600
7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)

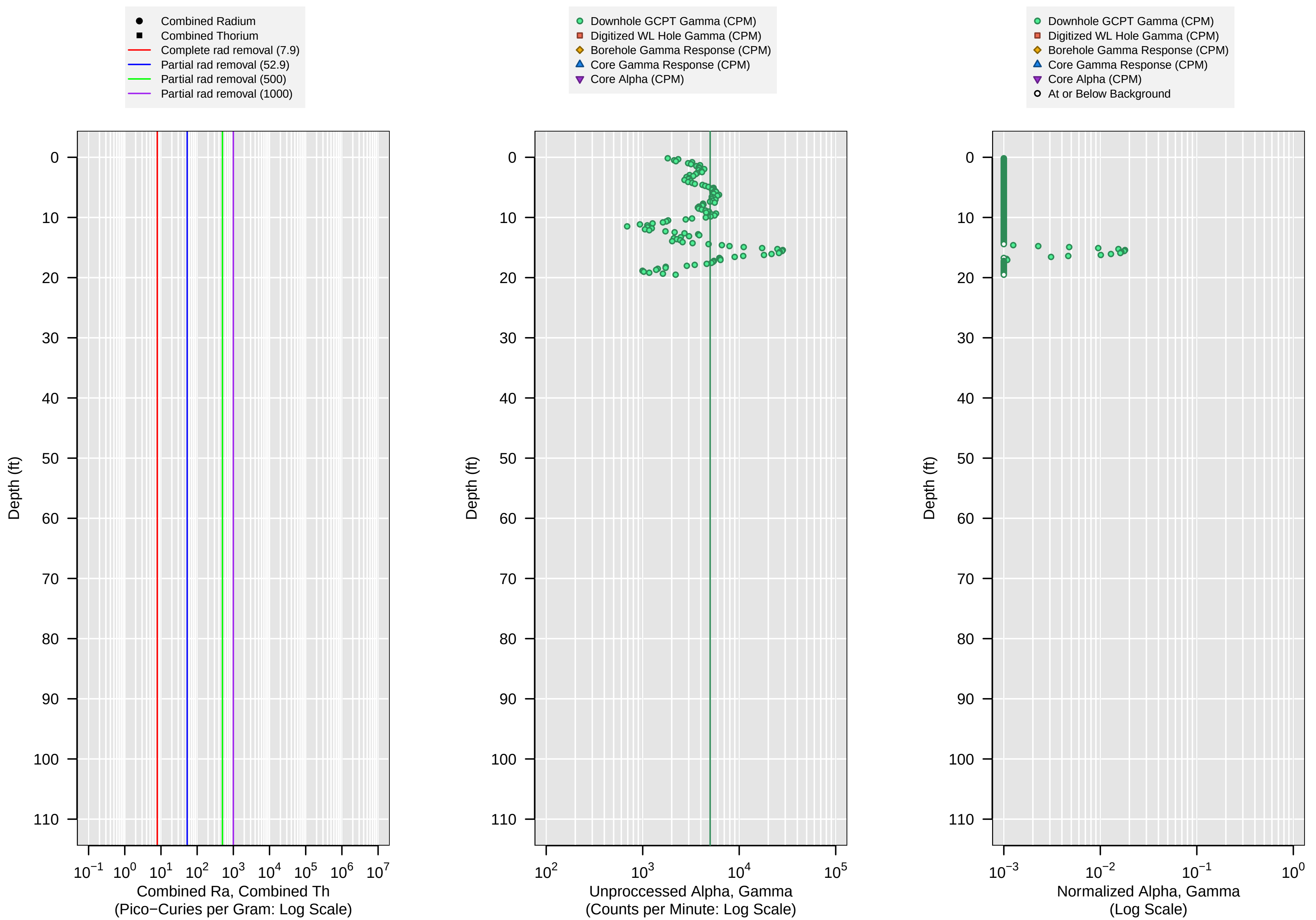

Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)


GCPT−12−6
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

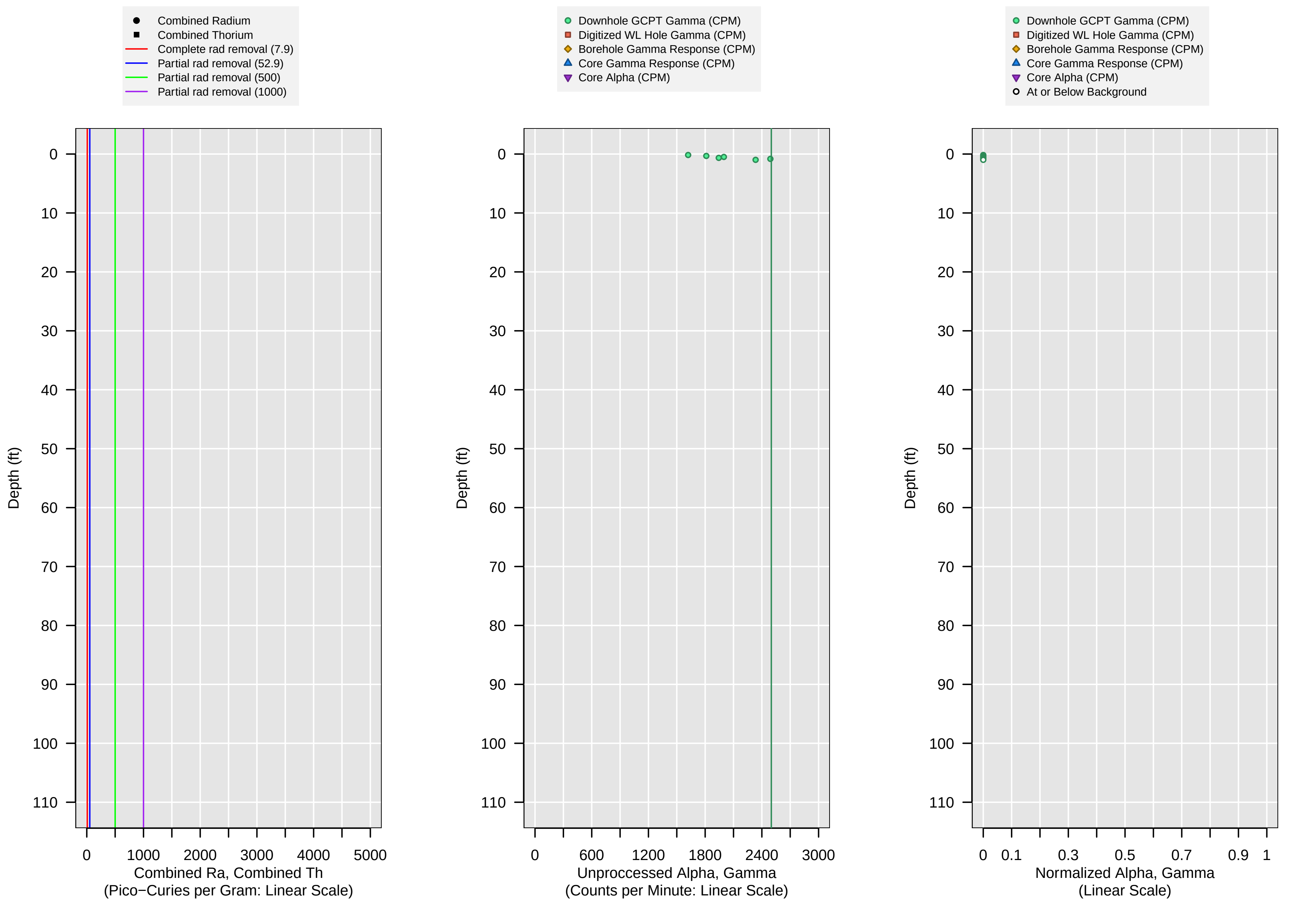
GCPT−13−1


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
6000
12000
18000
24000
30000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

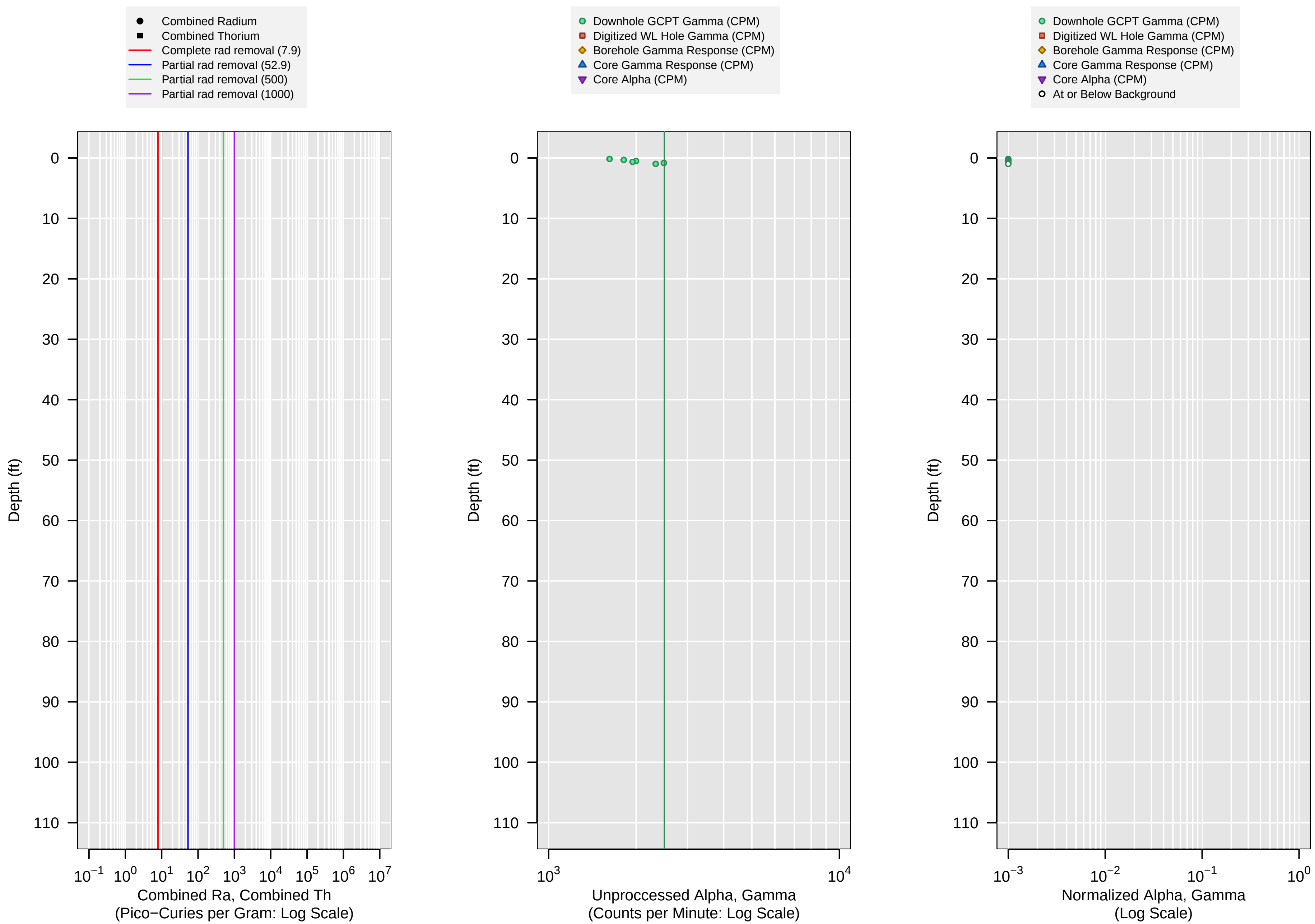
GCPT−13−1


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

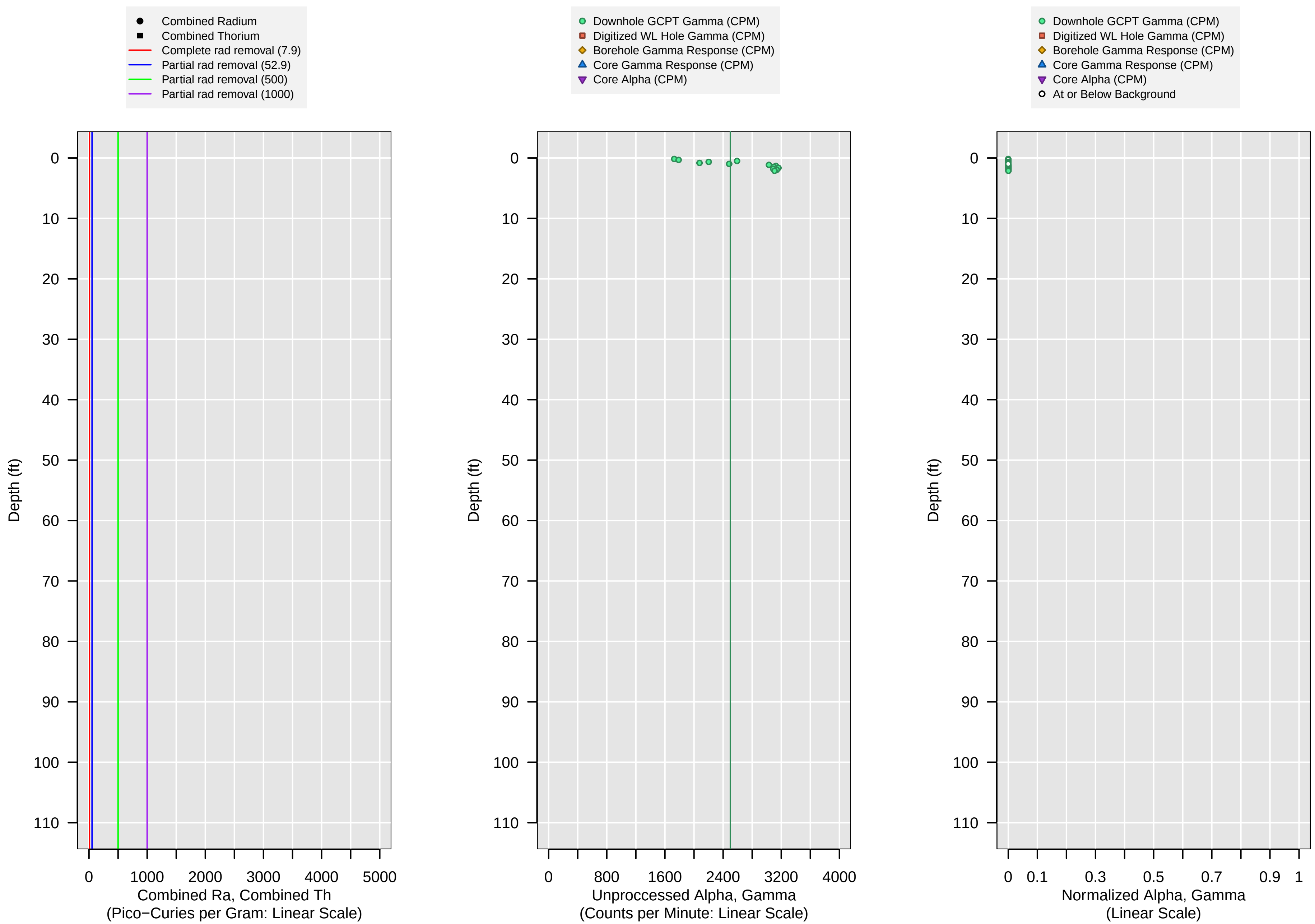
GCPT−13−2


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

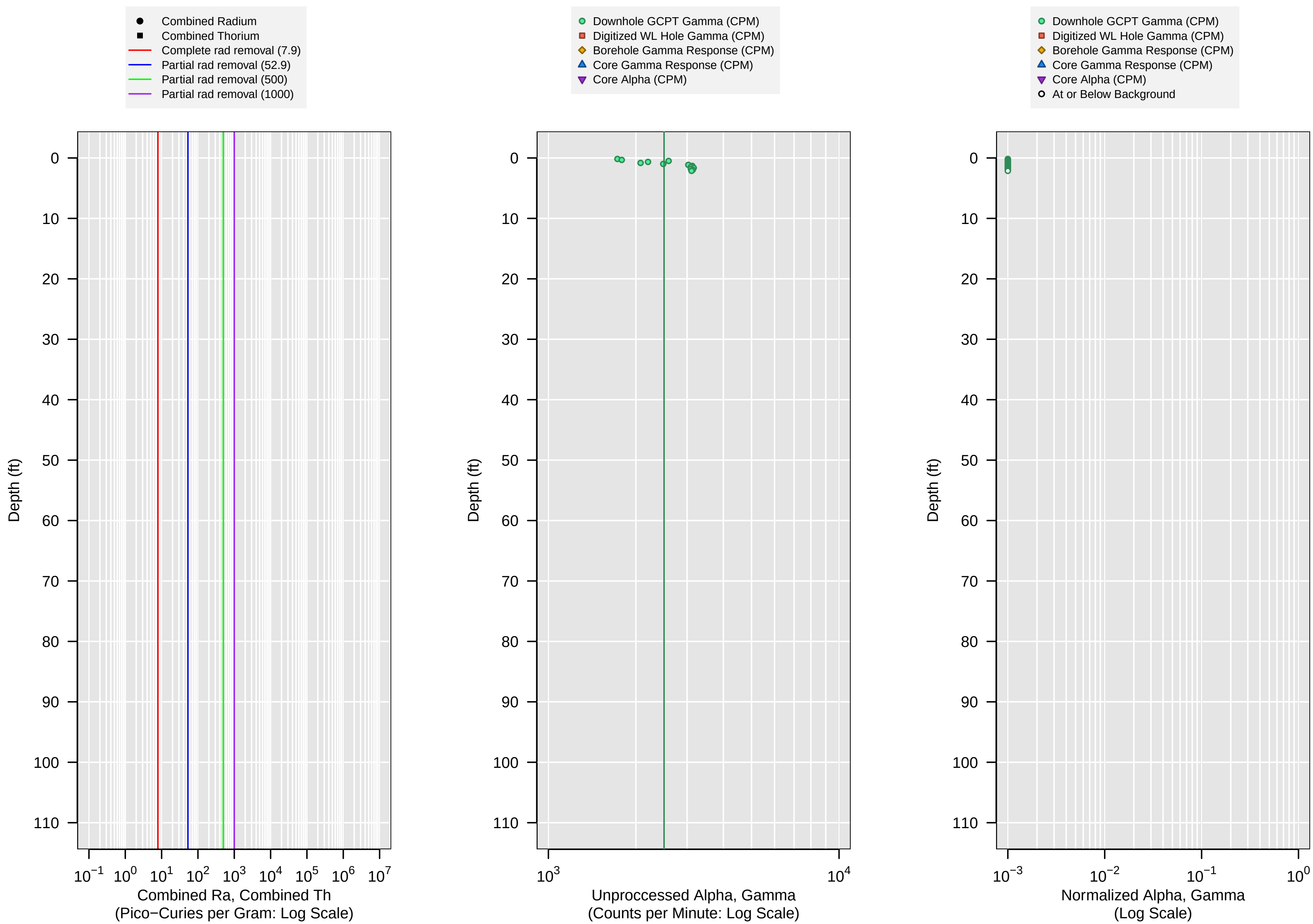
GCPT−13−2


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

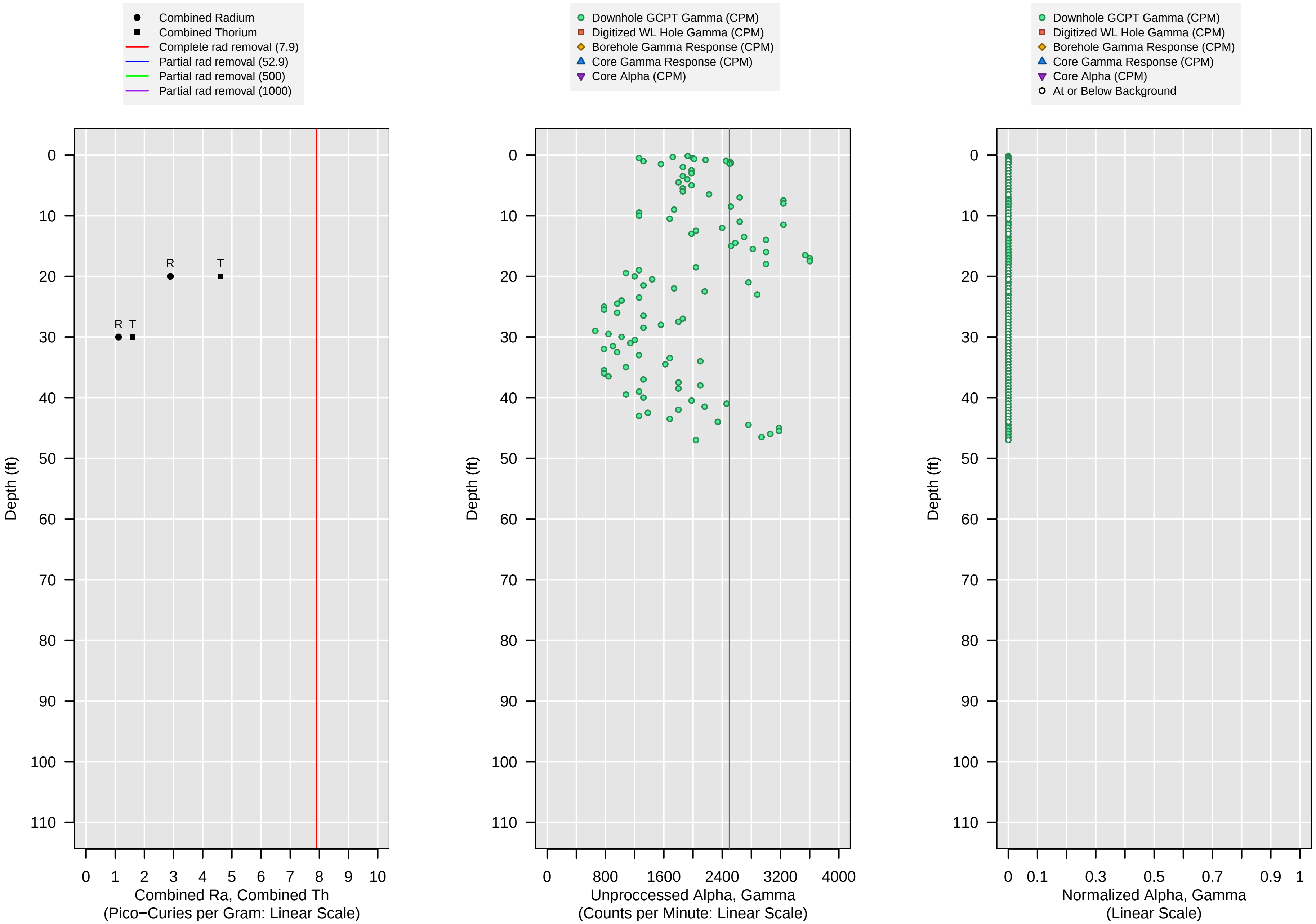
GCPT−13−2A


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0 10 20 30 40 50 60 70 80 90 100 110
0 1000 2000 3000 4000 5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0 800 1600 2400 3200 4000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

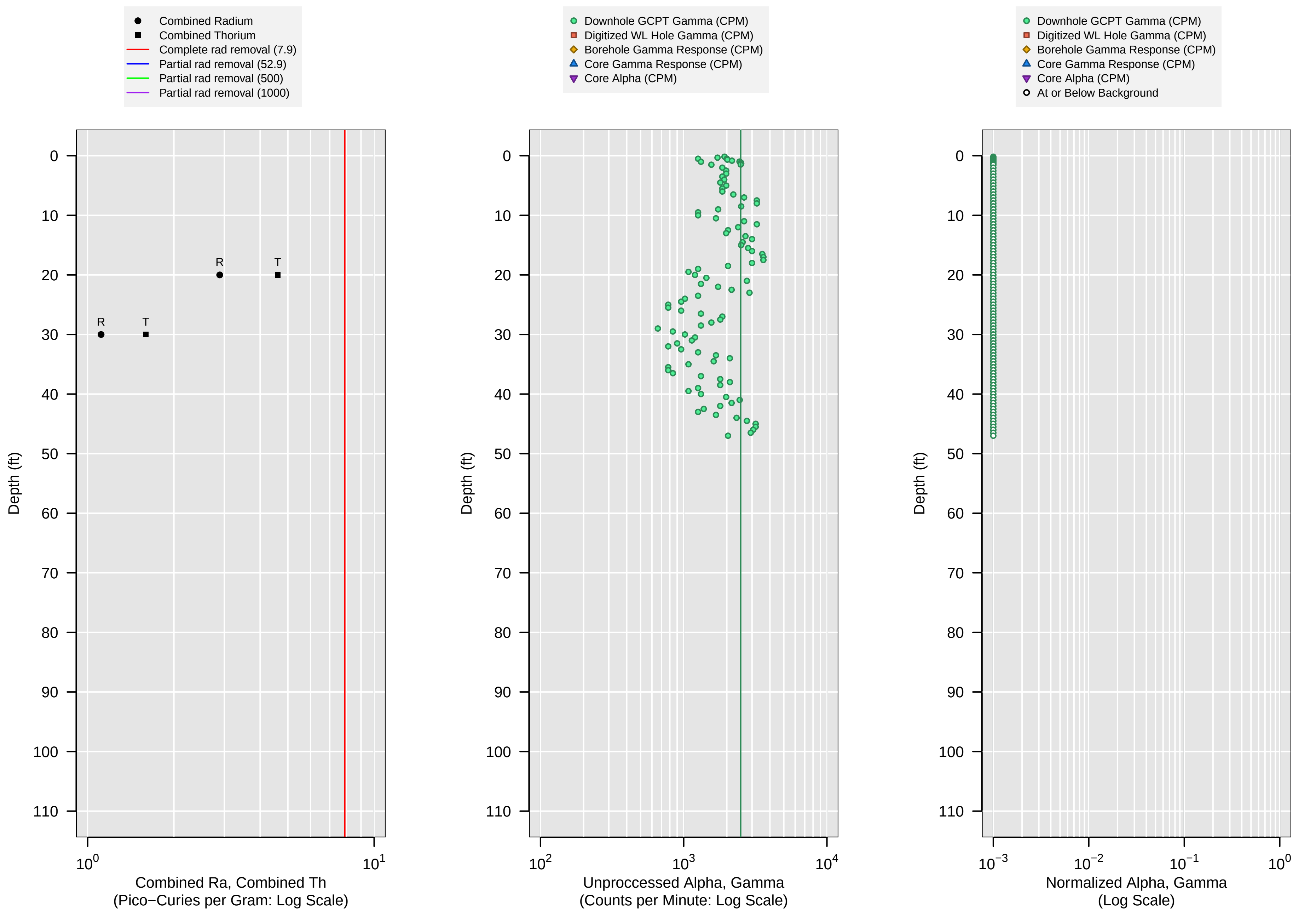
GCPT−13−2A

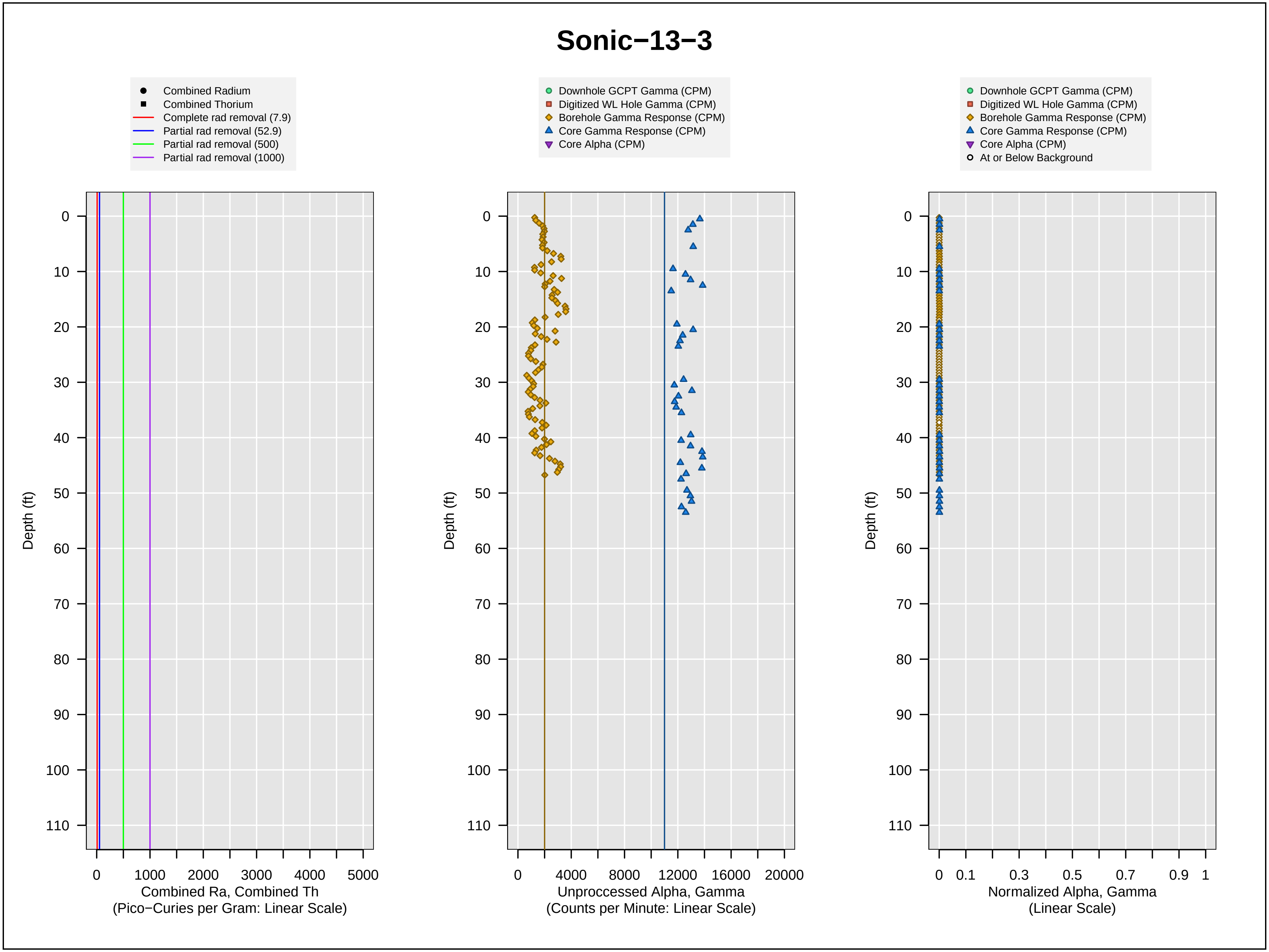

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−13−3

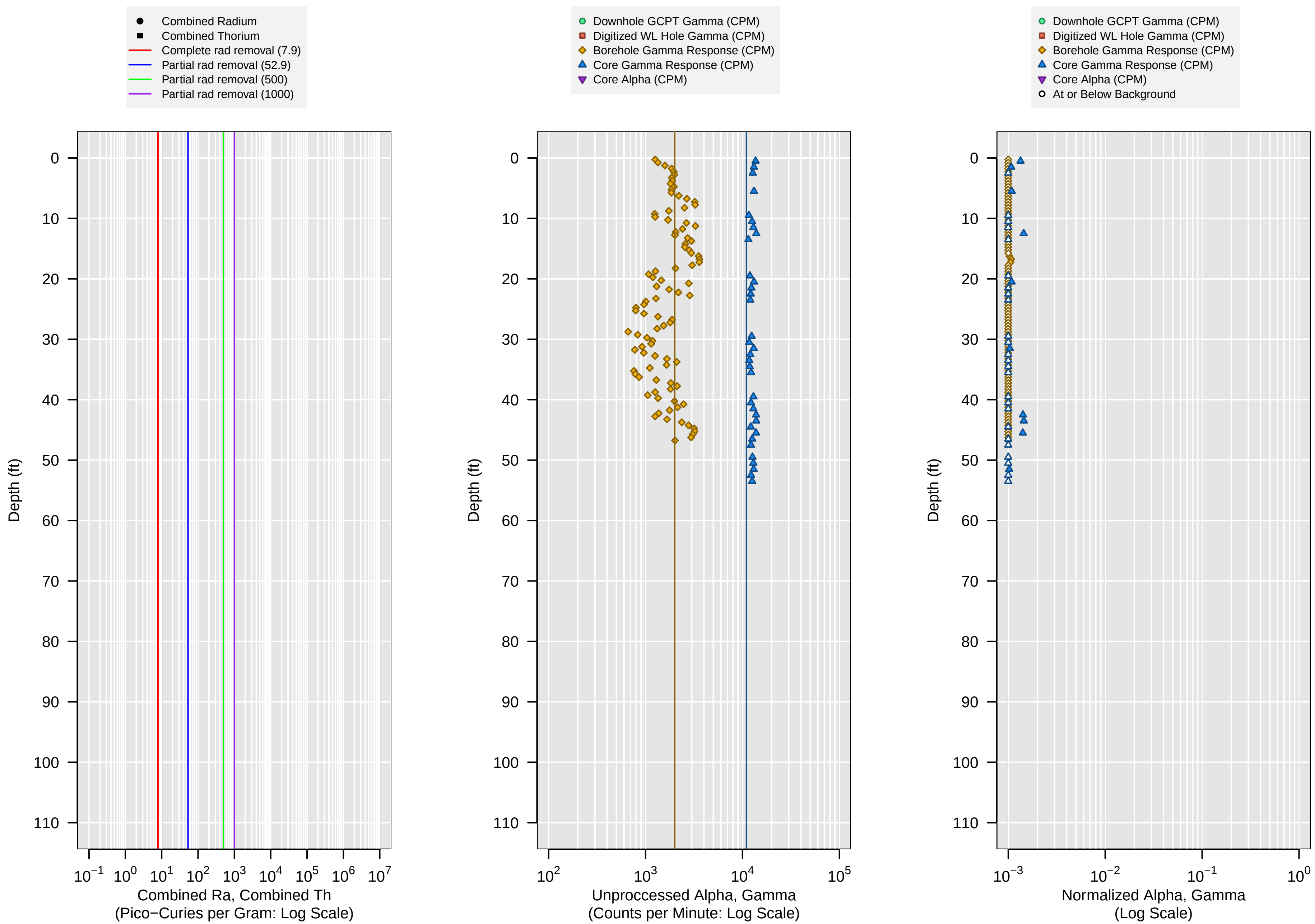

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Linear Scale)

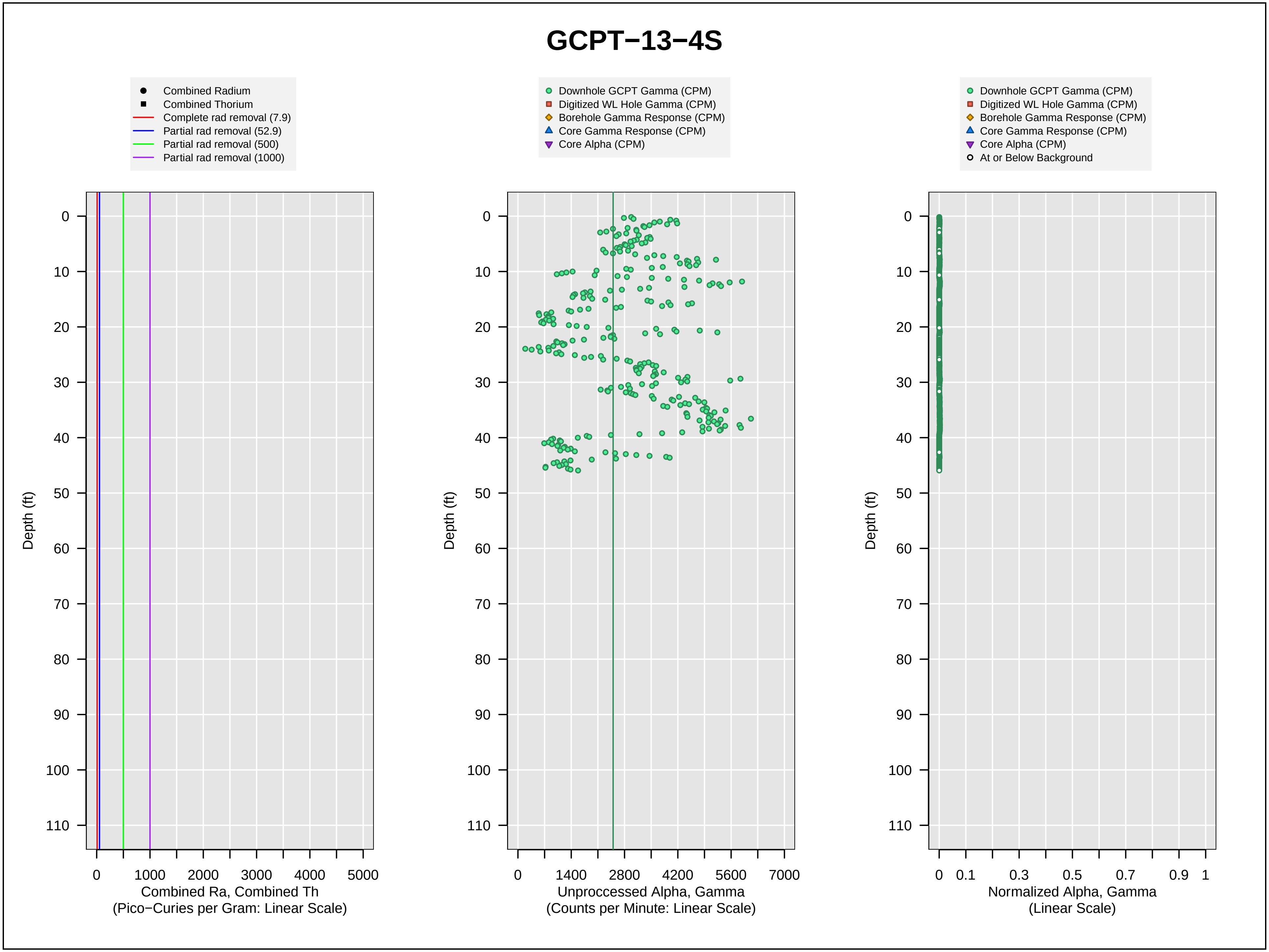
GCPT−13−3


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

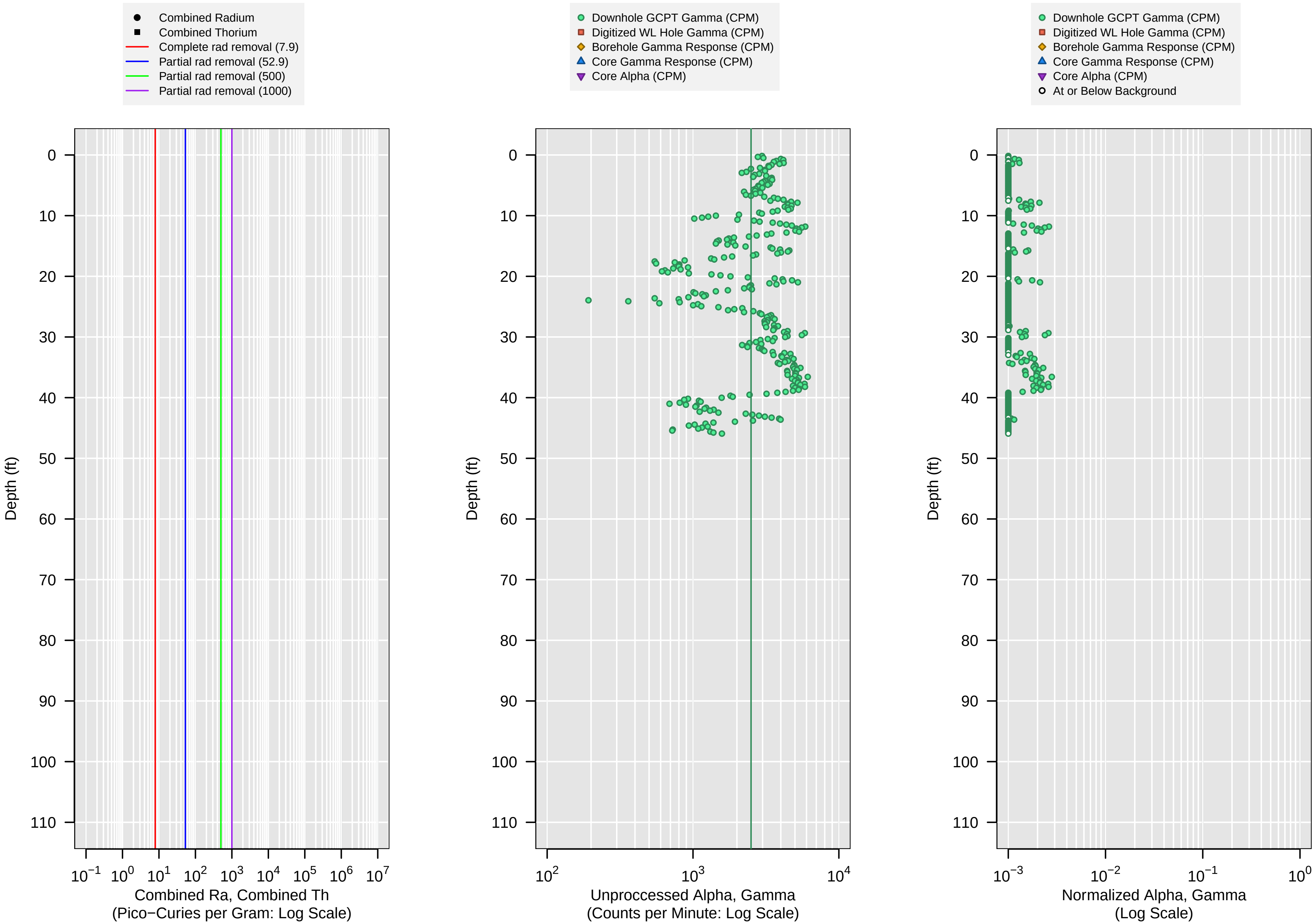

Sonic−13−3
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

Sonic−13−3

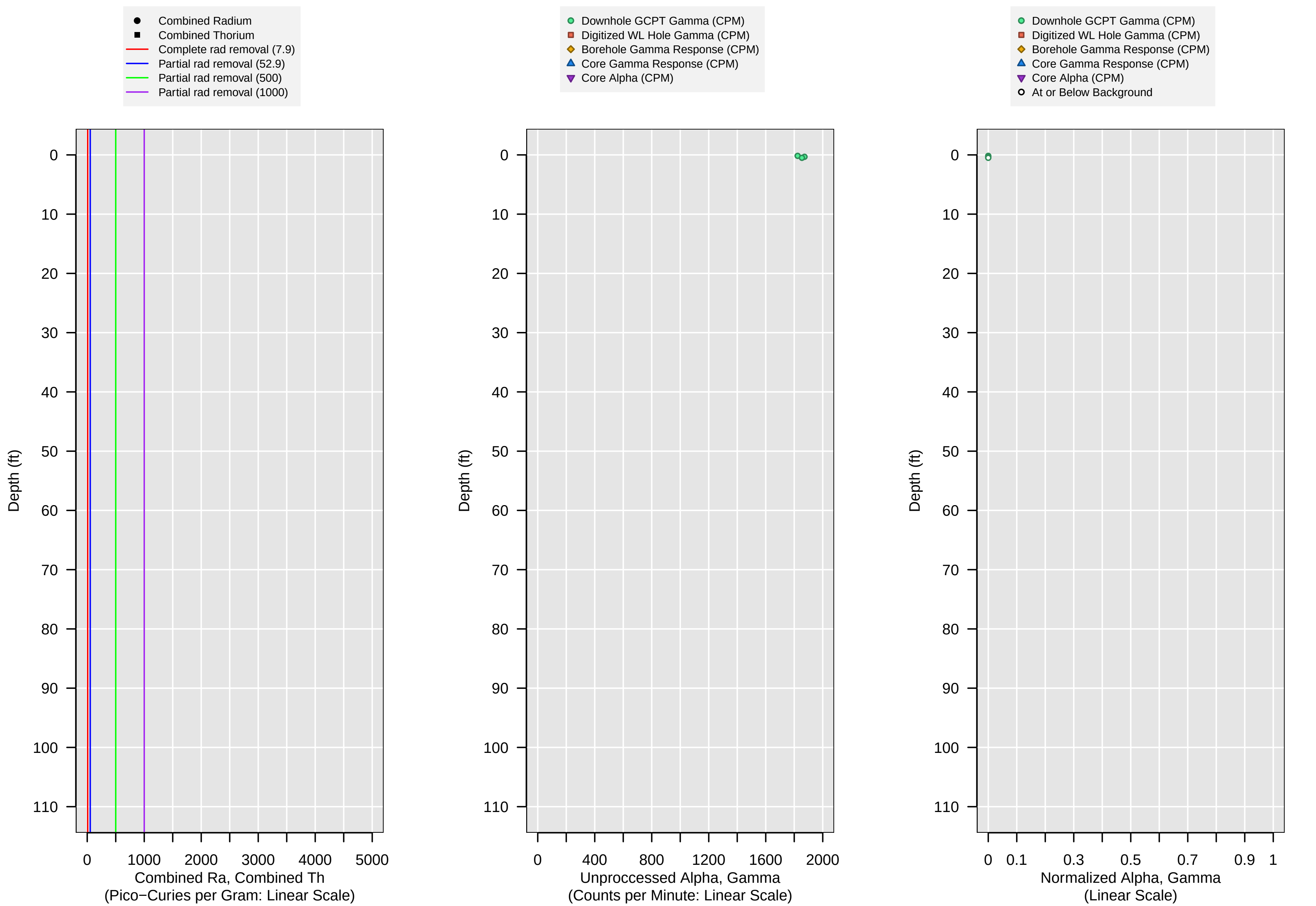

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)


GCPT−13−4S
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
1400
2800
4200
5600
7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

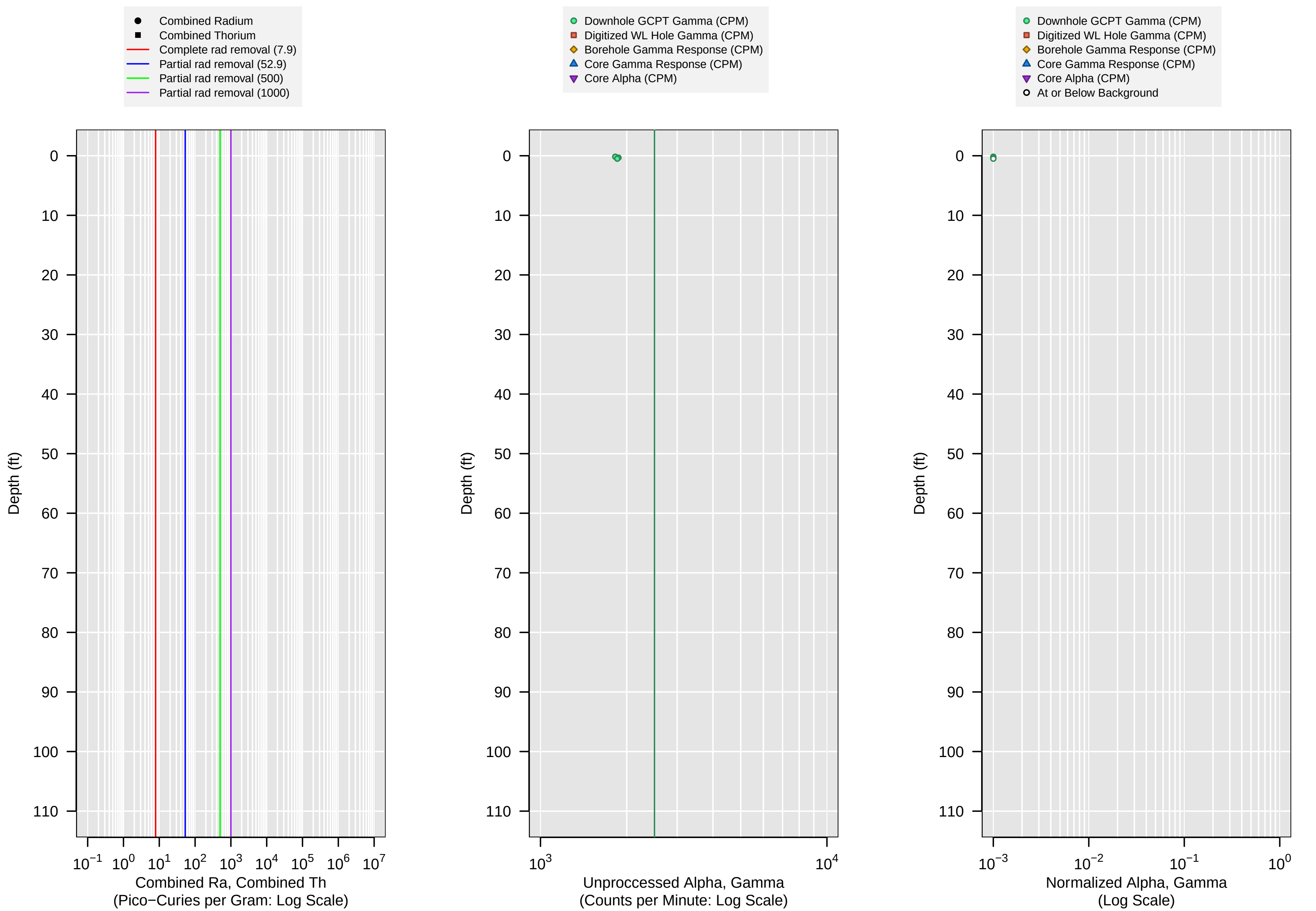
GCPT−13−4S


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

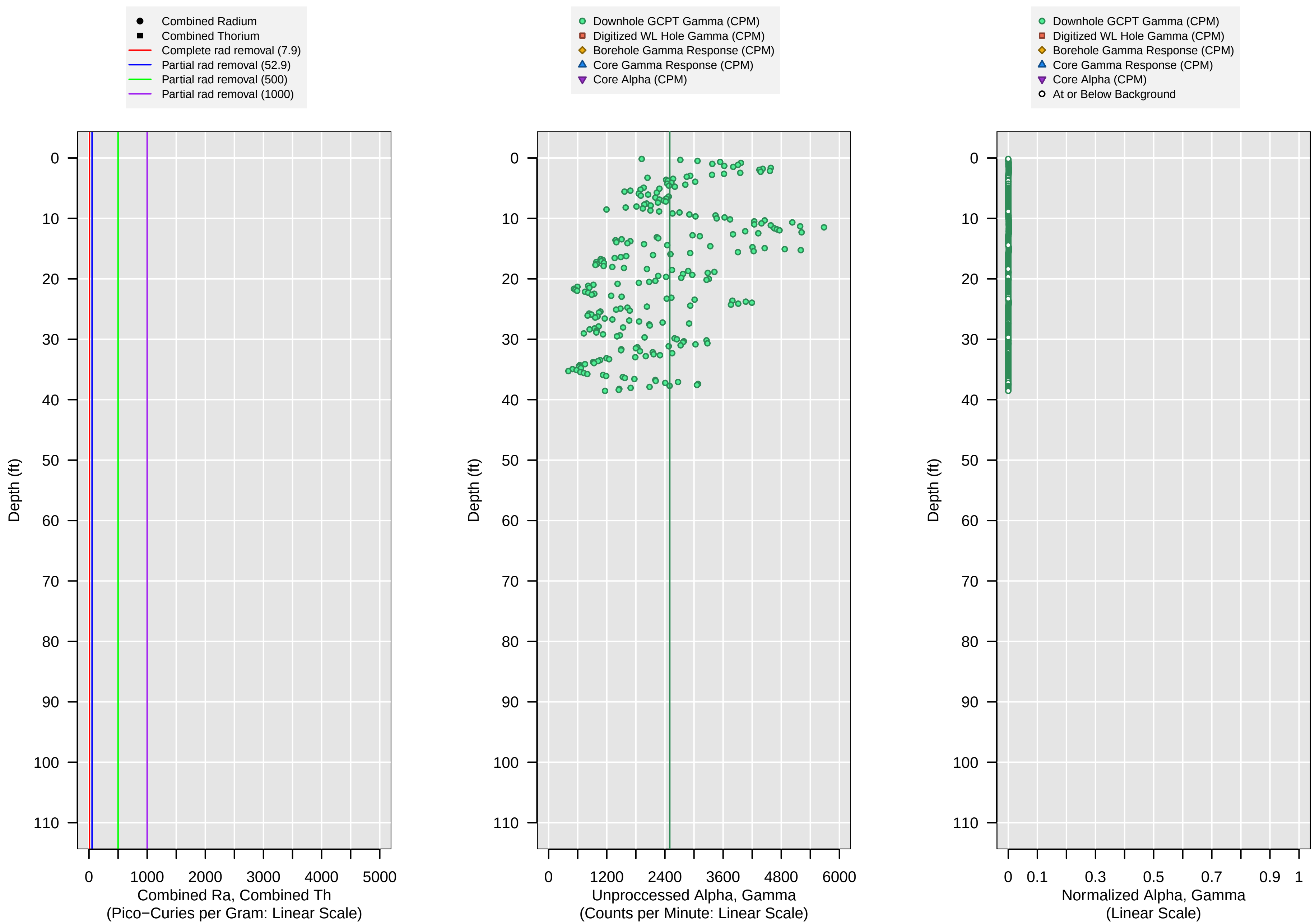
GCPT−13−5


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
400
800
1200
1600
2000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

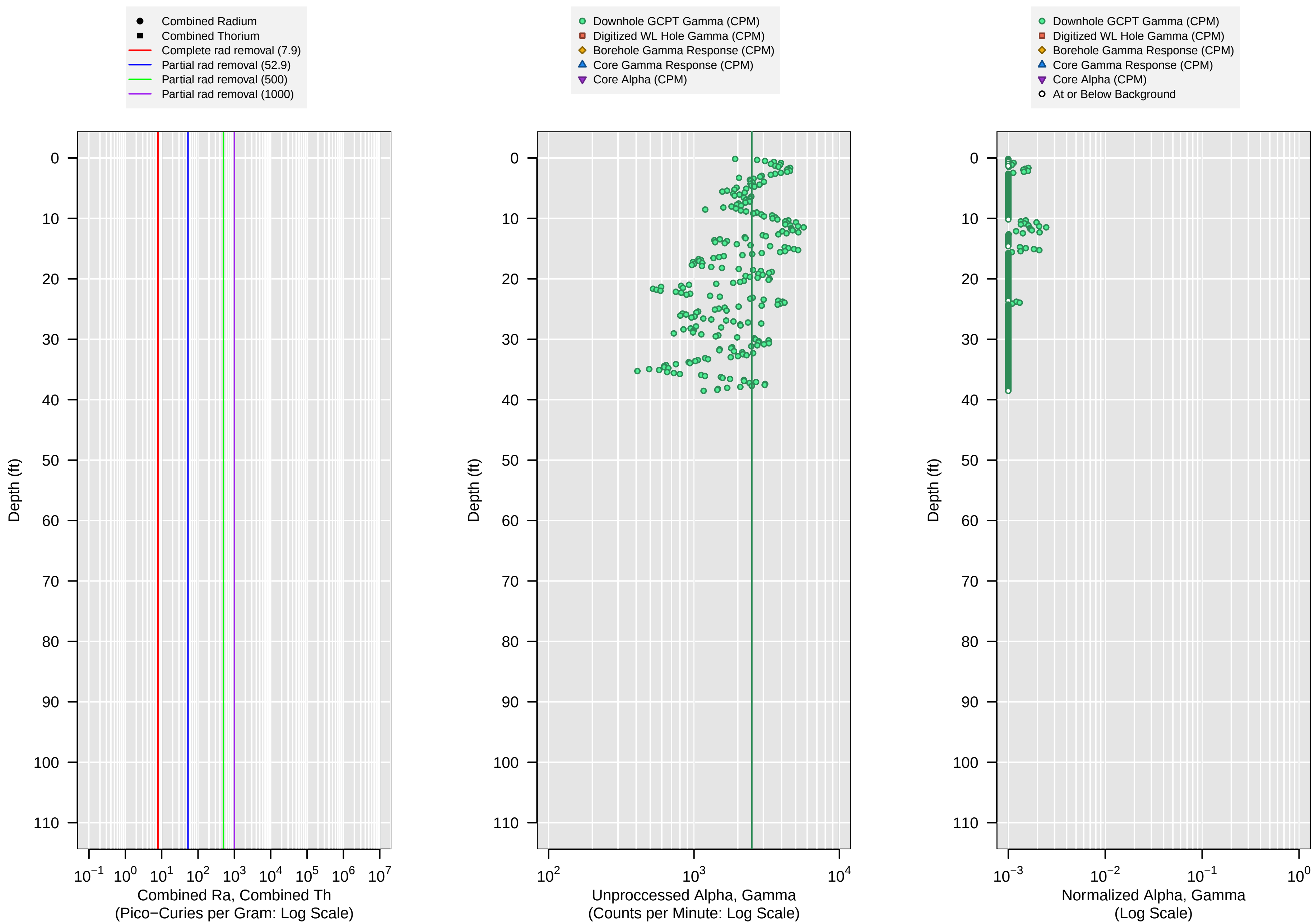
GCPT−13−5


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

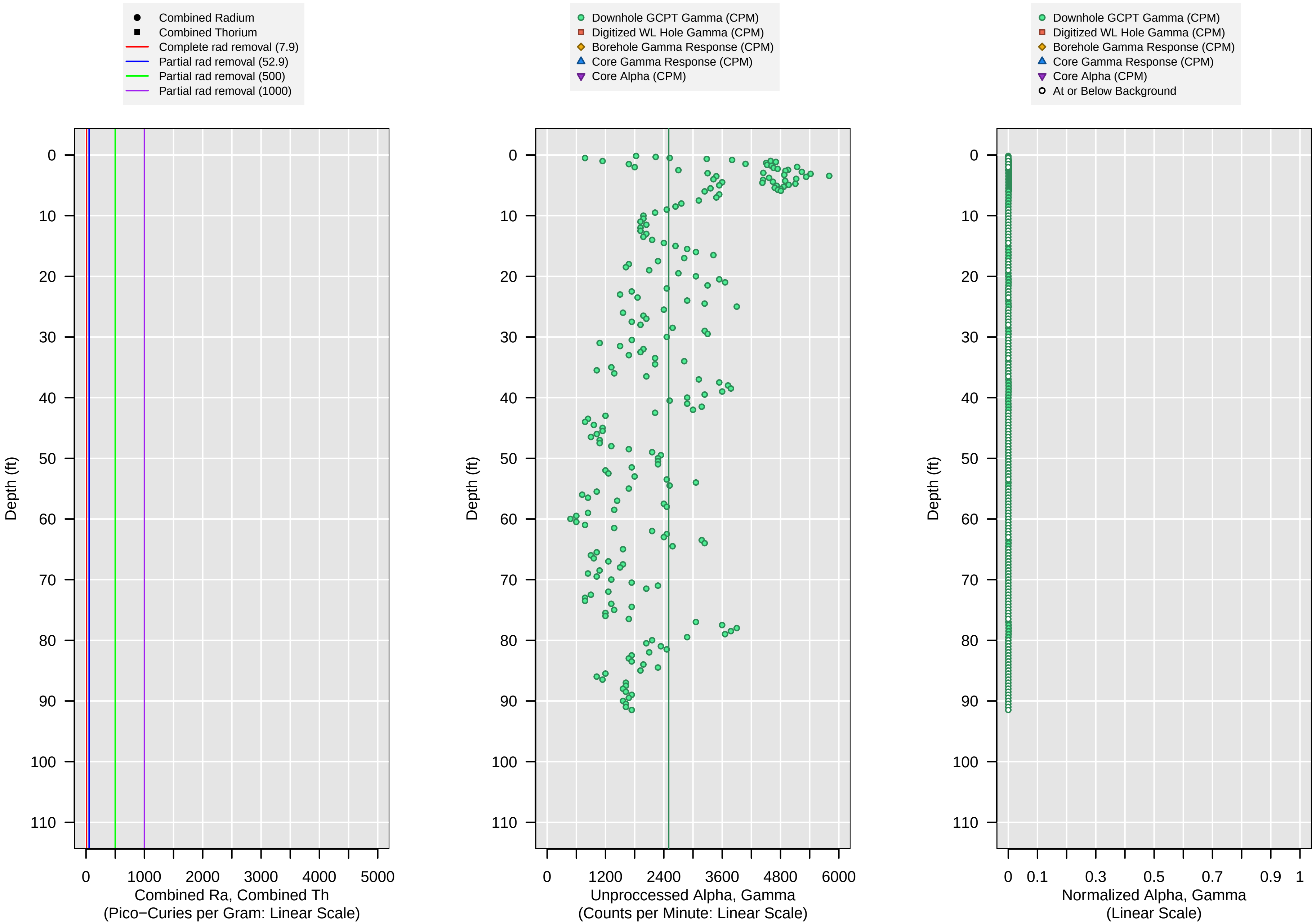
GCPT−13−5S


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−13−5S

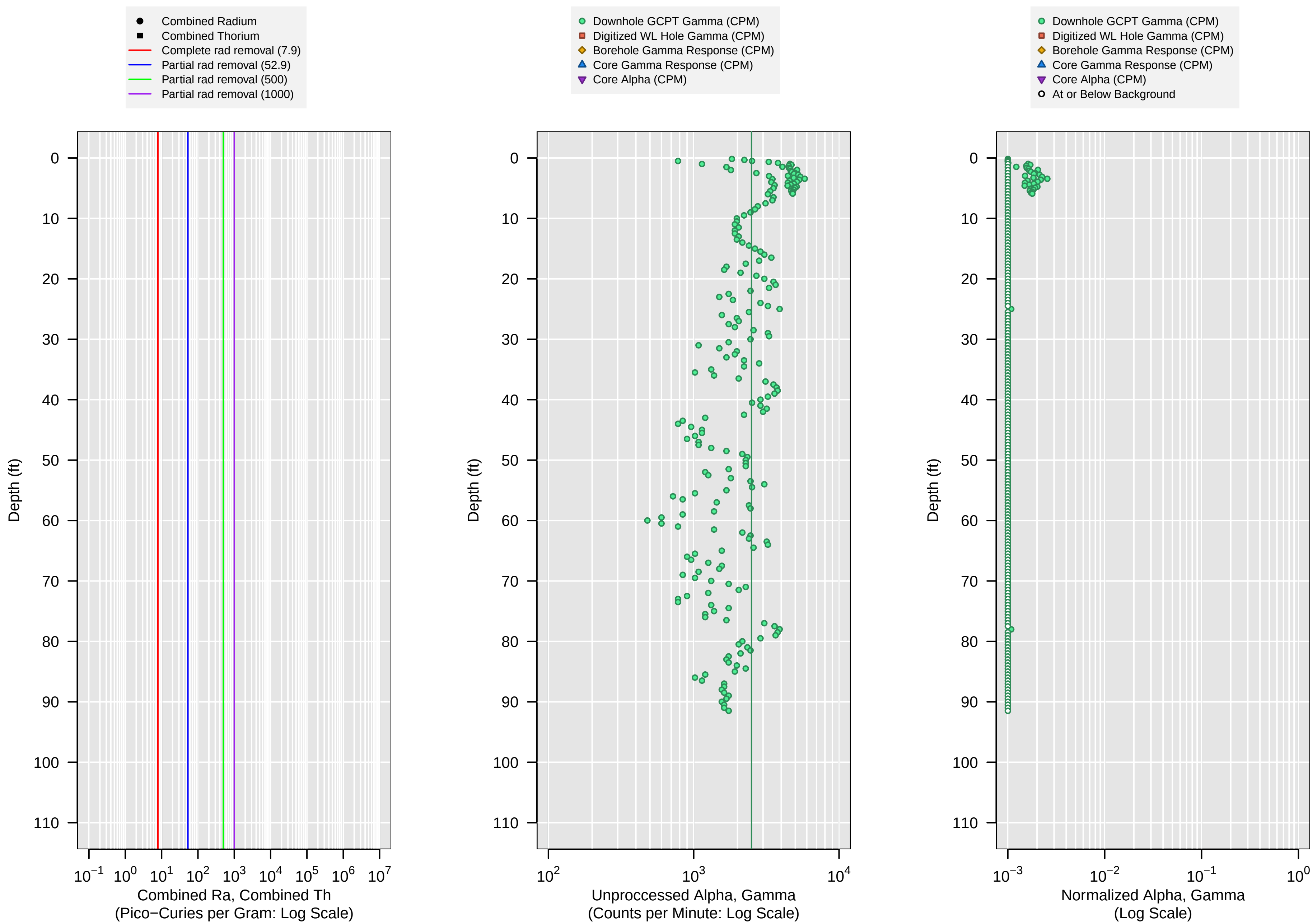

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−13−6

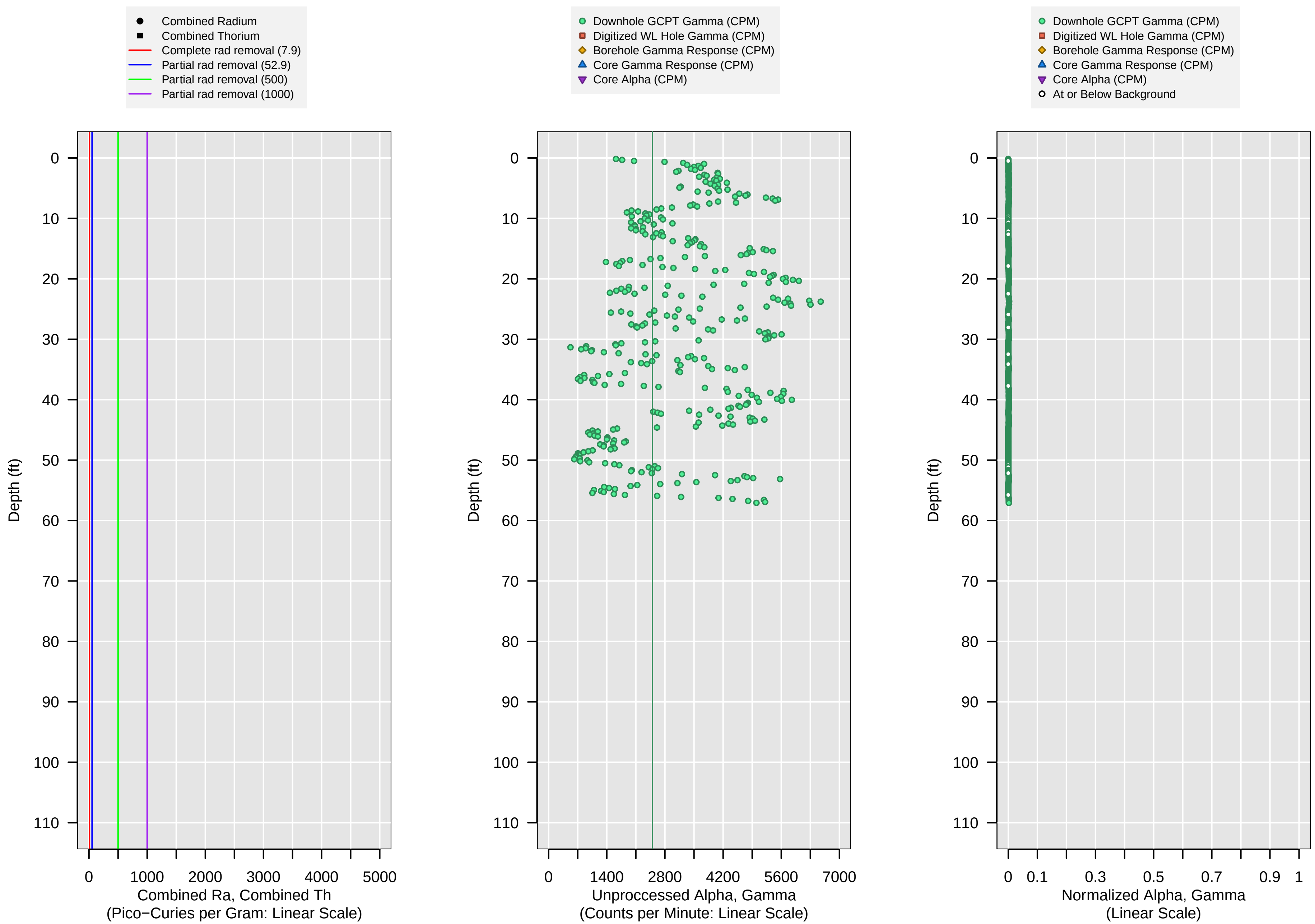


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 1000 2000 3000 4000 5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0 1200 2400 3600 4800 6000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

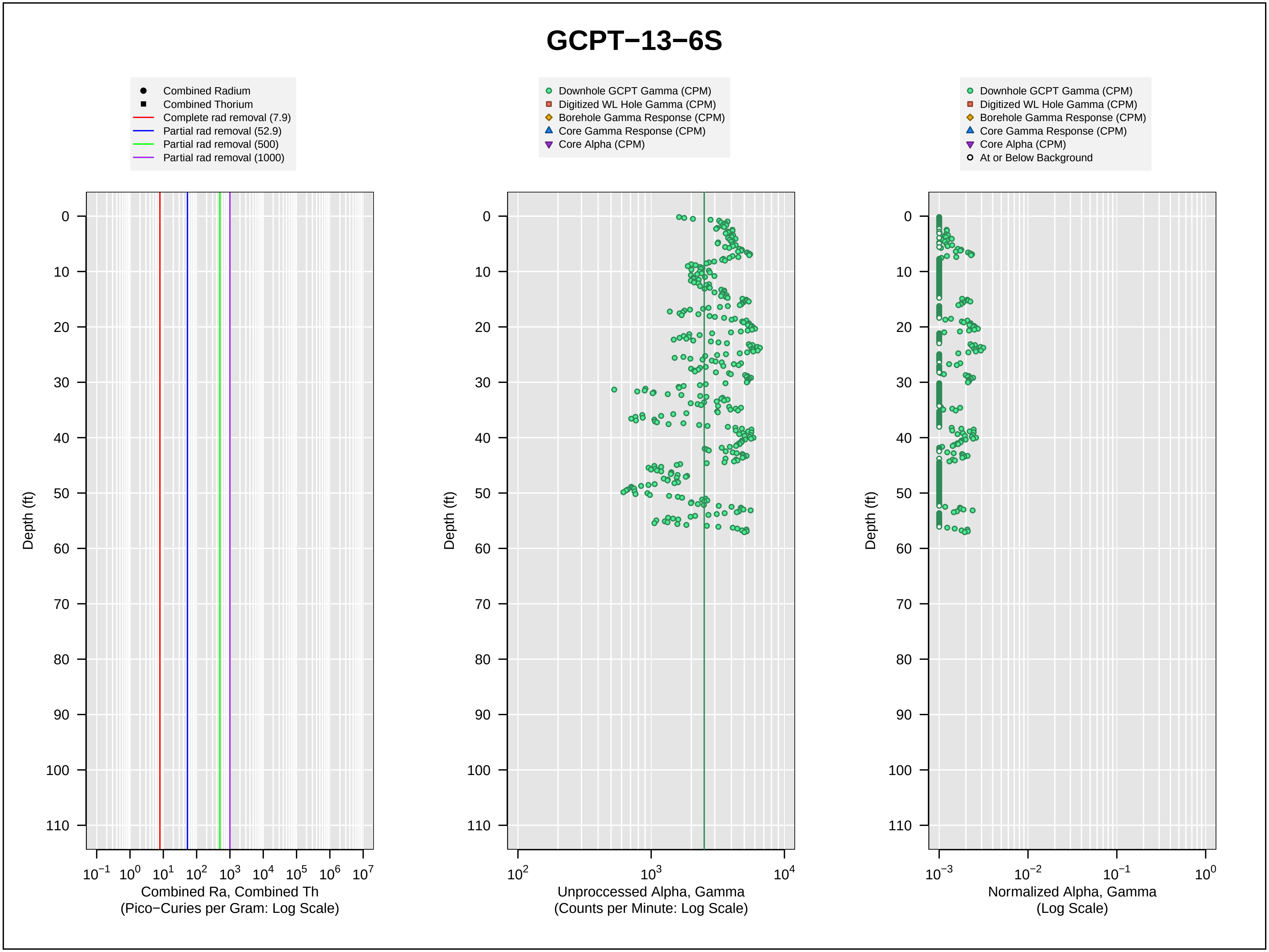
GCPT−13−6


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

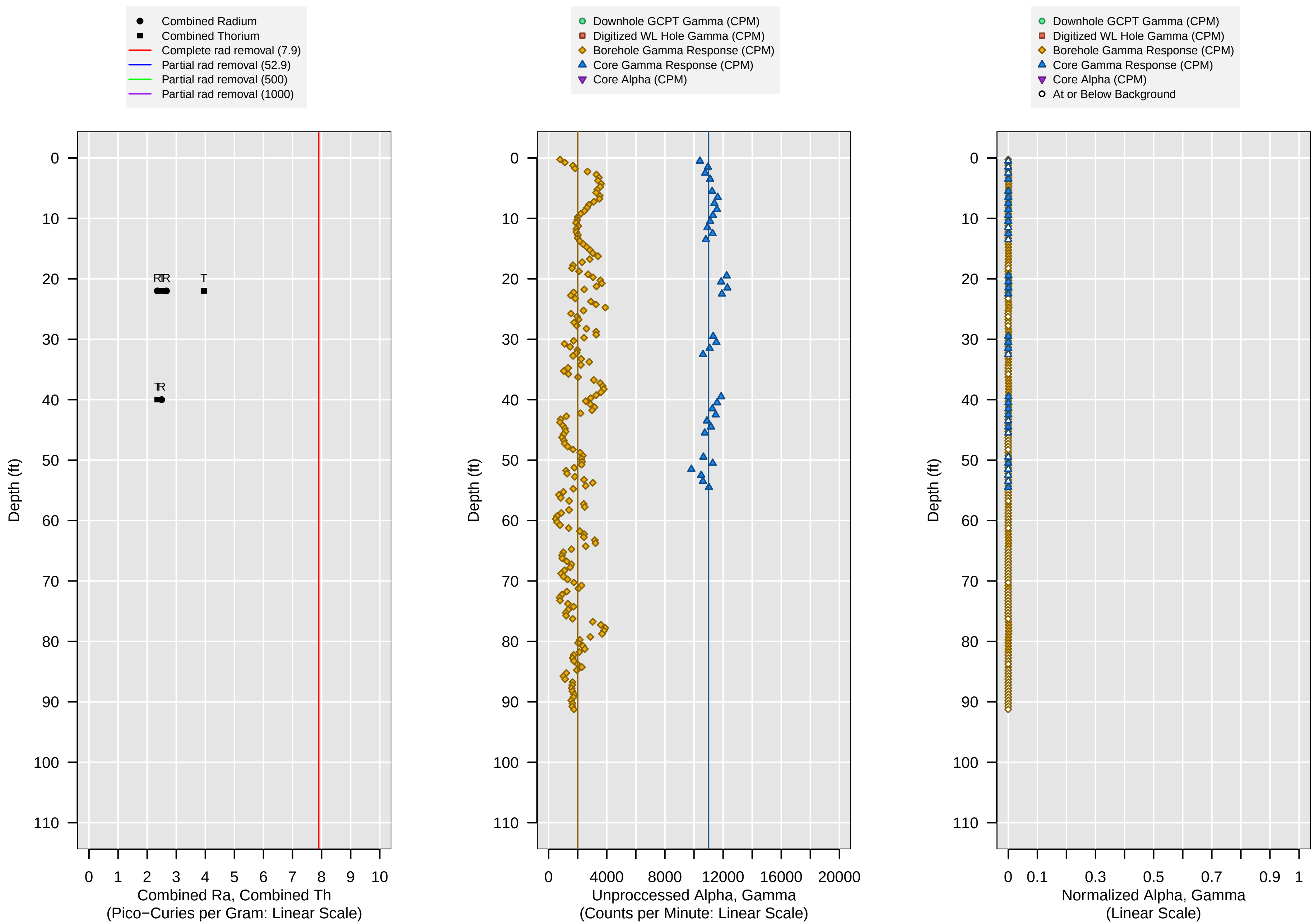
GCPT−13−6S



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1400
2800
4200
5600
7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

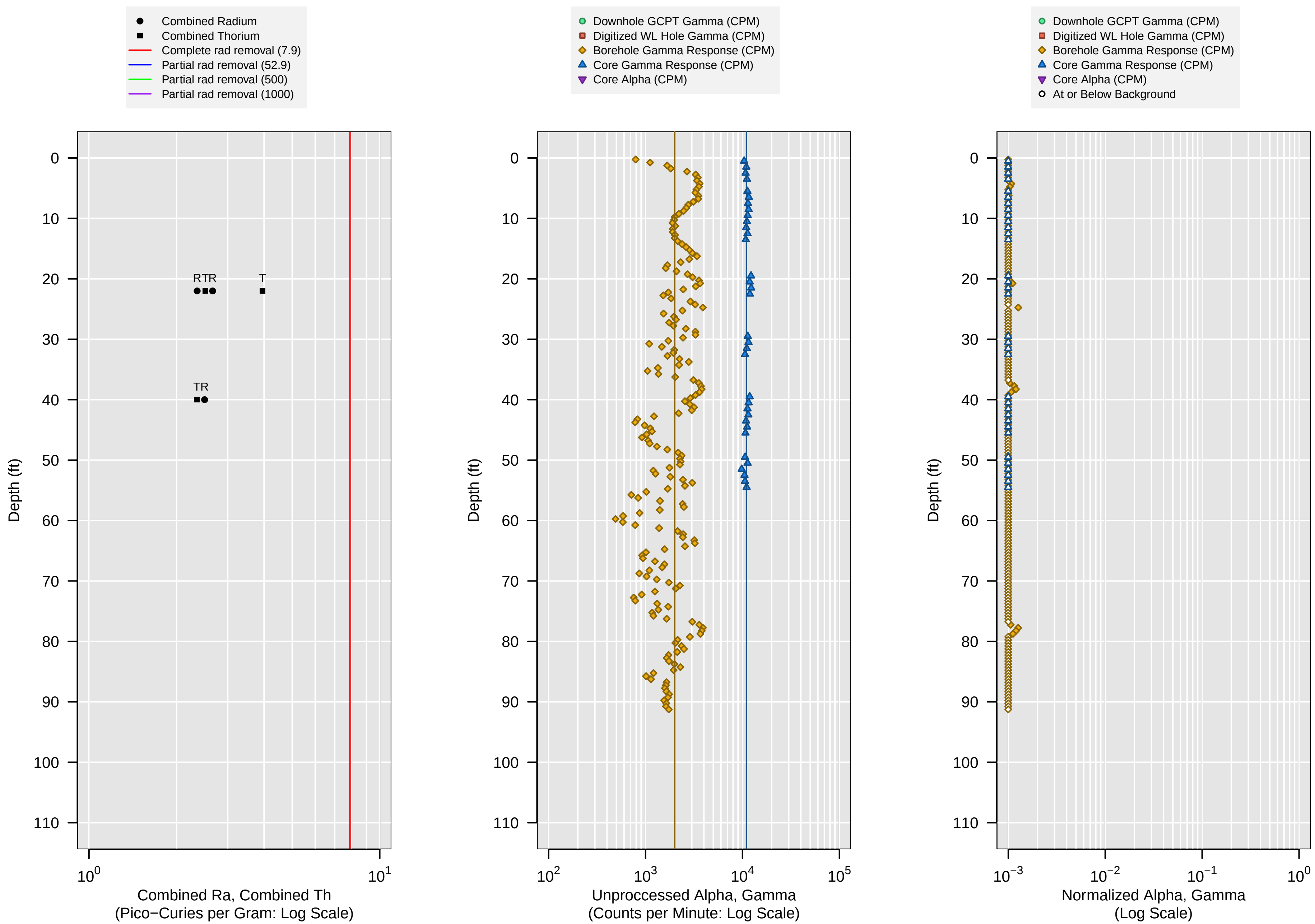

GCPT−13−6S
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

Sonic−13−6

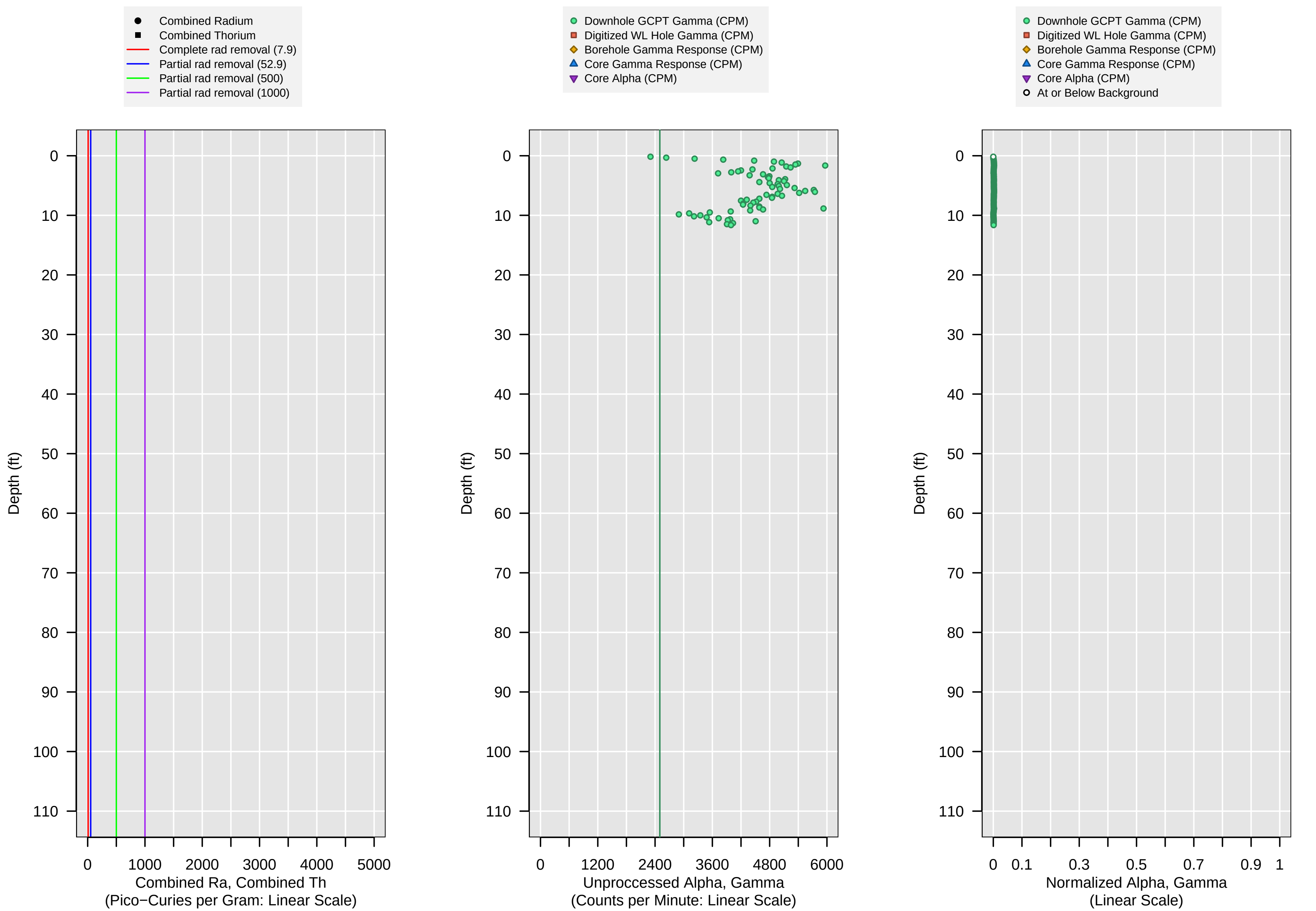


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
R T R
T
TR
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

Sonic−13−6

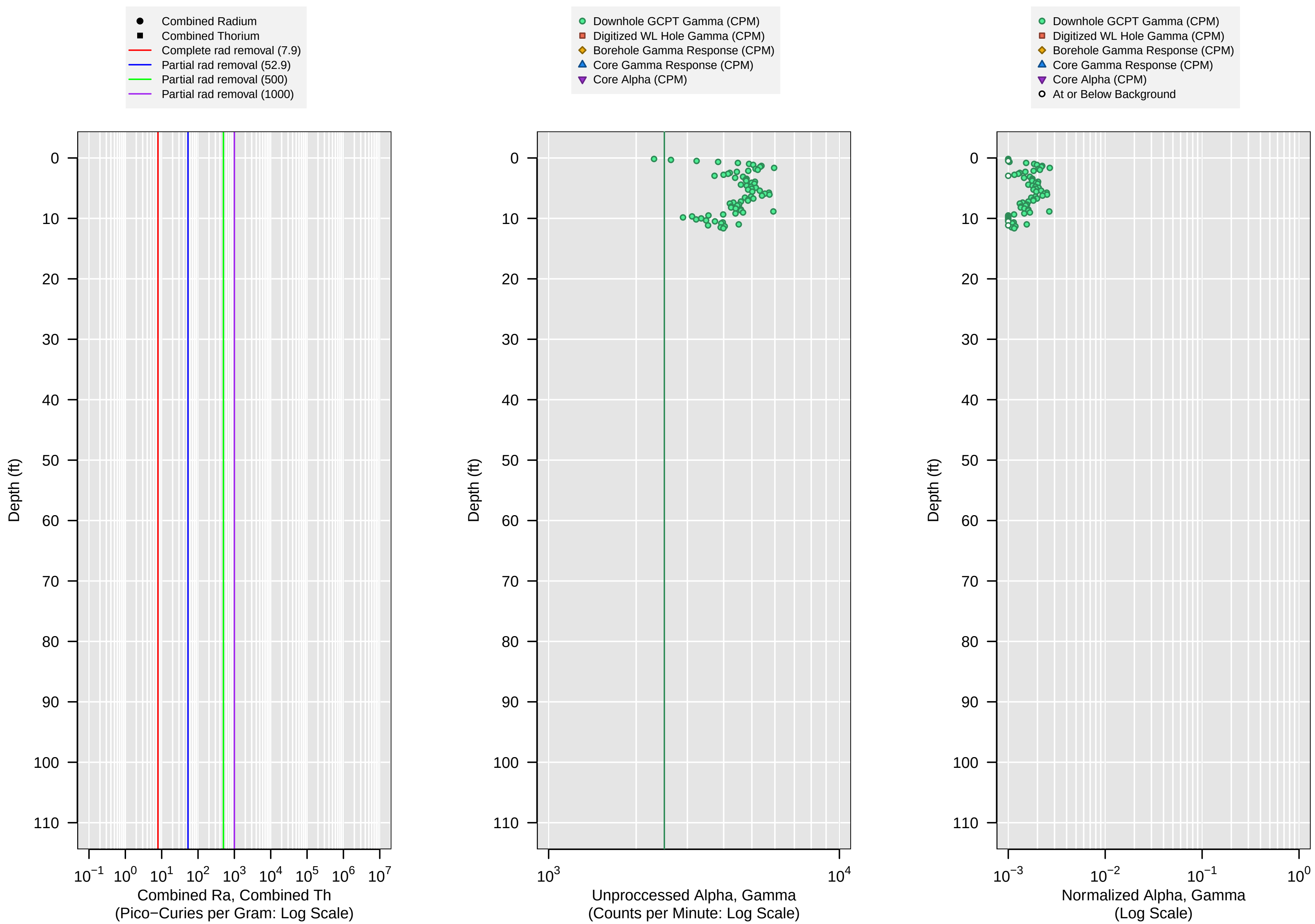

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
RTR
T
TR
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−13−7

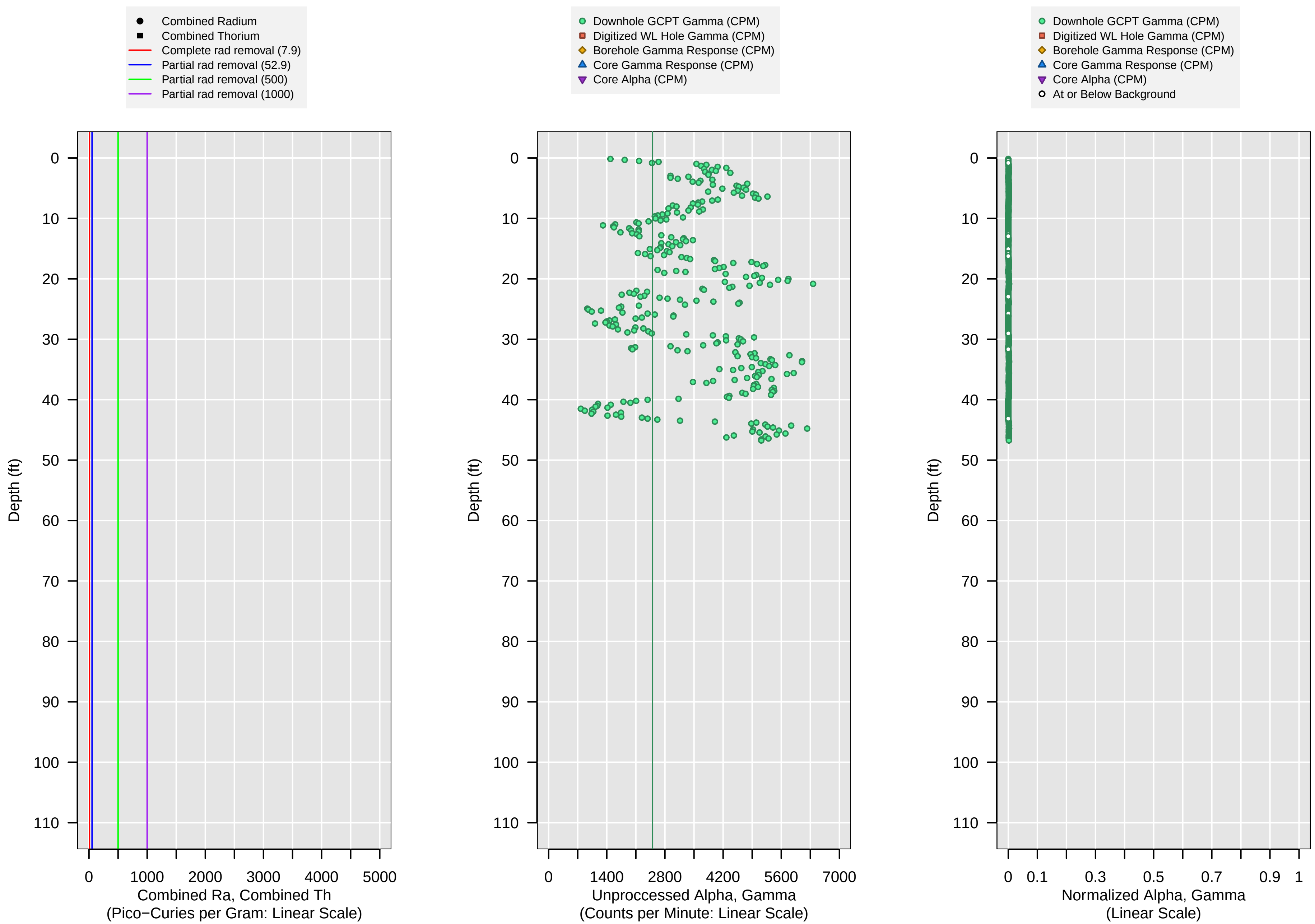


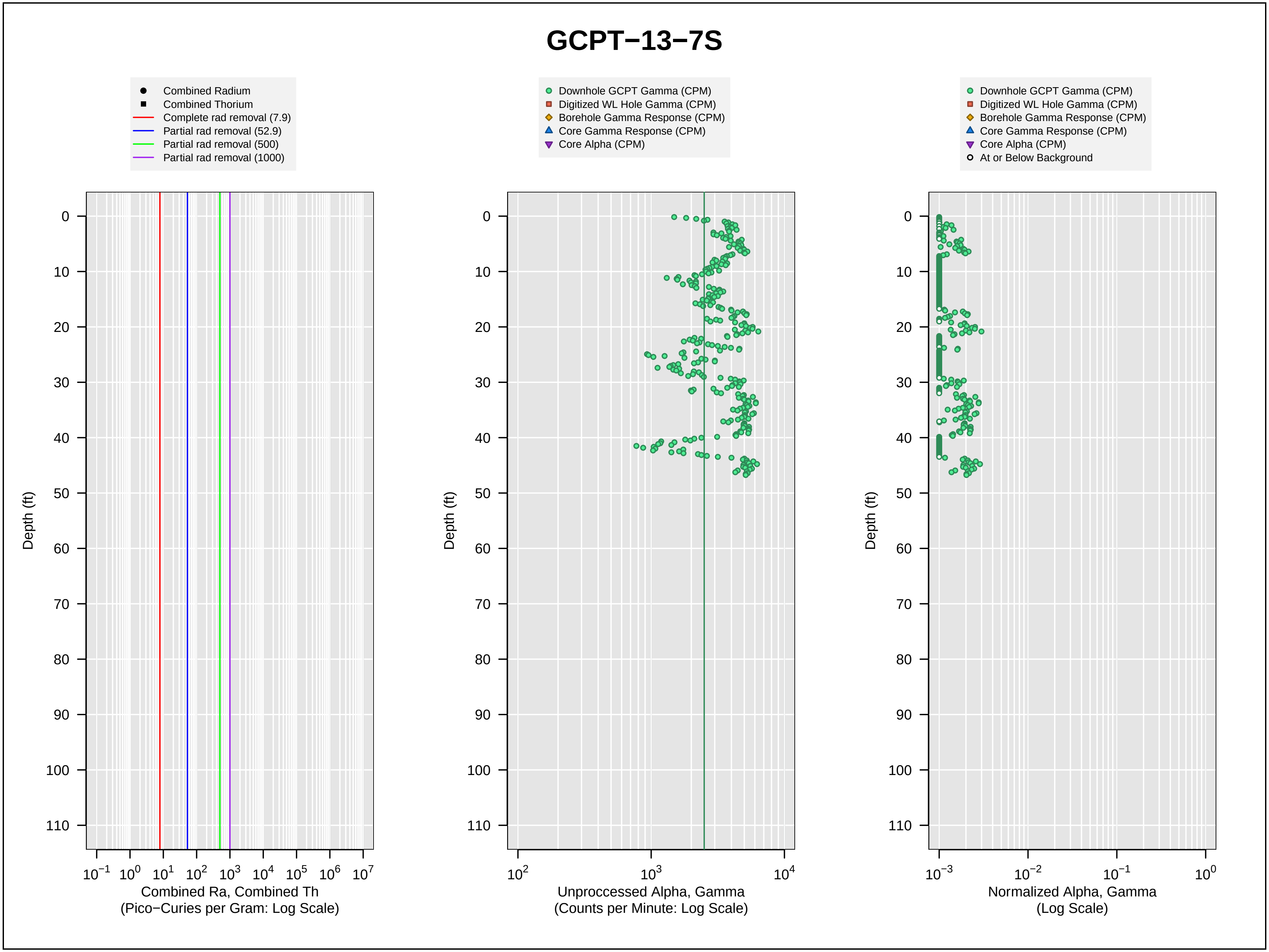
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
1200
2400
3600
4800
6000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

GCPT−13−7

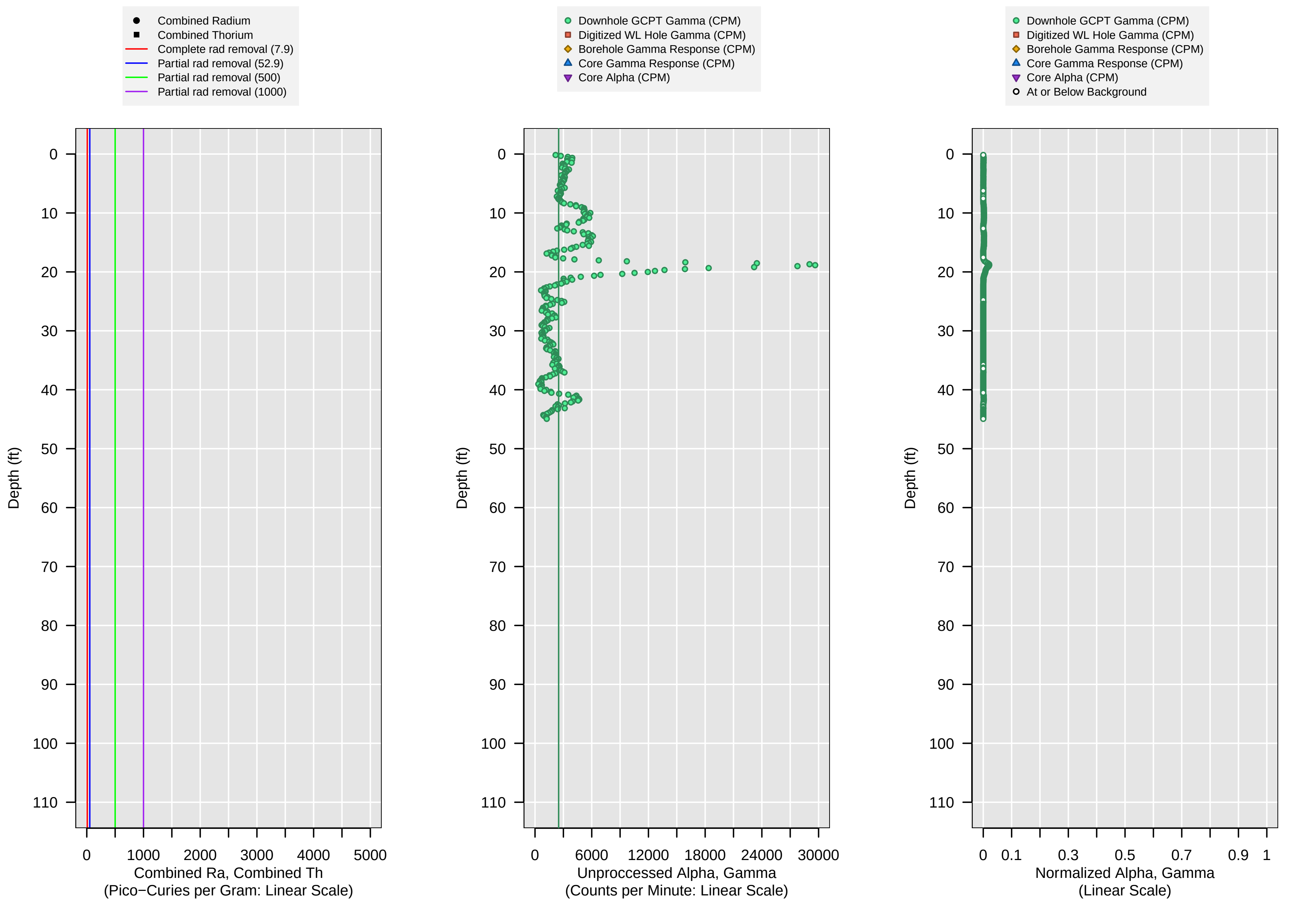

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{-1} 10^{0} 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6} 10^{7}
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
10^{3} 10^{4}
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
10^{-3} 10^{-2} 10^{-1} 10^{0}
Normalized Alpha, Gamma
(Log Scale)

GCPT−13−7S


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

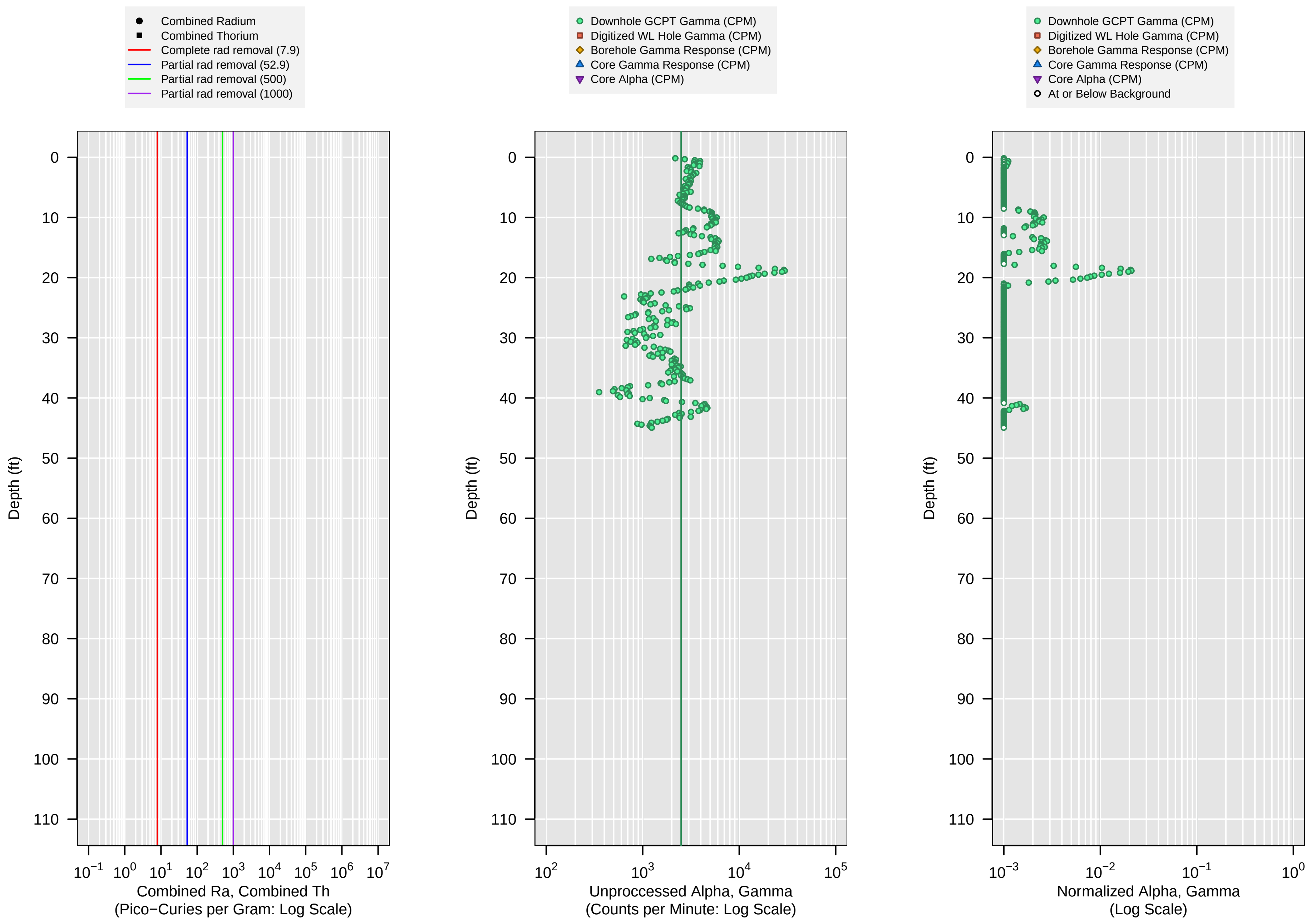

GCPT−13−7S
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−14−1

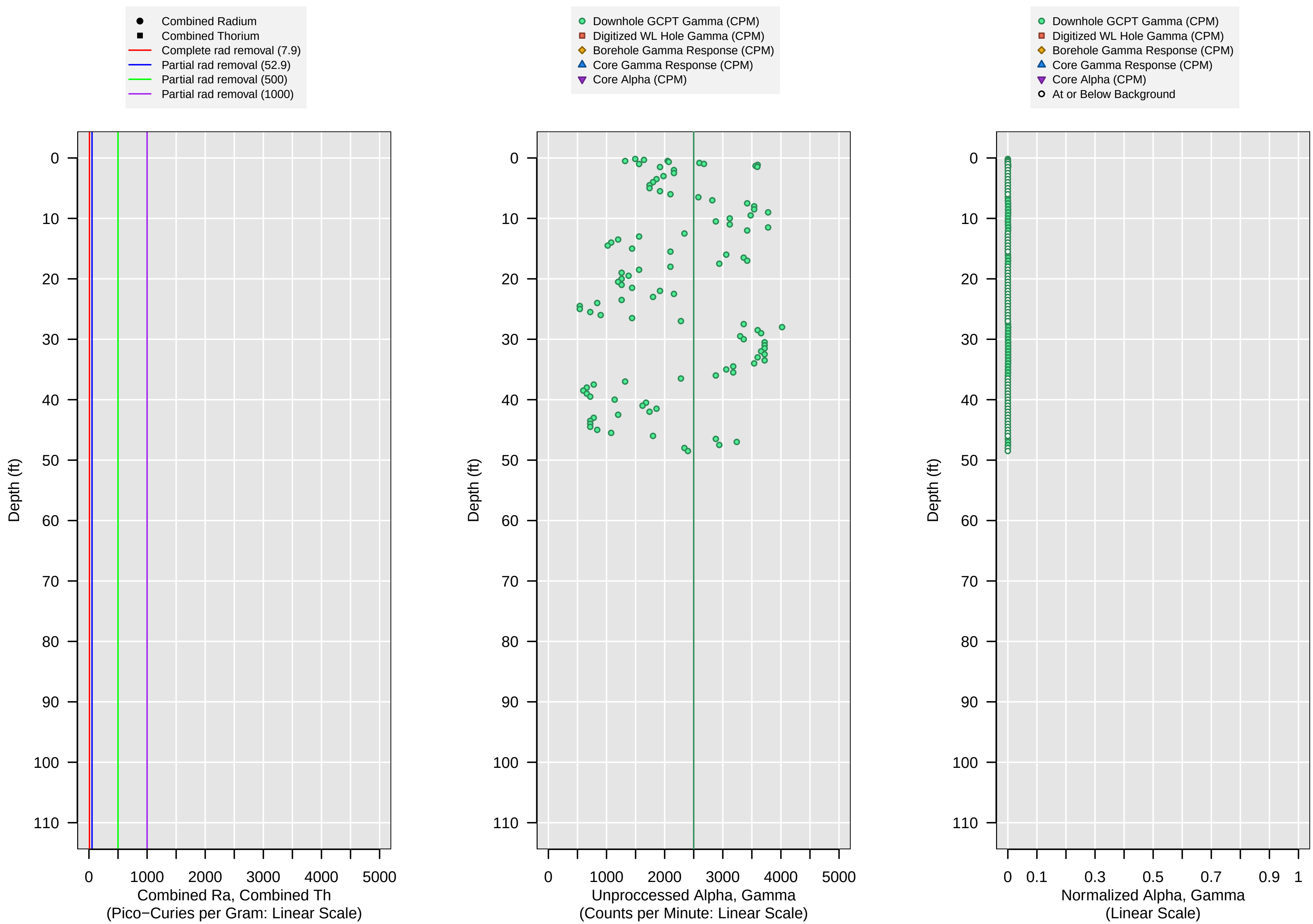


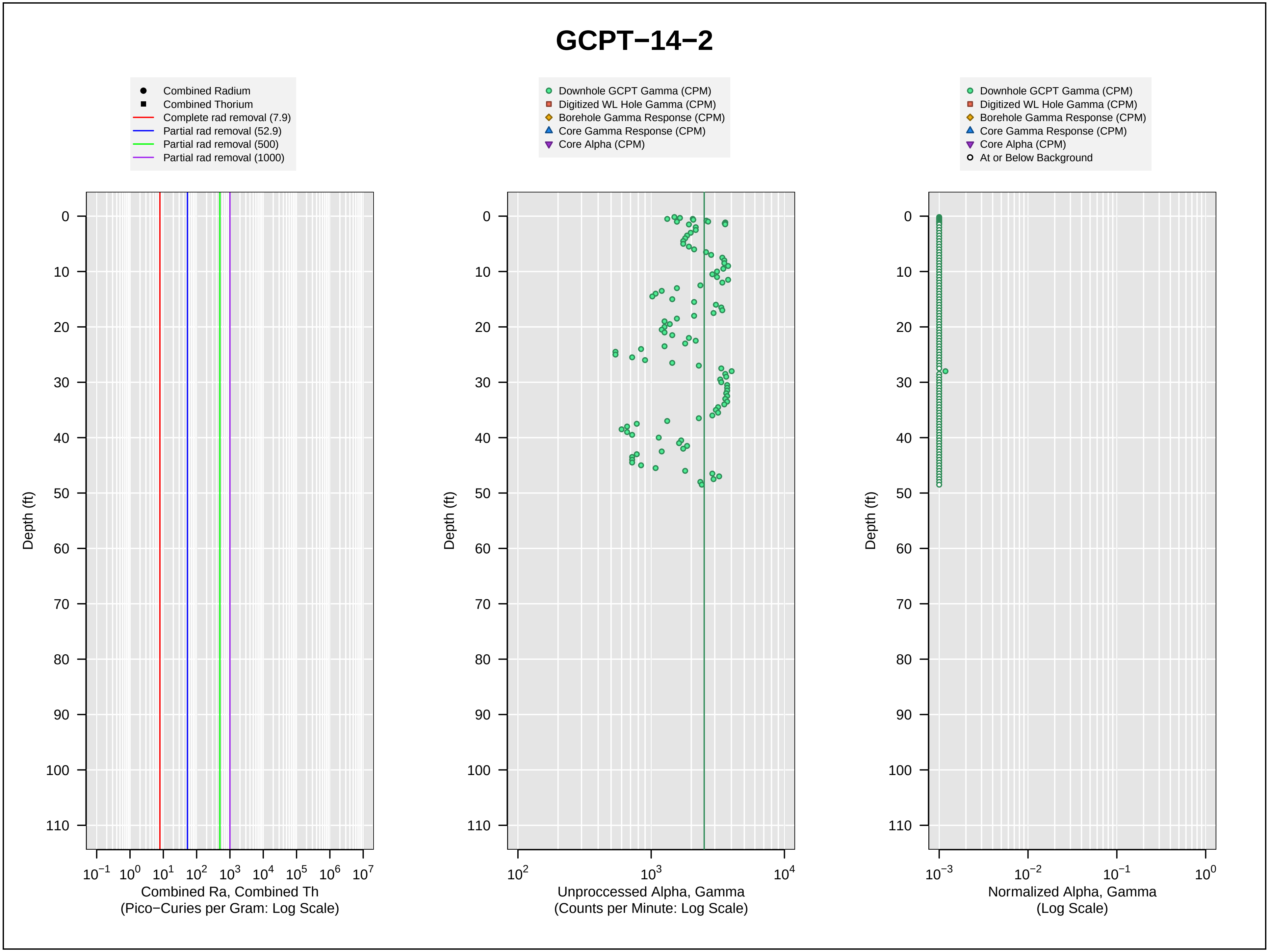
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
6000
12000
18000
24000
30000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

GCPT−14−1


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{-1} 10^{0} 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6} 10^{7}
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
10^{2} 10^{3} 10^{4} 10^{5}
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
10^{-3} 10^{-2} 10^{-1} 10^{0}
Normalized Alpha, Gamma
(Log Scale)

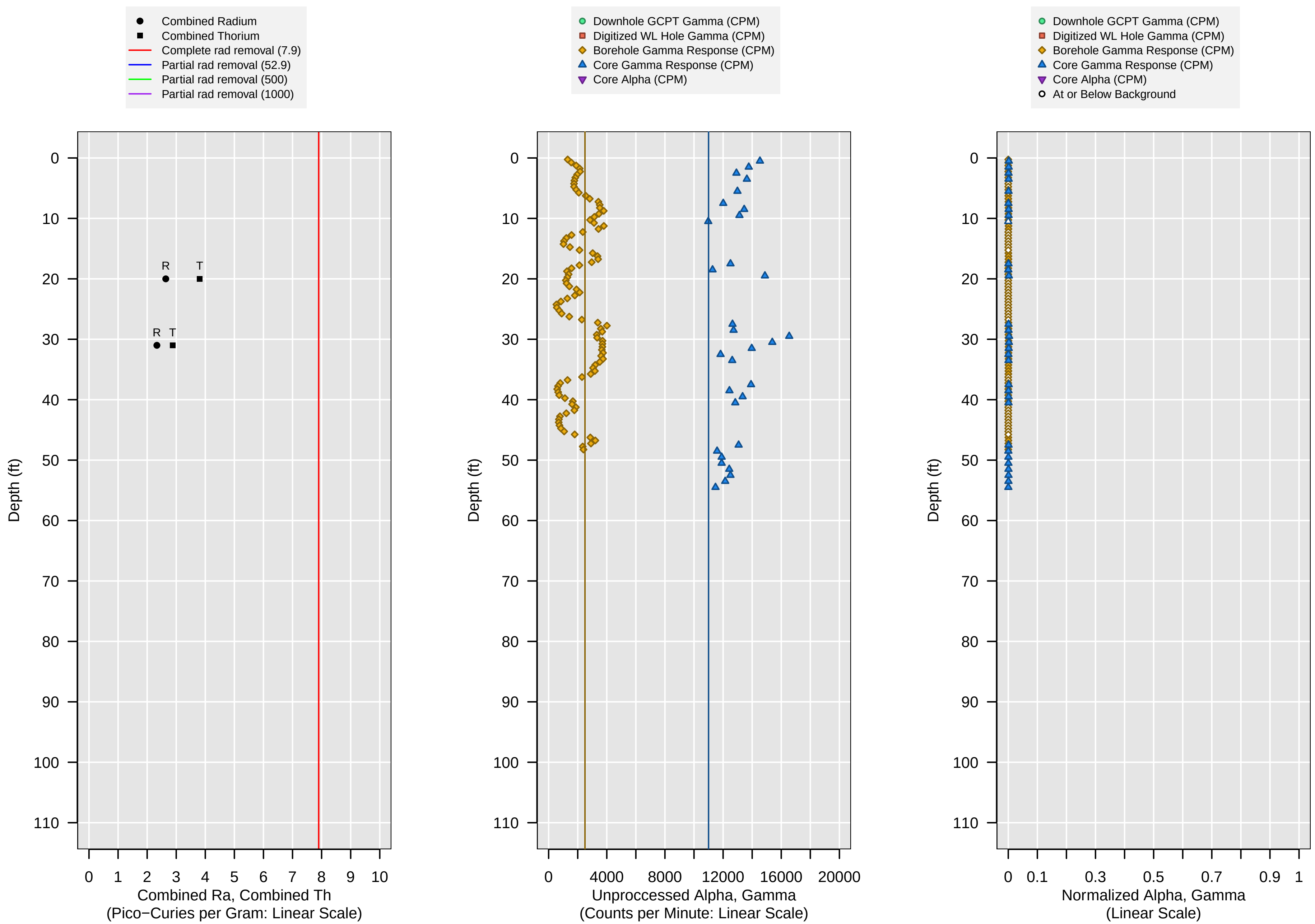
GCPT−14−2


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

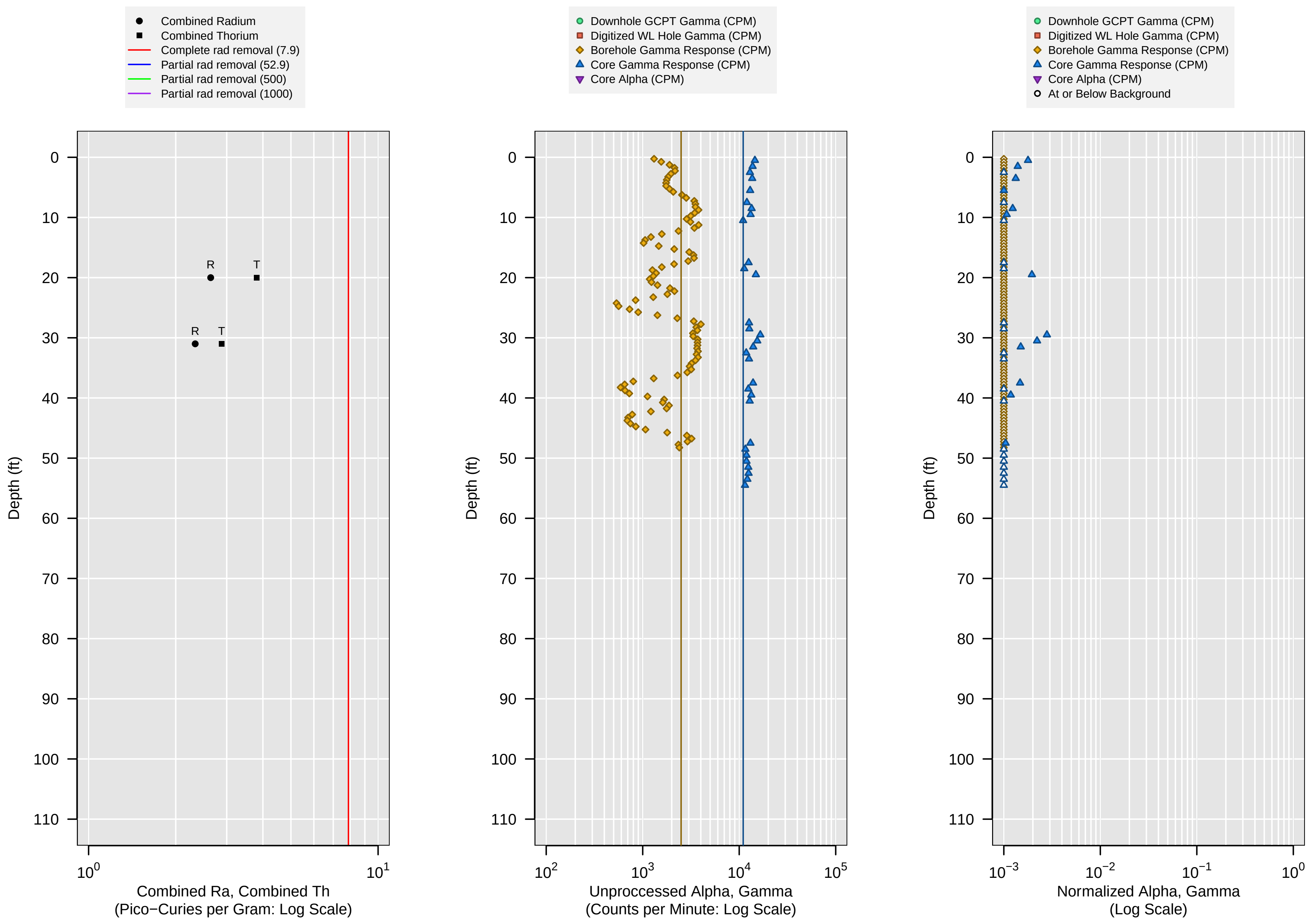


GCPT−14−2
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

Sonic−14−2

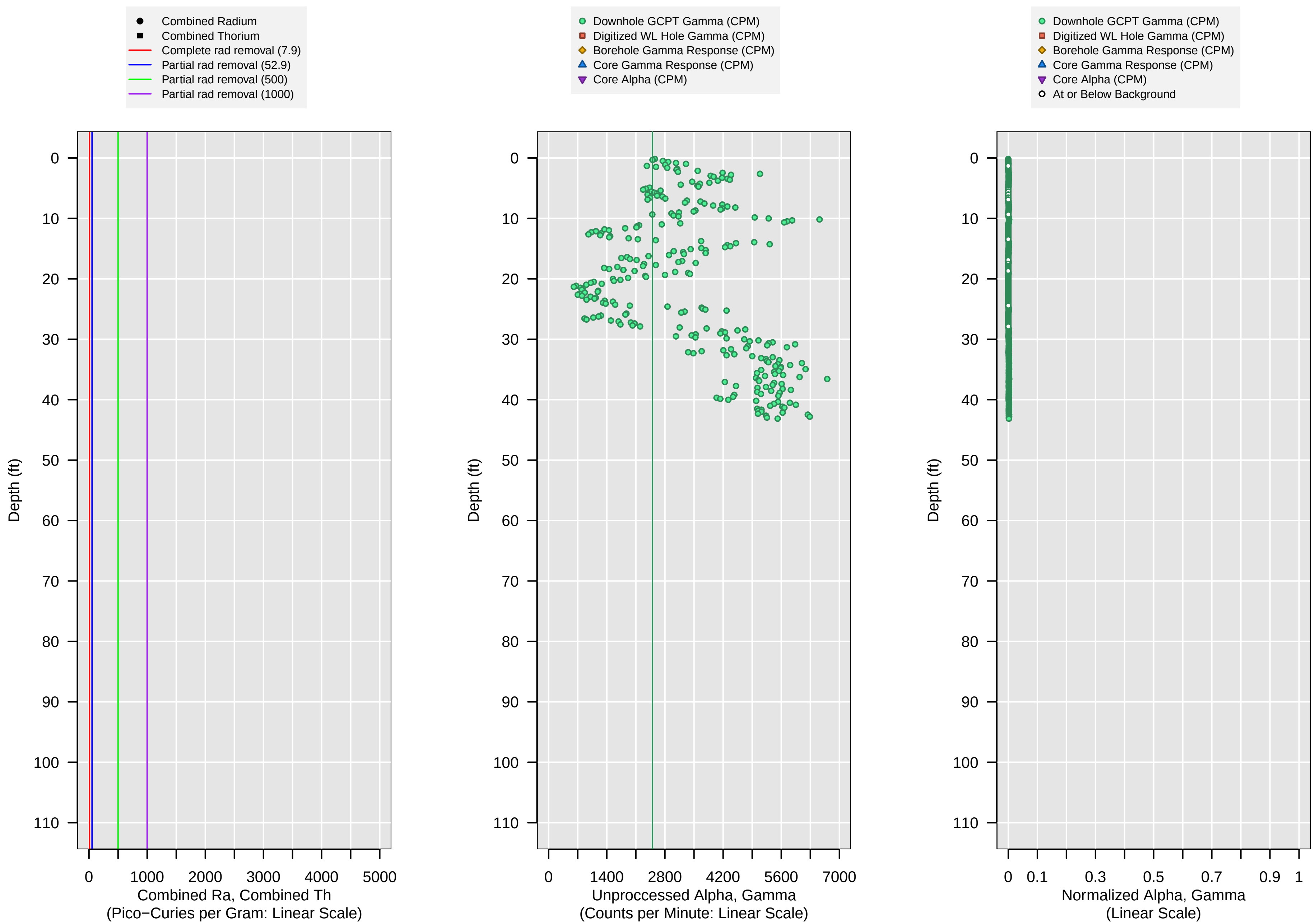

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
R
T
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

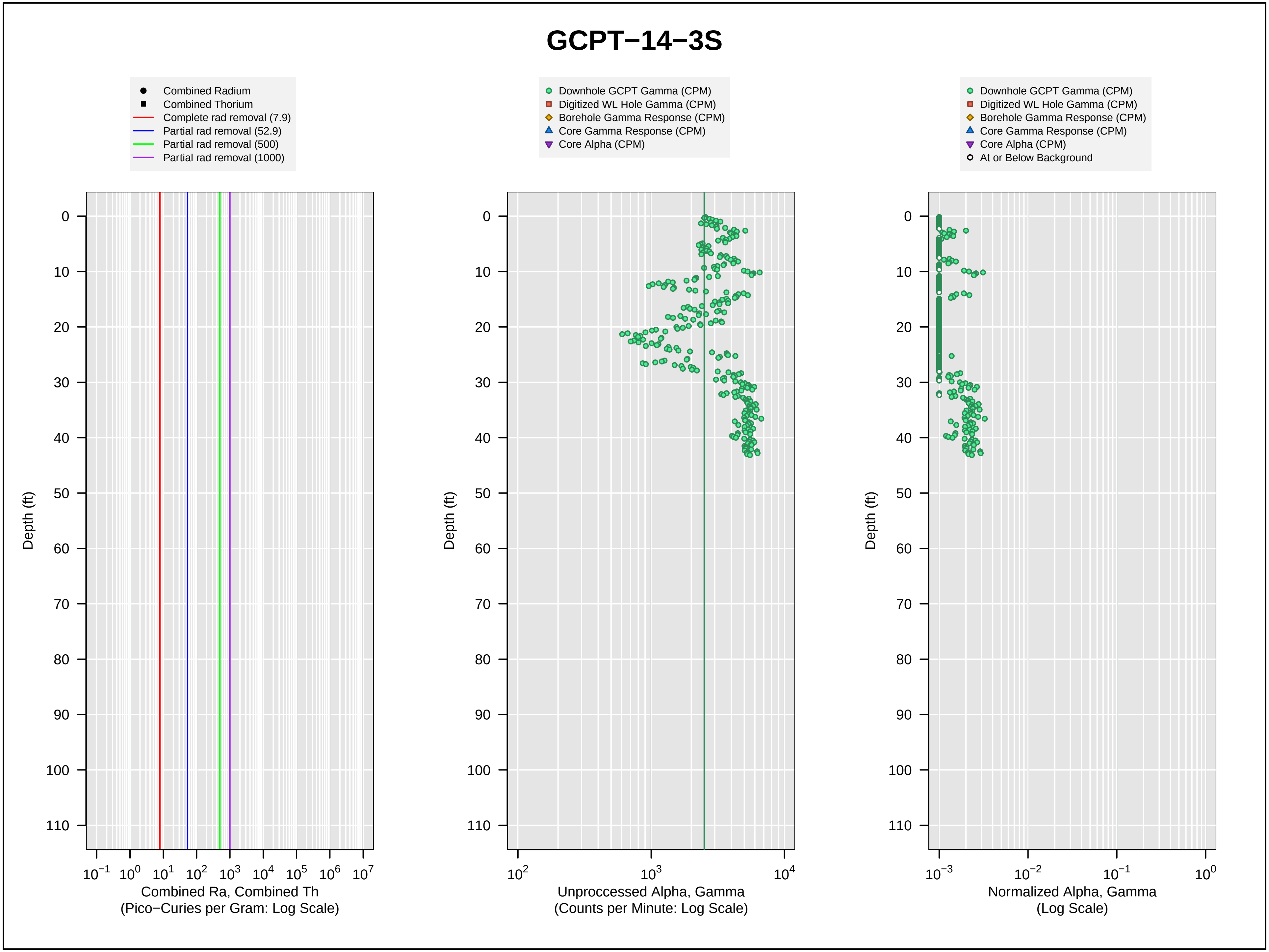
Sonic−14−2



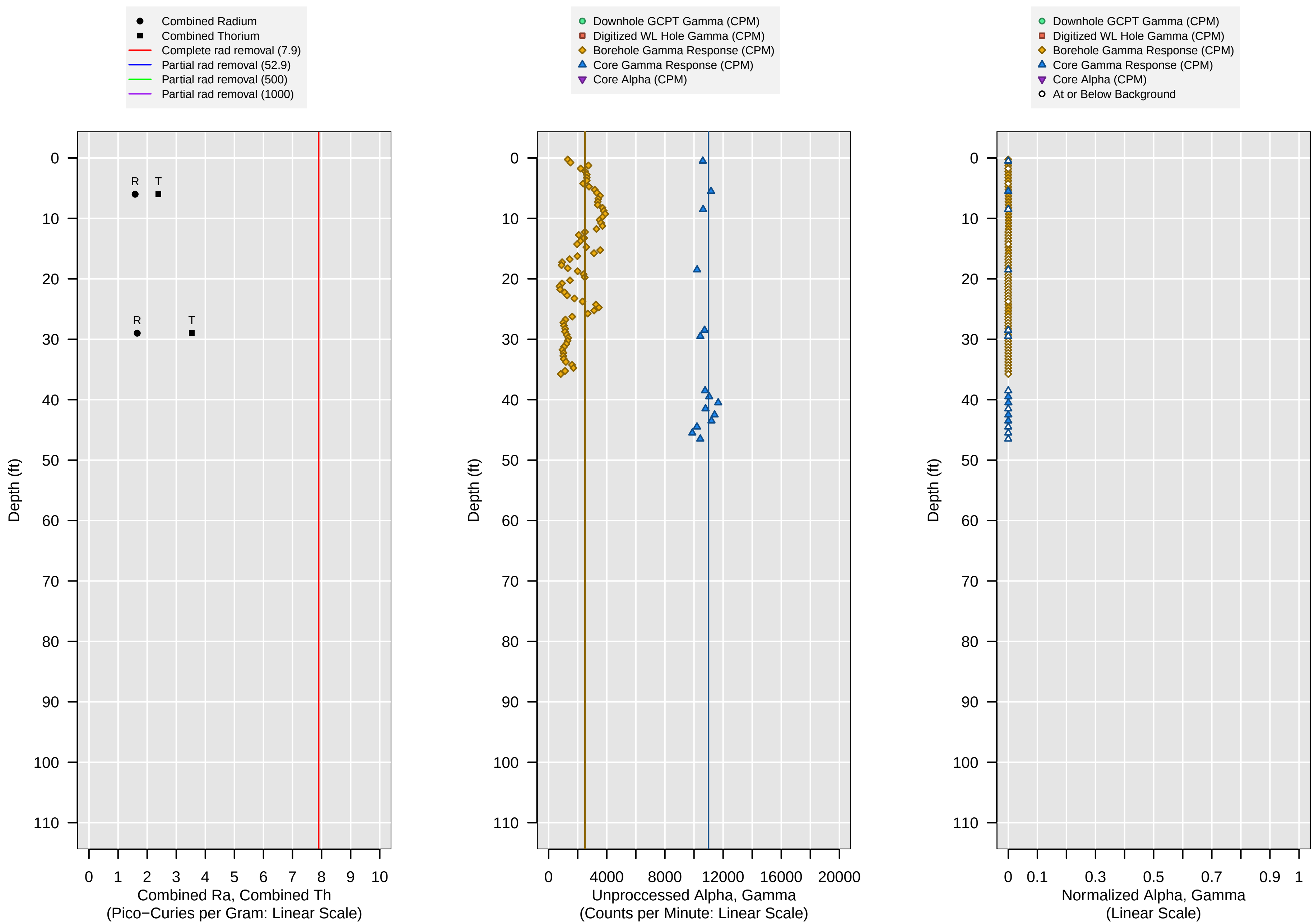
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
R
T
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−14−3S


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

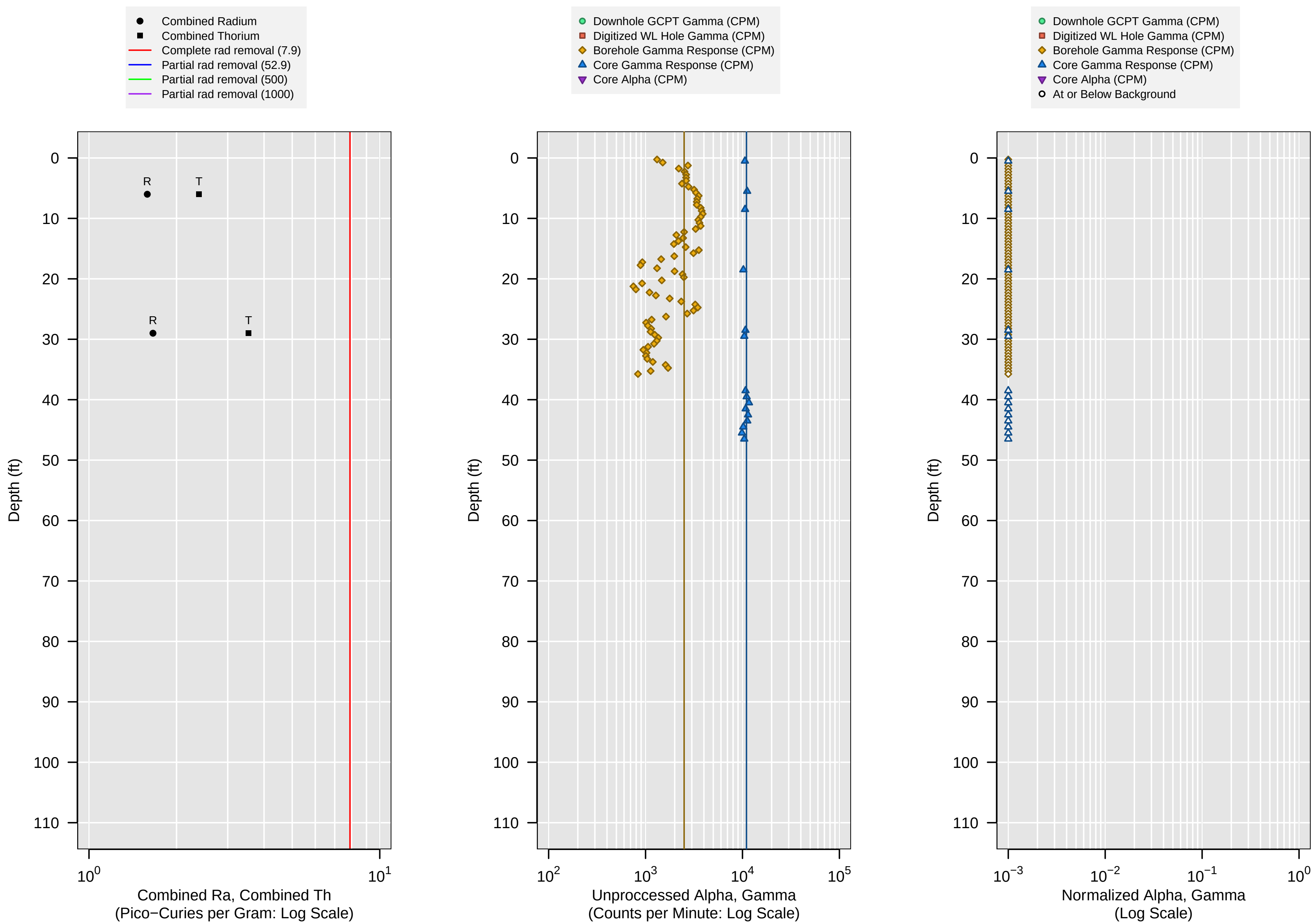

GCPT−14−3S
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

Sonic−14−4



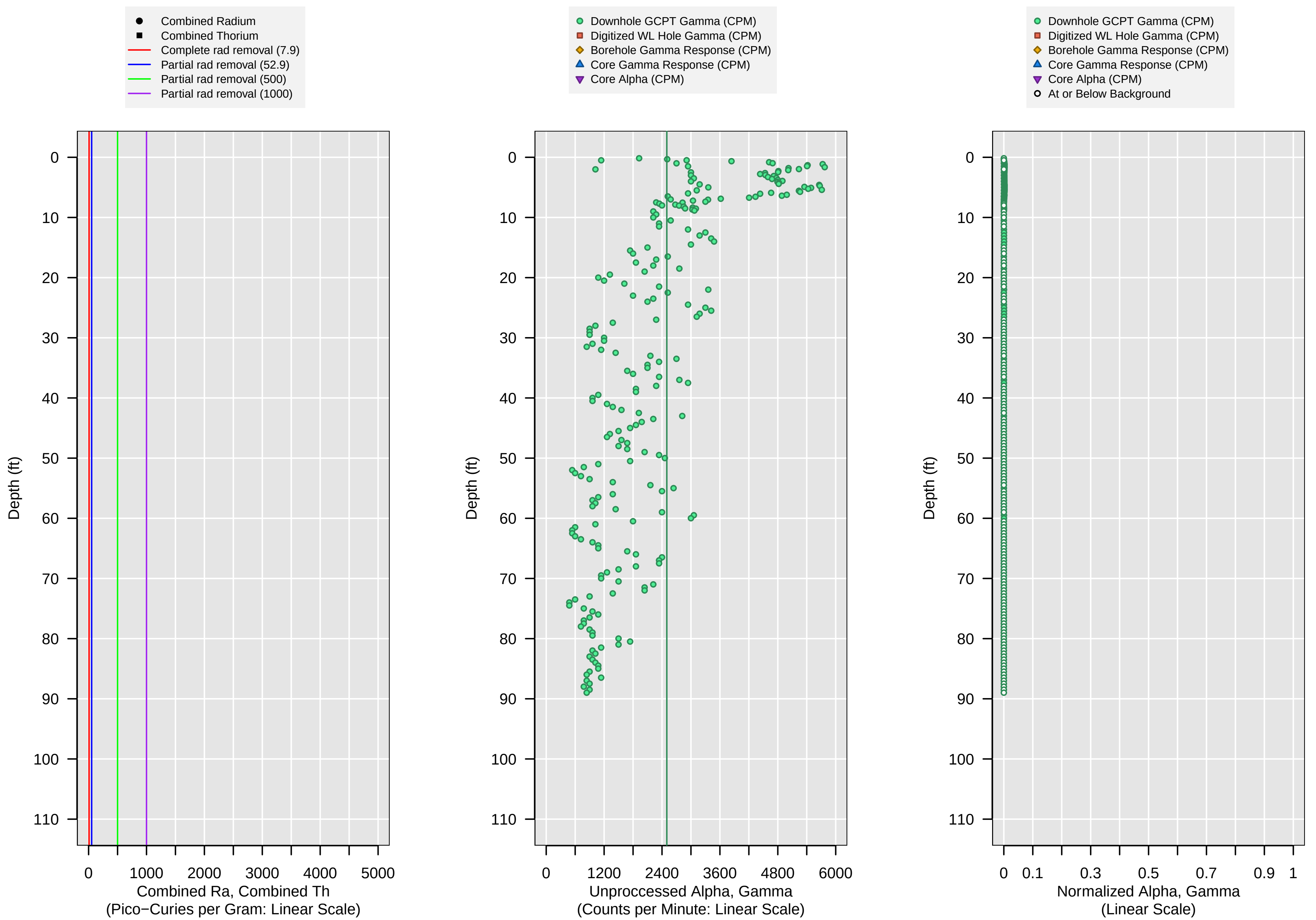
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

Sonic−14−4



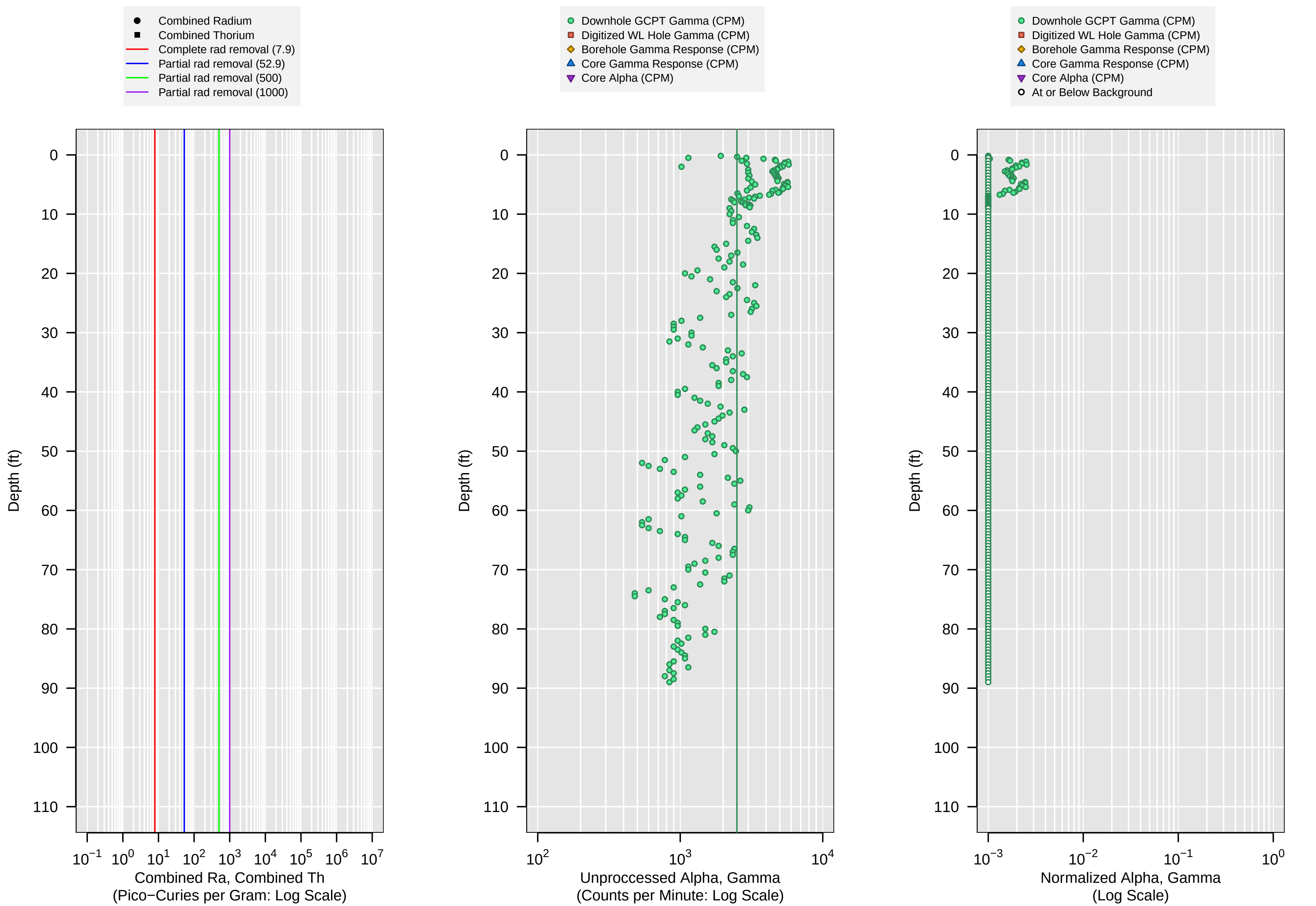
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−14−5

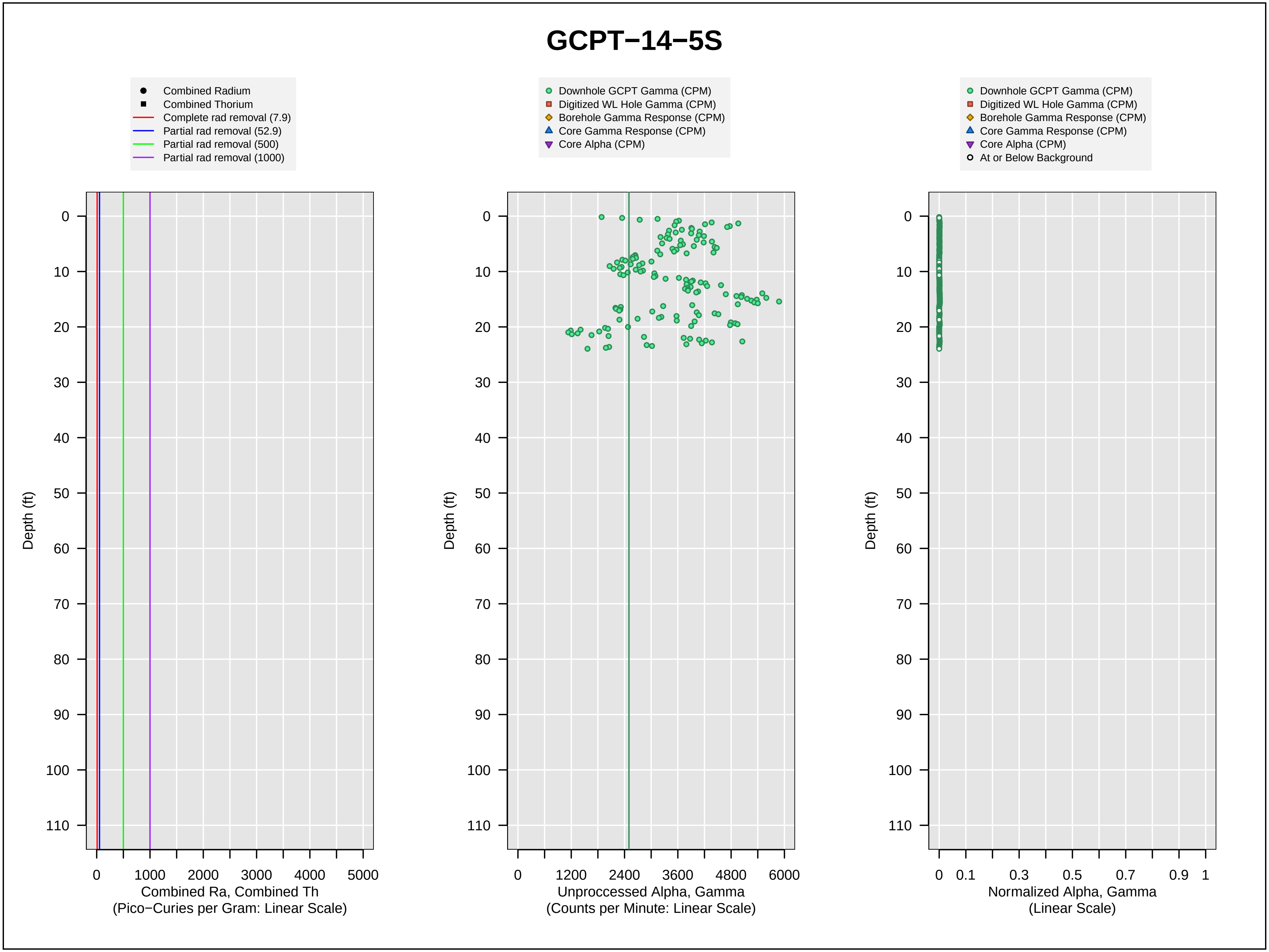


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

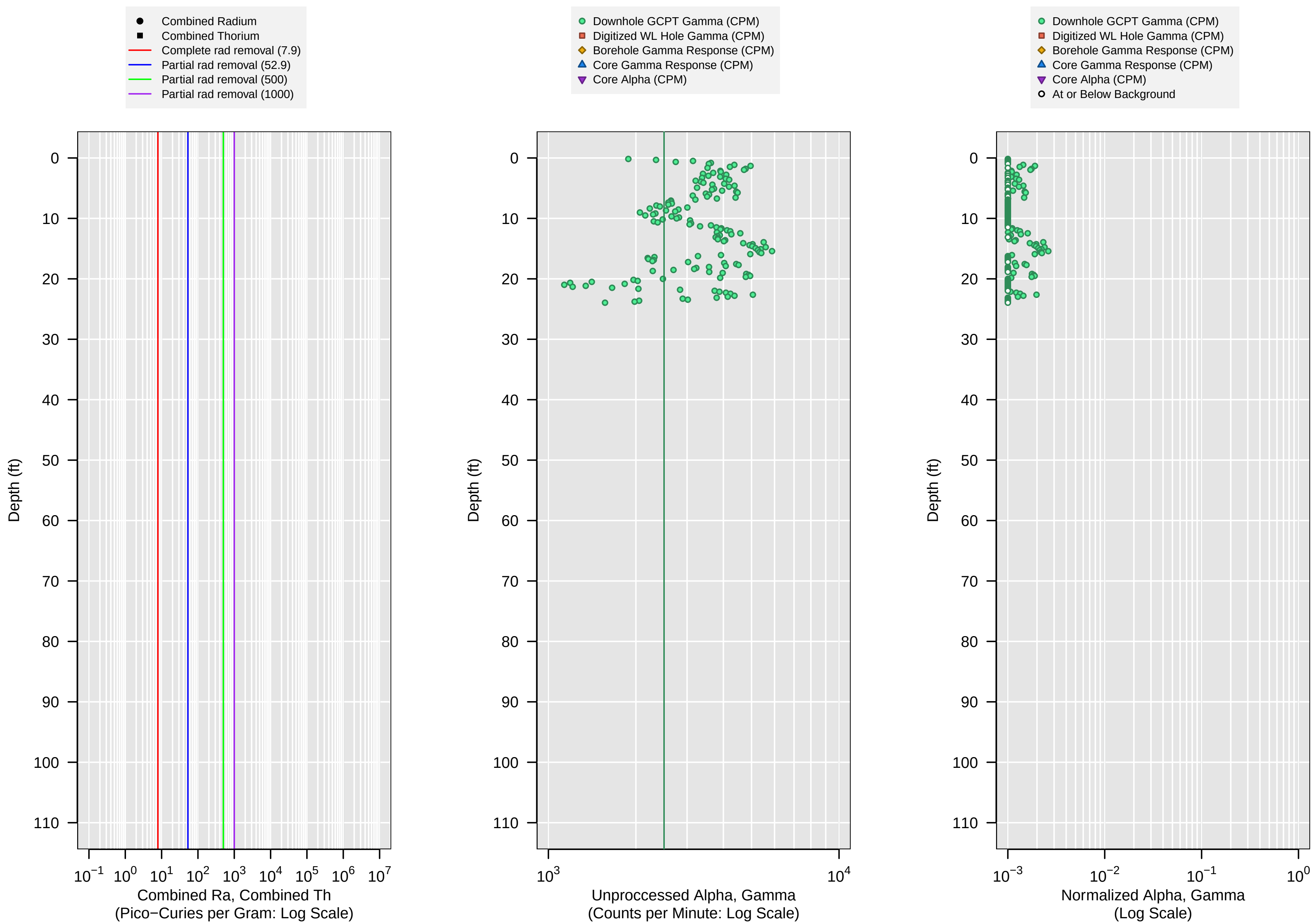
GCPT−14−5



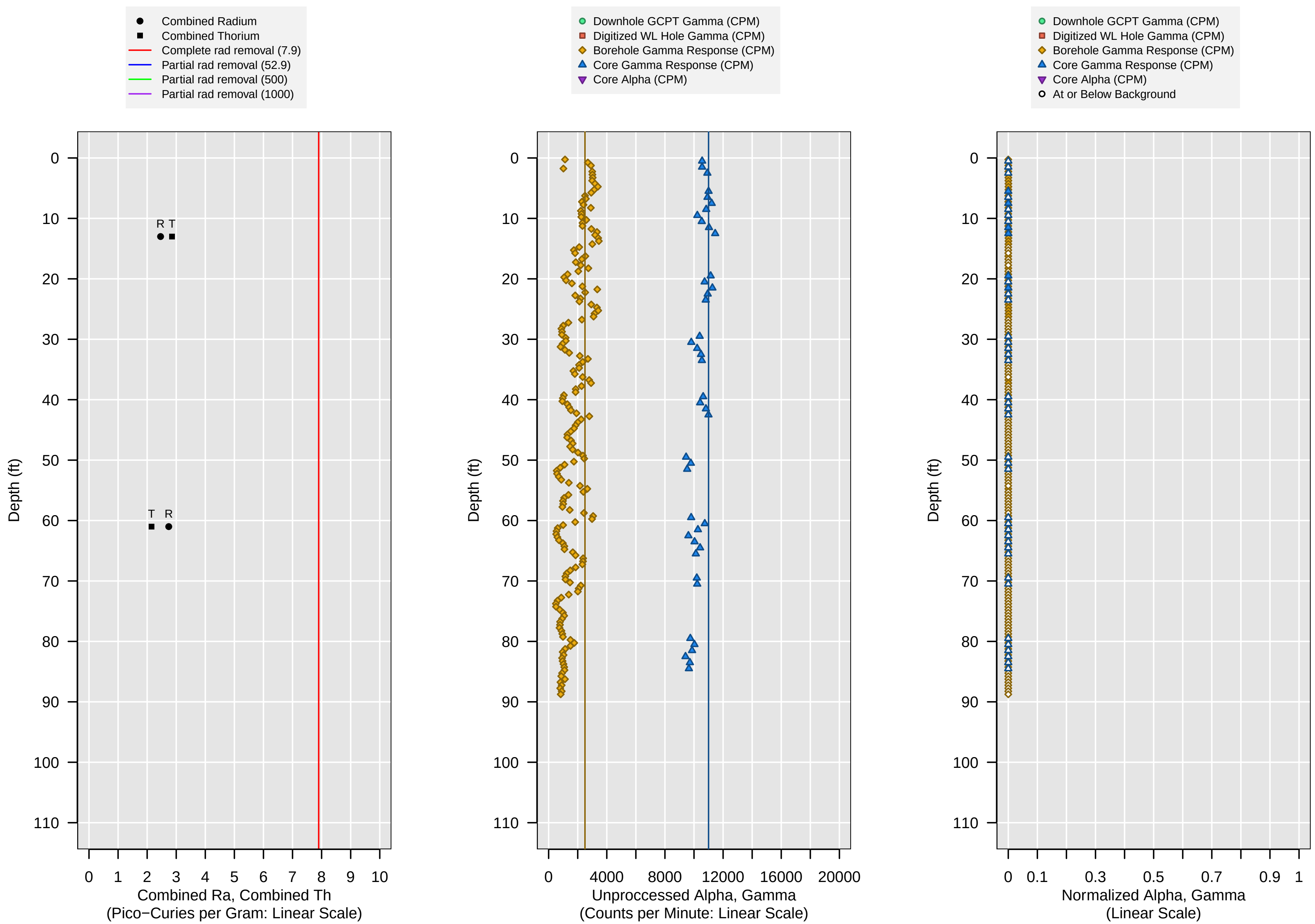
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)


GCPT−14−5S
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

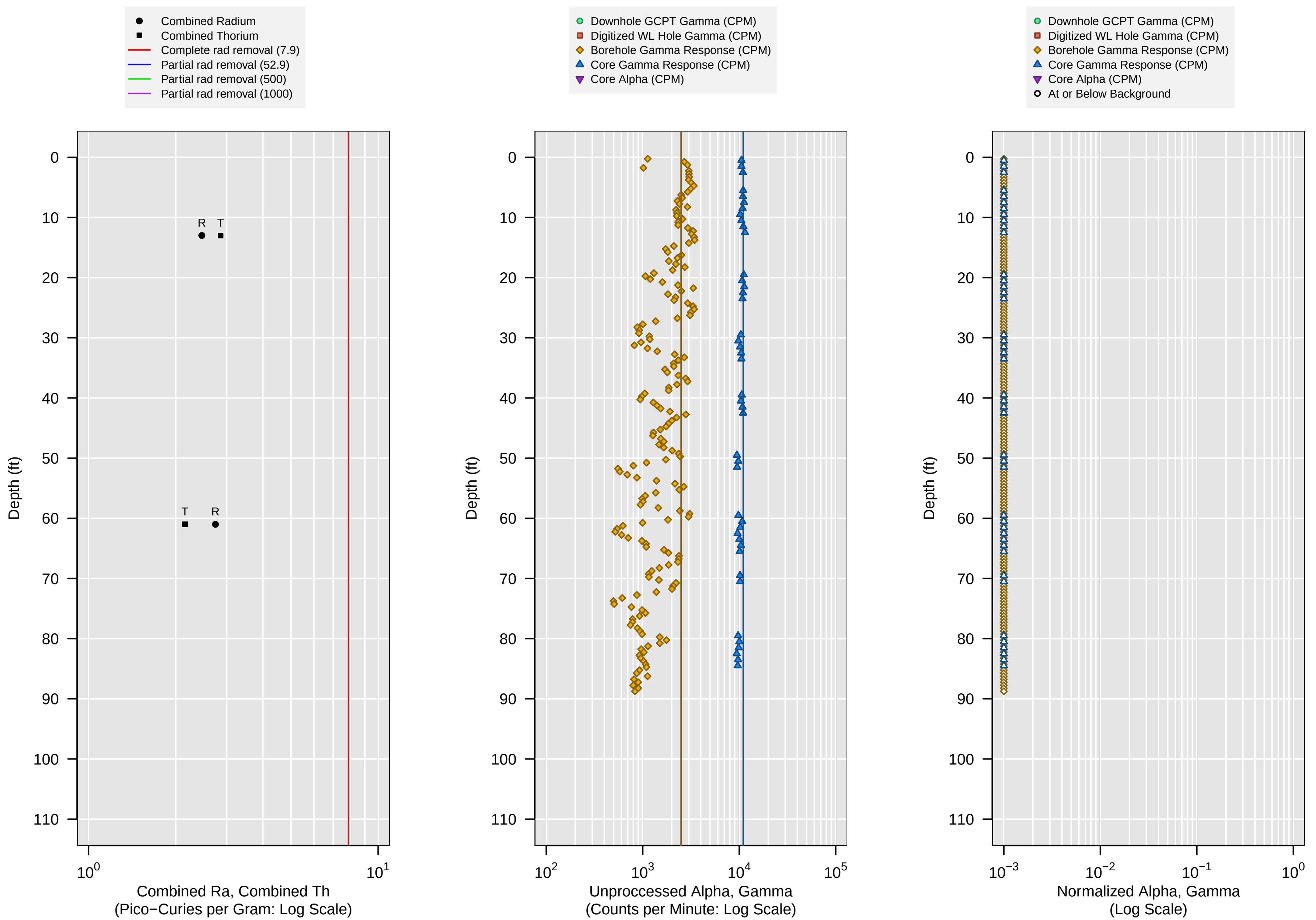
GCPT−14−5S


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

Sonic−14−5

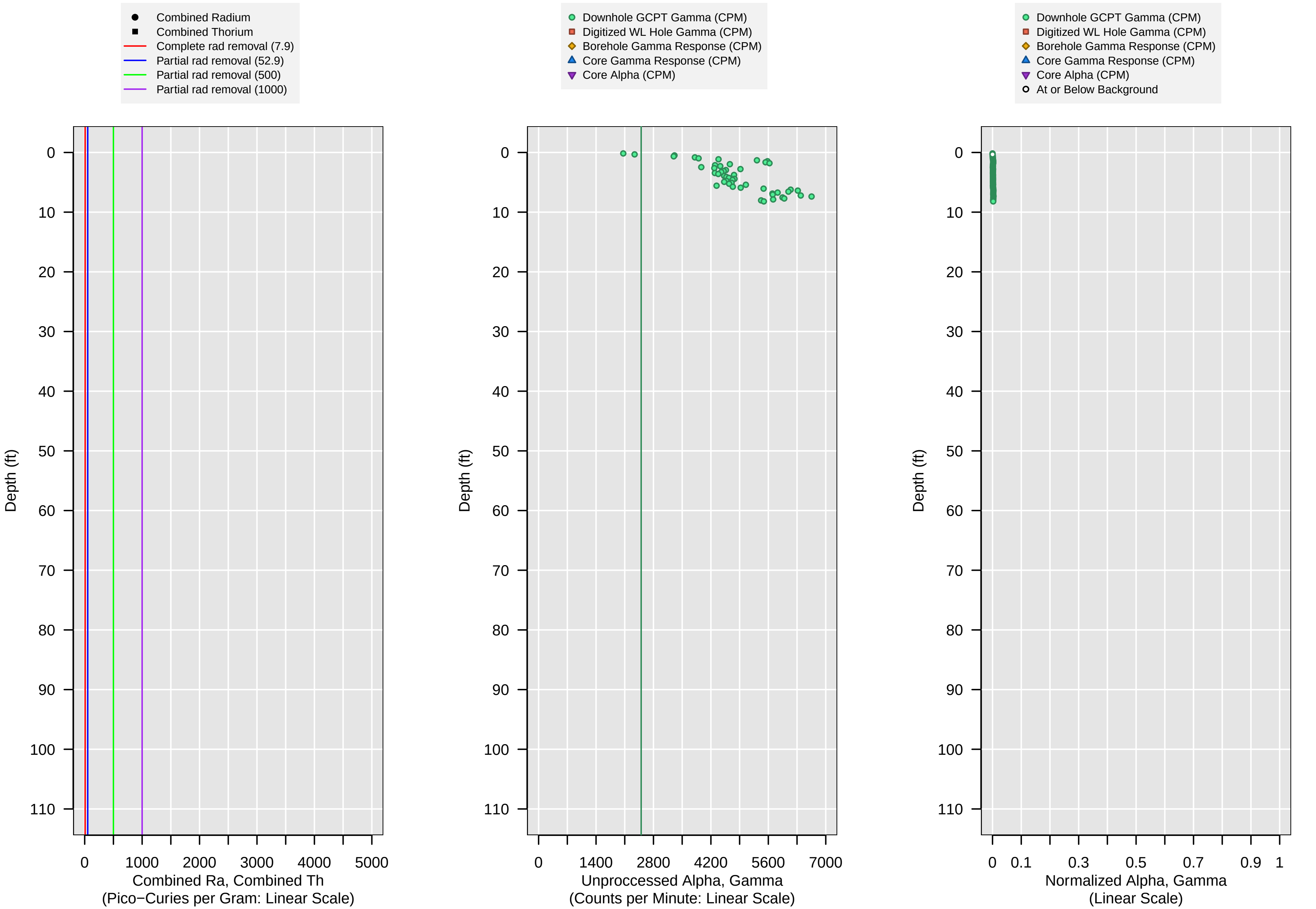

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

Sonic−14−5

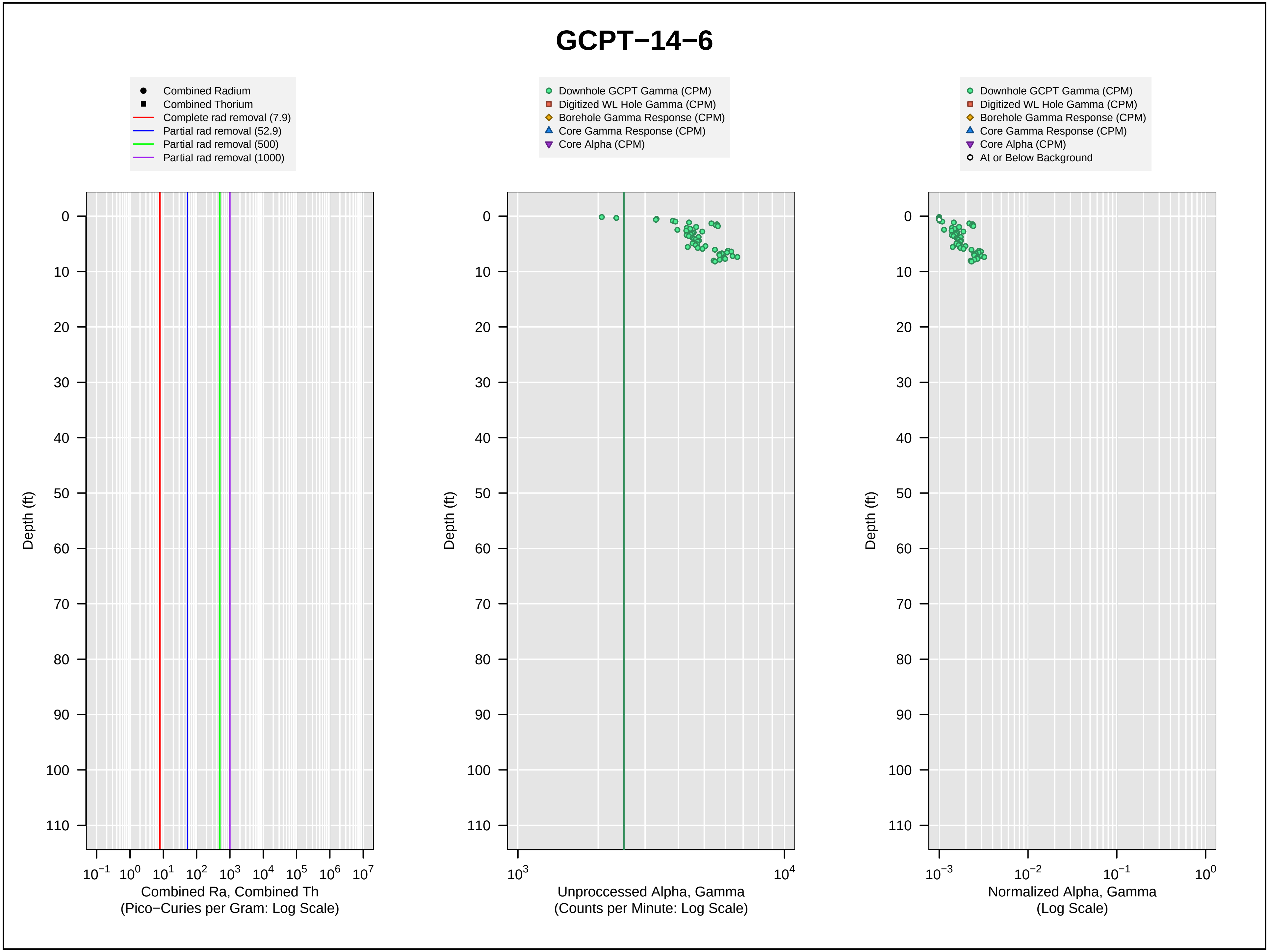


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R T
T R
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

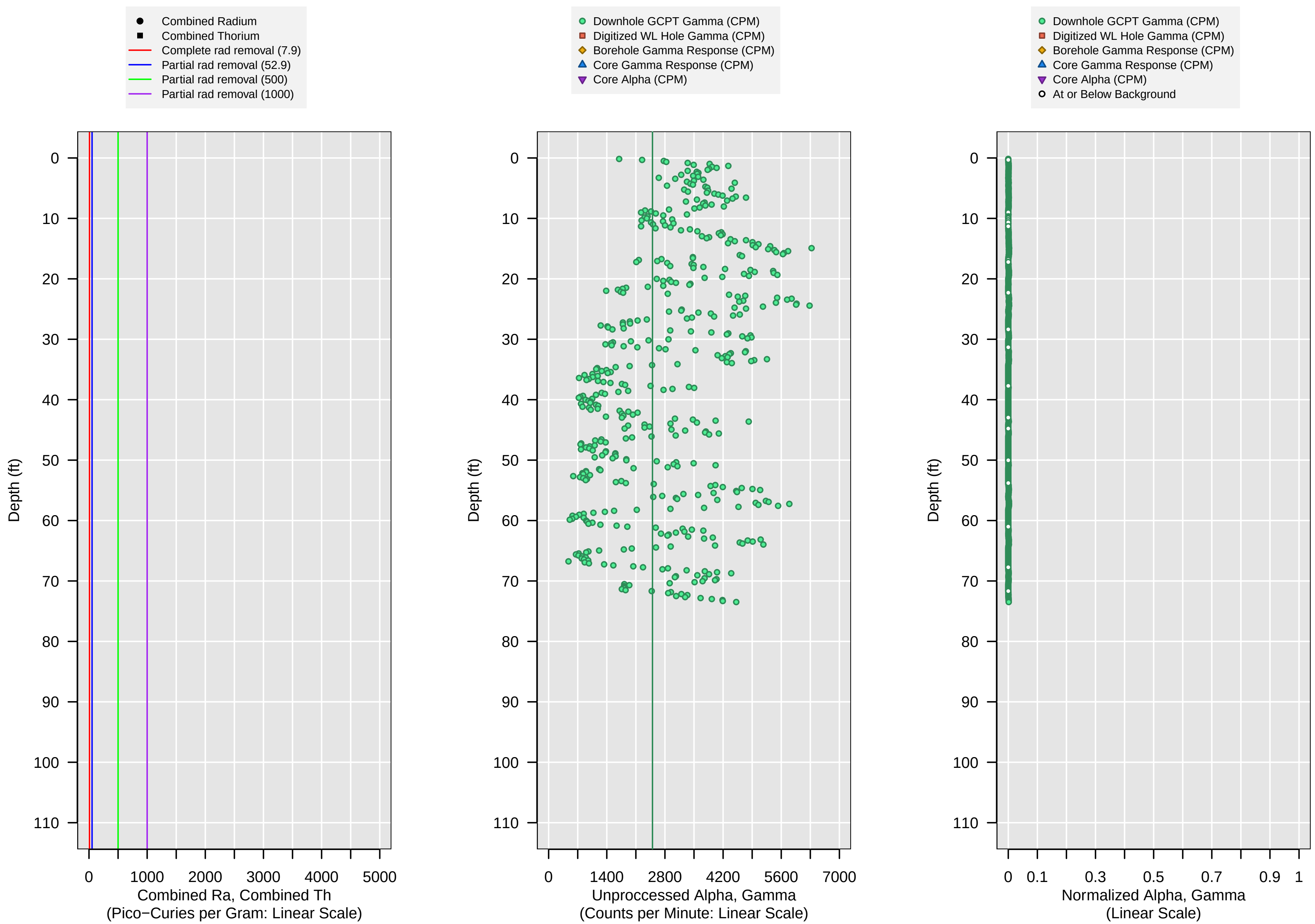
GCPT−14−6



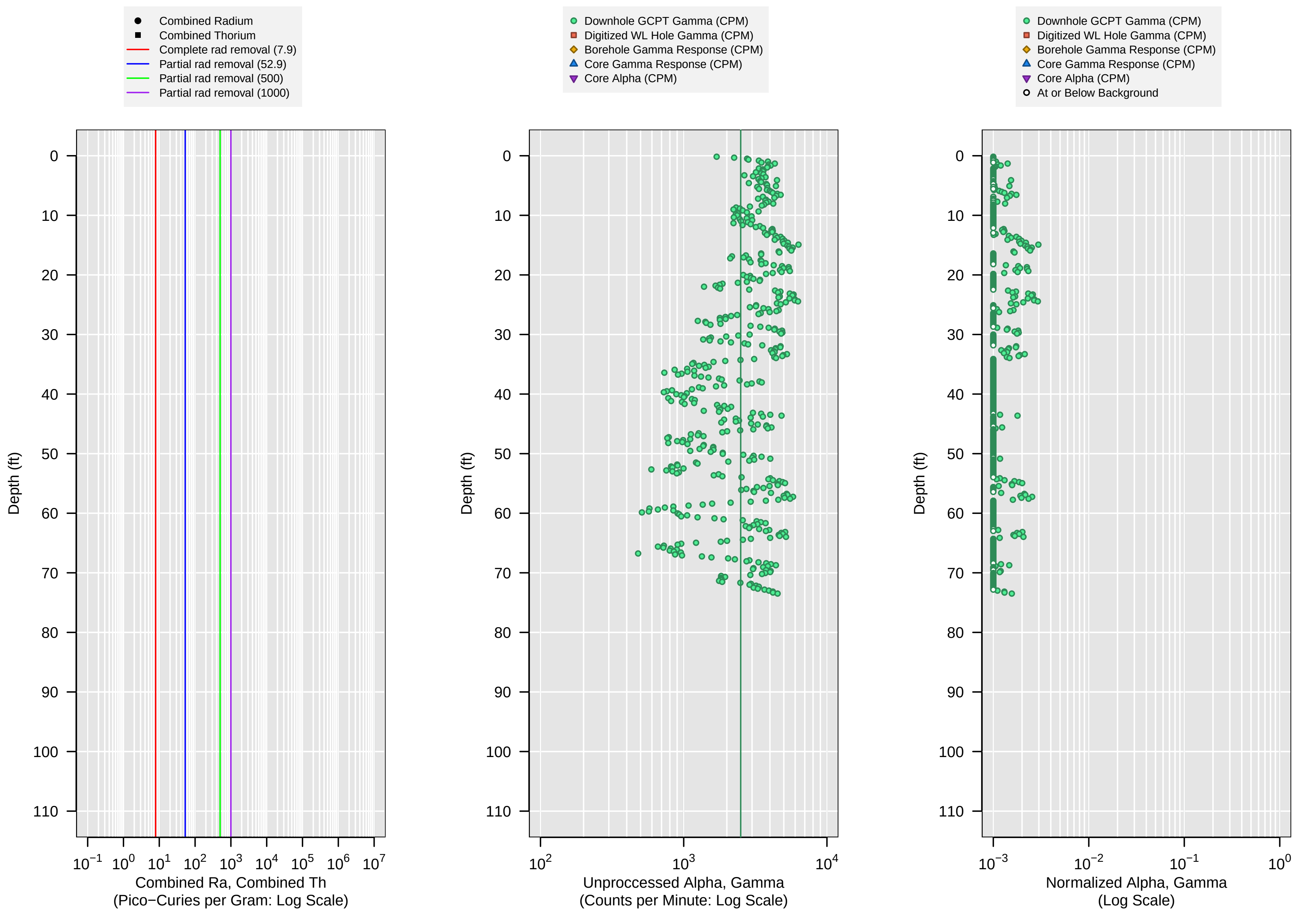
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
1400
2800
4200
5600
7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)


GCPT−14−6
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Normalized Alpha, Gamma
(Log Scale)

GCPT−14−6S

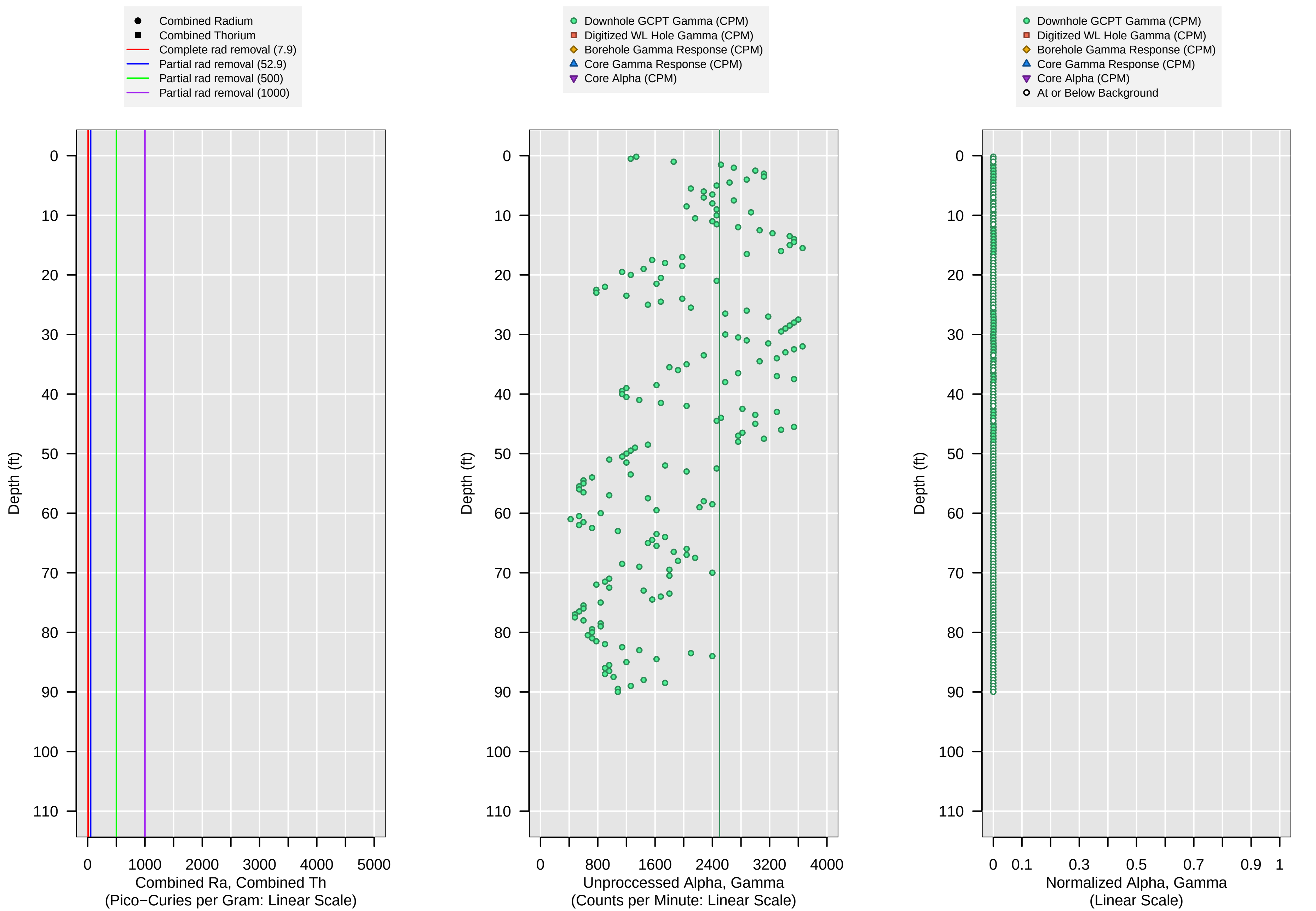

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−14−6S



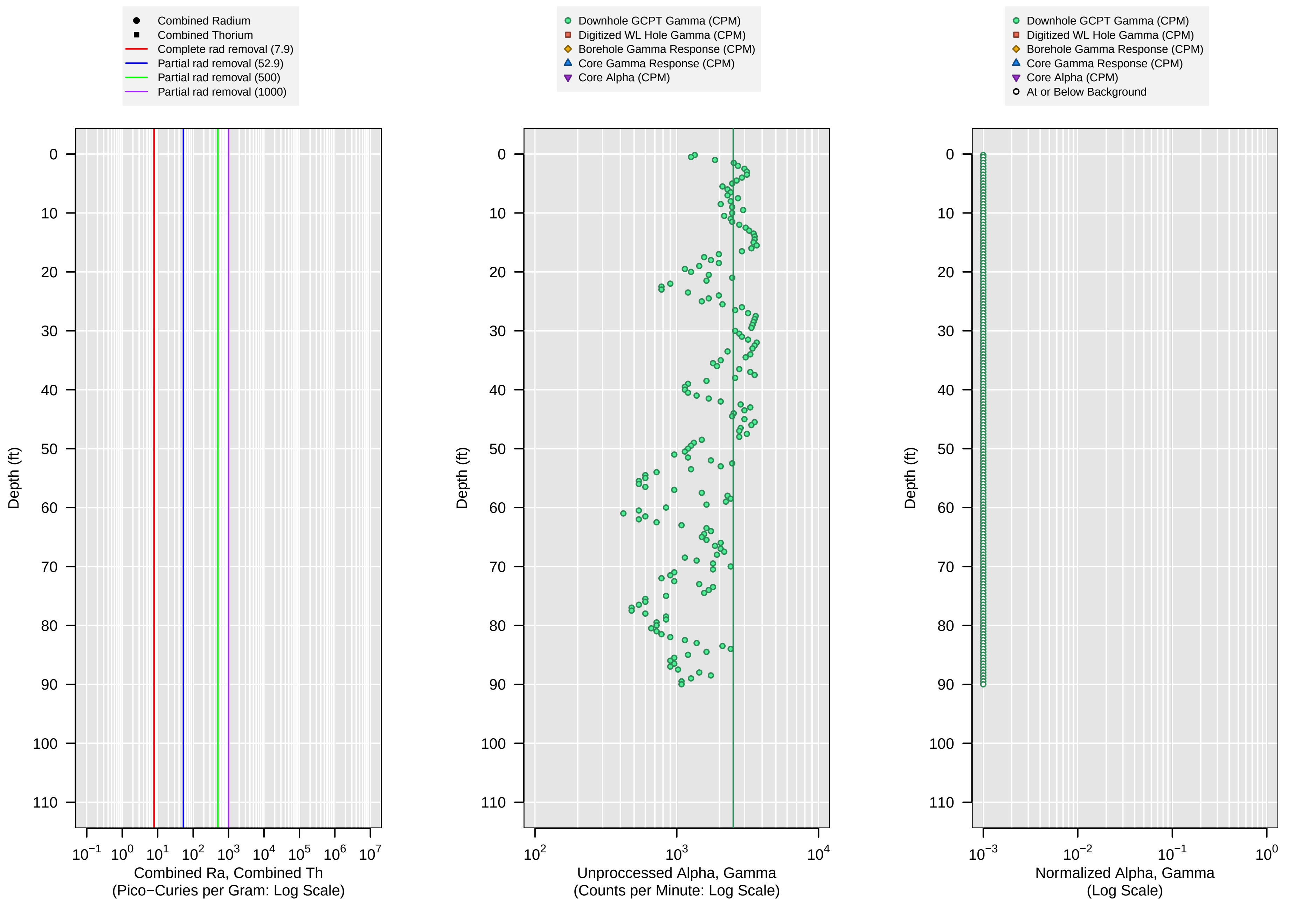
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

GCPT−14−7

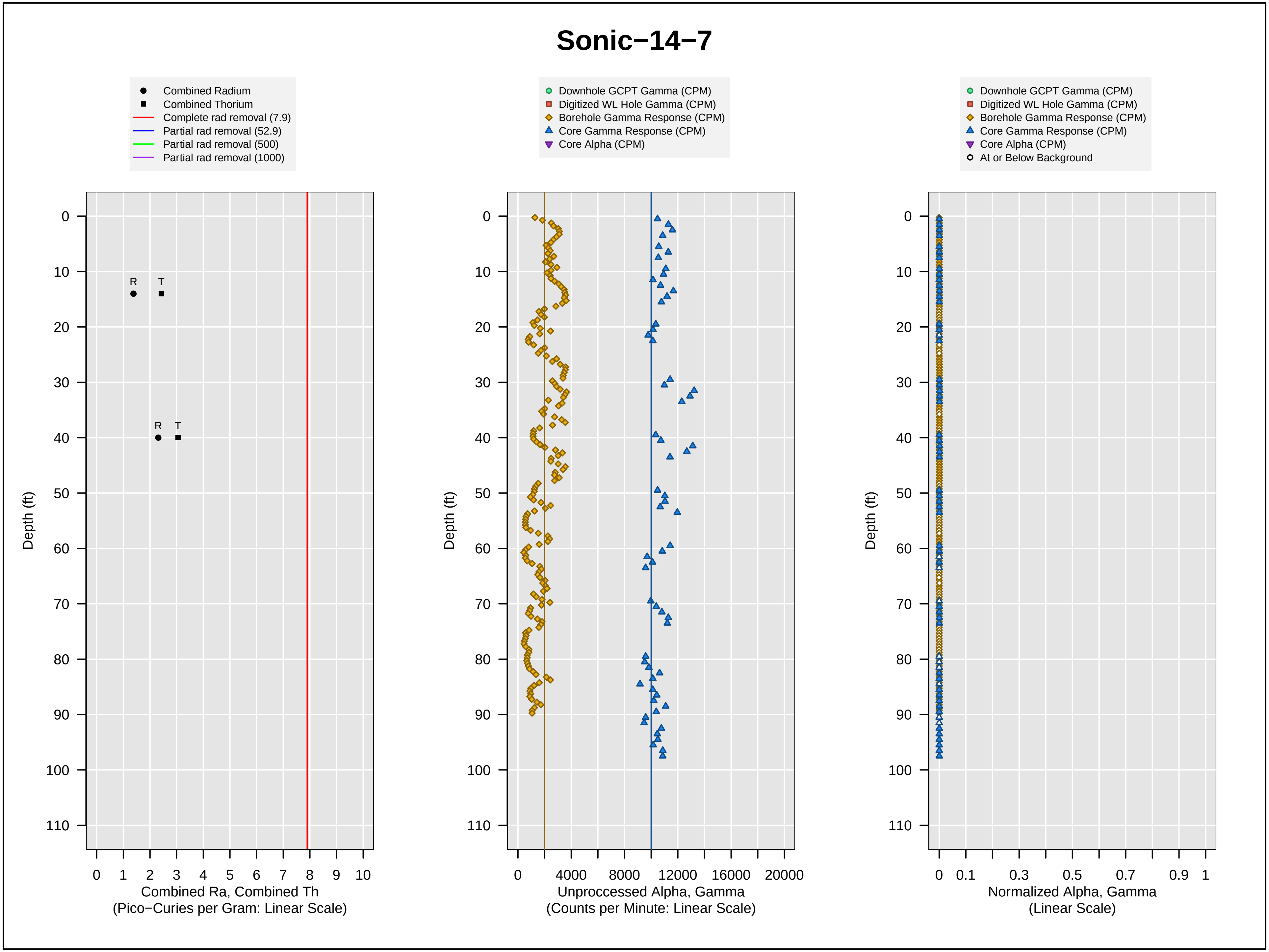


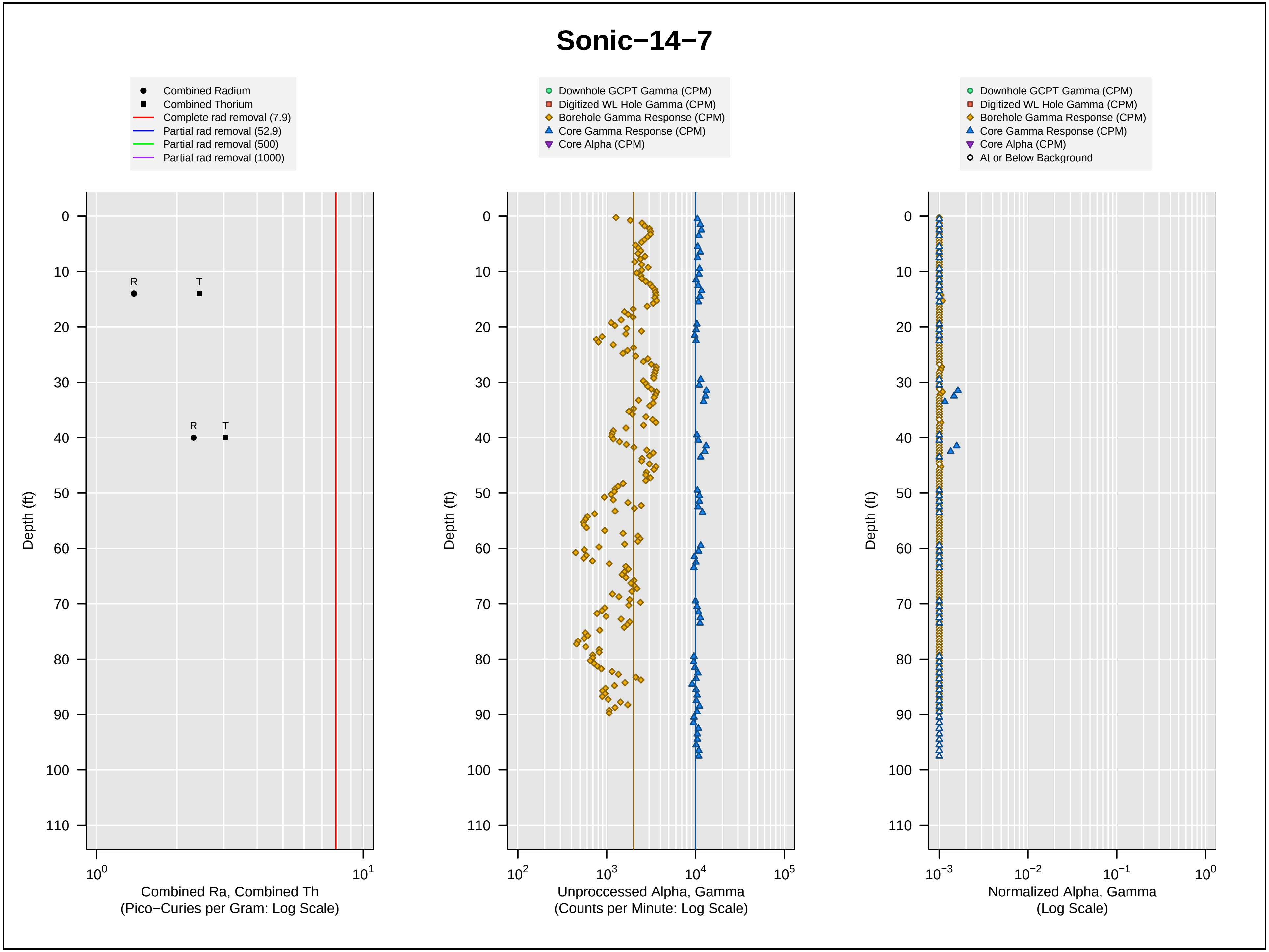
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
800
1600
2400
3200
4000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

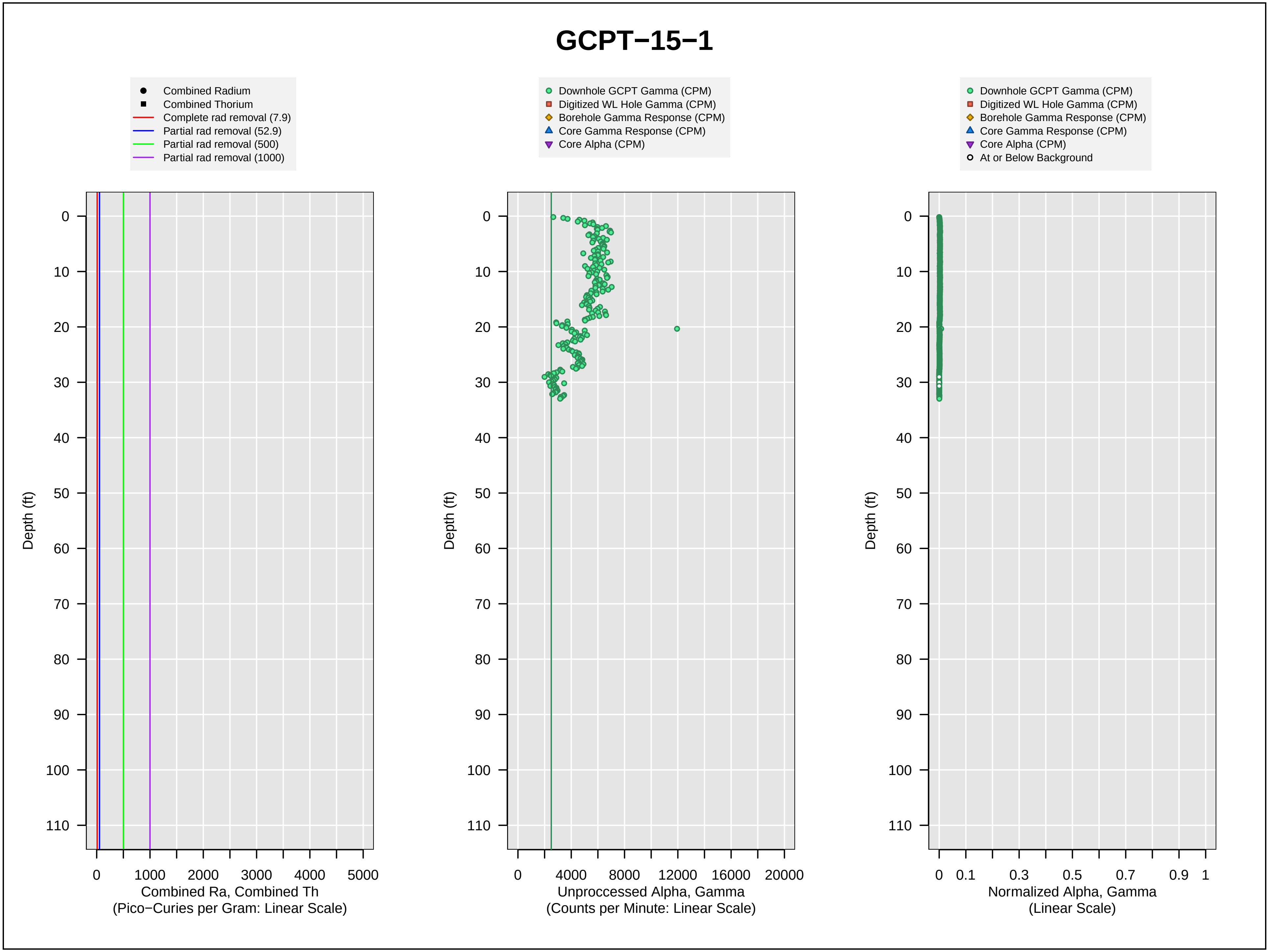
GCPT−14−7

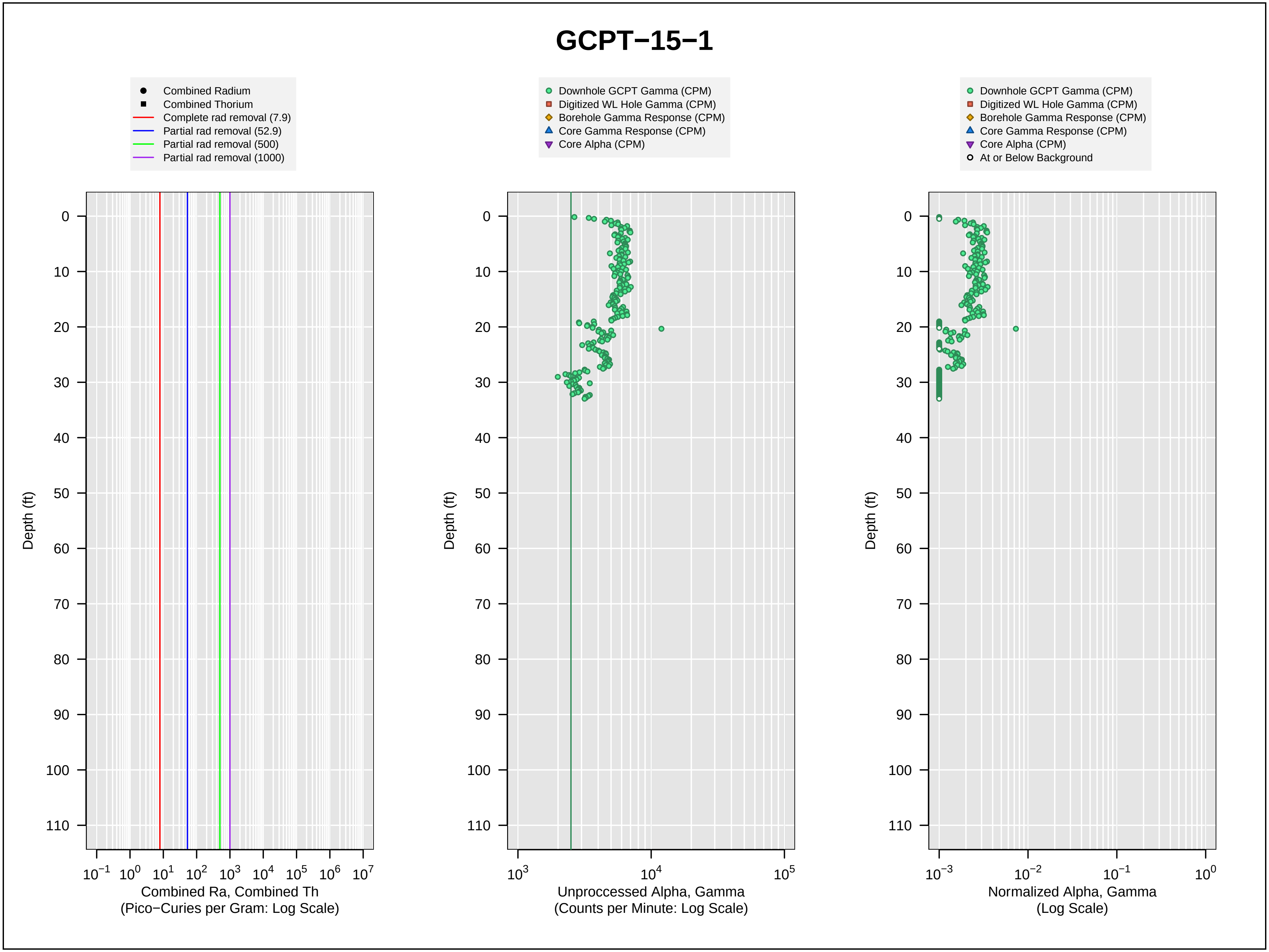


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

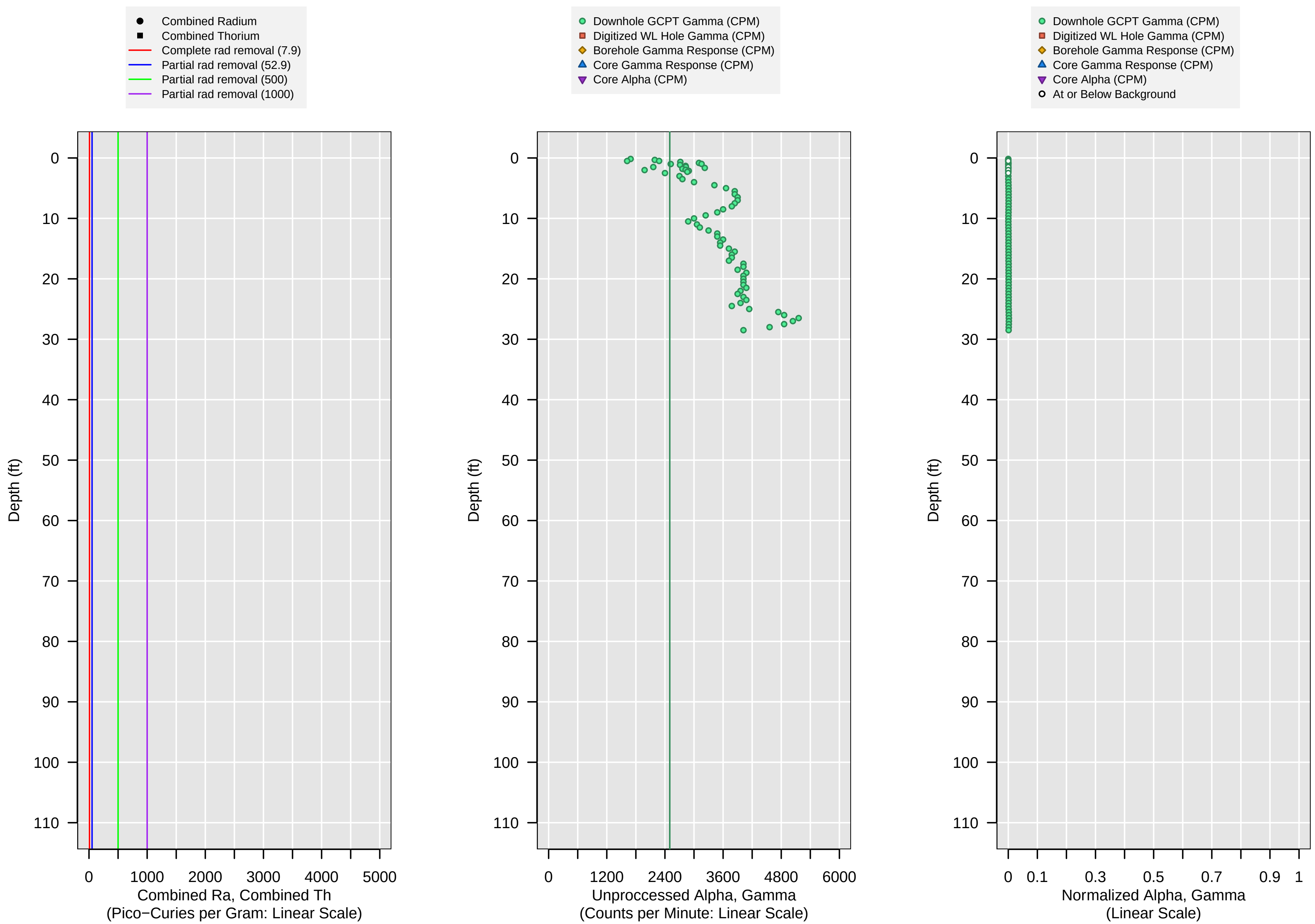

Sonic−14−7
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)


Sonic−14−7
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)


GCPT−15−1
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

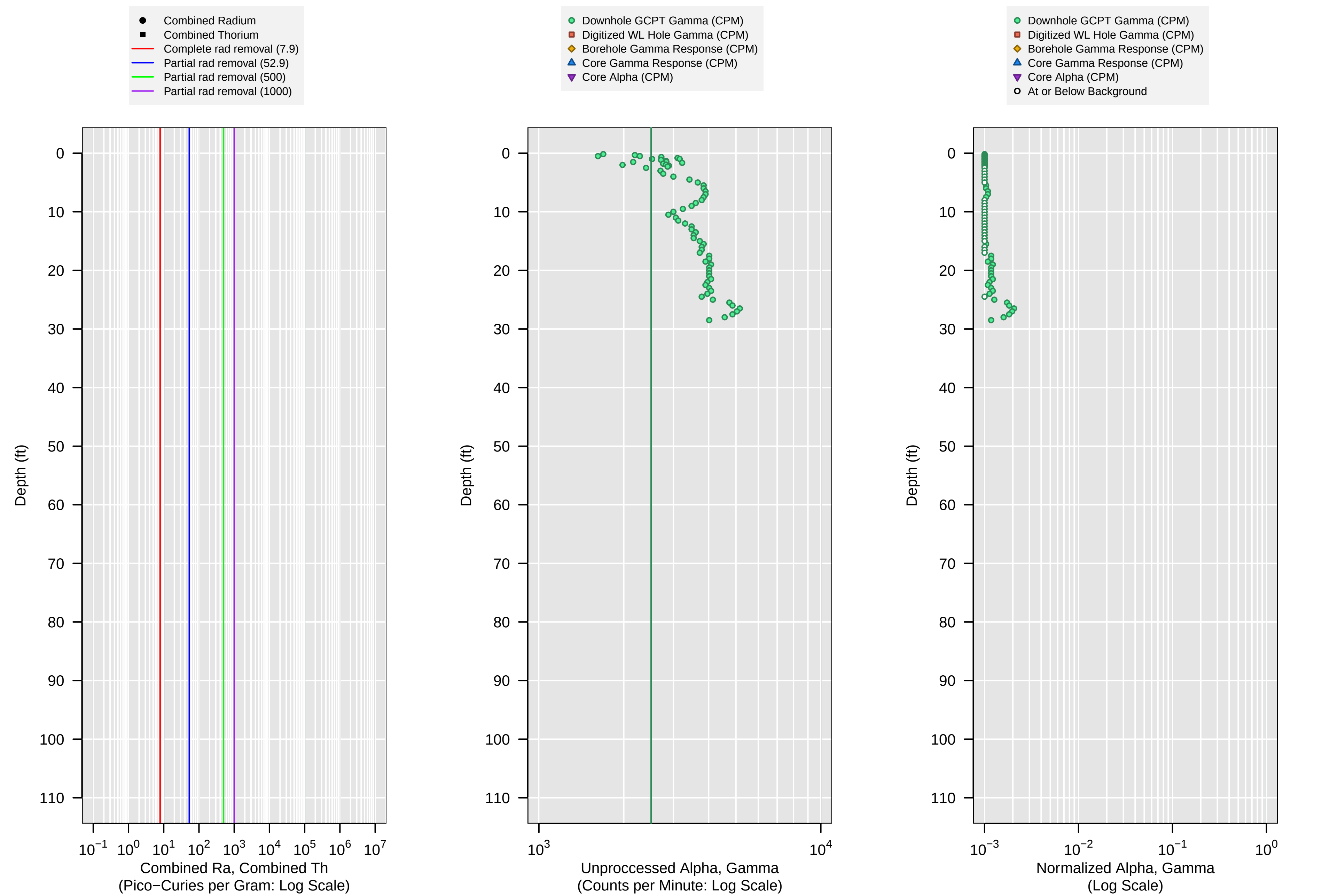

GCPT−15−1
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

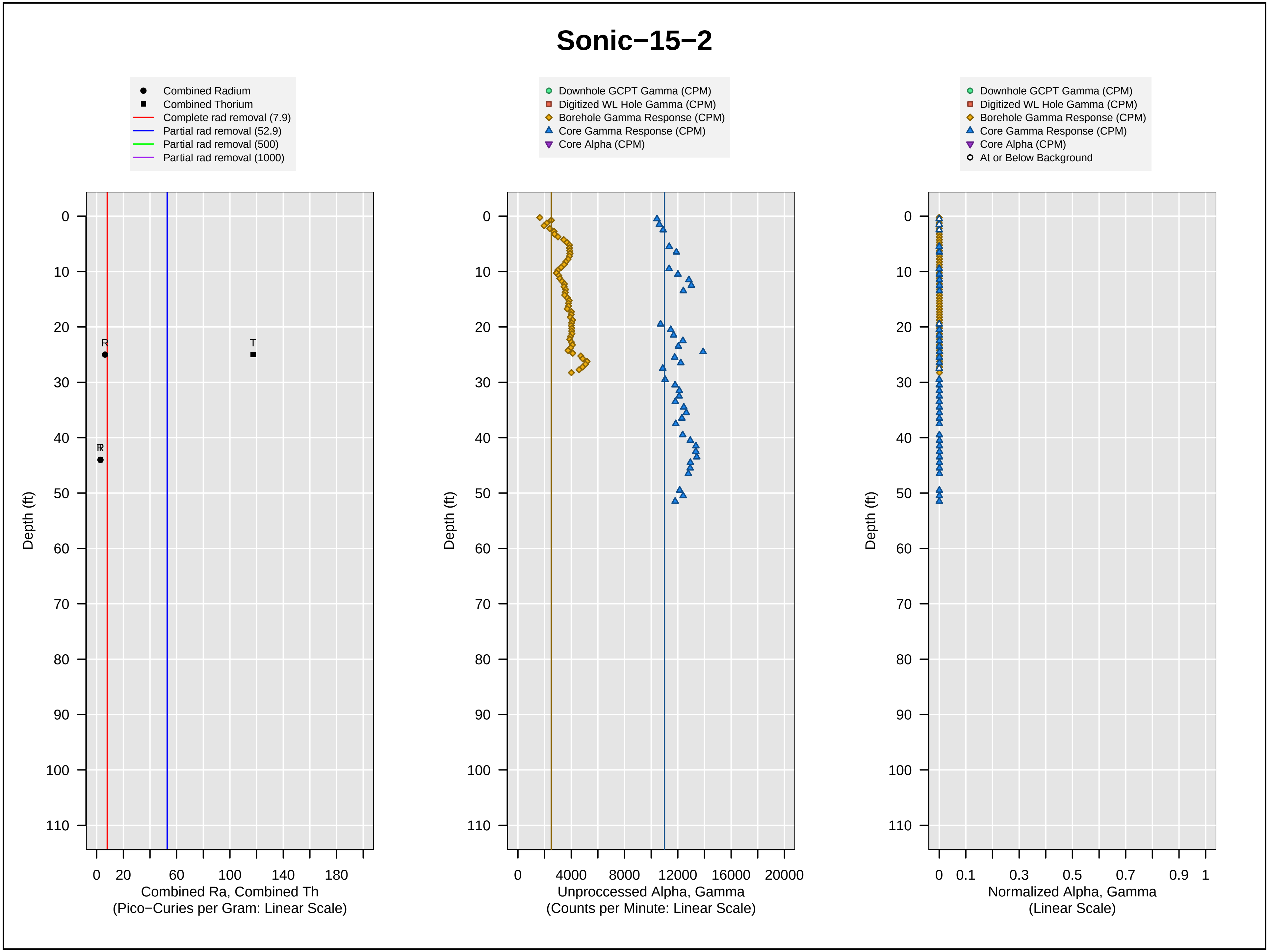
GCPT−15−2

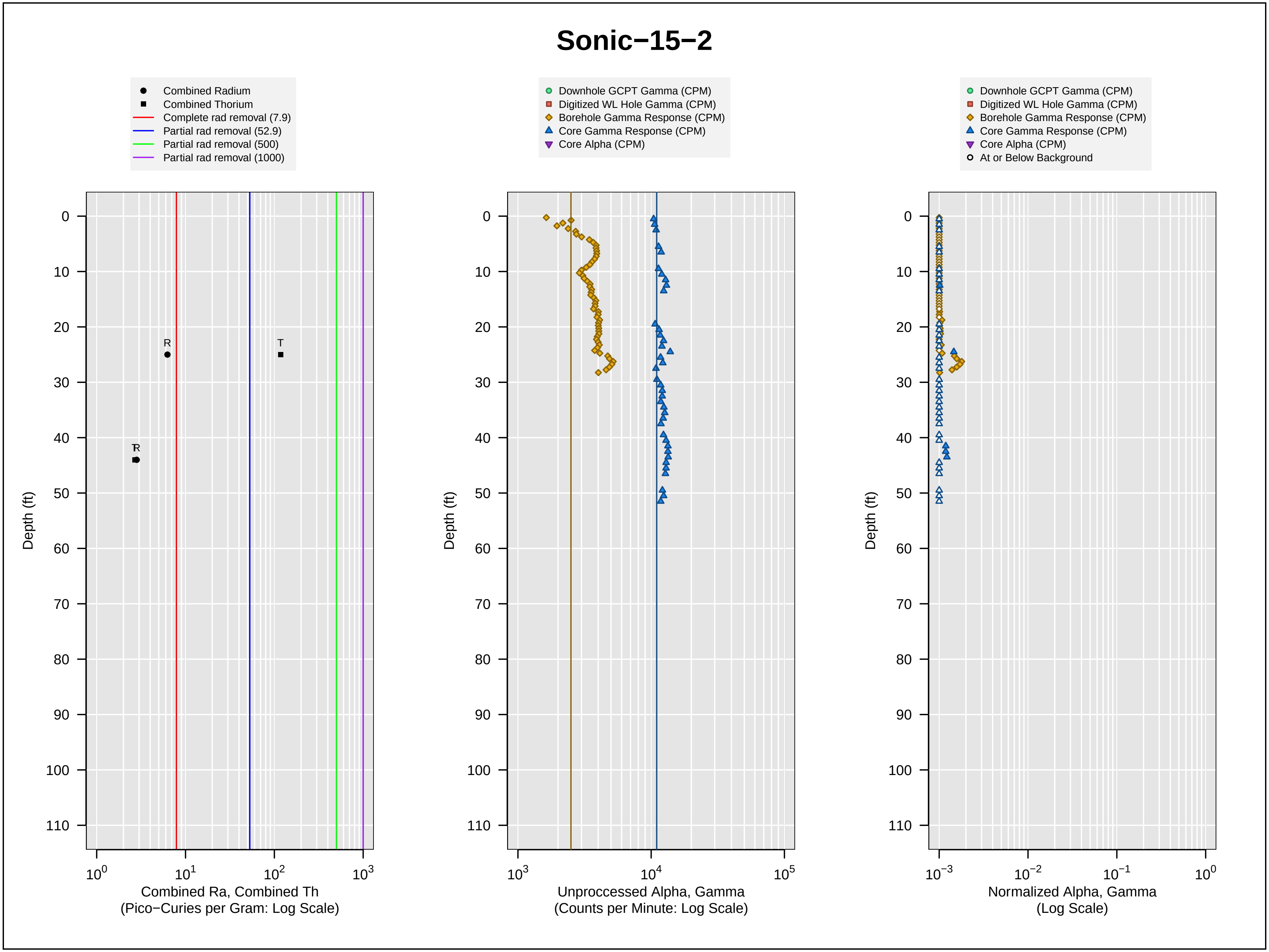


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

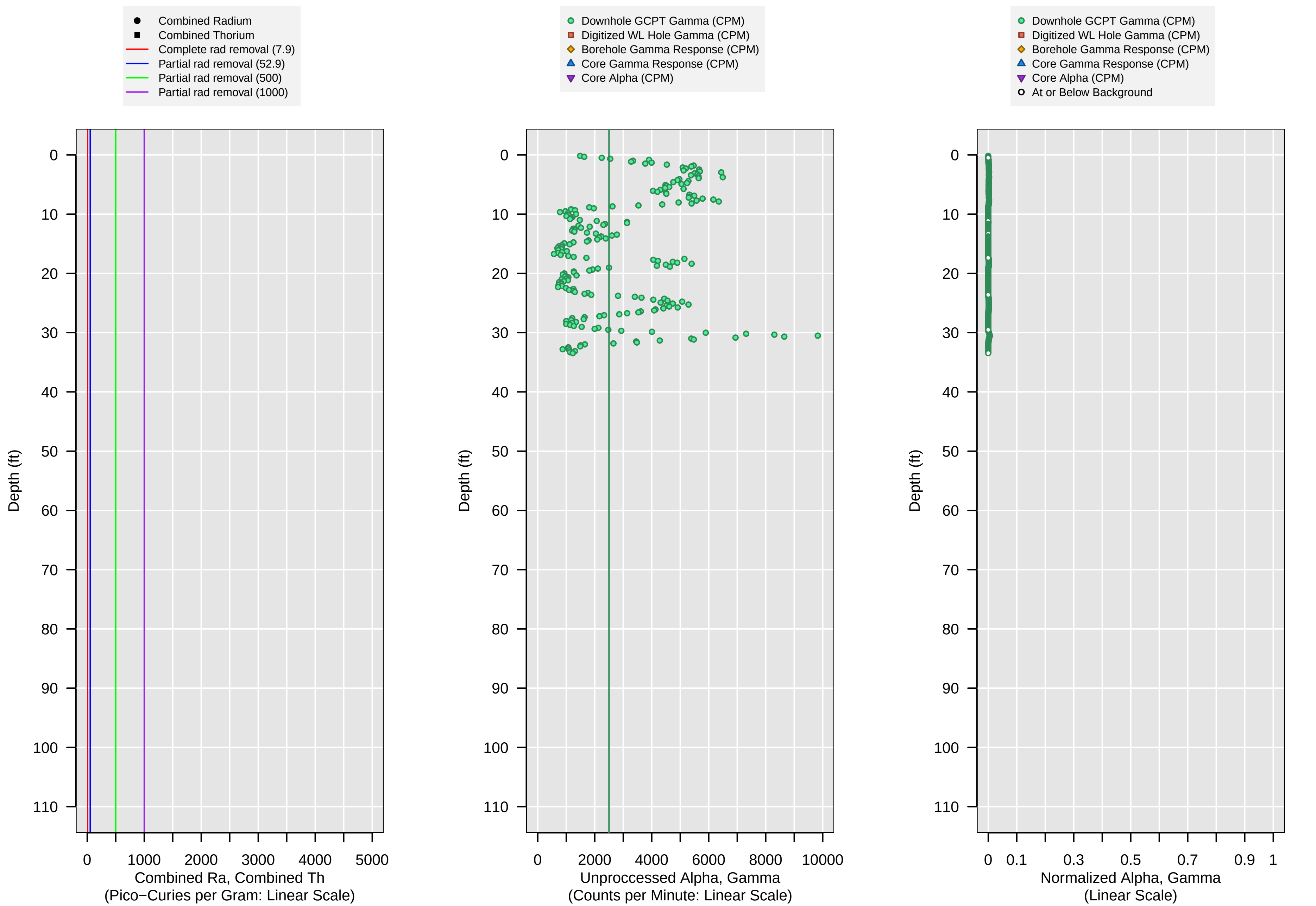
GCPT−15−2


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

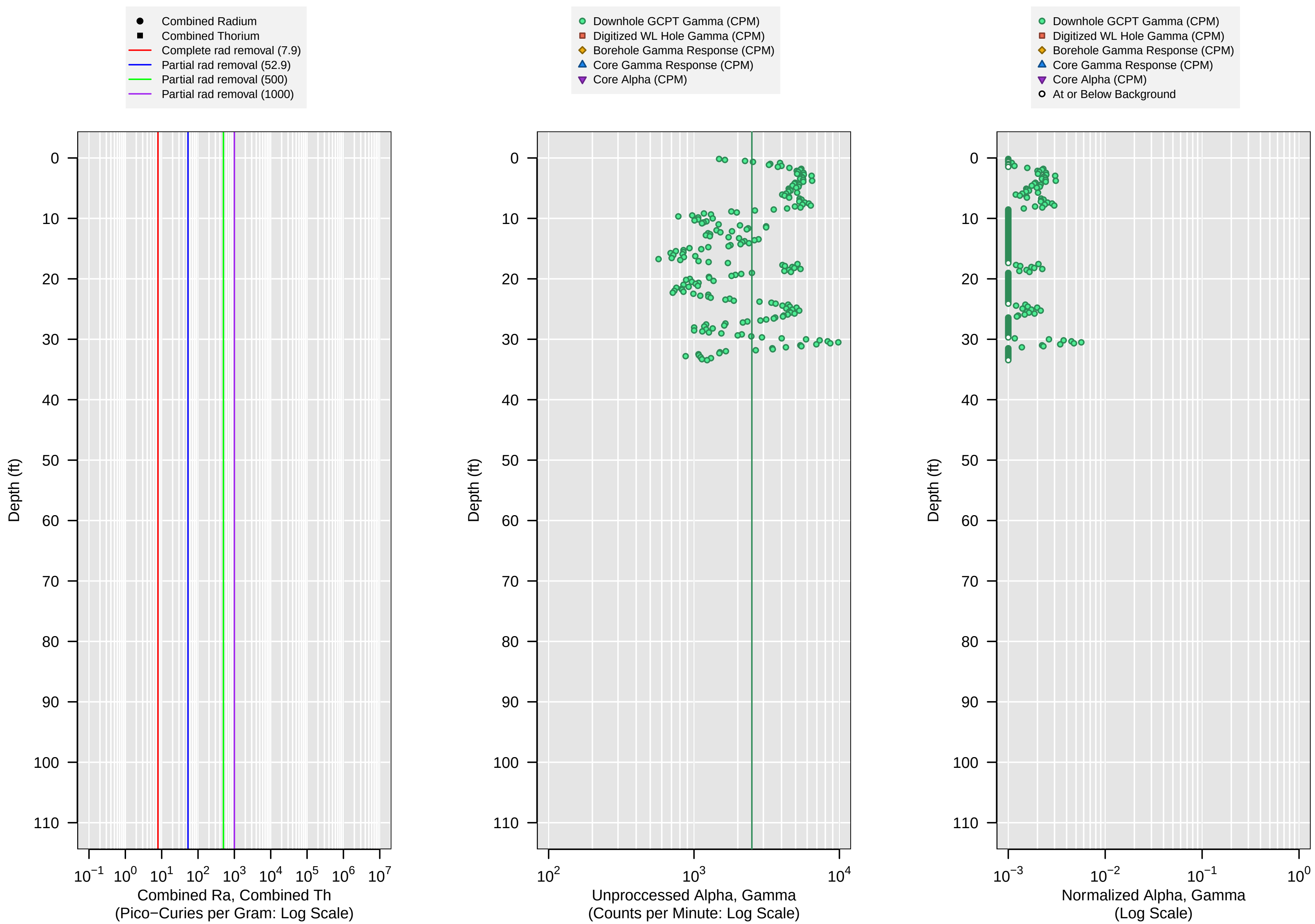

Sonic−15−2
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
R
T
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)


Sonic−15−2
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

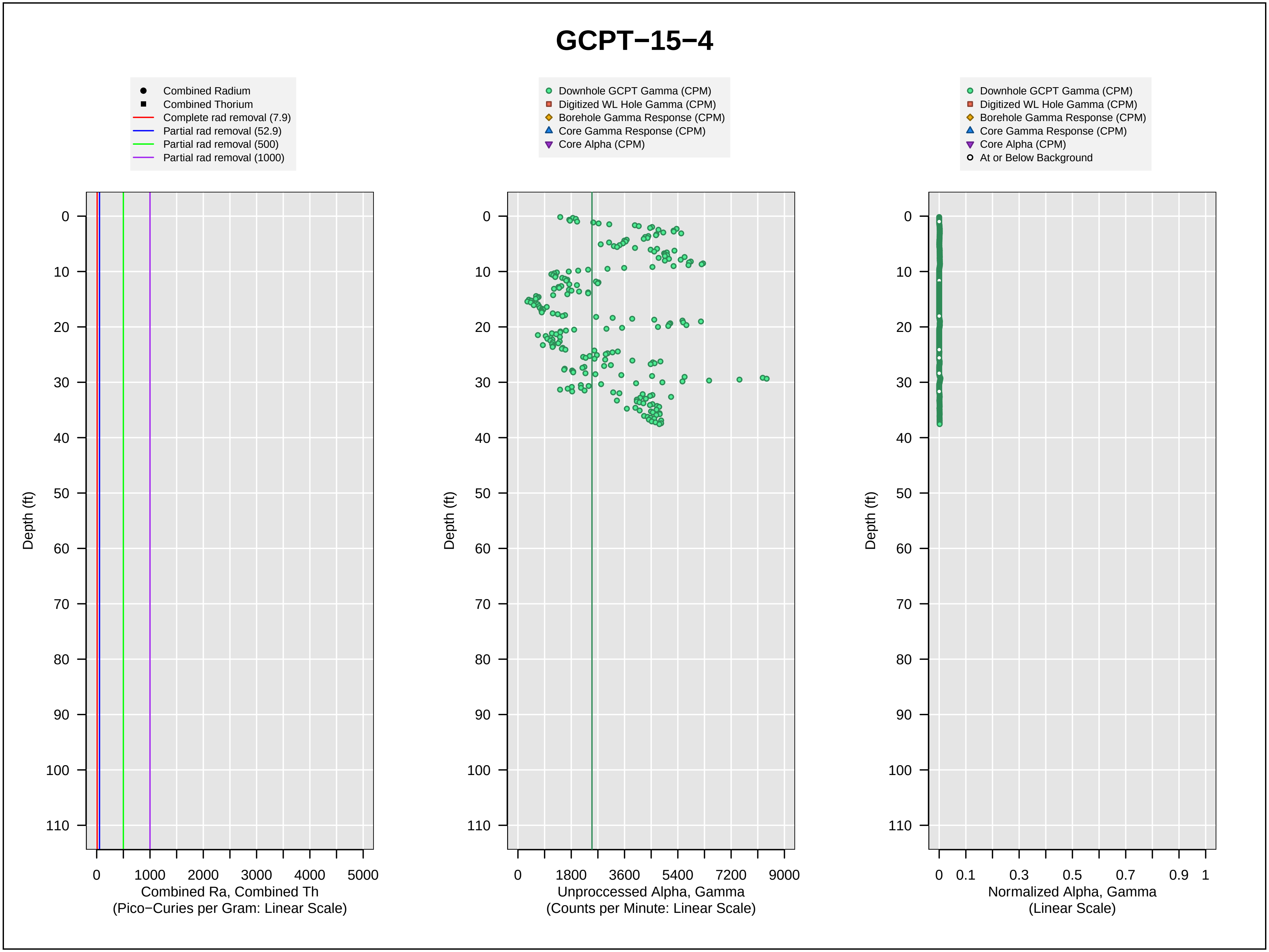
GCPT−15−3


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Linear Scale)

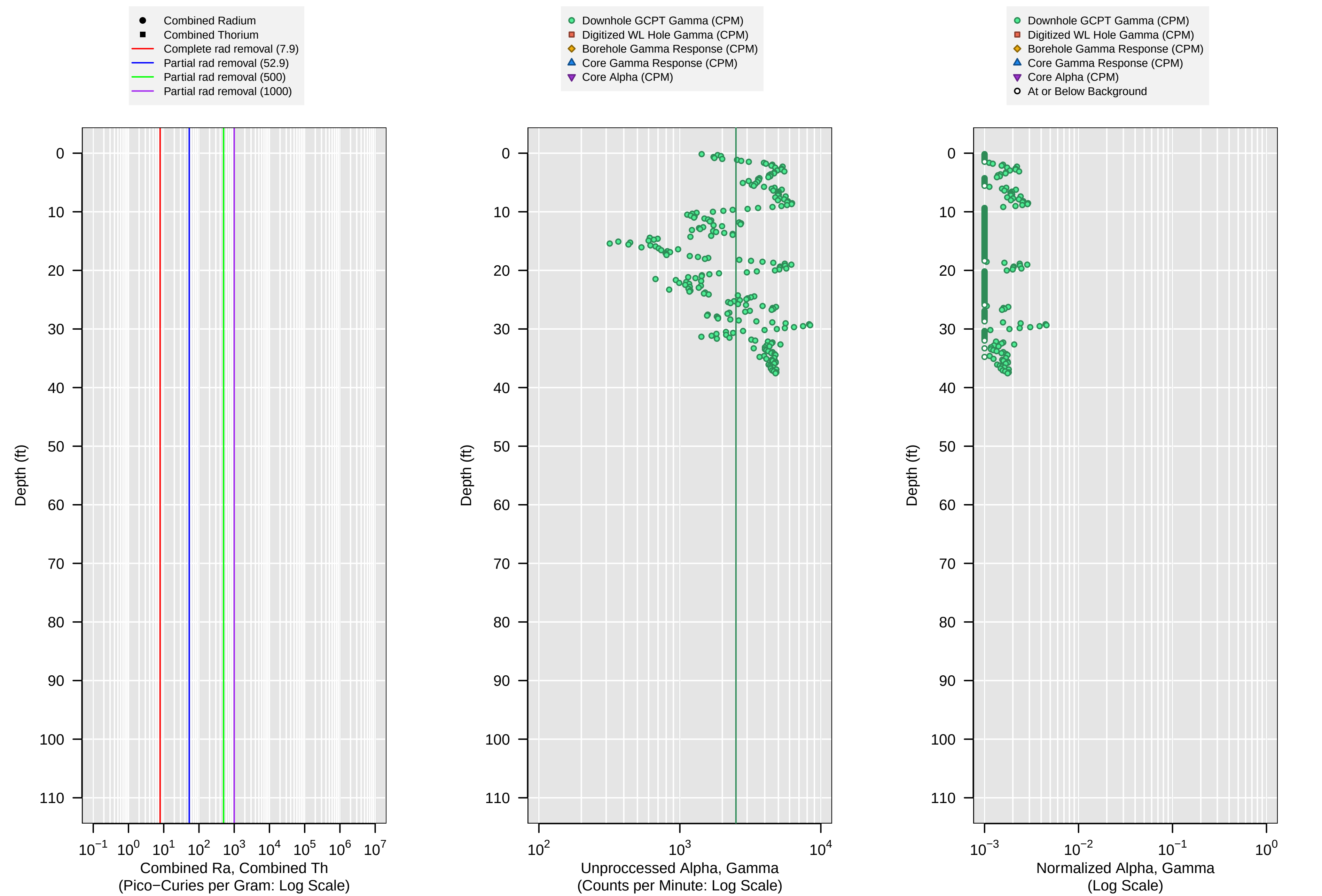
GCPT−15−3



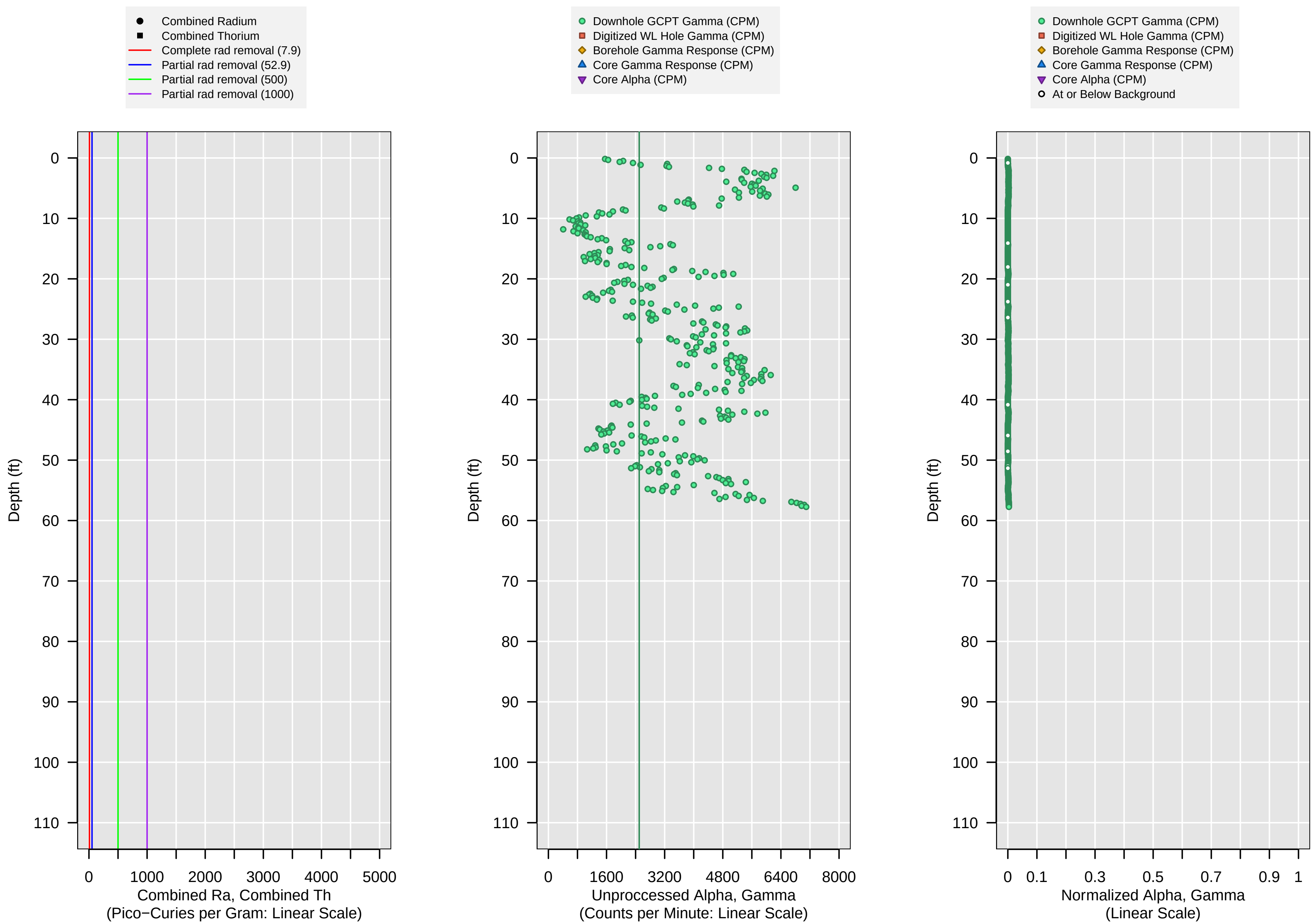
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)


GCPT−15−4
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Depth (ft)
0
1800
3600
5400
7200
9000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Depth (ft)
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

GCPT−15−4

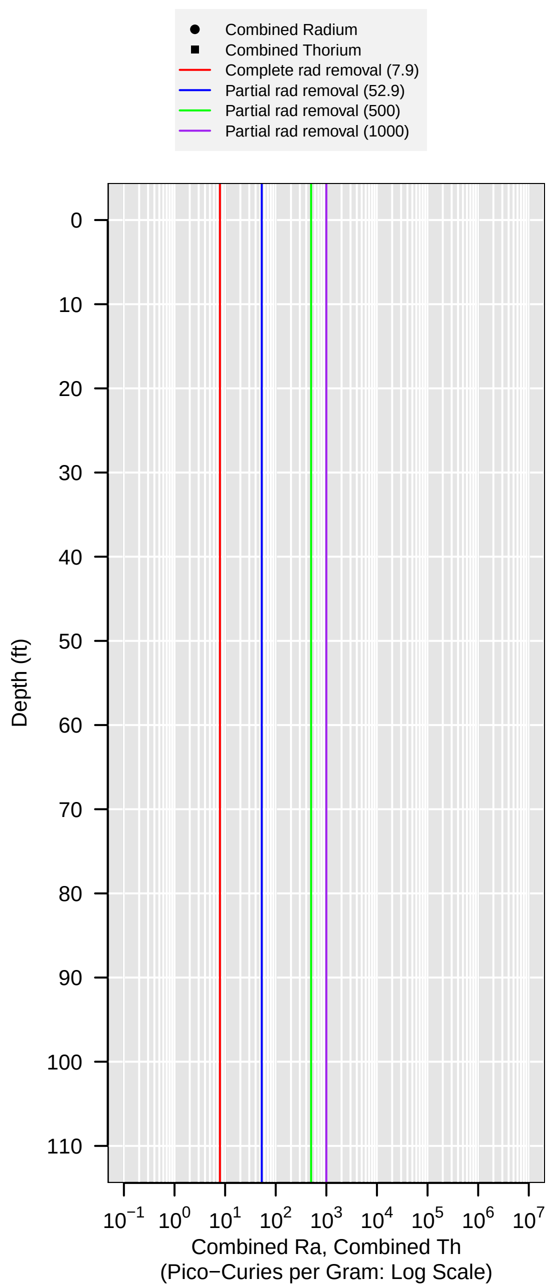

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

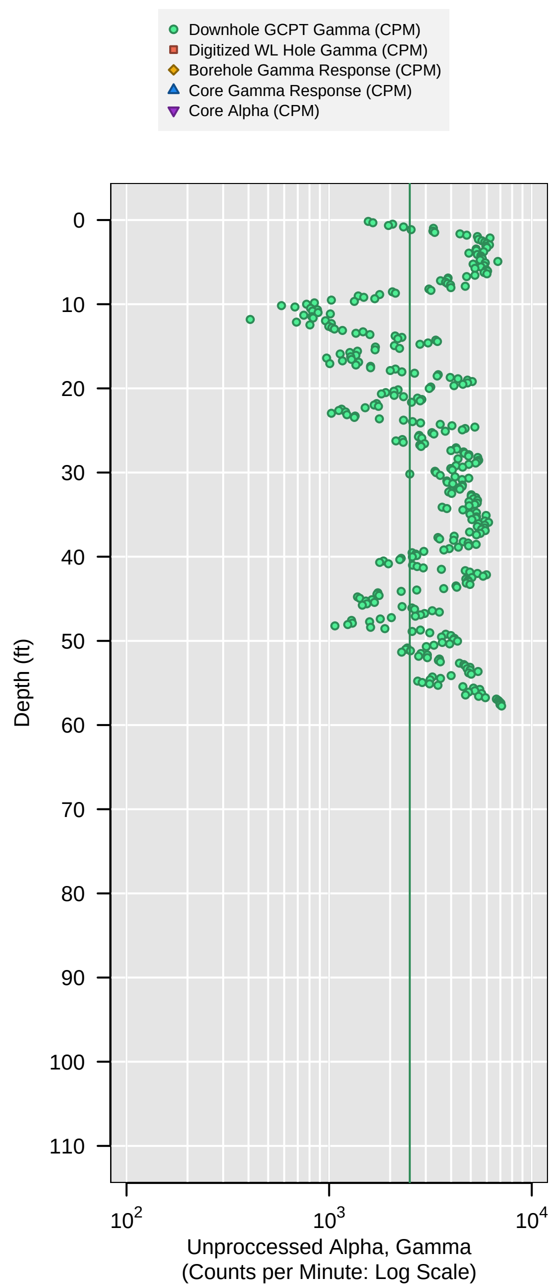
GCPT−15−5

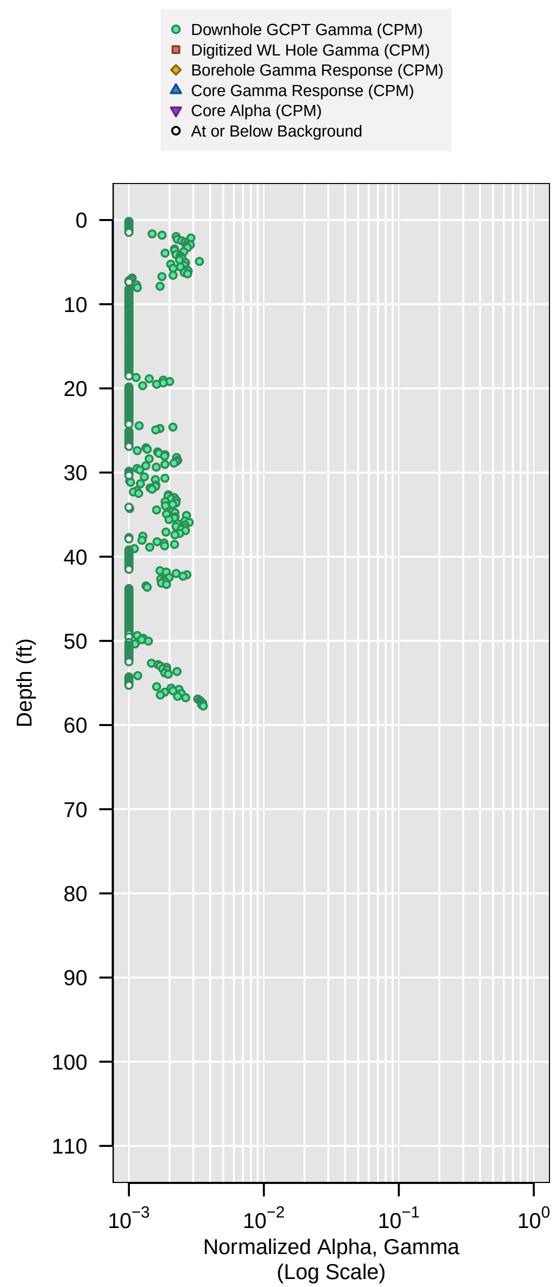


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

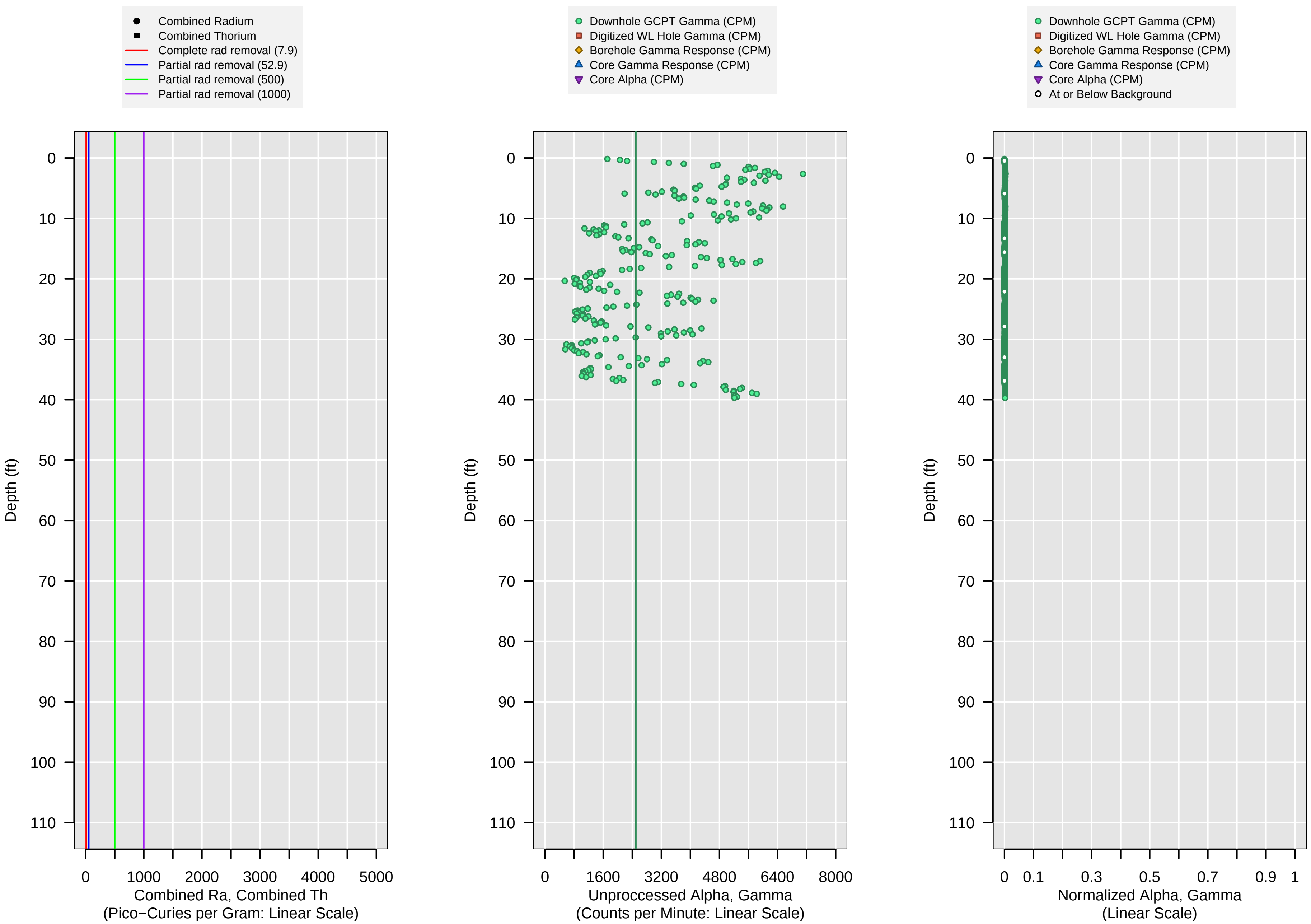
GCPT−15−5


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{-1} 10^{0} 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6} 10^{7}
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)

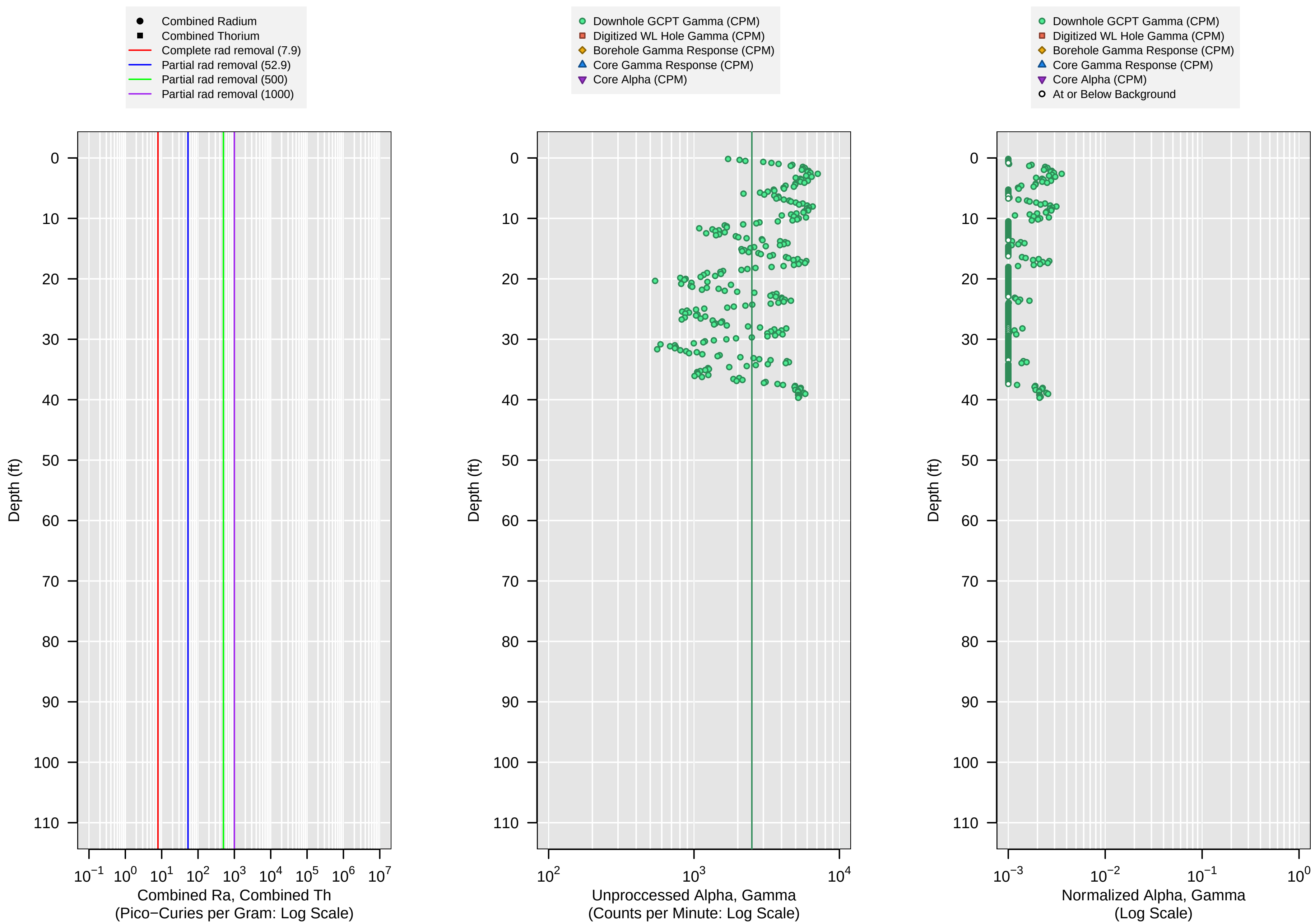

Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{2} 10^{3} 10^{4}
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{-3} 10^{-2} 10^{-1} 10^{0}
Normalized Alpha, Gamma
(Log Scale)

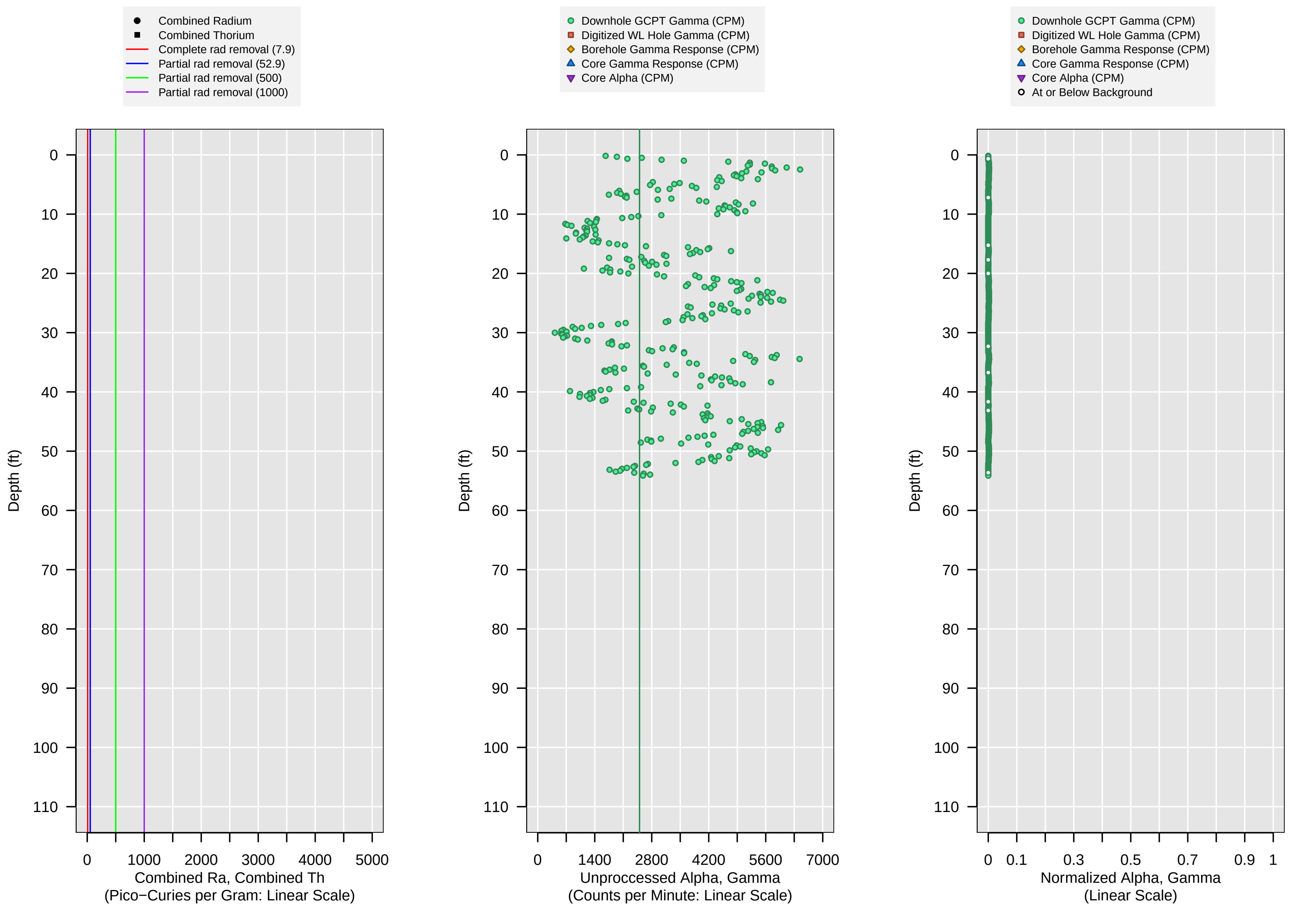
GCPT−15−6


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

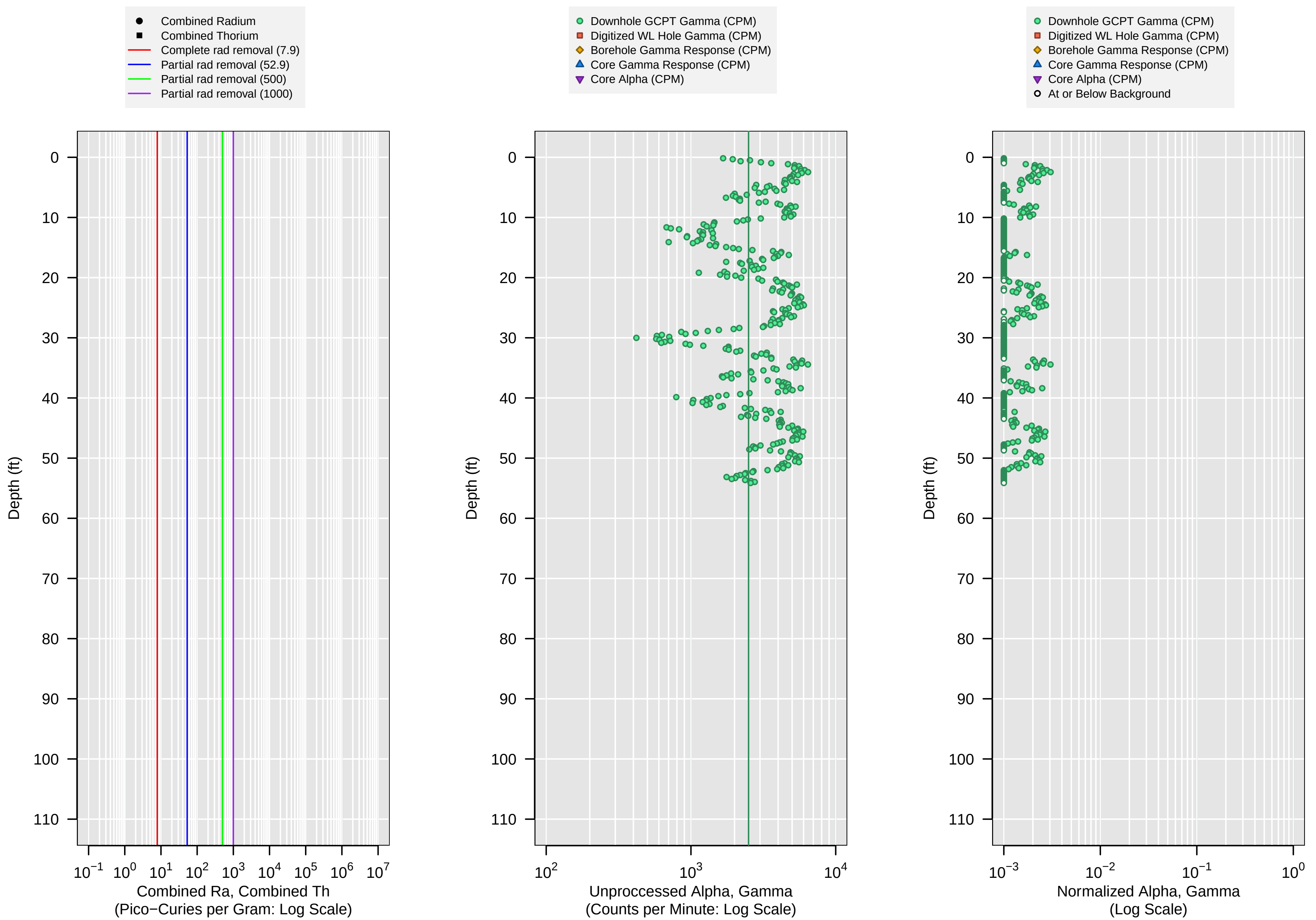
GCPT−15−6


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{-1} 10^{0} 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6} 10^{7}
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
10^{2} 10^{3} 10^{4}
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
10^{-3} 10^{-2} 10^{-1} 10^{0}
Normalized Alpha, Gamma
(Log Scale)

GCPT−15−7

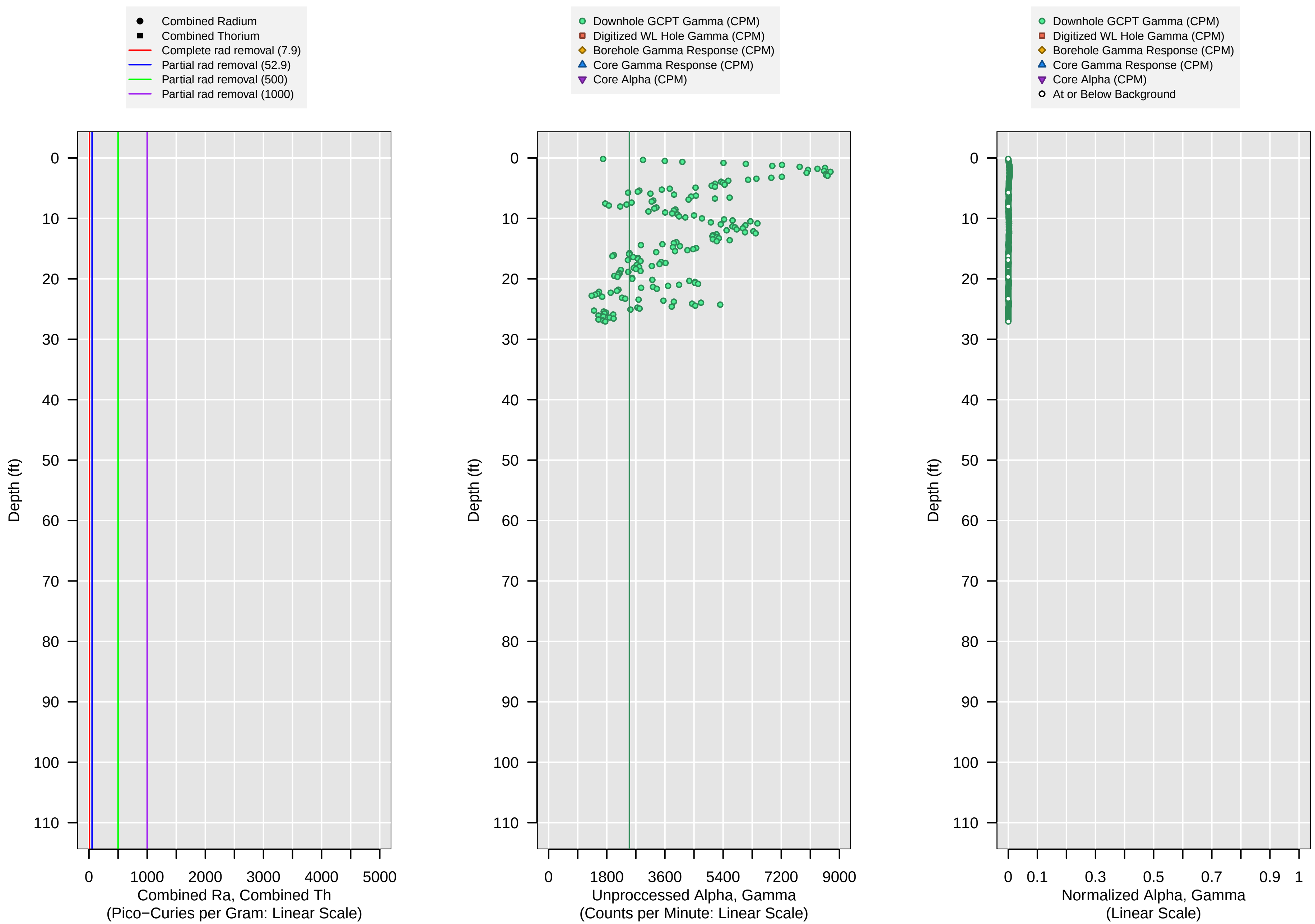

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

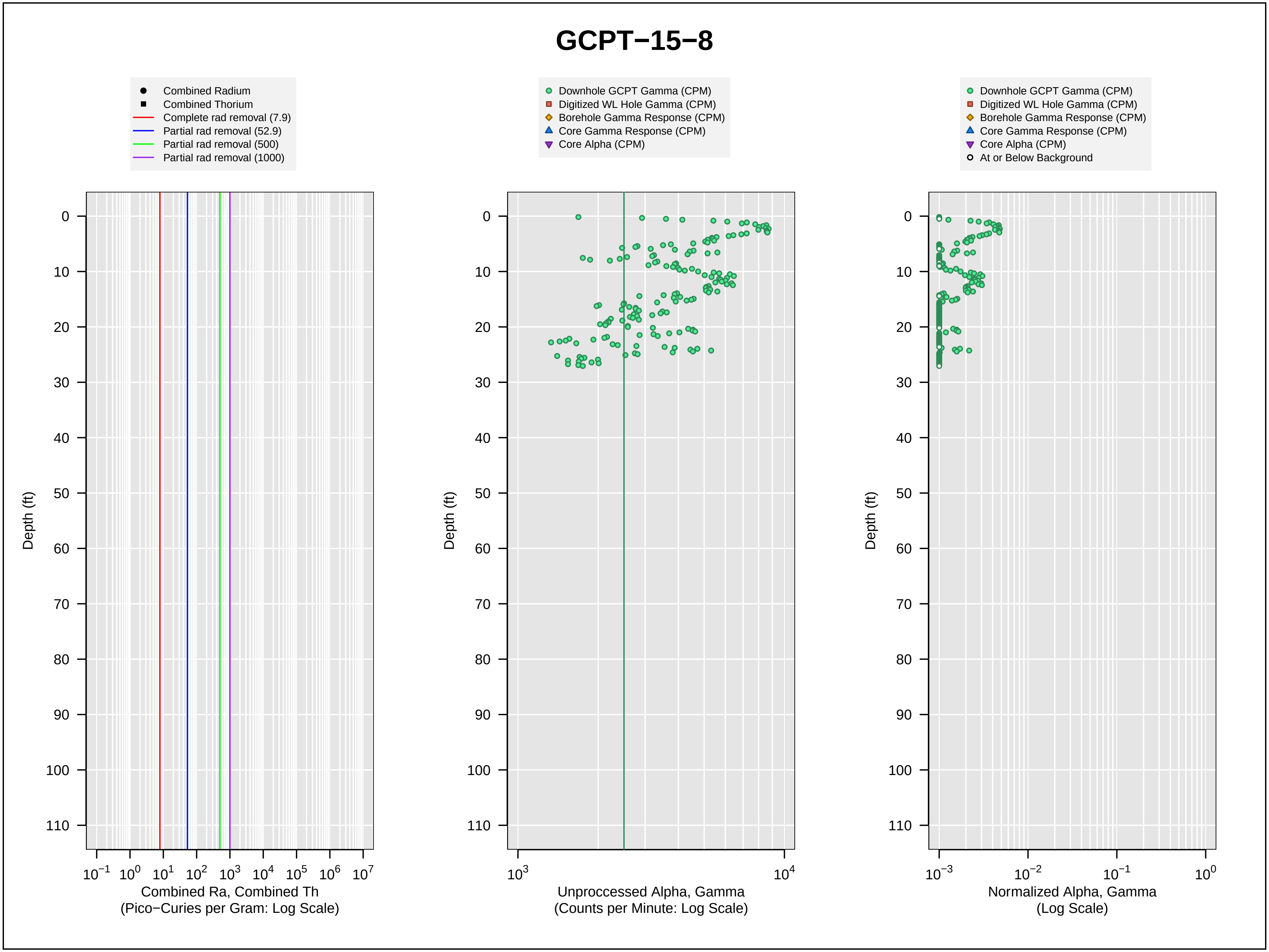
GCPT−15−7

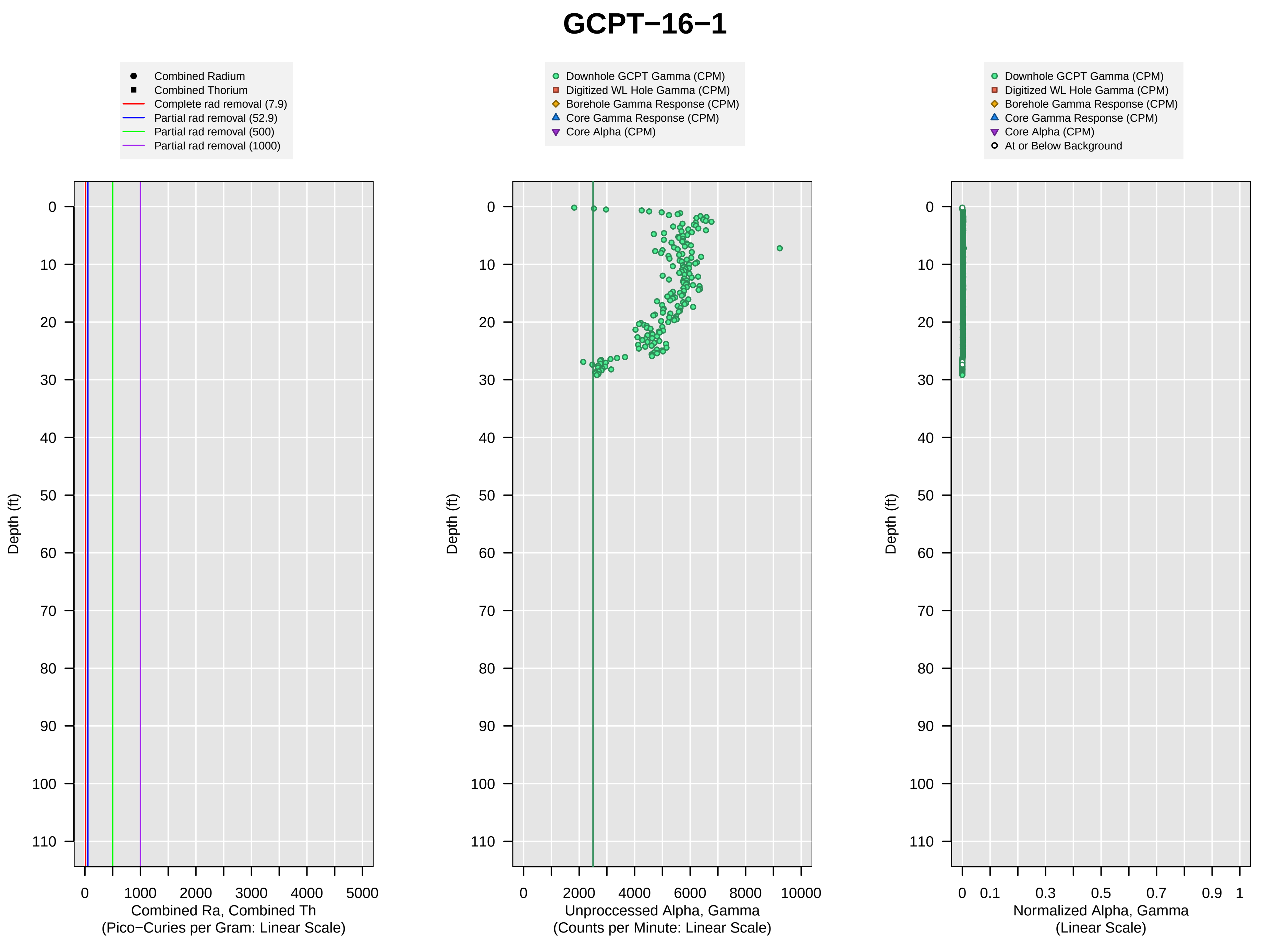


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

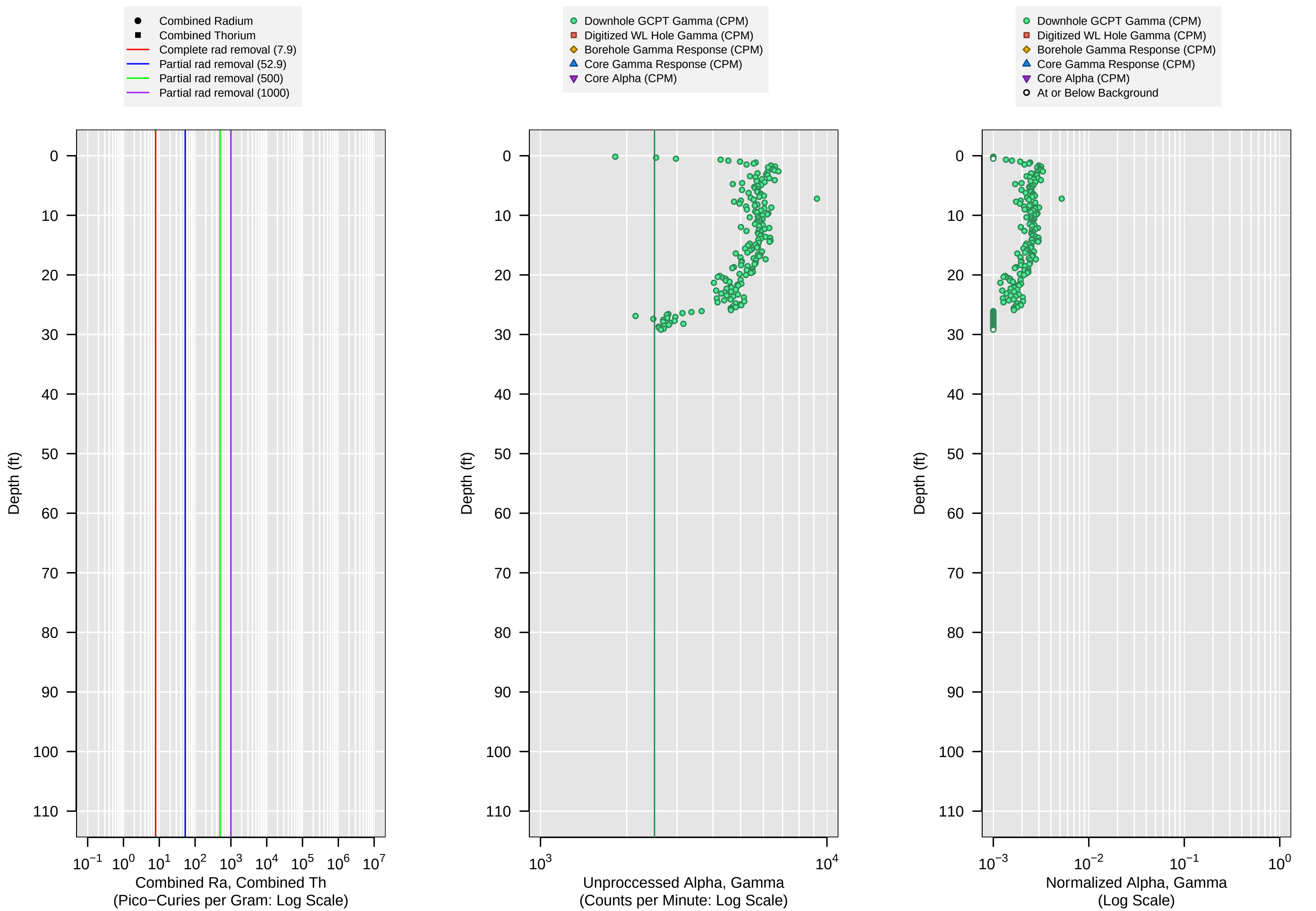
GCPT−15−8


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1800
3600
5400
7200
9000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)


GCPT−15−8
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

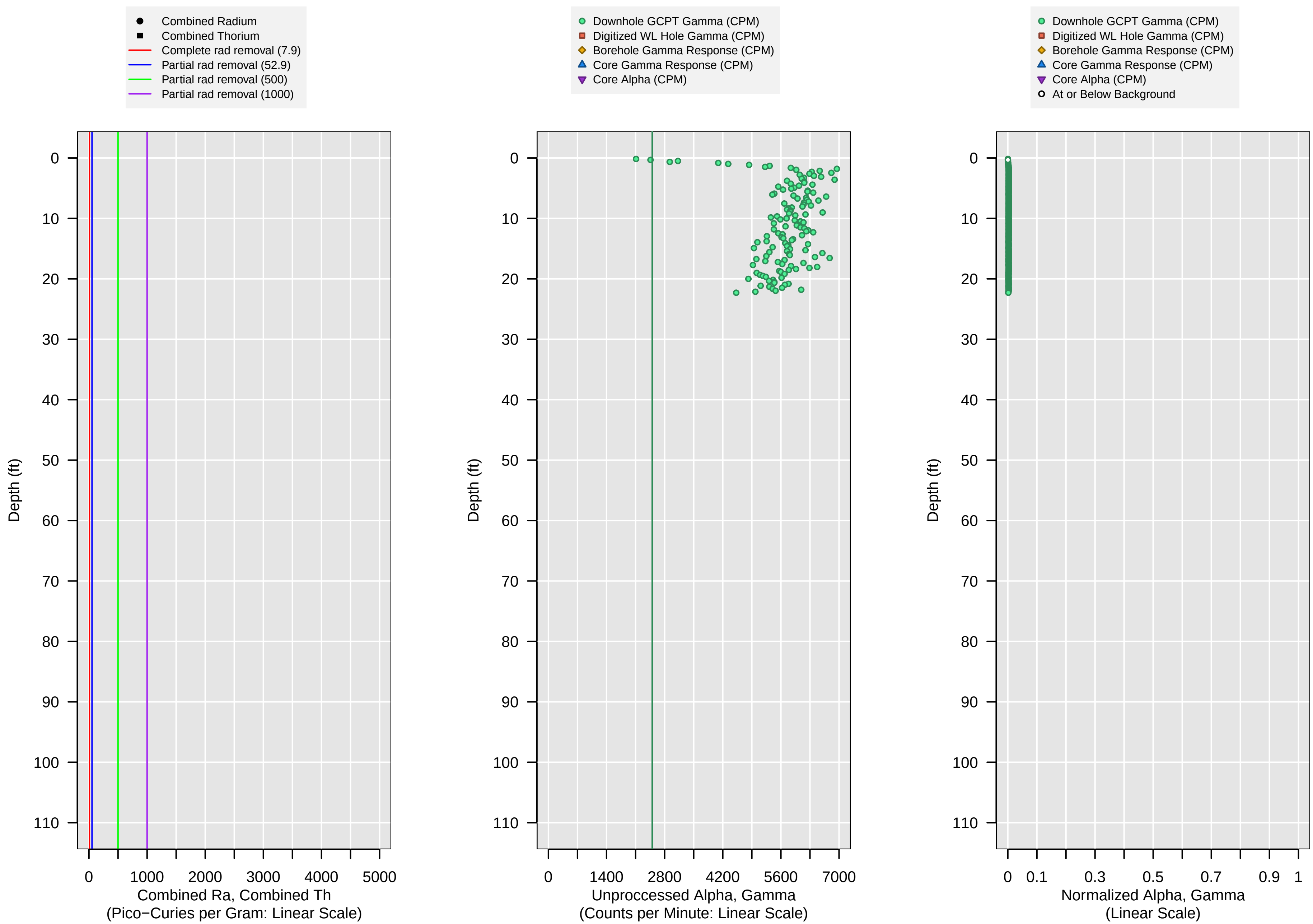

GCPT−16−1
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−16−1

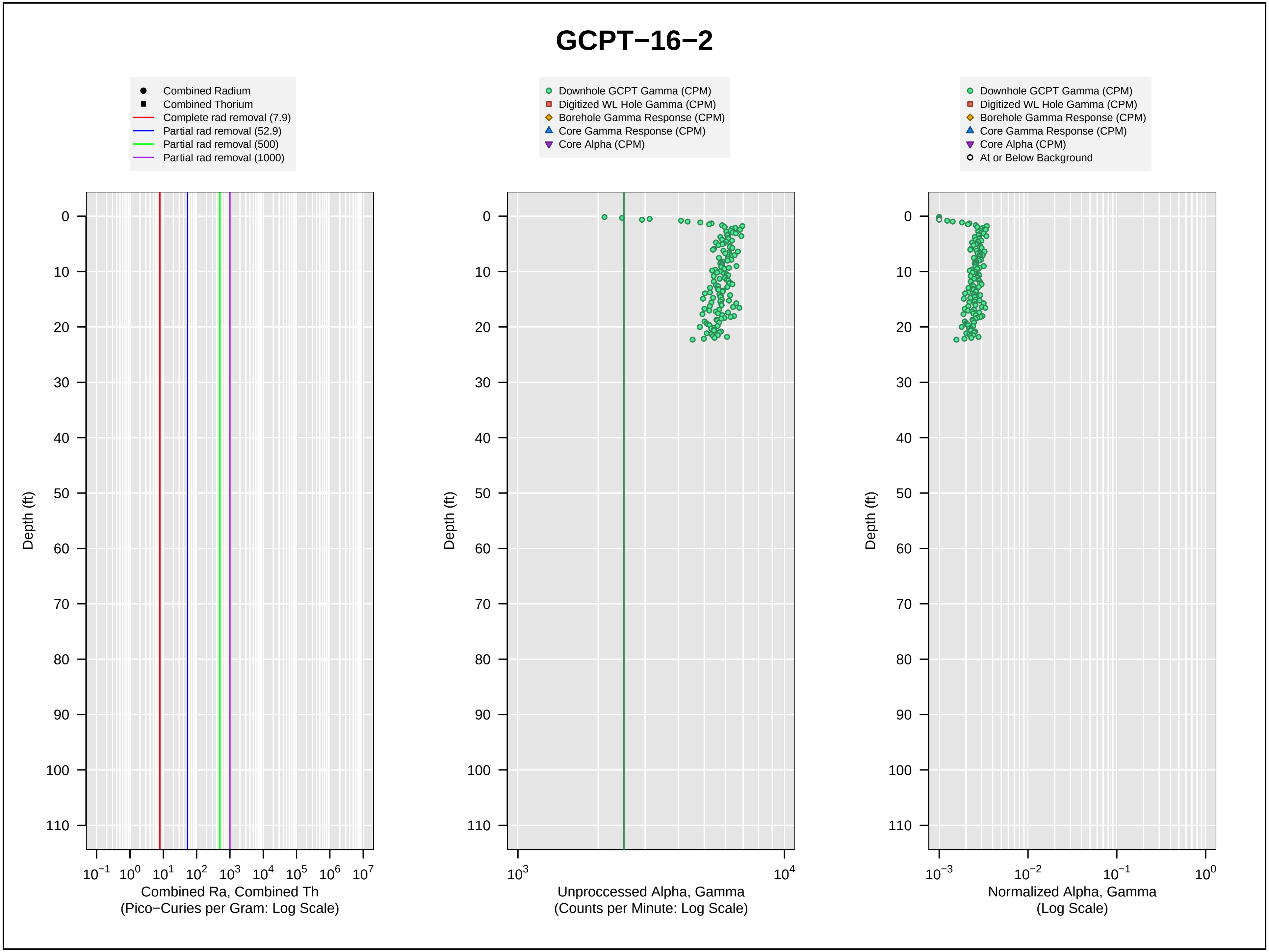


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

GCPT−16−2

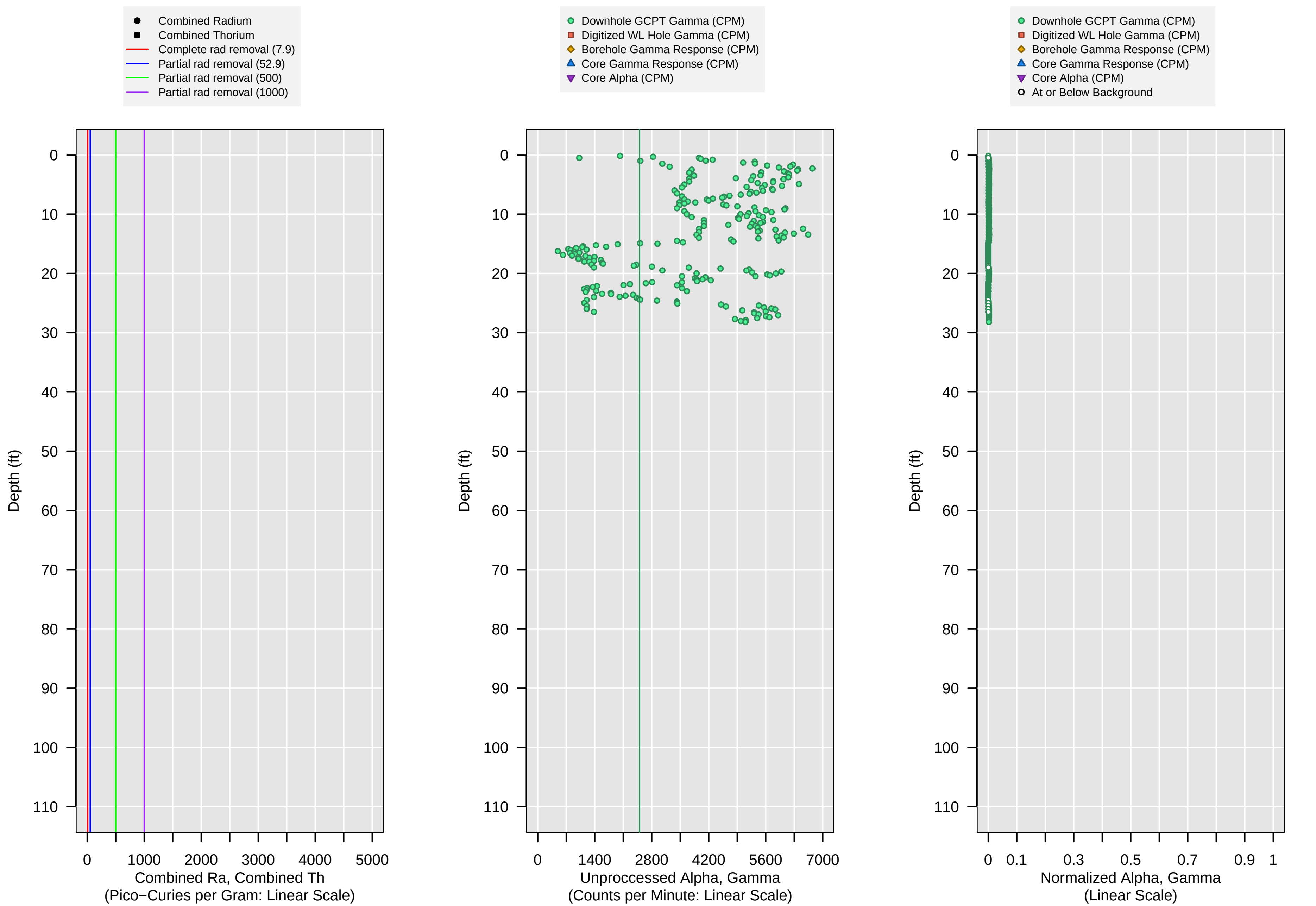


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1400
2800
4200
5600
7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

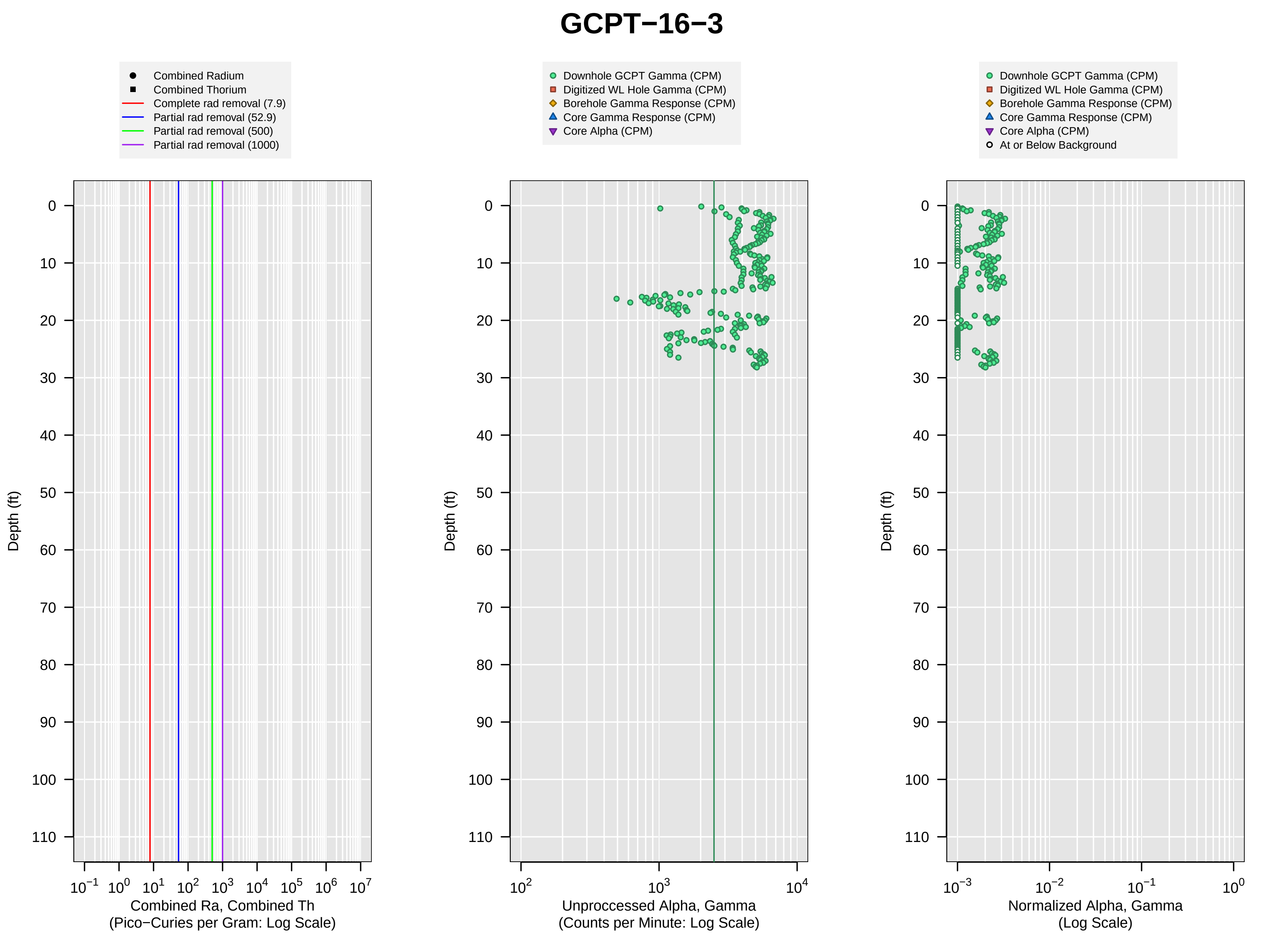


GCPT−16−2
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−16−3

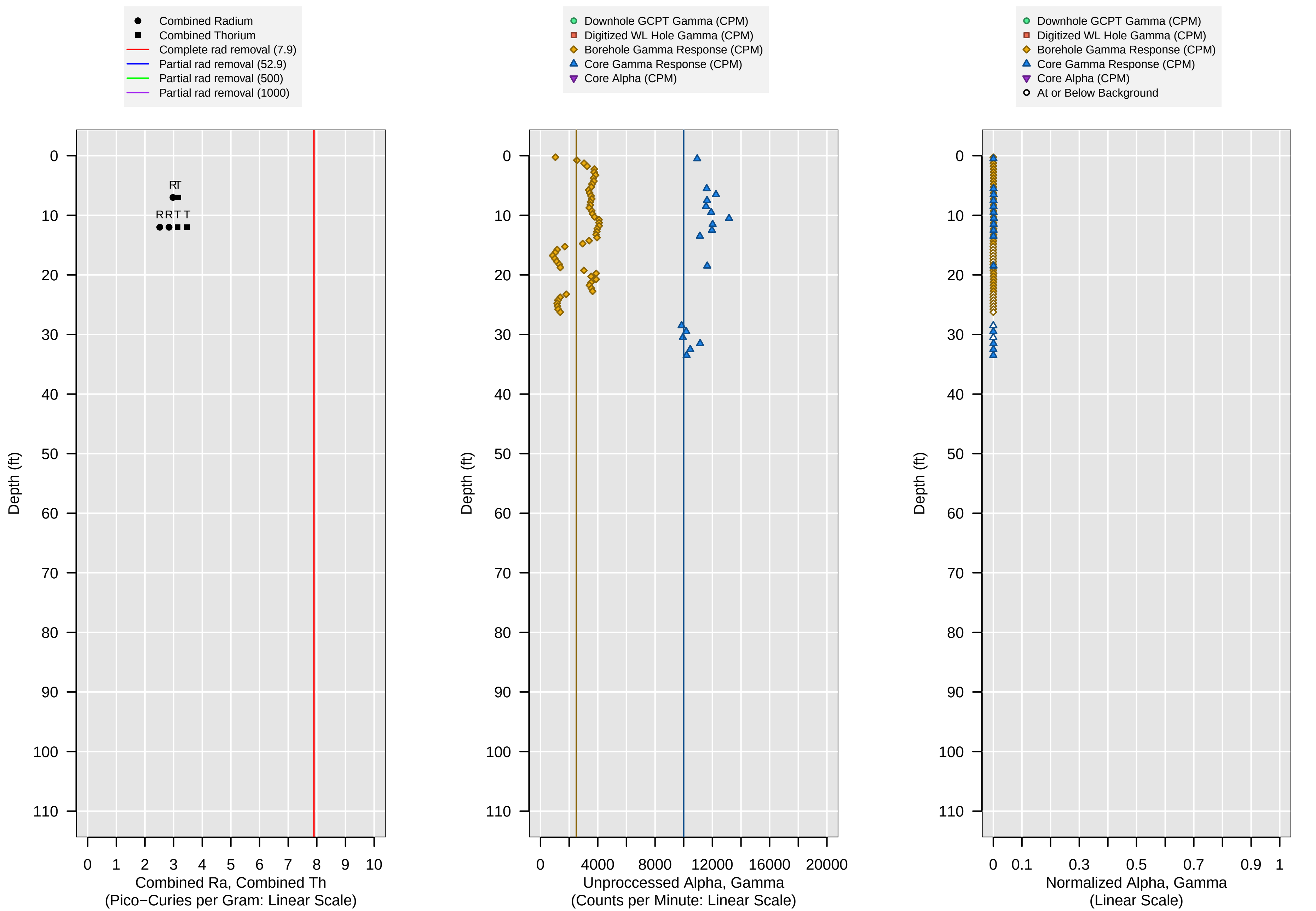


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Linear Scale)

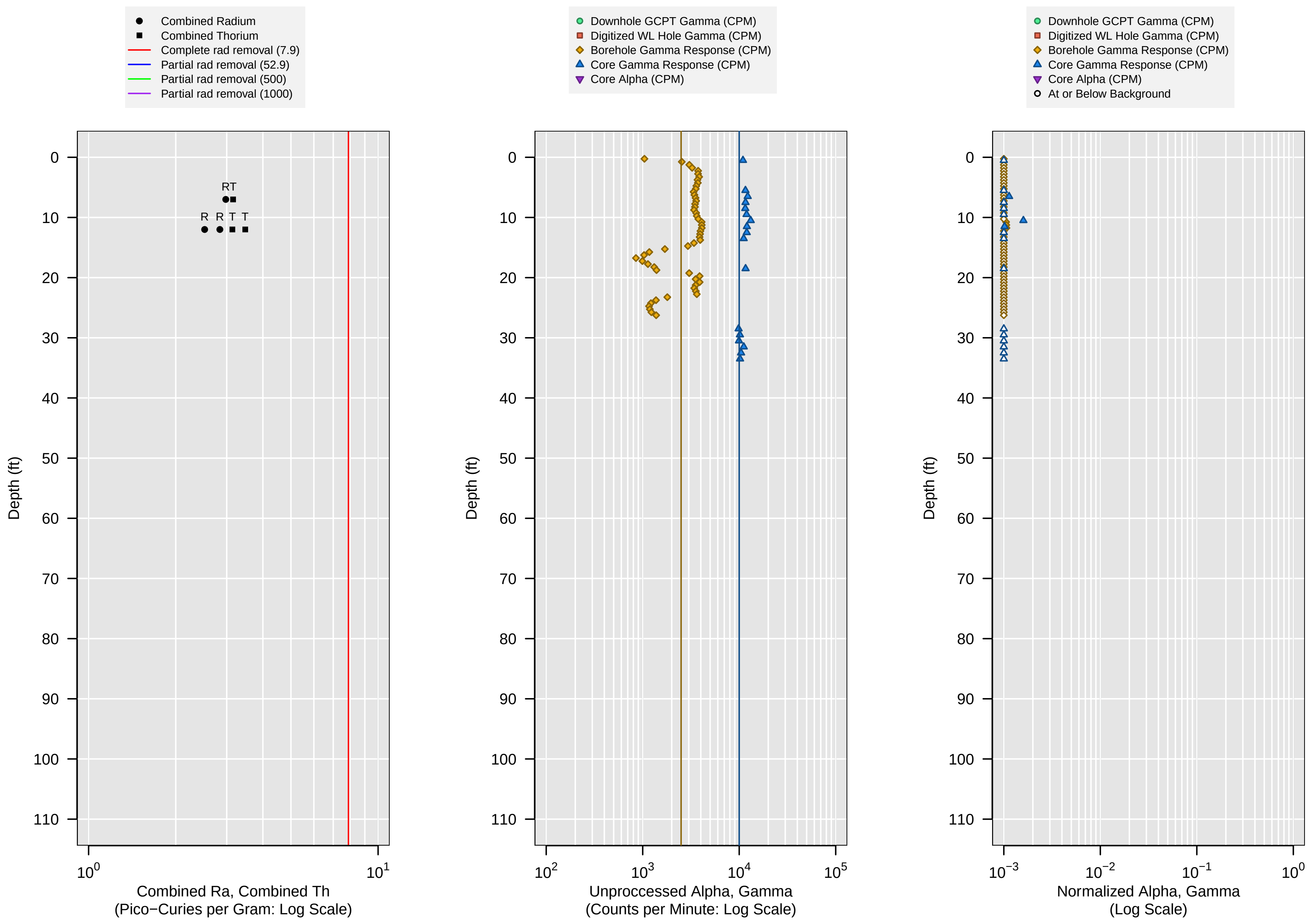


GCPT−16−3
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

Sonic−16−3

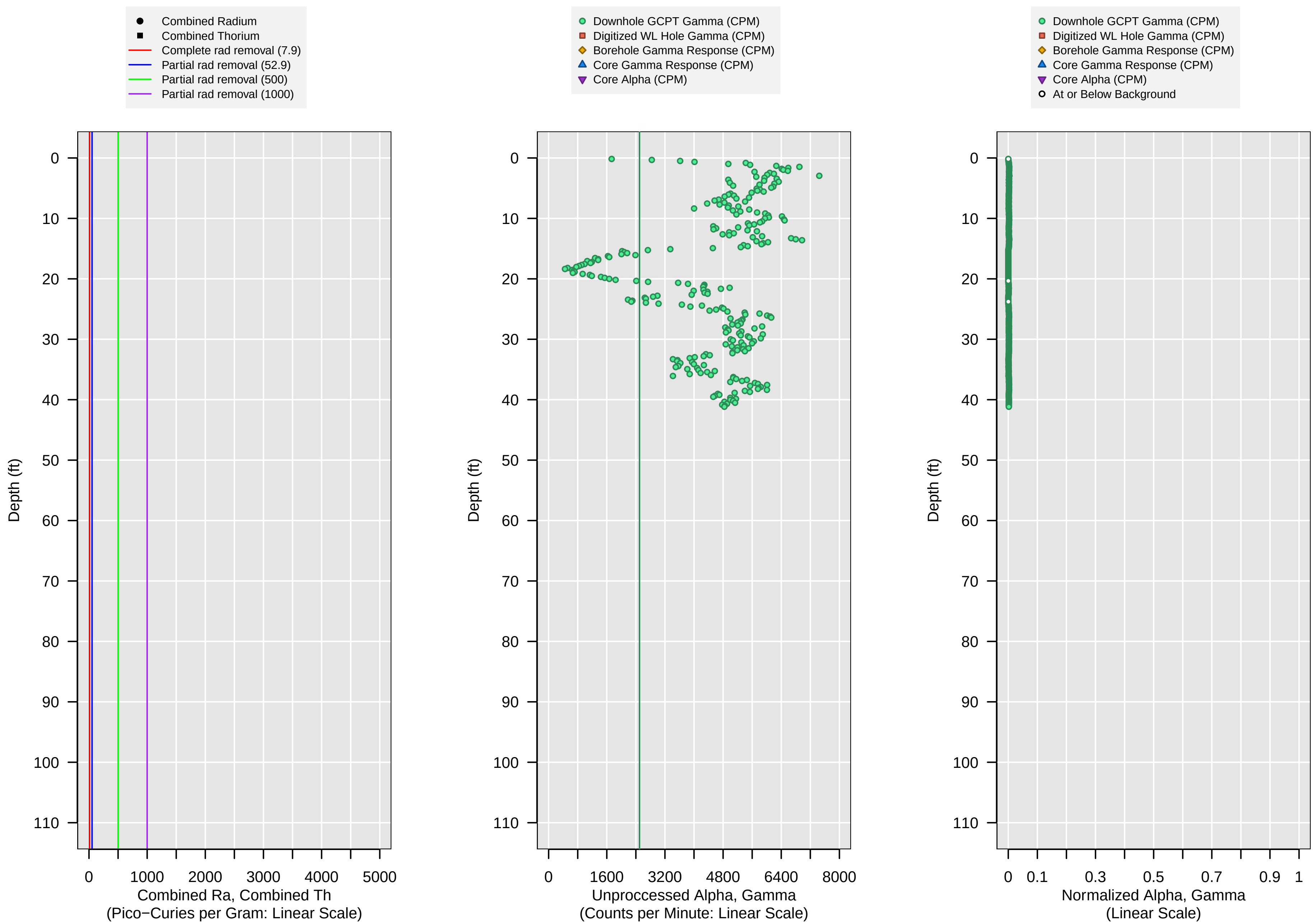

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
RT
RRTT
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

Sonic−16−3

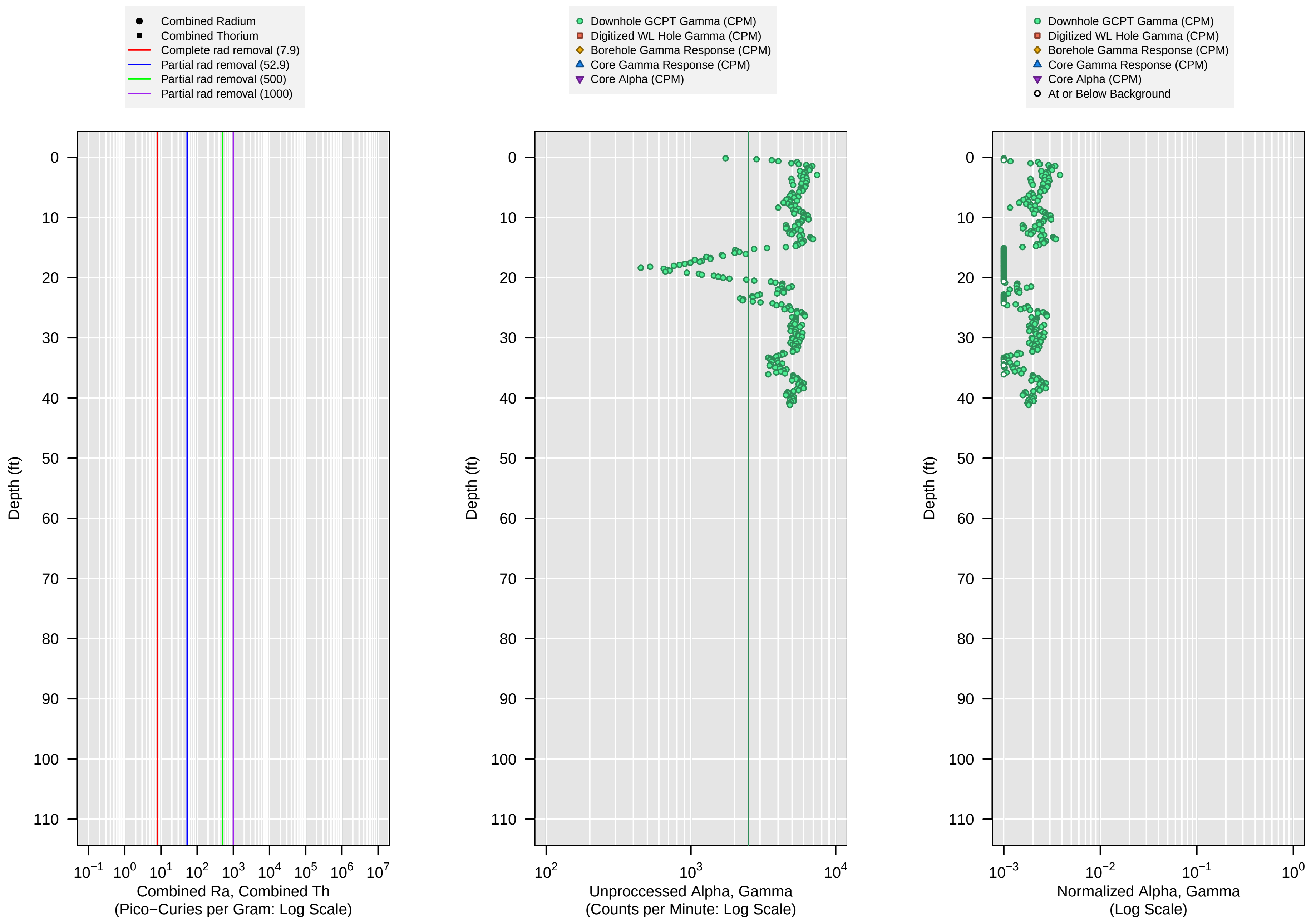


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
RT
R R T T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

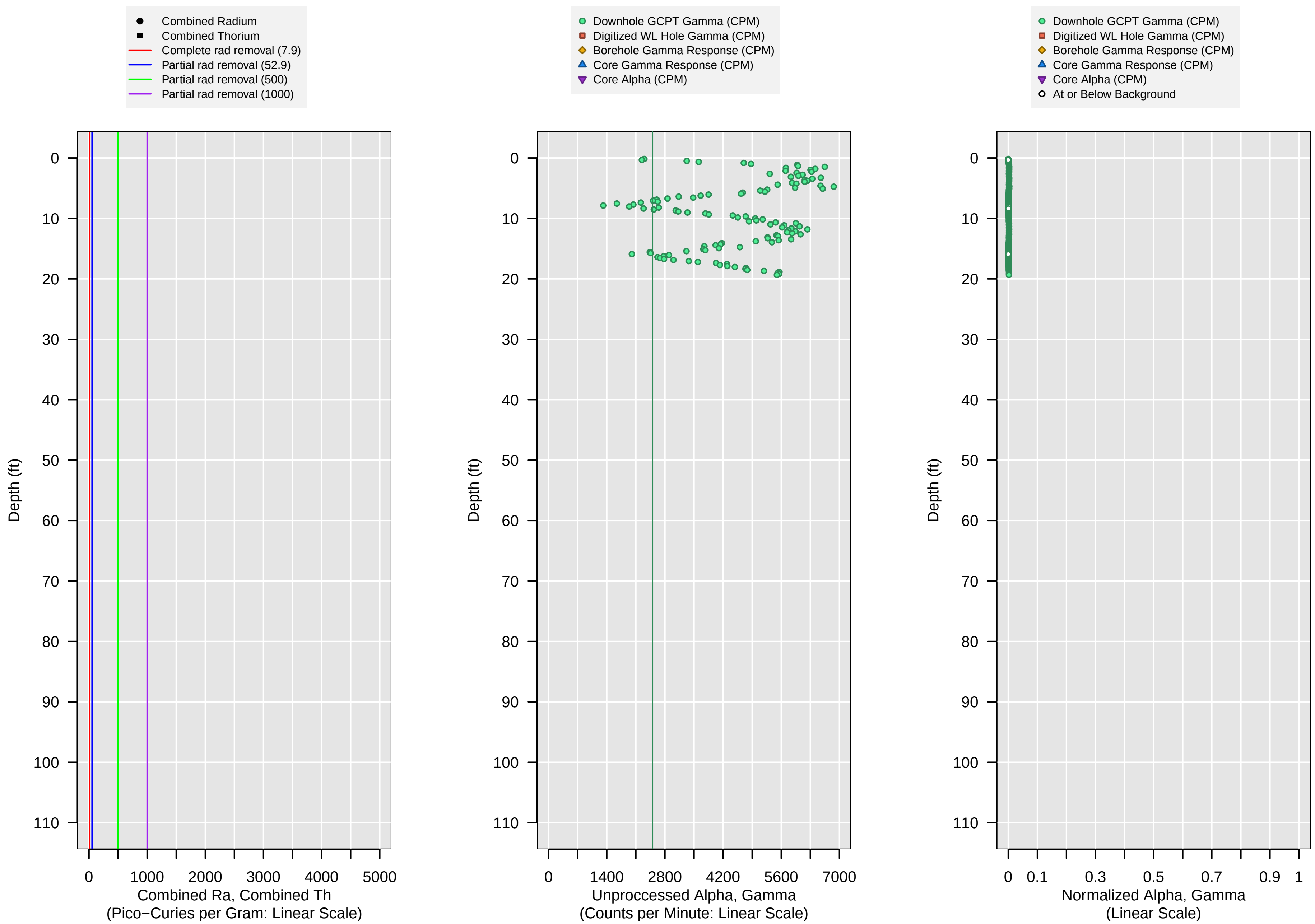
GCPT−16−4


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Linear Scale)

GCPT−16−4

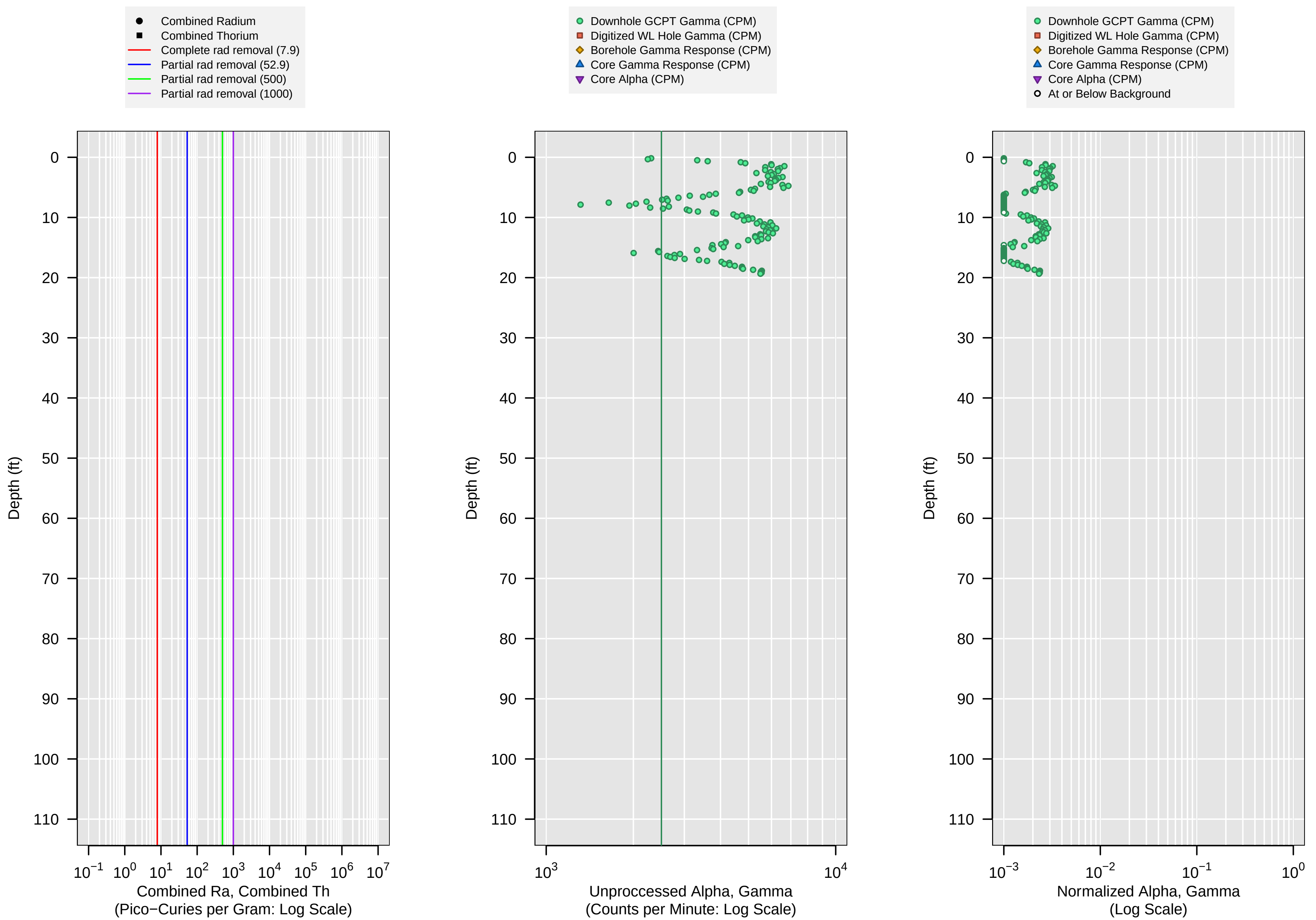

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−16−5

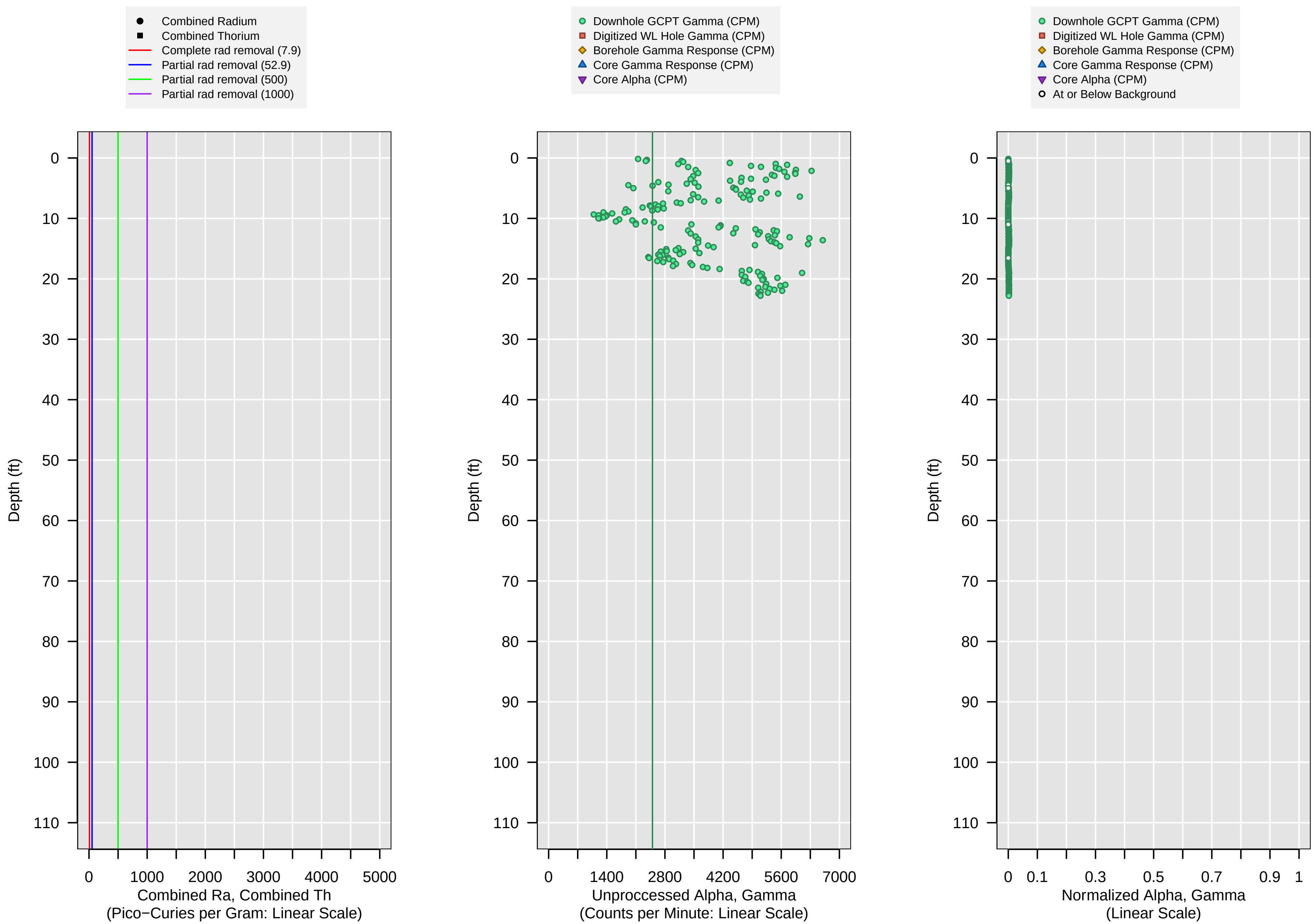


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−16−5

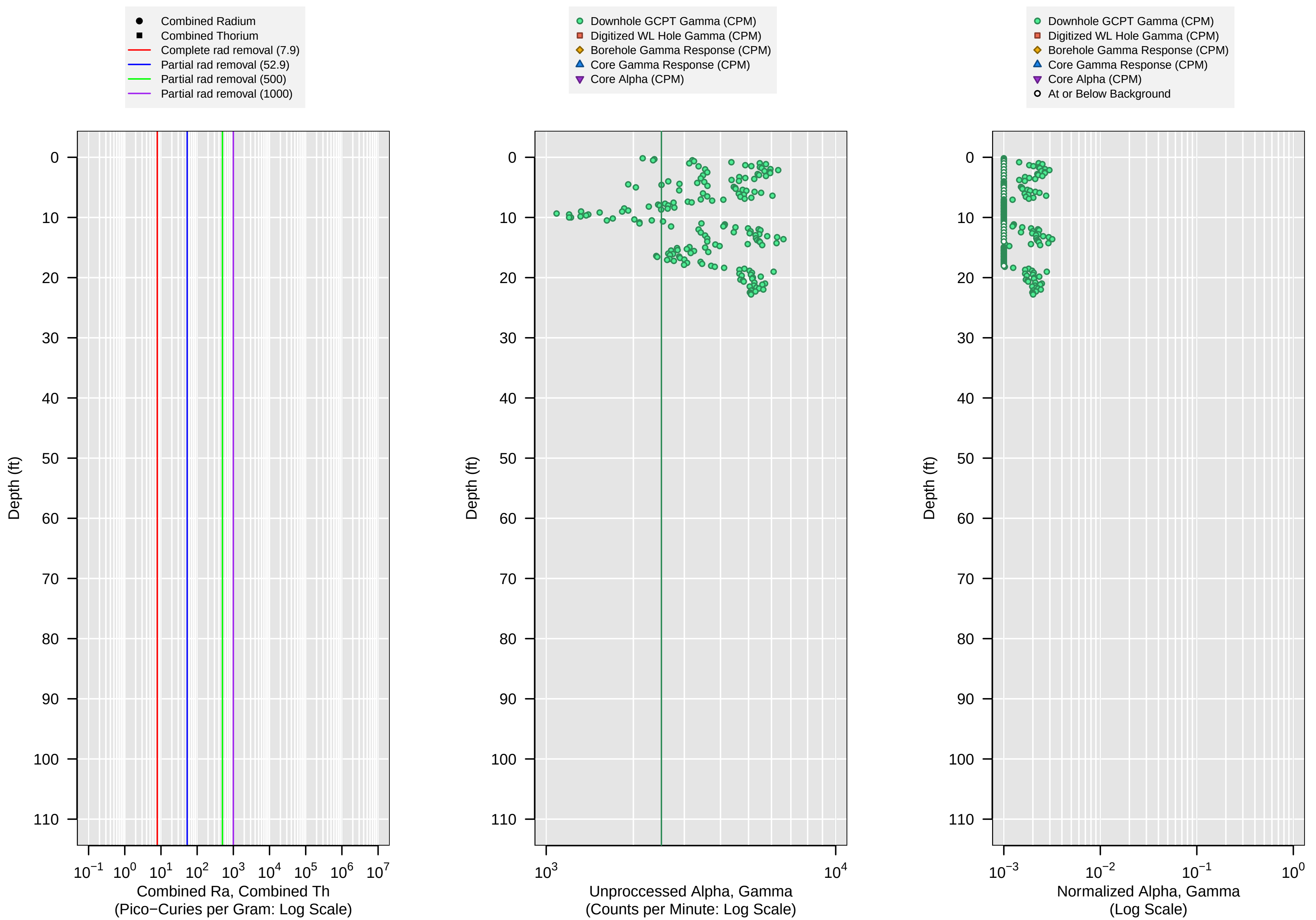

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−16−6



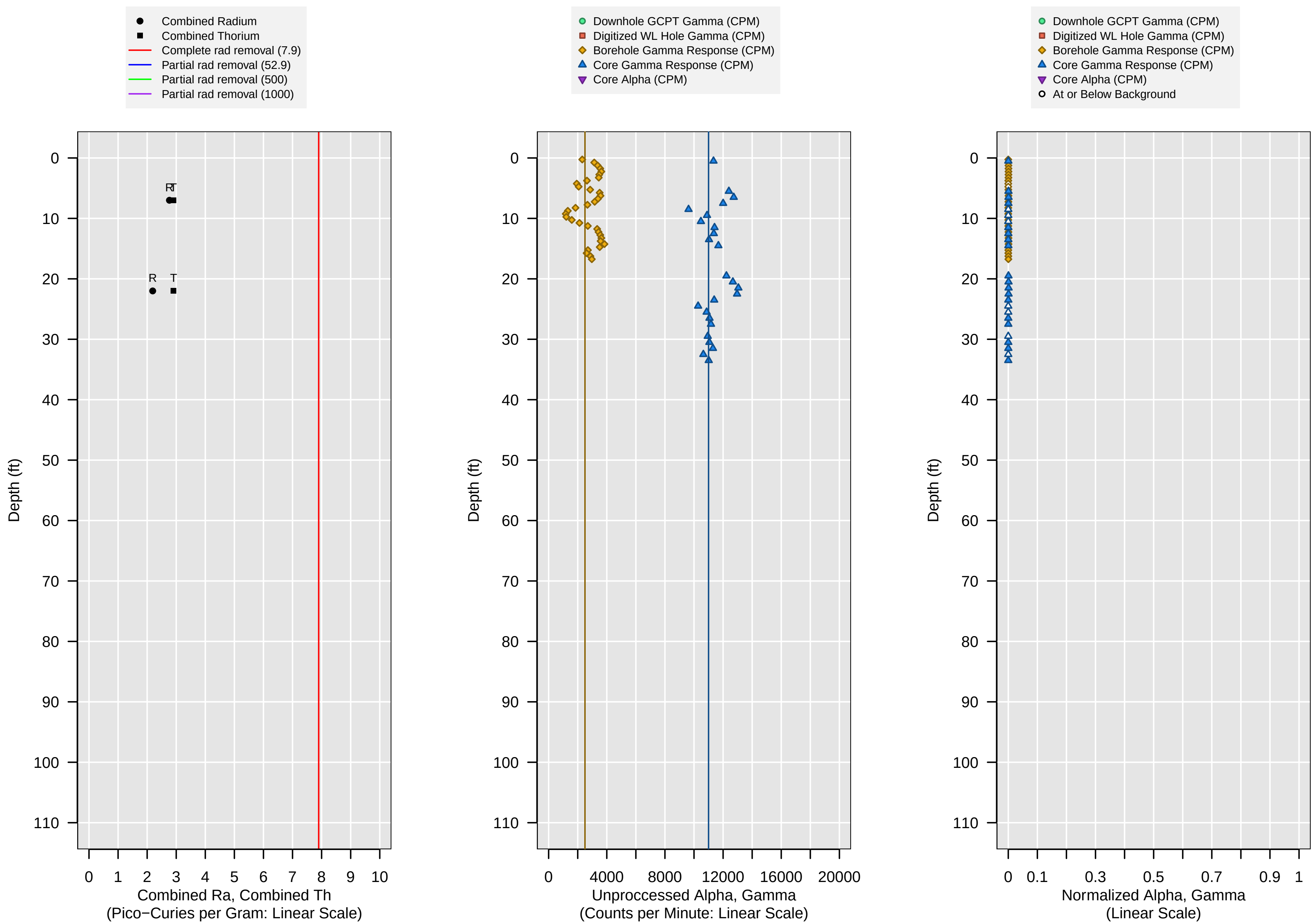
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1400
2800
4200
5600
7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

GCPT−16−6

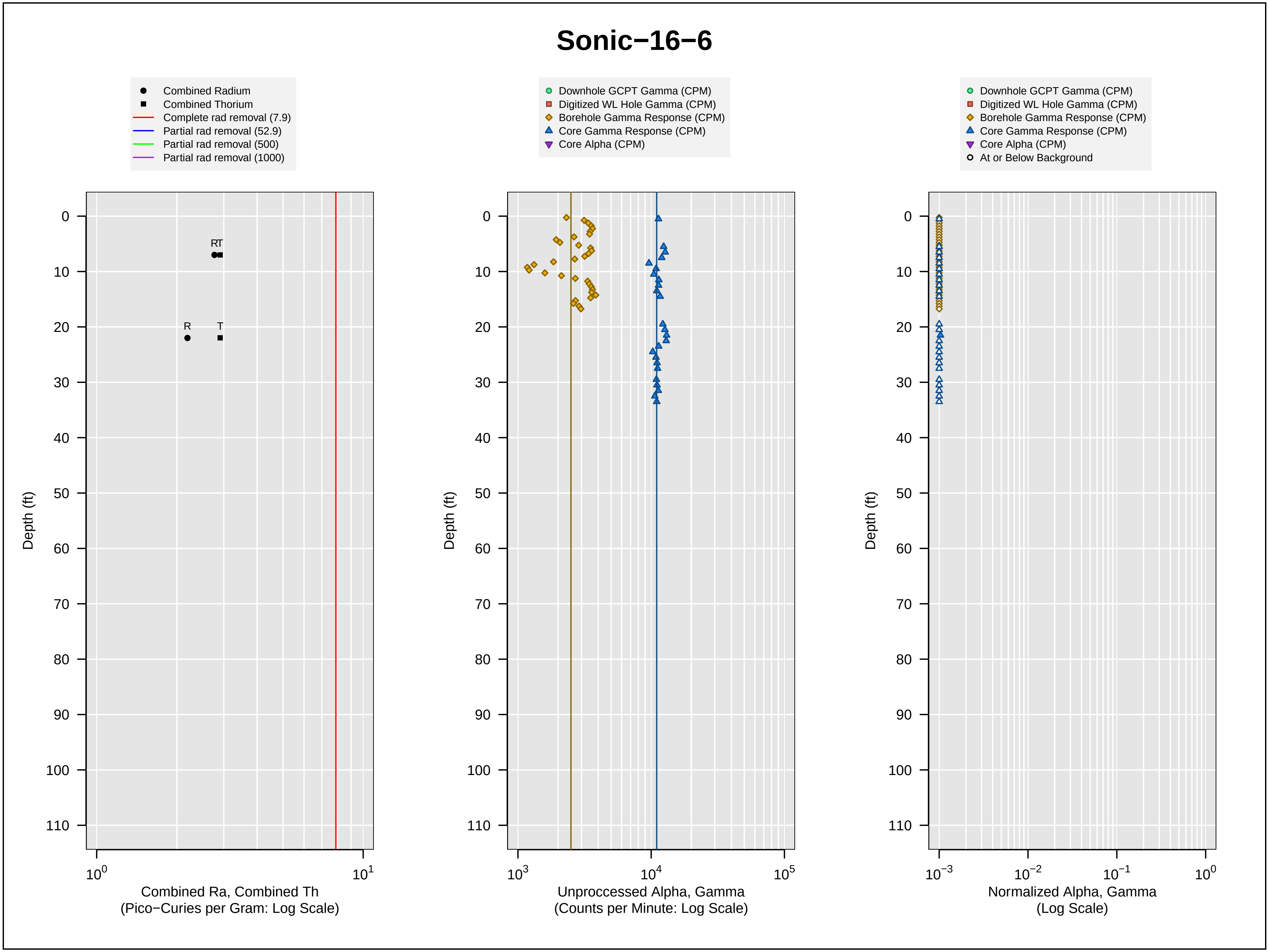


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

Sonic−16−6

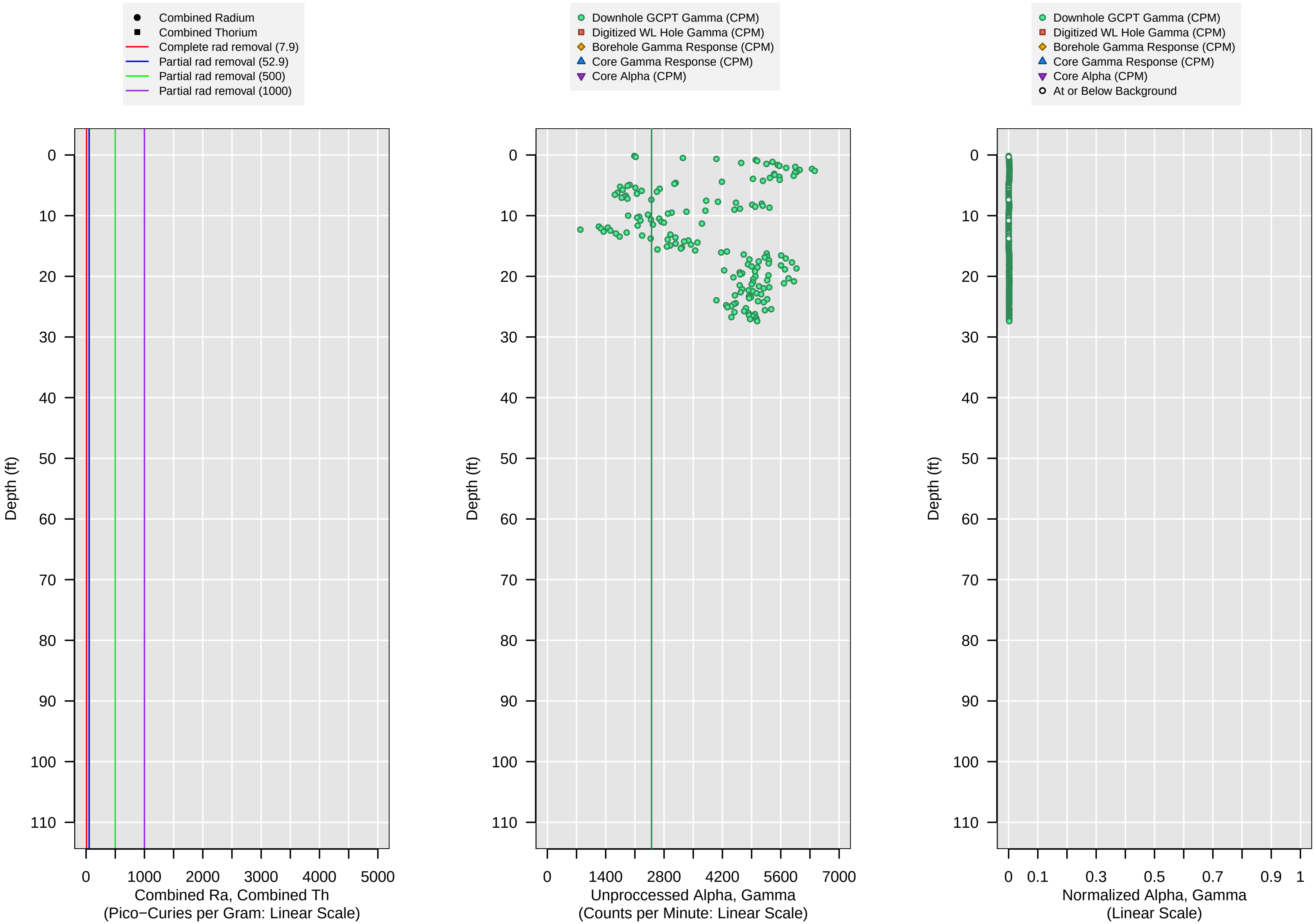


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R T
R T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Linear Scale)

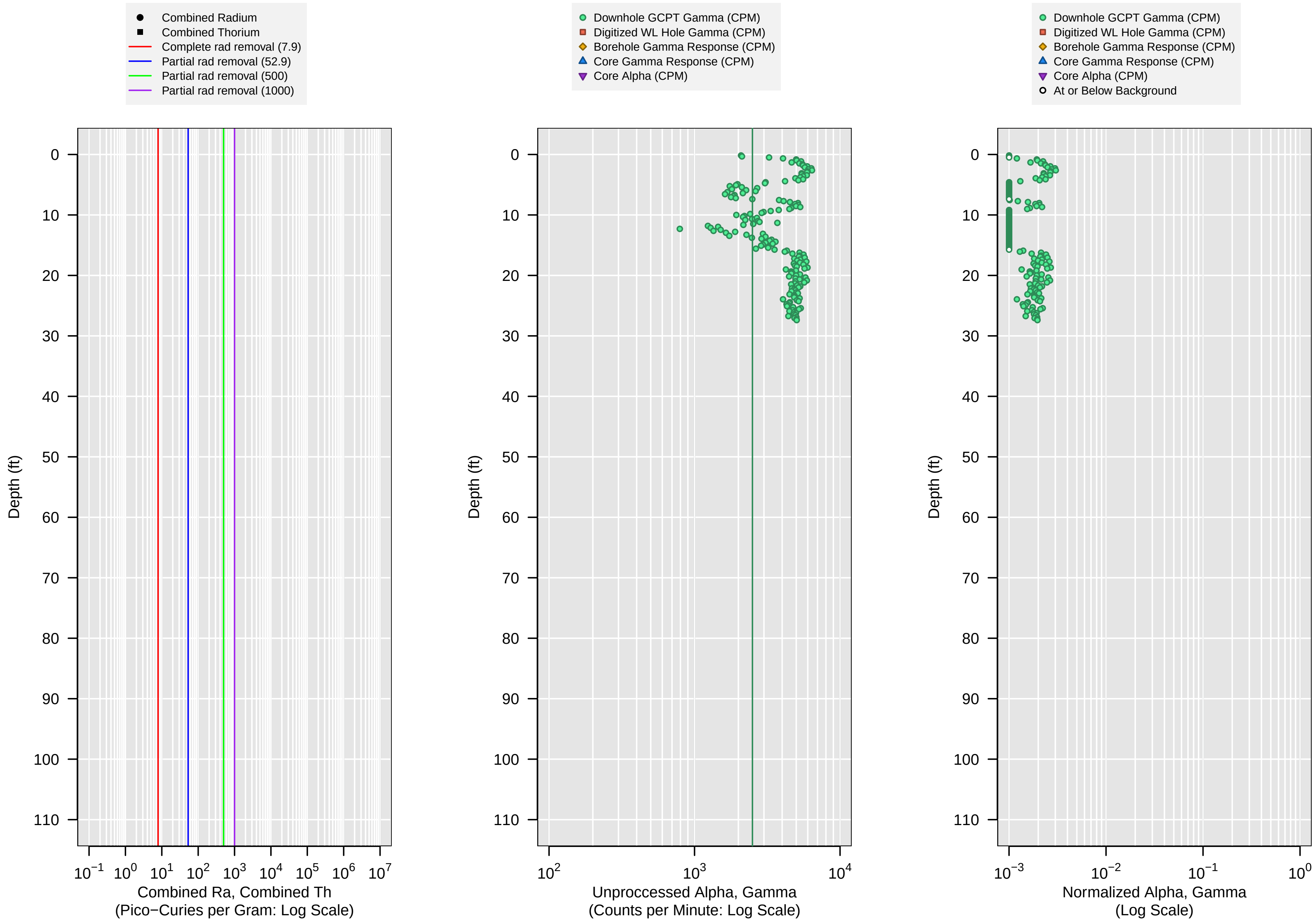


Sonic−16−6
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
R
T
RT
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−16−7

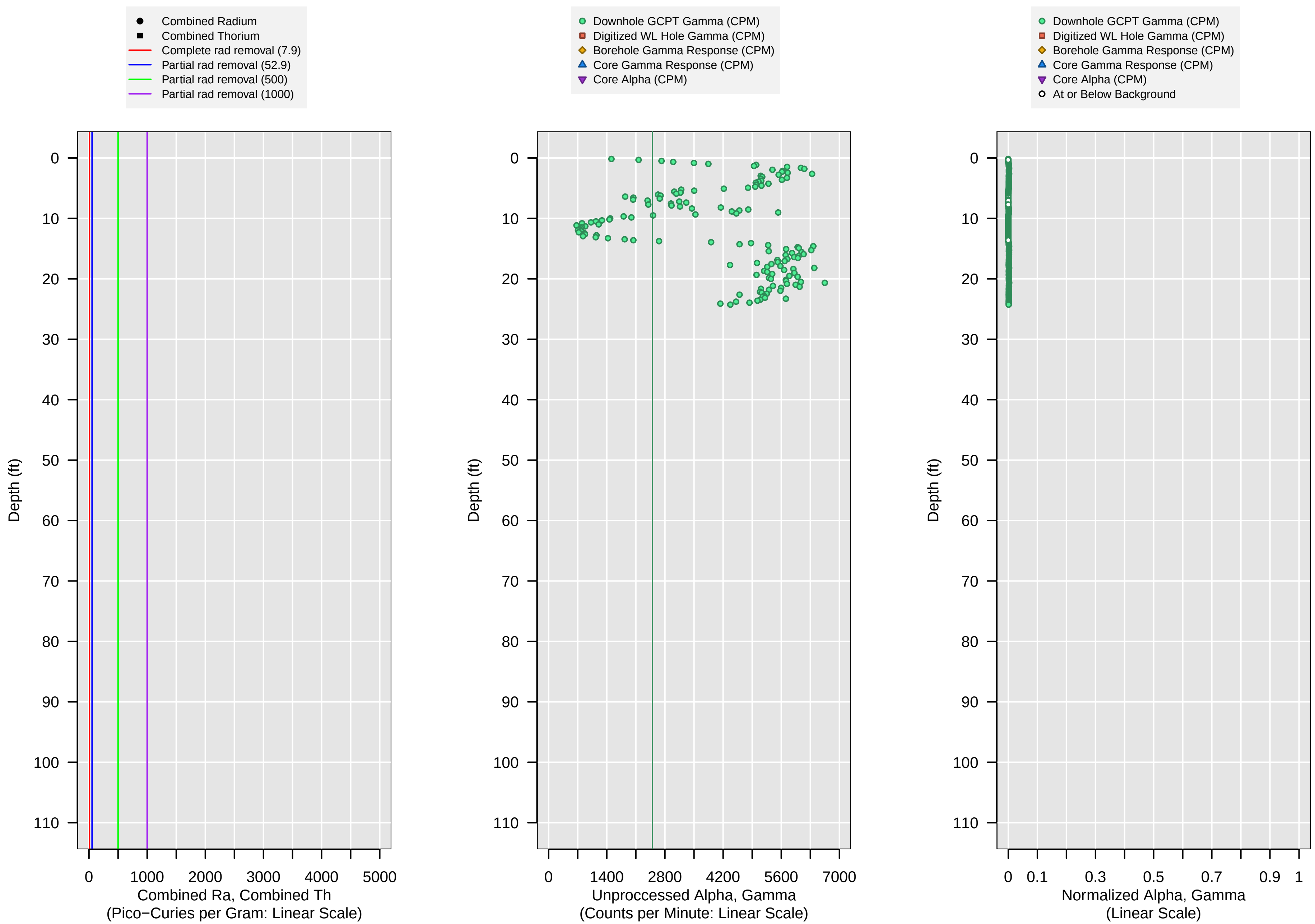

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1400
2800
4200
5600
7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

GCPT−16−7



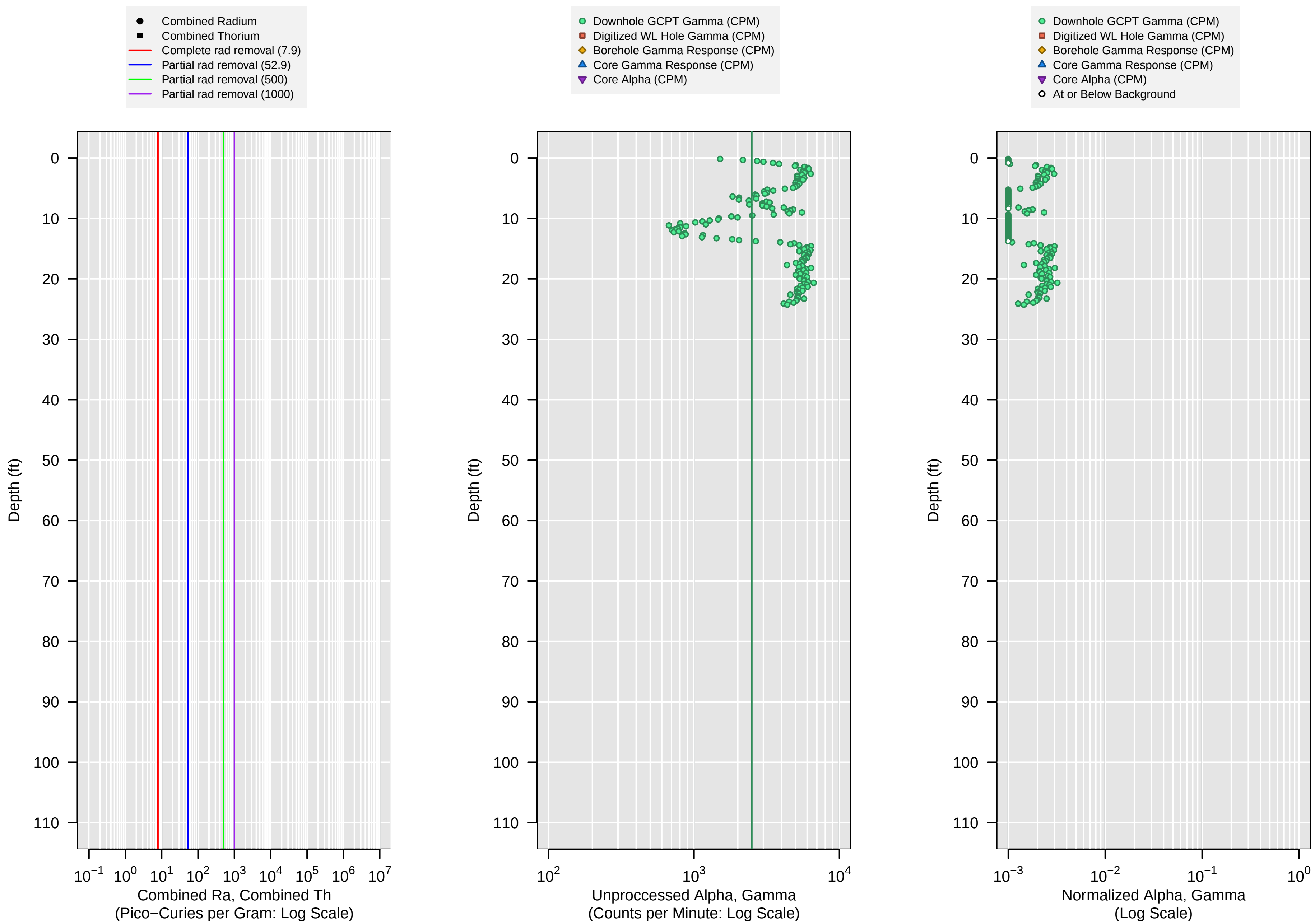
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−16−8



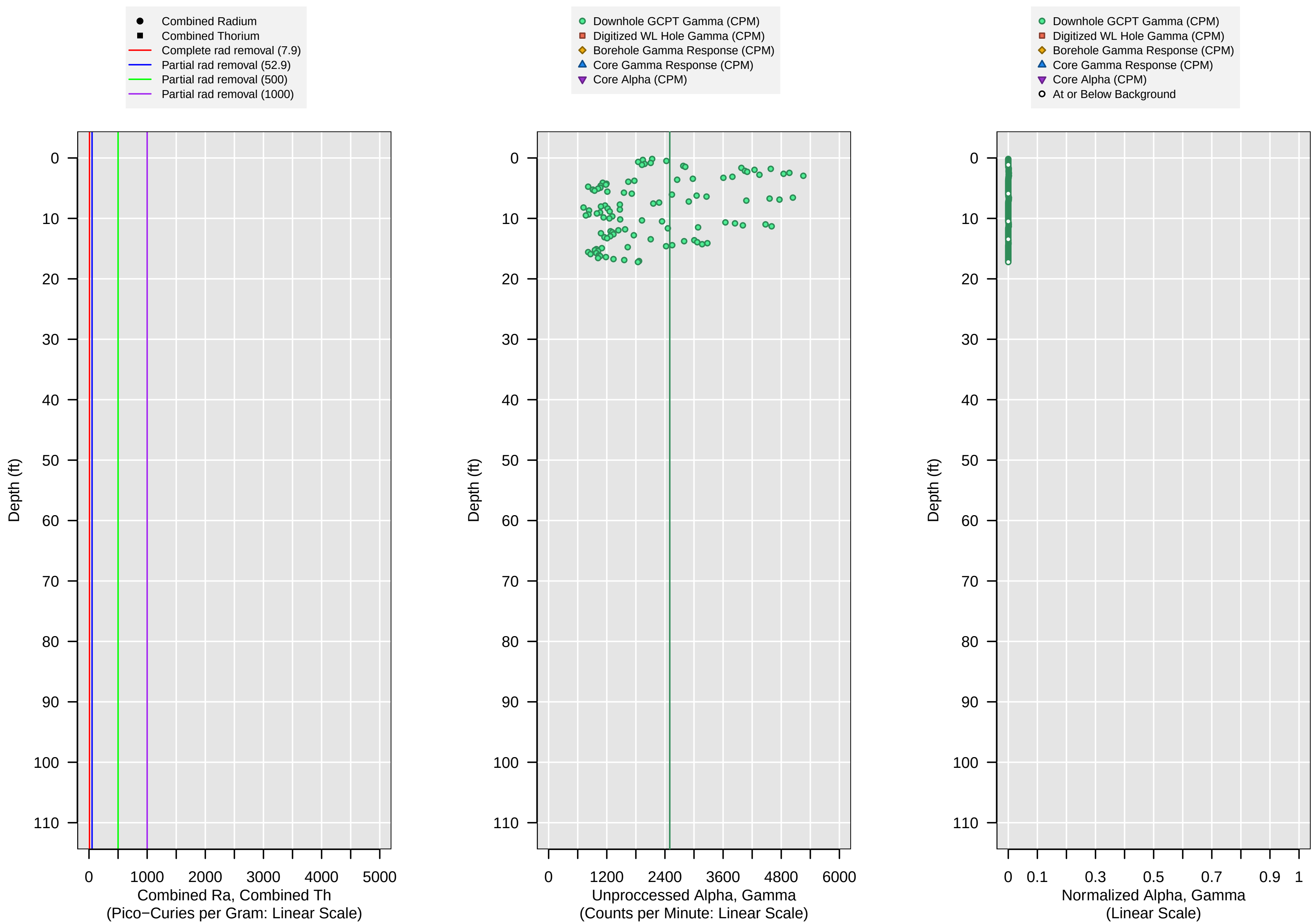
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−16−8

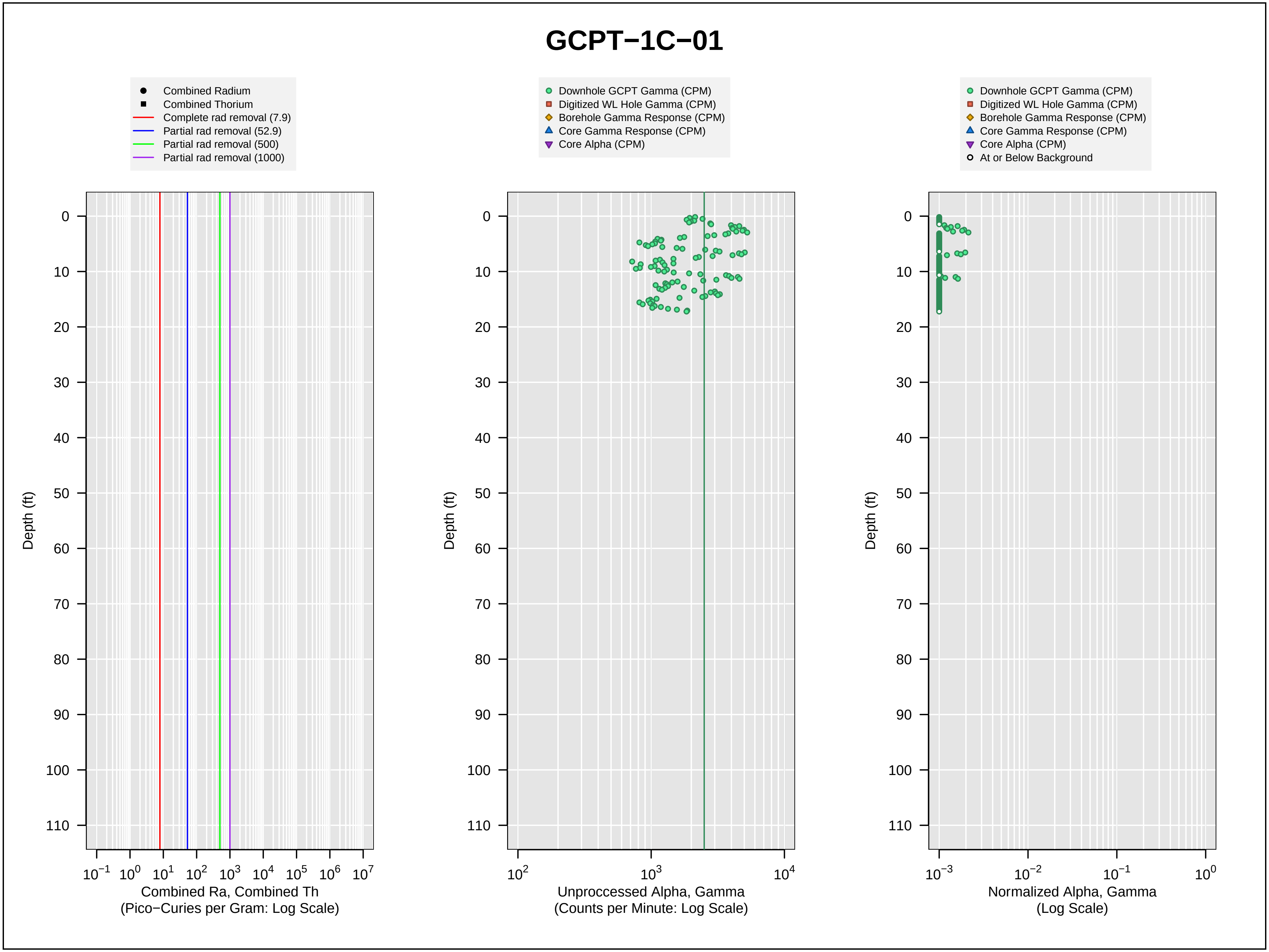


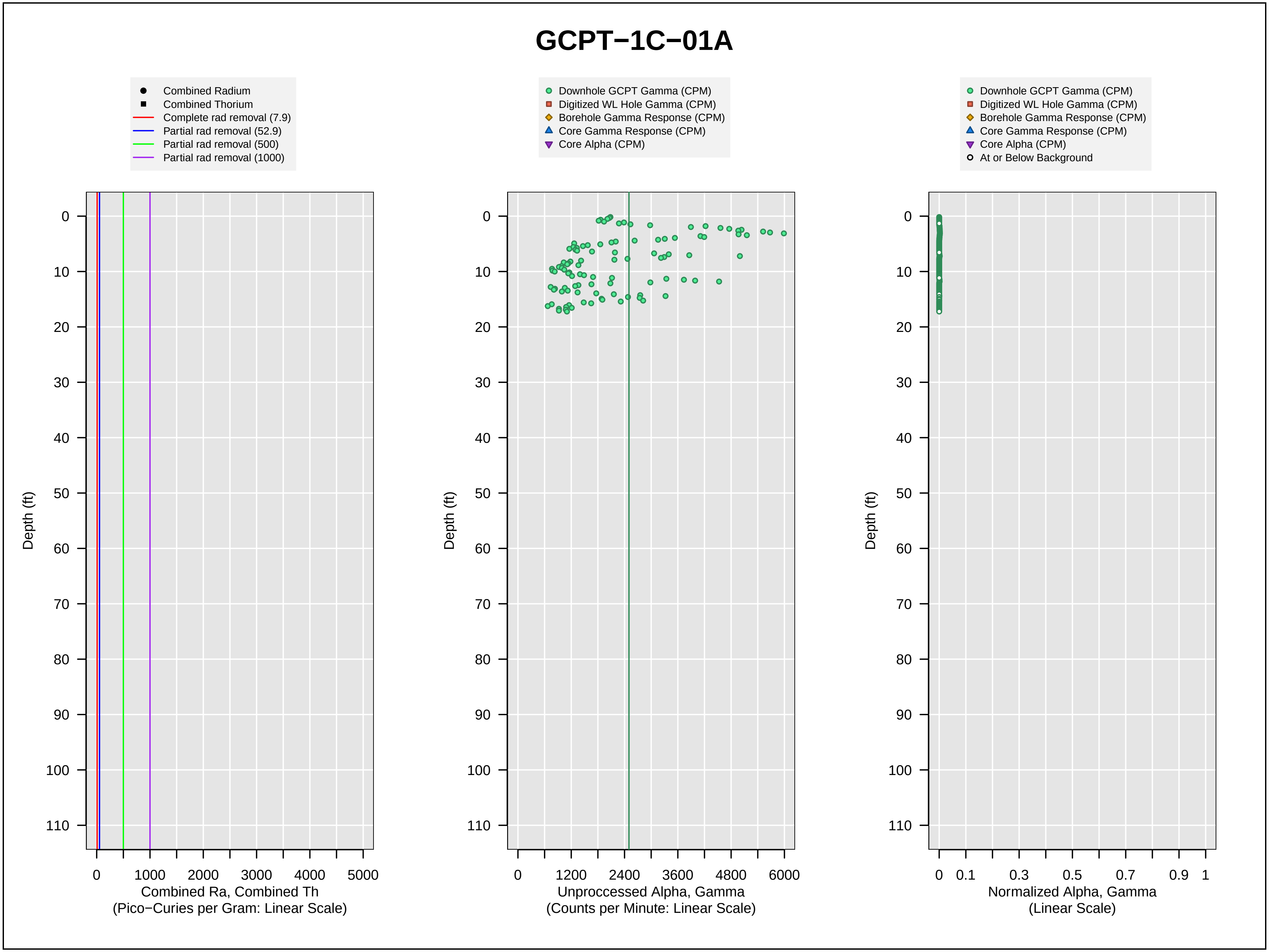
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−1C−01

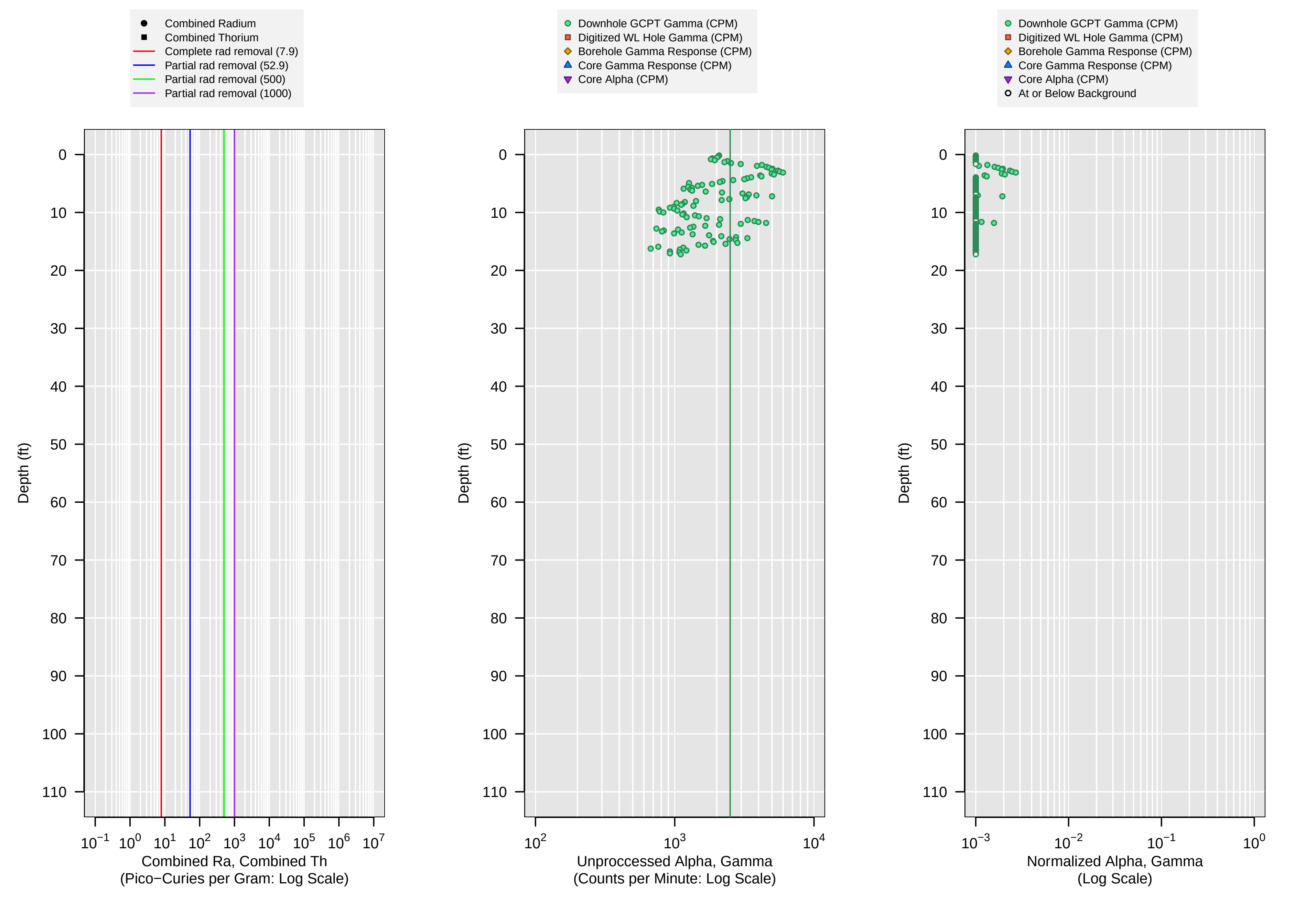


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1200
2400
3600
4800
6000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

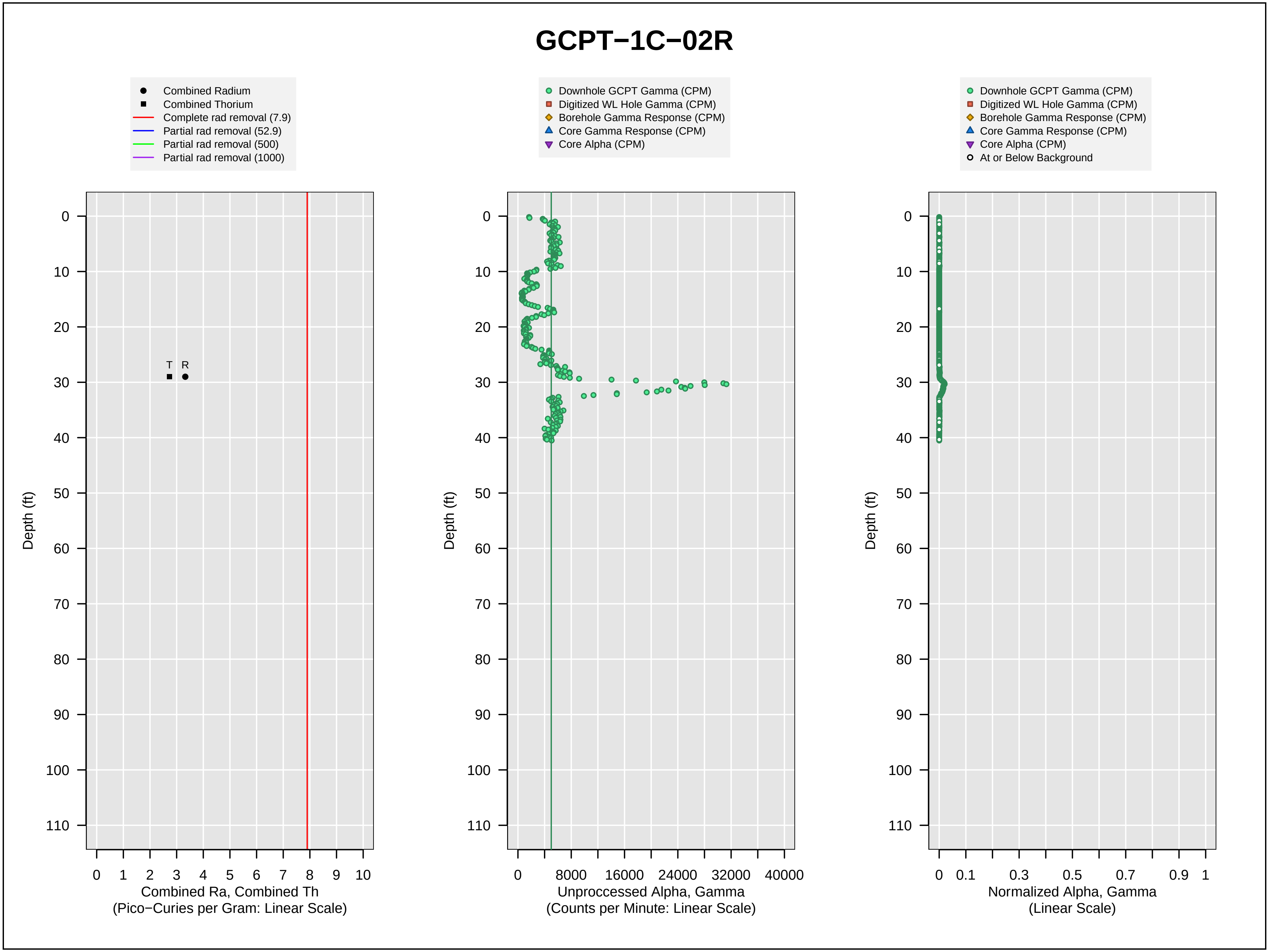

GCPT−1C−01
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)


GCPT−1C−01A
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

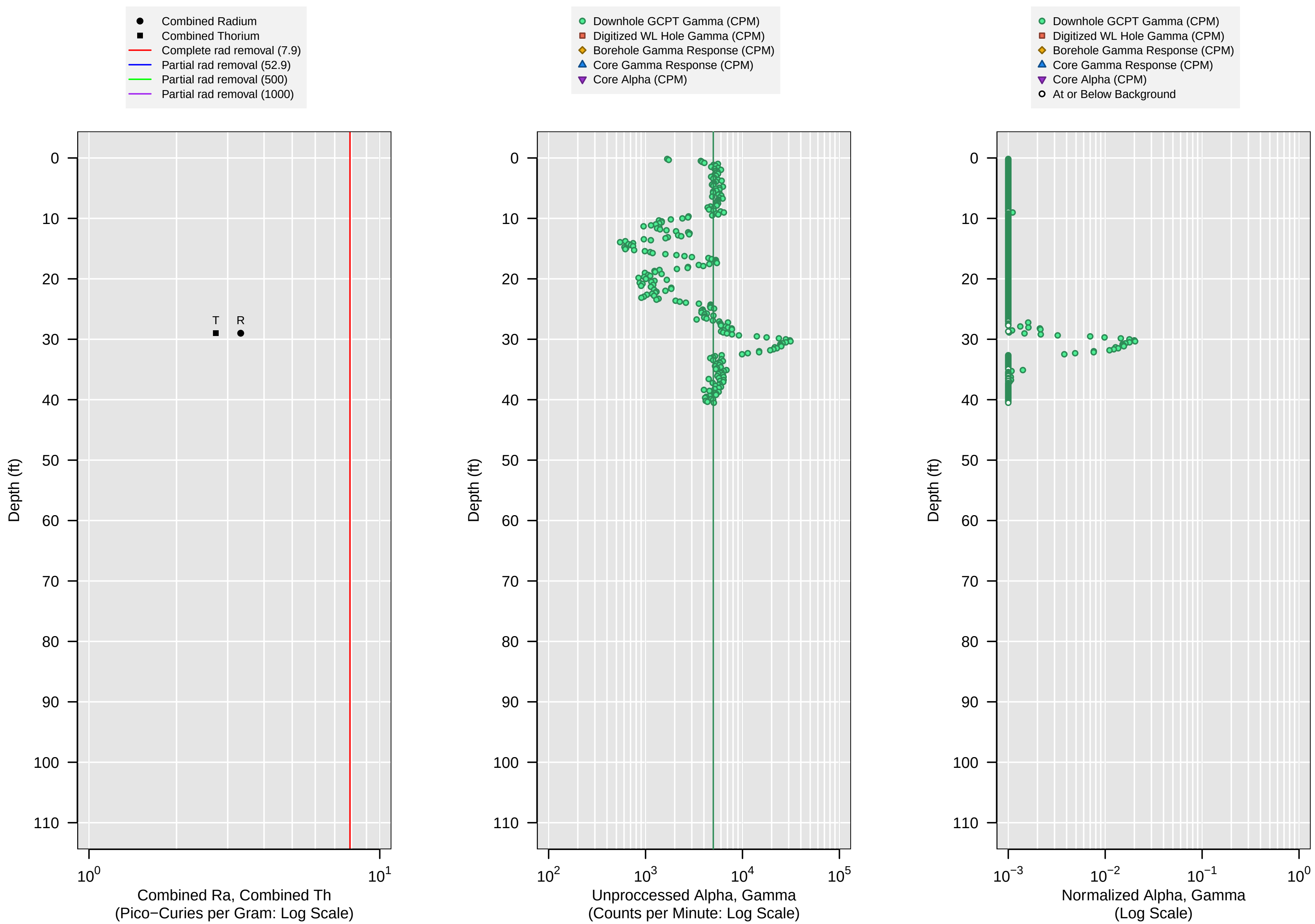
GCPT−1C−01A



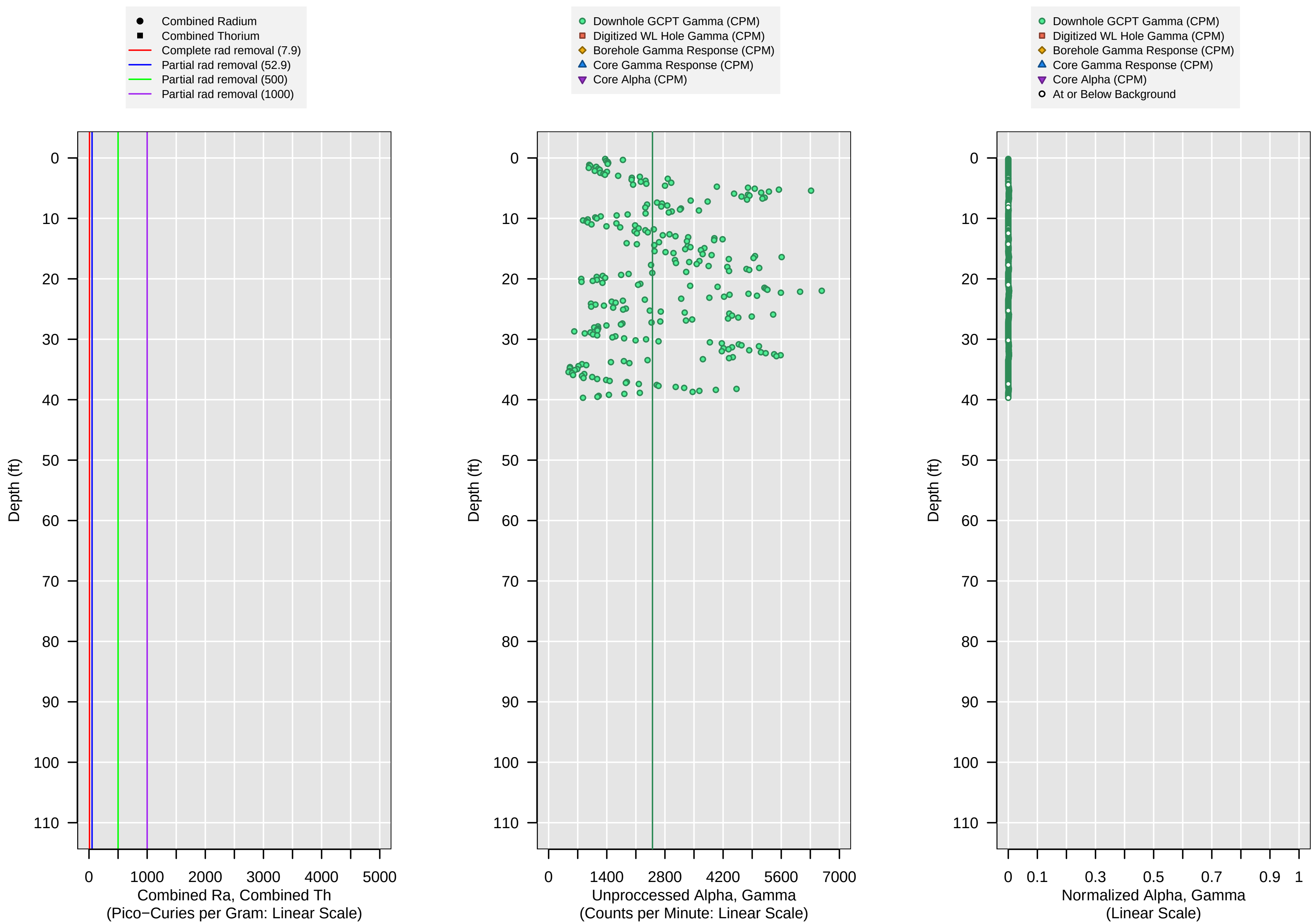
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)


GCPT−1C−02R
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
T R
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

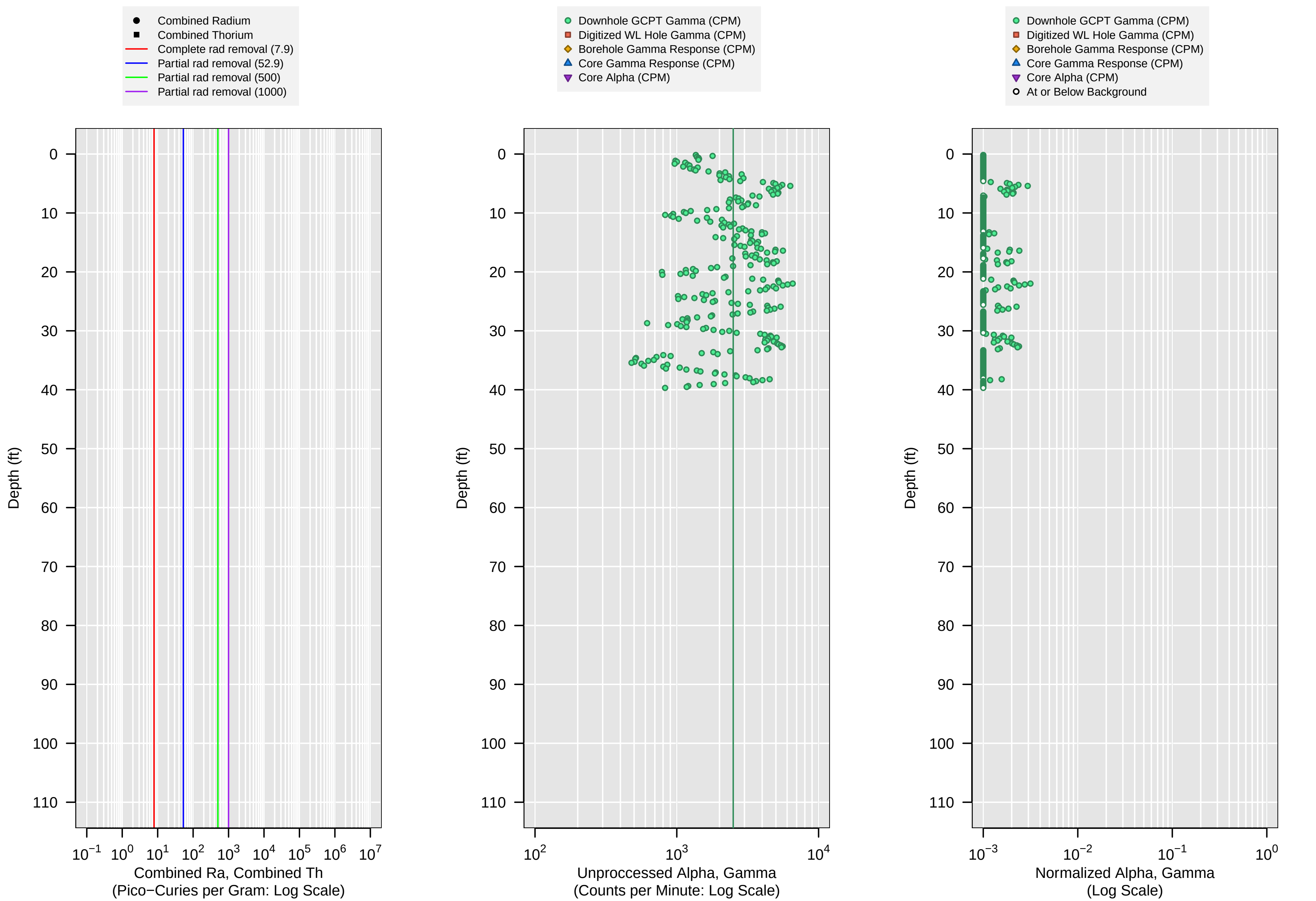
GCPT−1C−02R


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
T
R
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

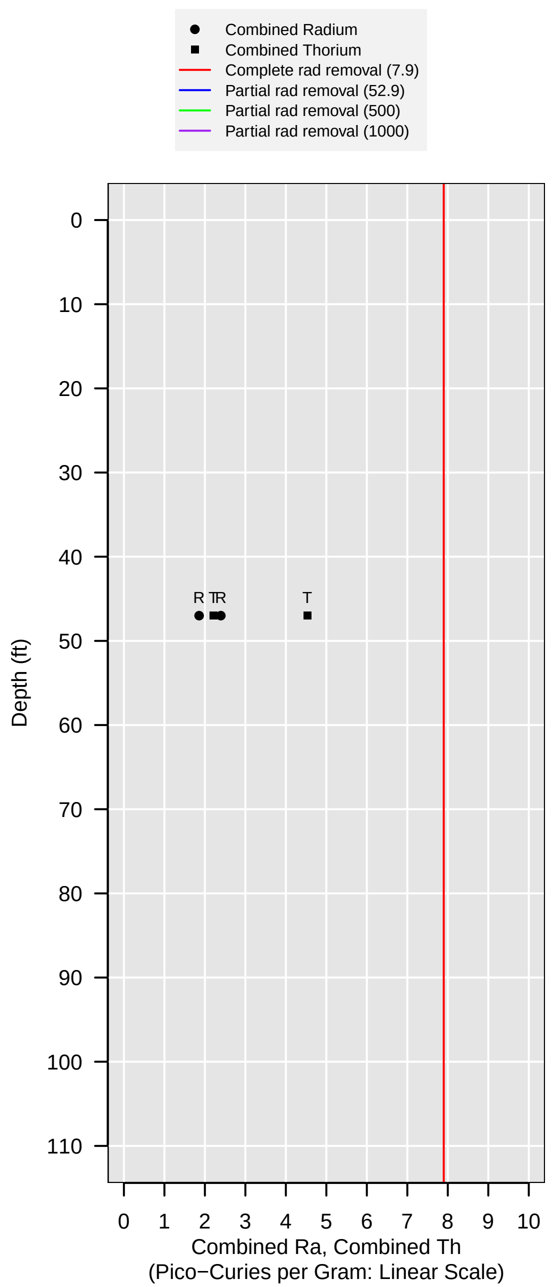
GCPT−1C−03

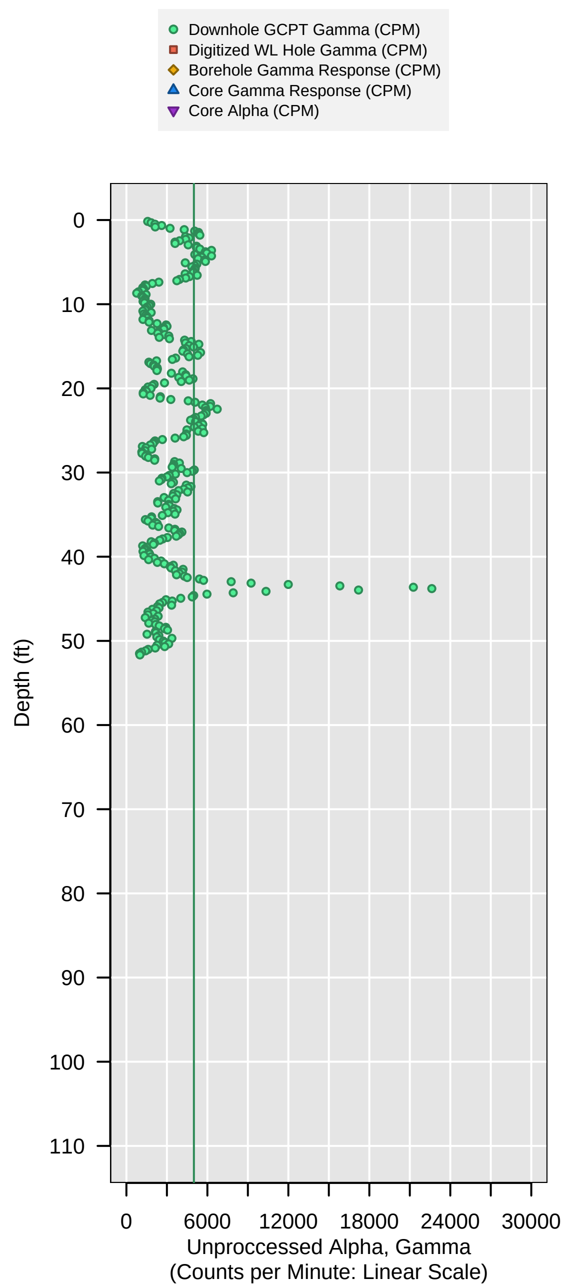

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1400
2800
4200
5600
7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

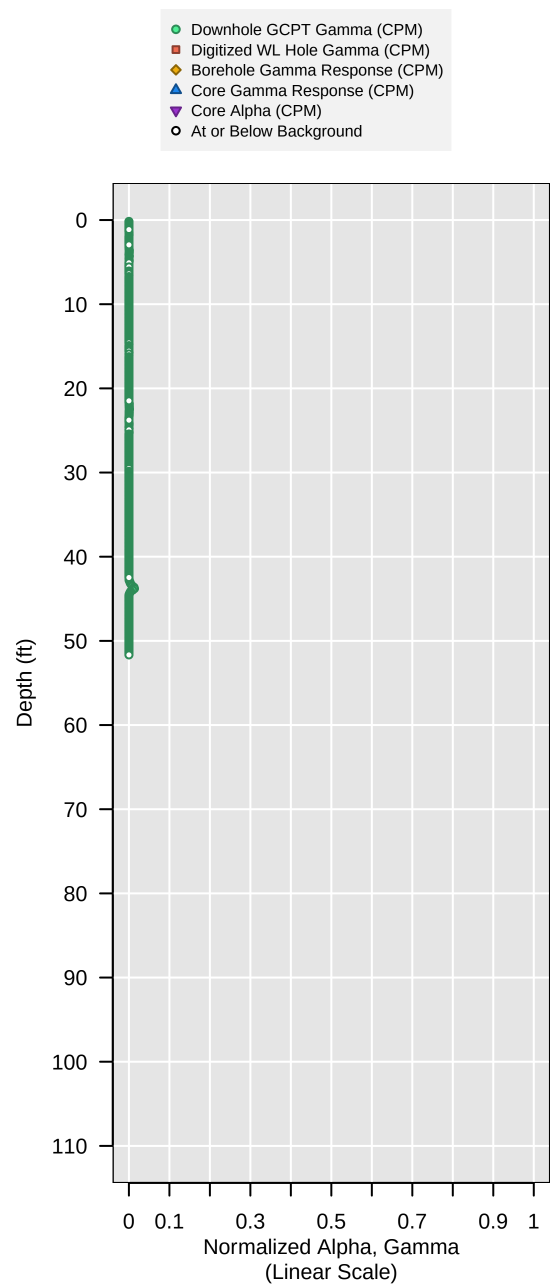
GCPT−1C−03


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

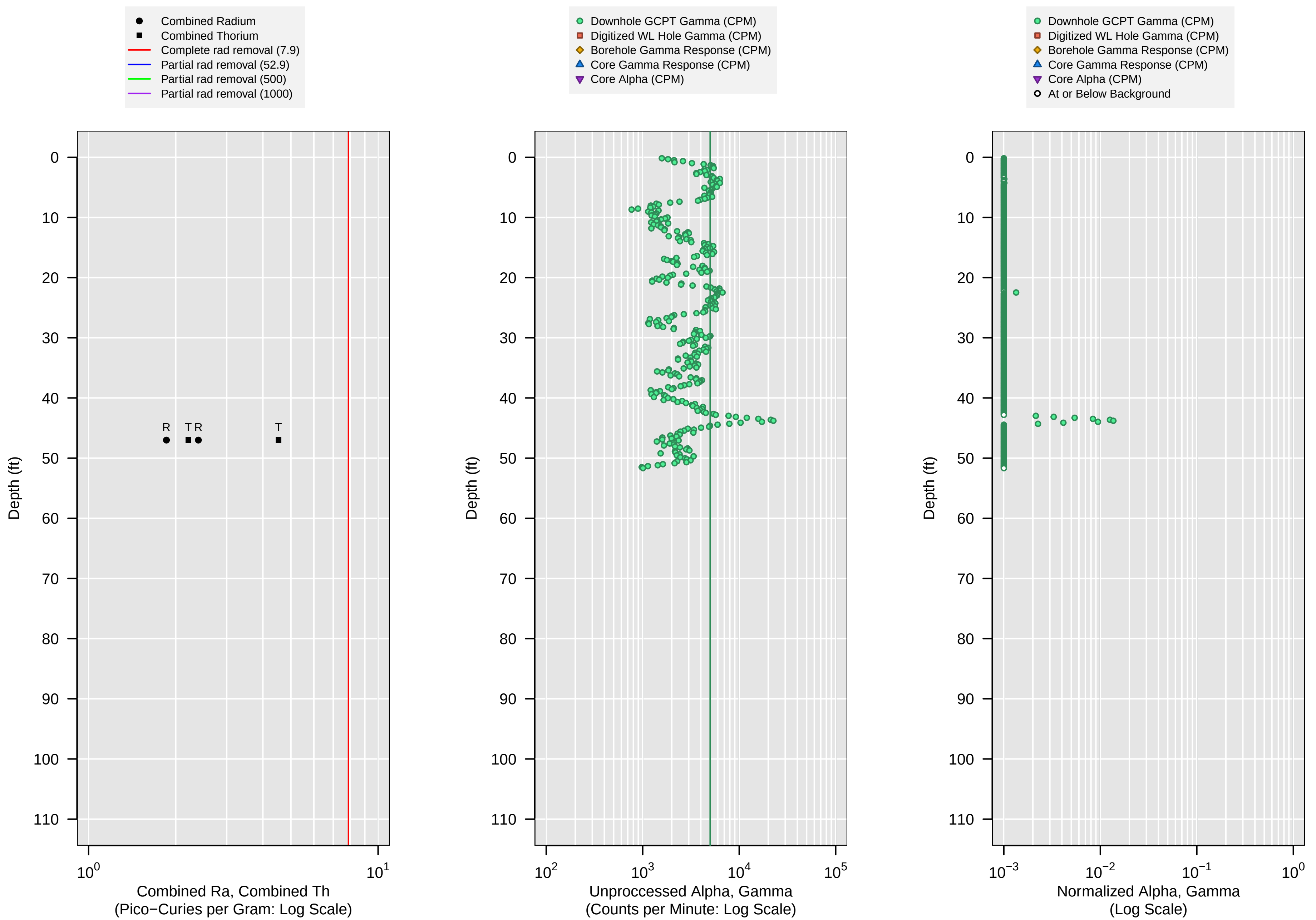
GCPT−1C−04R


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R TR T
Depth (ft)
0 10 20 30 40 50 60 70 80 90 100 110
0 1 2 3 4 5 6 7 8 9 10
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0 10 20 30 40 50 60 70 80 90 100 110
0 6000 12000 18000 24000 30000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)

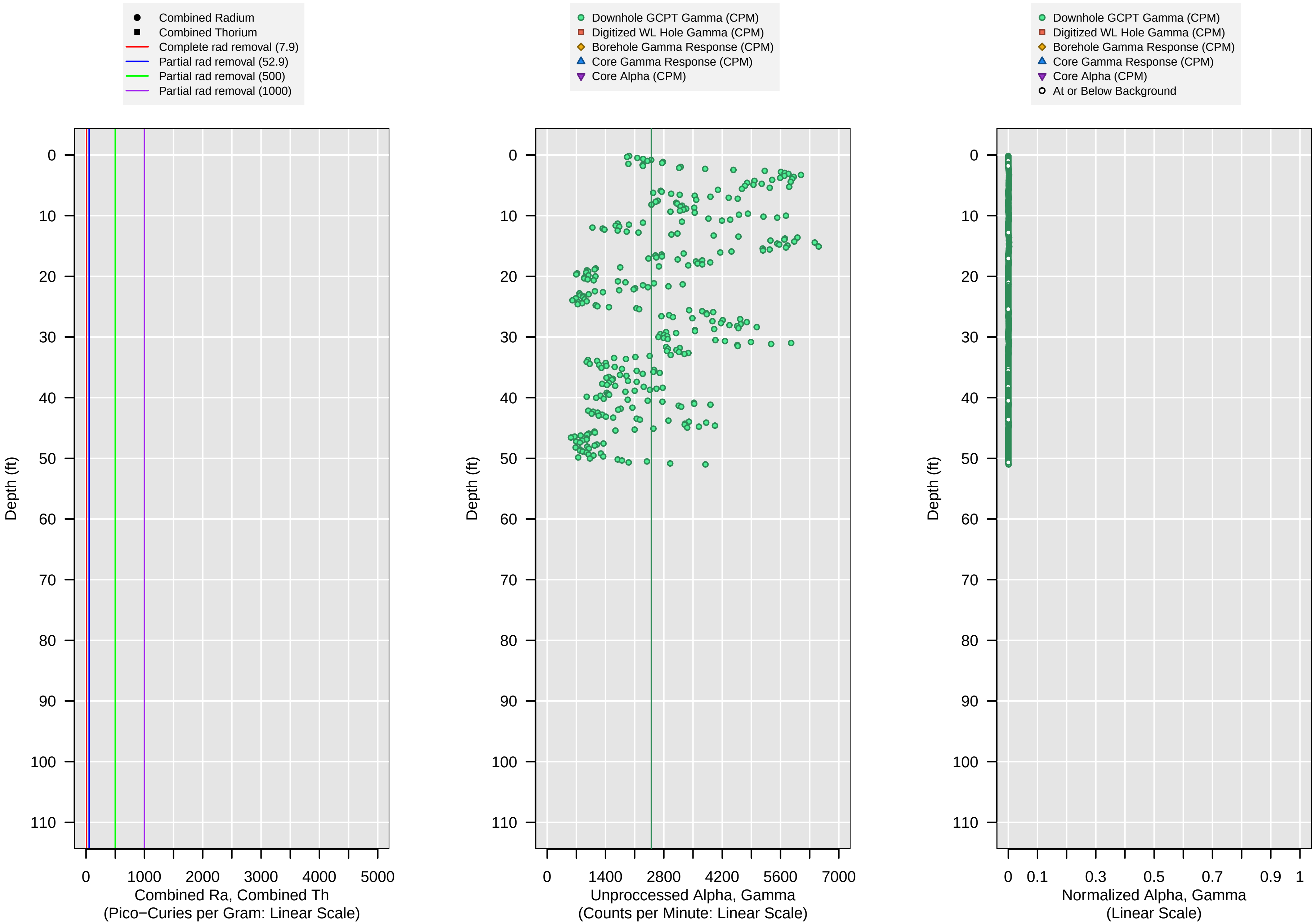

Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0 10 20 30 40 50 60 70 80 90 100 110
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

GCPT−1C−04R

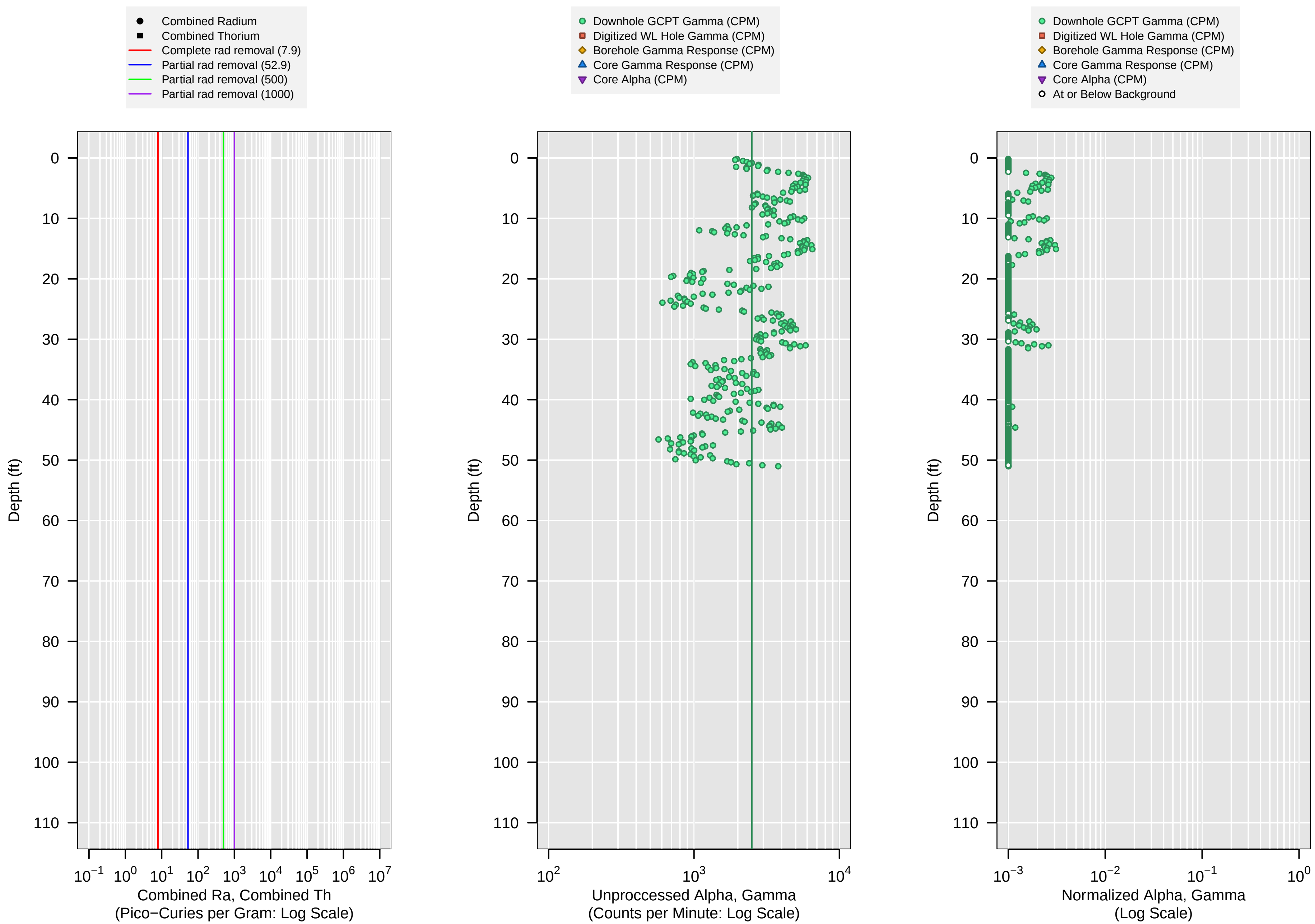

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
R
T R
T
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

S.S. Papadopulos & Associates, Inc.

GCPT−1C−05

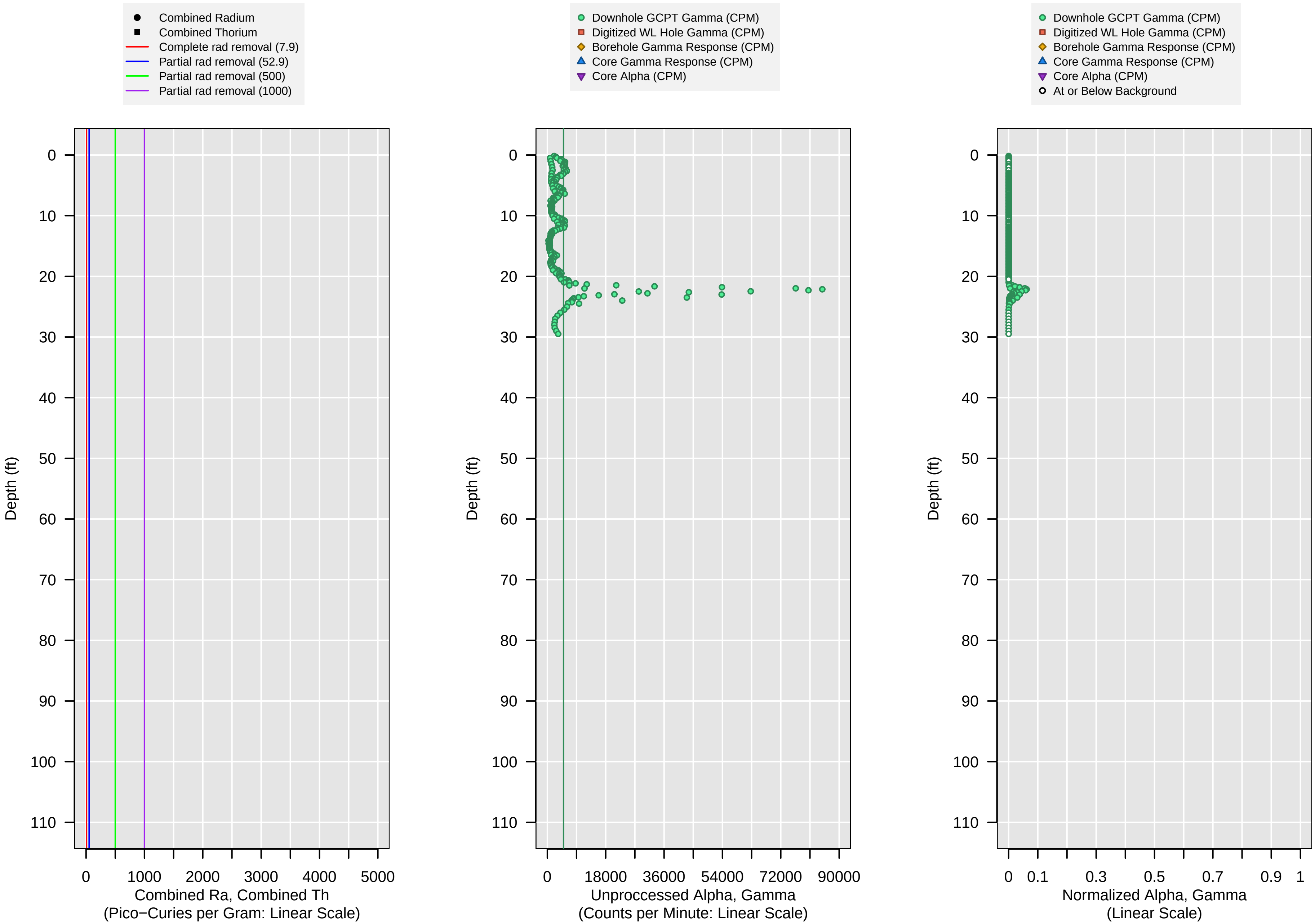


GCPT−1C−05

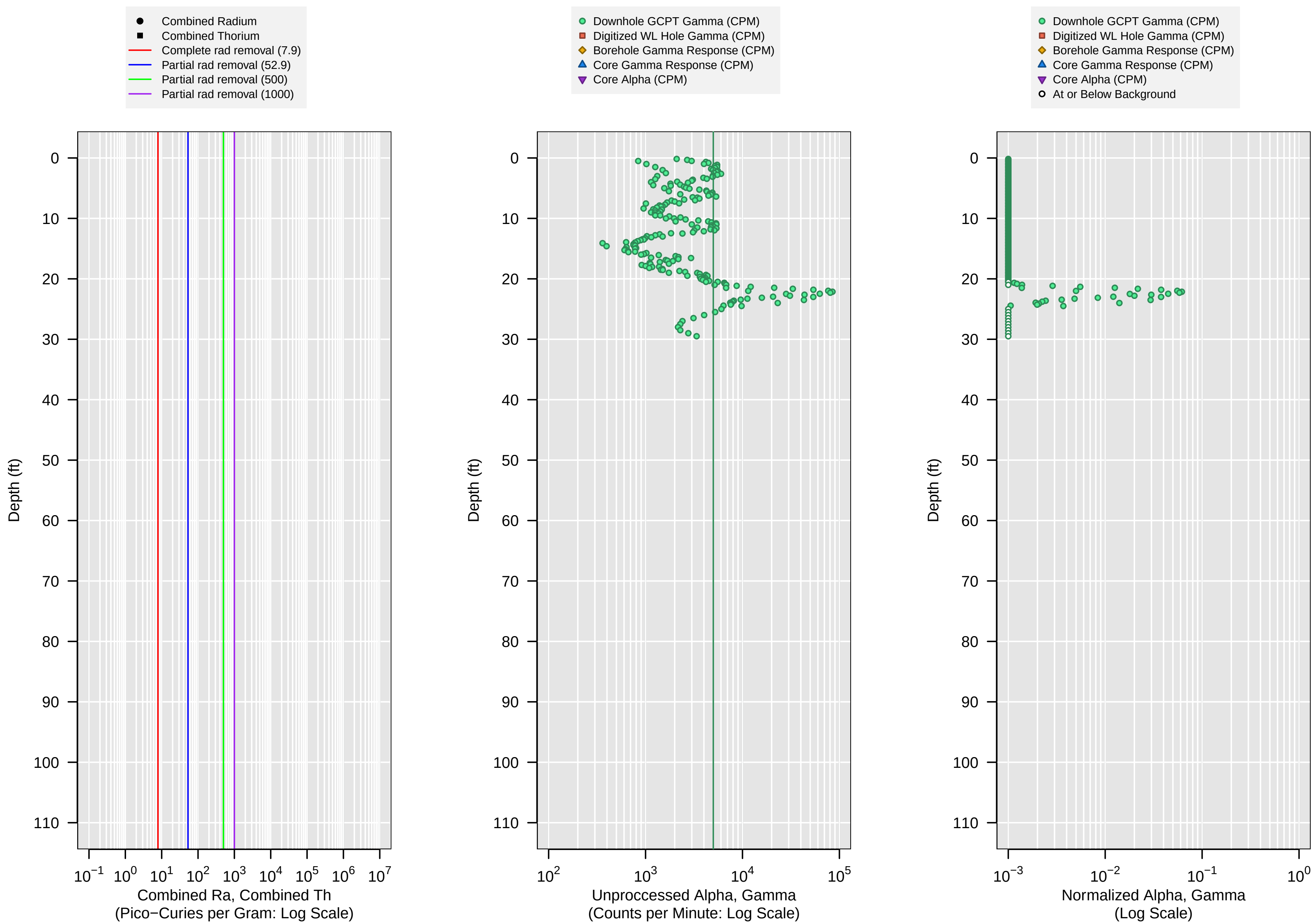


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−1C−06

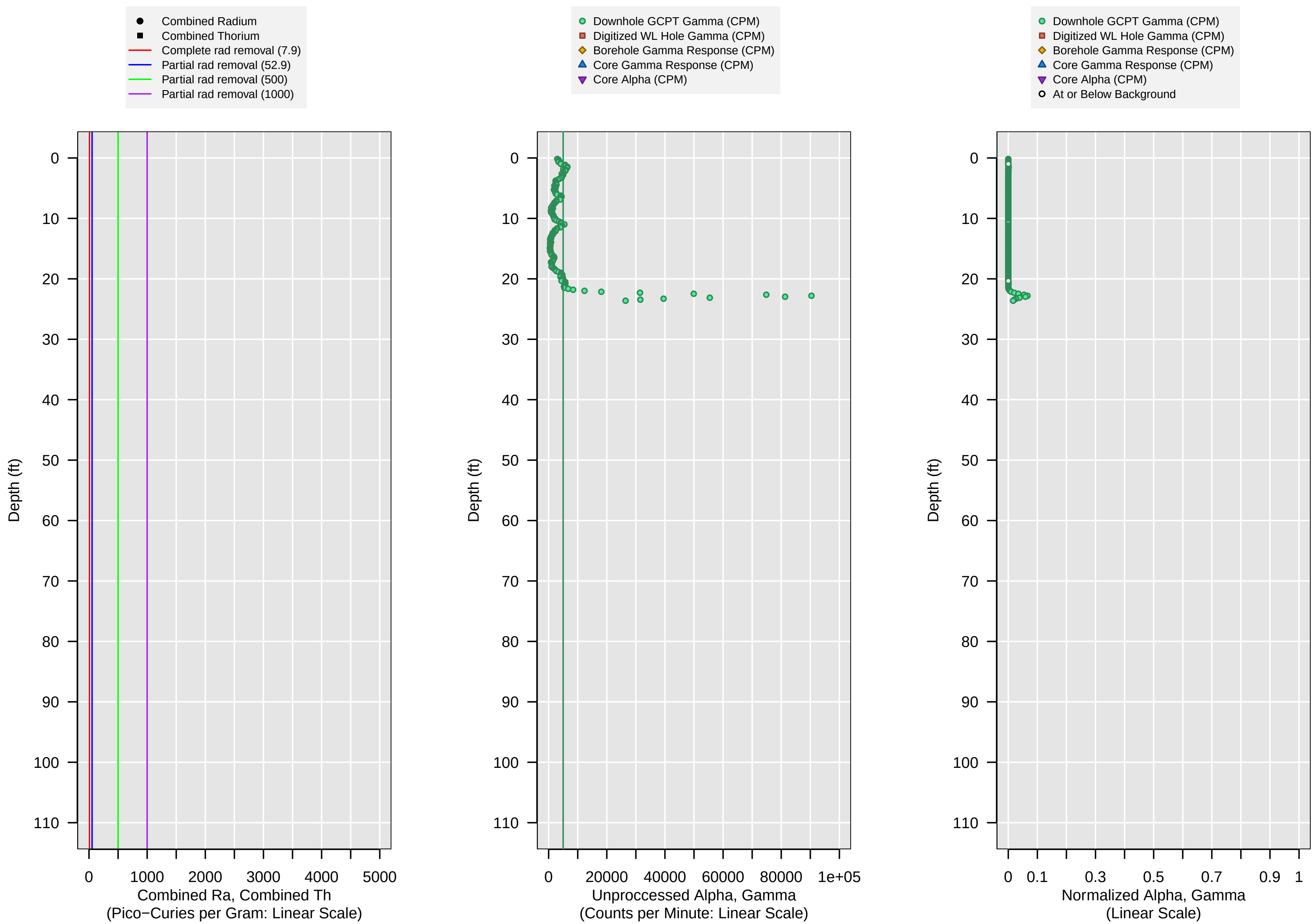

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
18000
36000
54000
72000
90000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

GCPT−1C−06



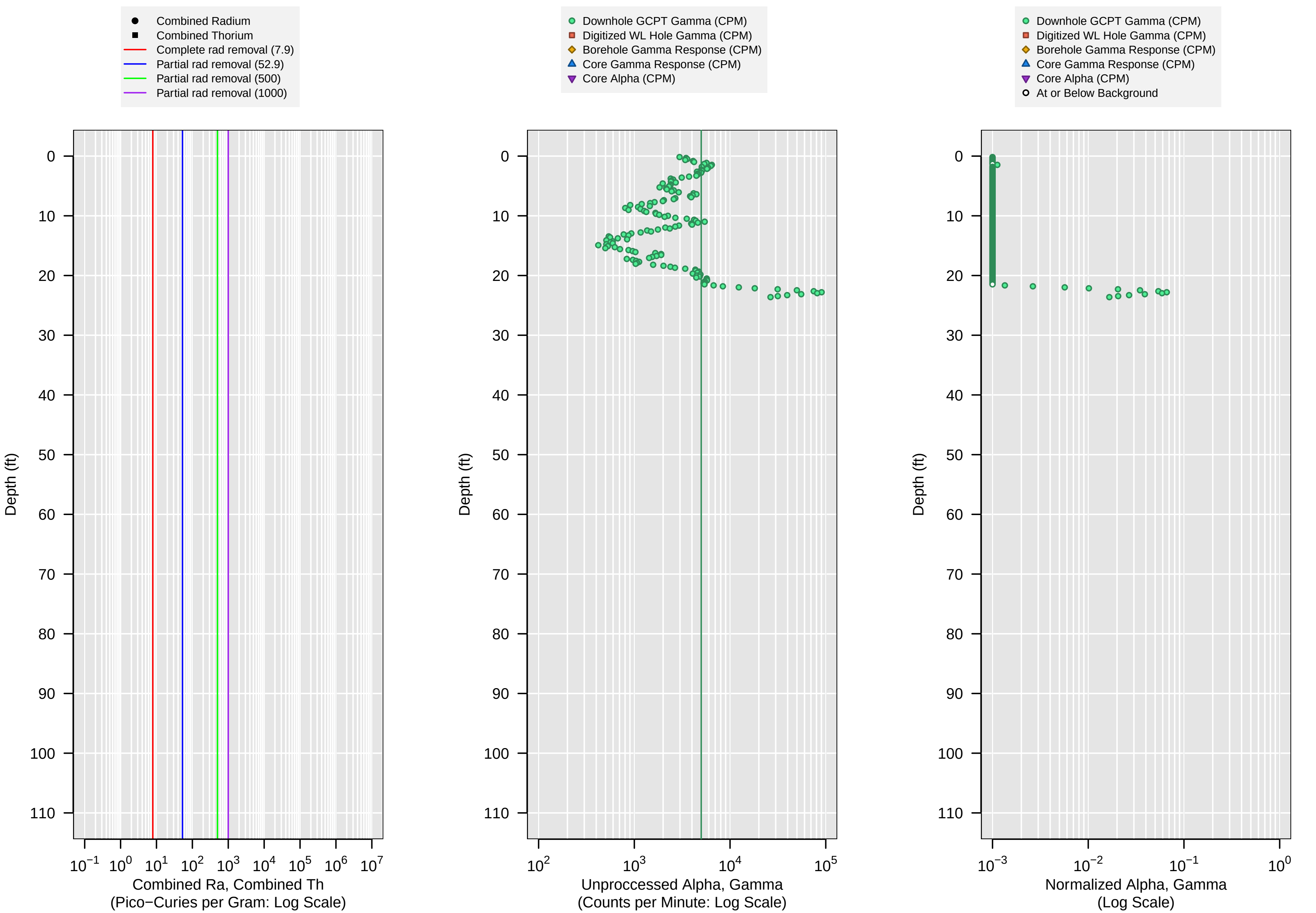
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−1C−06T

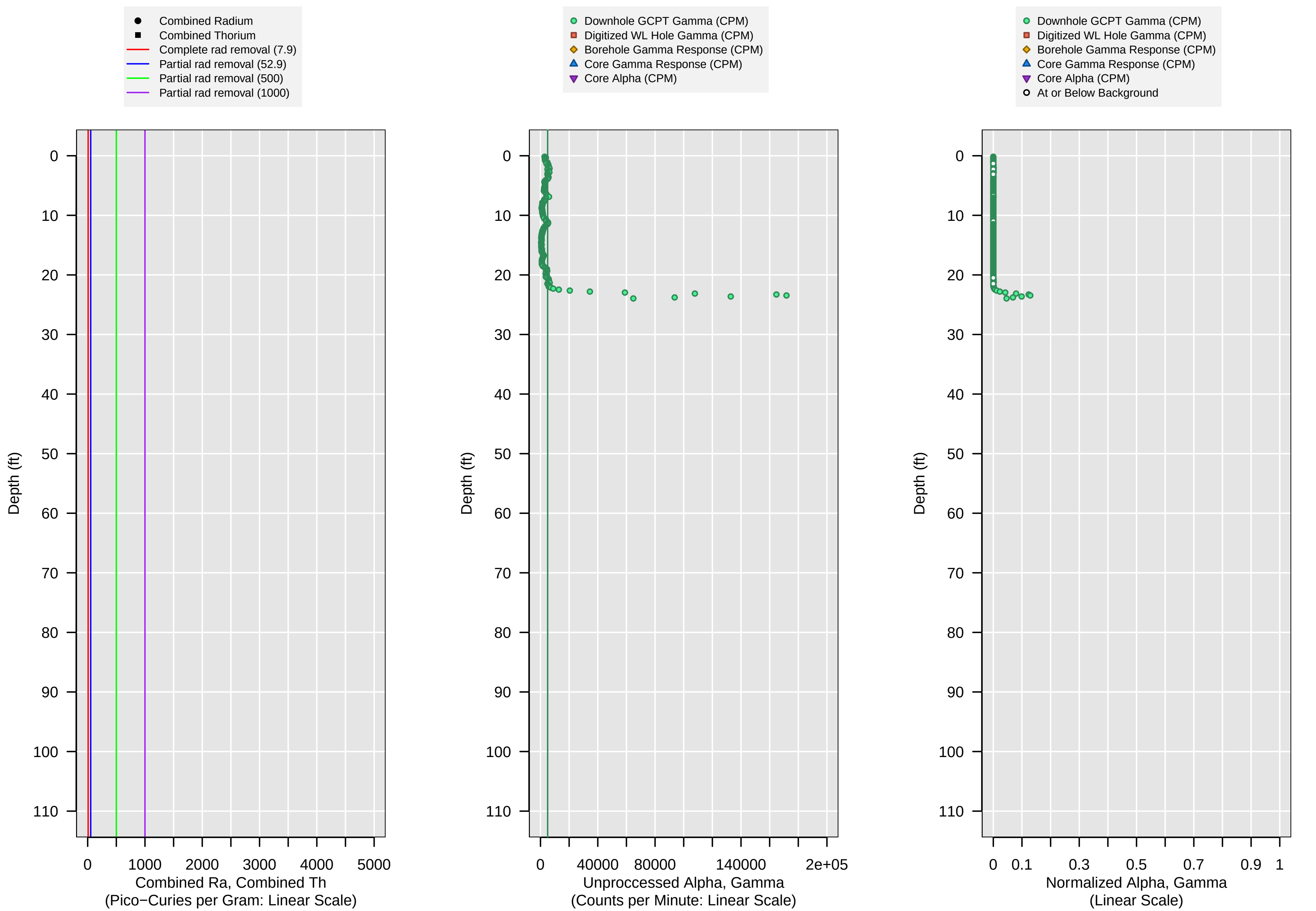


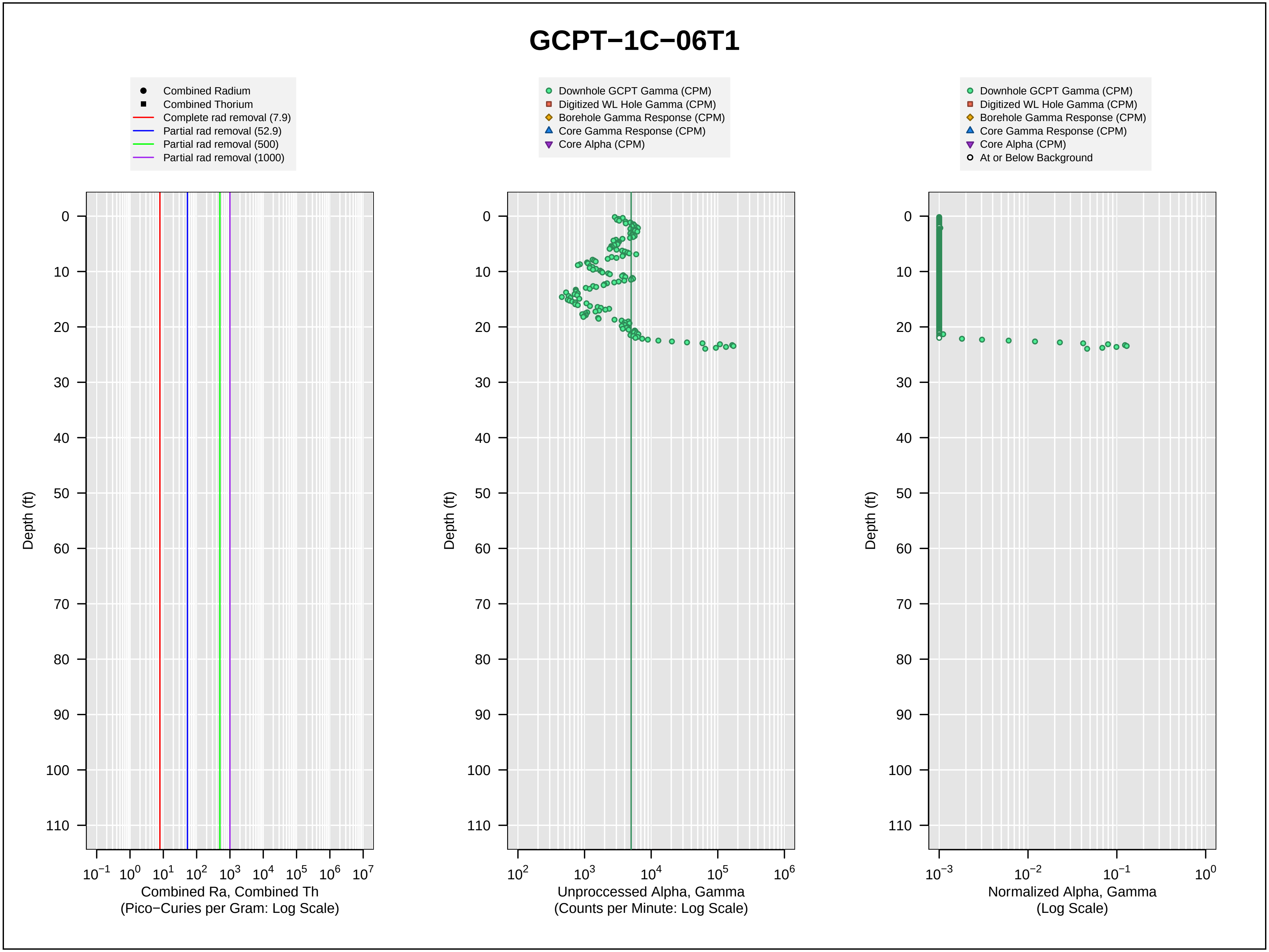
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−1C−06T

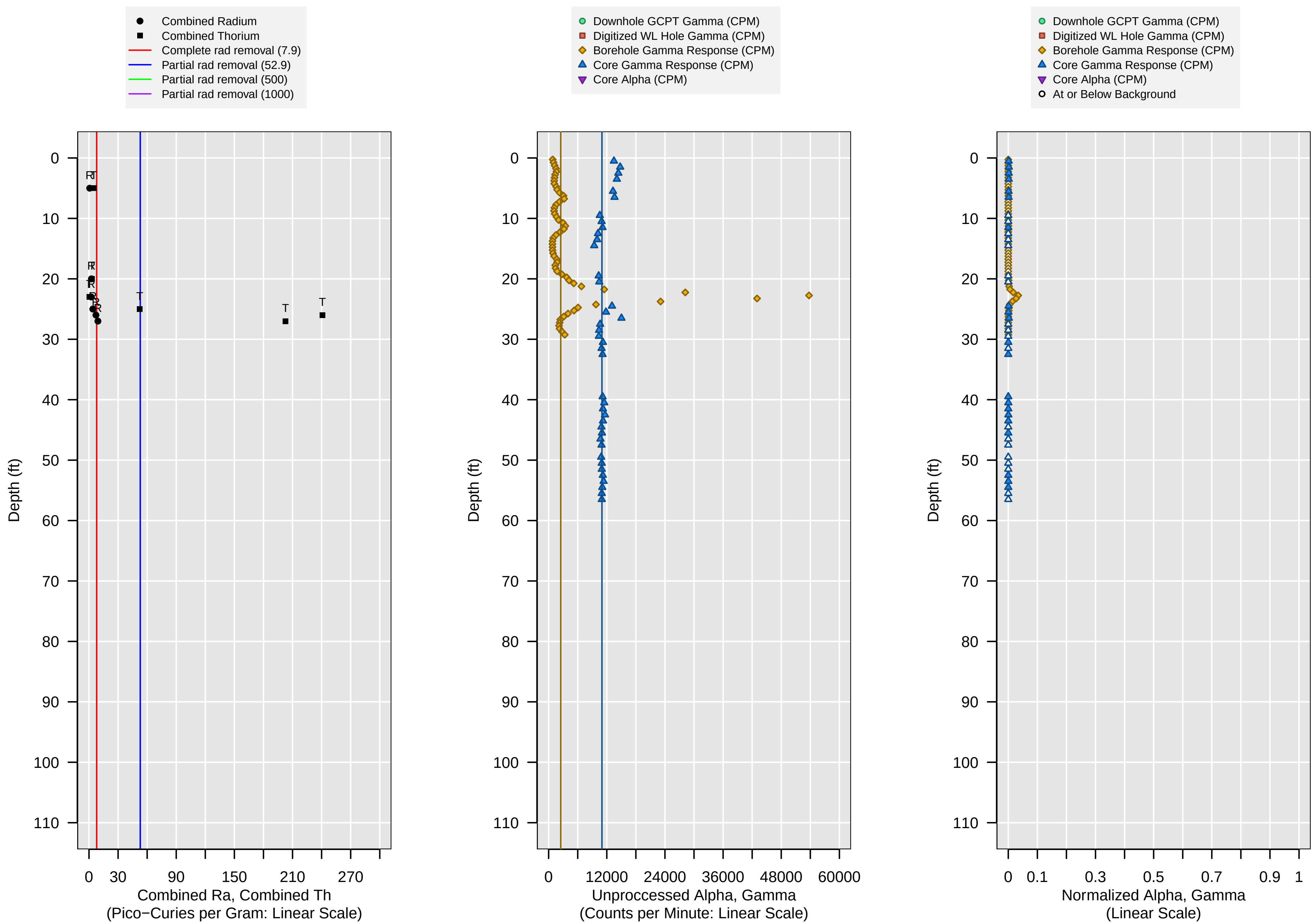

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{-1} 10^{0} 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6} 10^{7}
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
10^{2} 10^{3} 10^{4} 10^{5}
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
10^{-3} 10^{-2} 10^{-1} 10^{0}
Normalized Alpha, Gamma
(Log Scale)

GCPT−1C−06T1


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

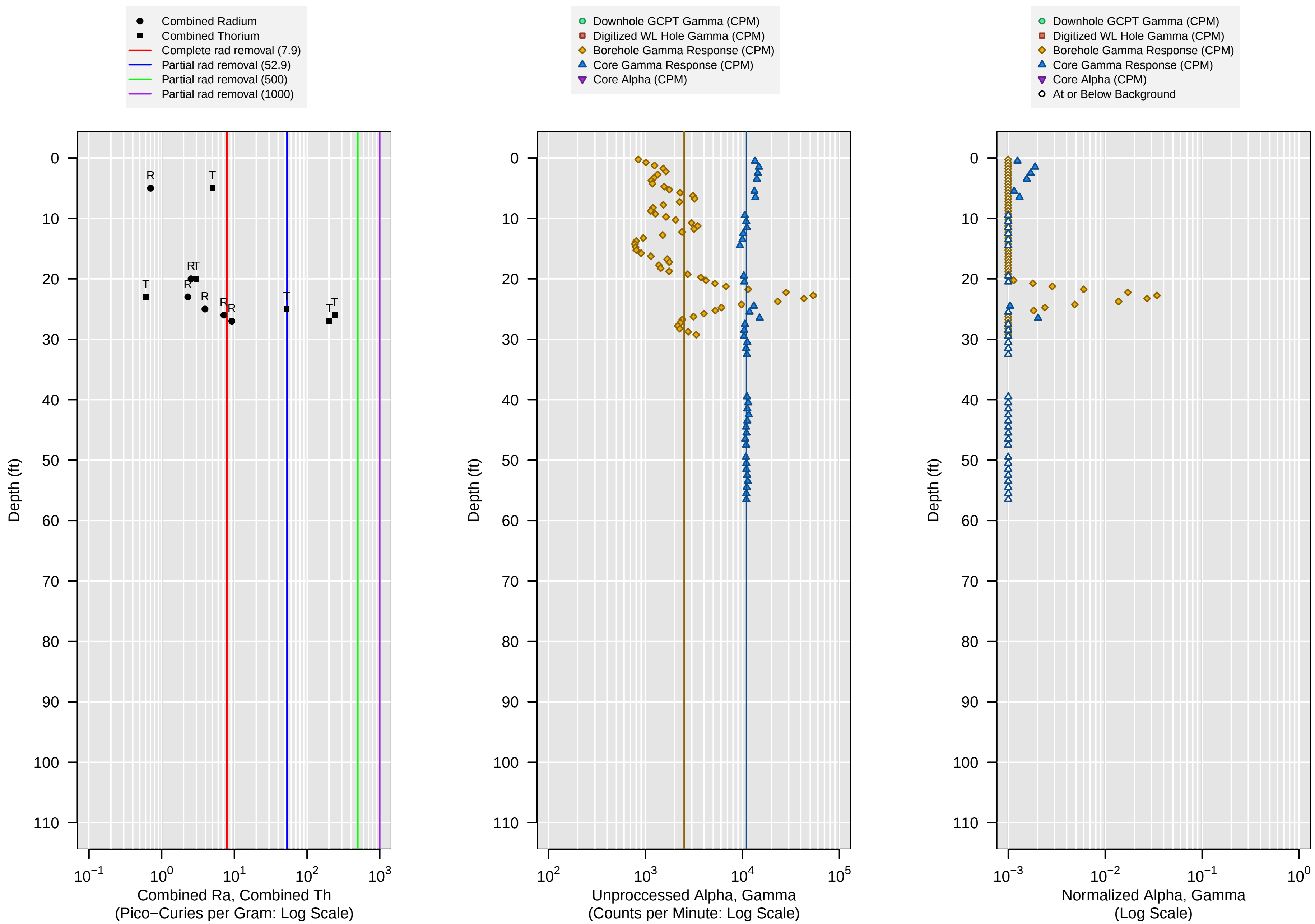

GCPT−1C−06T1
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

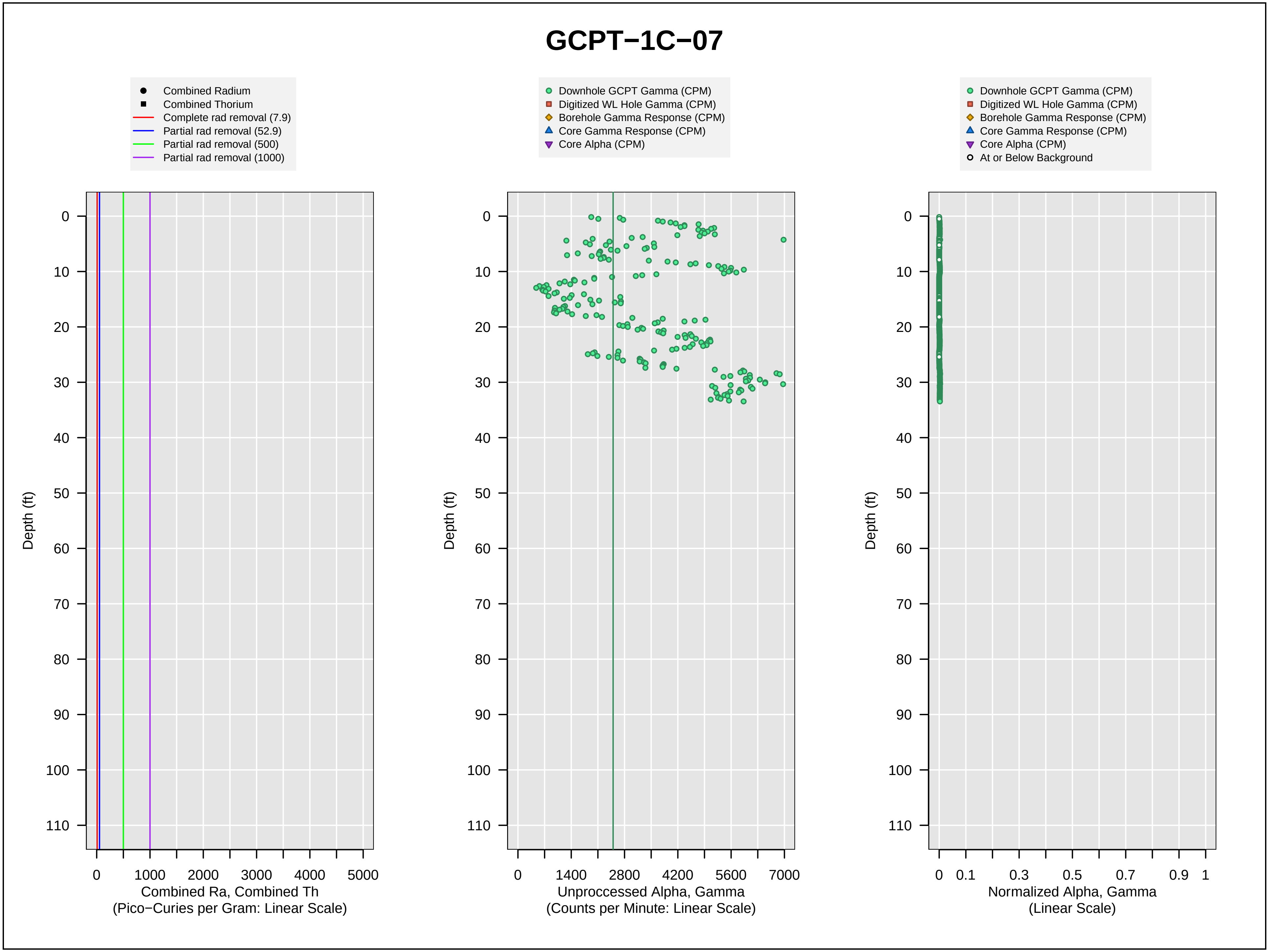
Sonic−1C−06

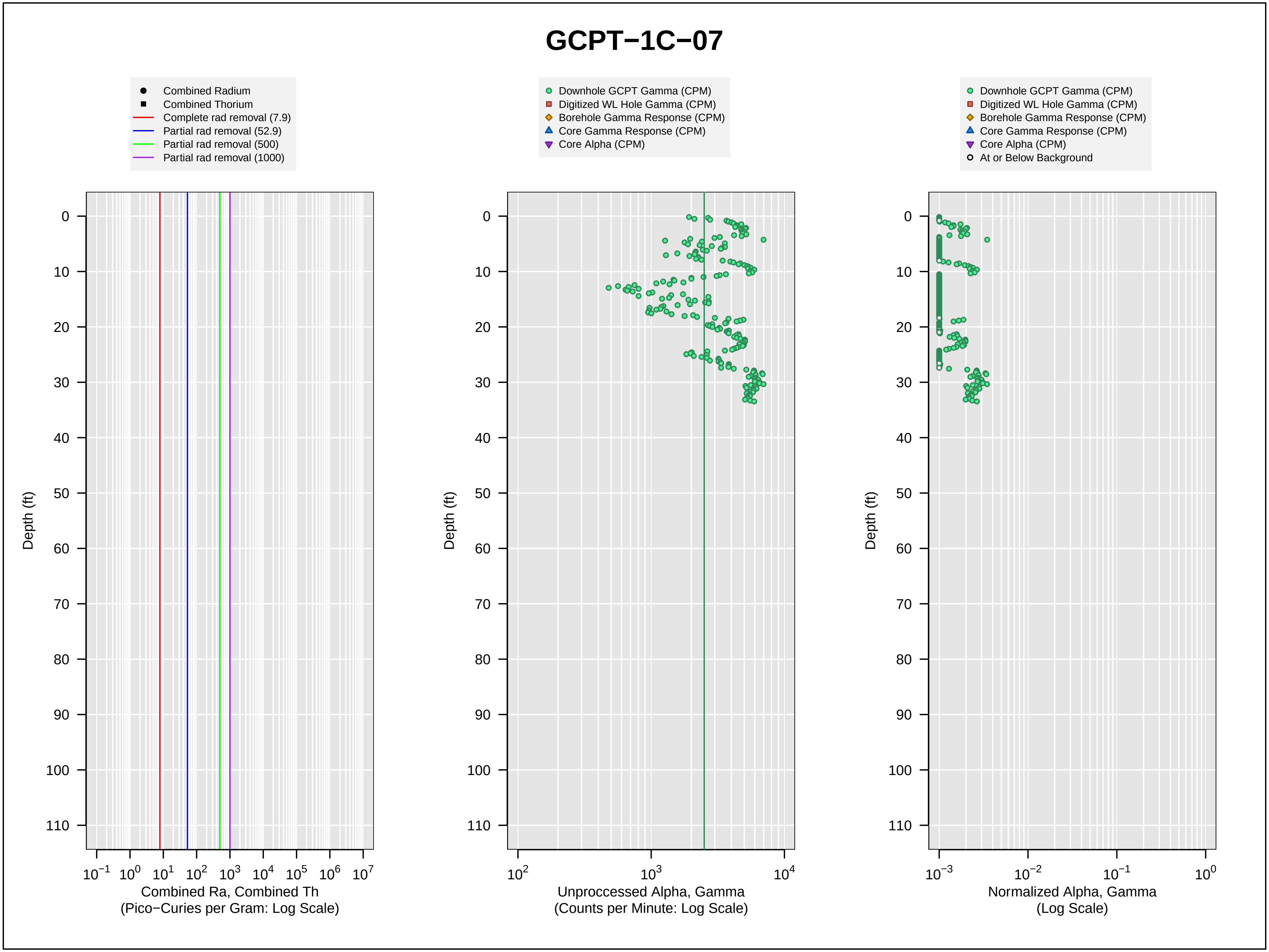


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Linear Scale)

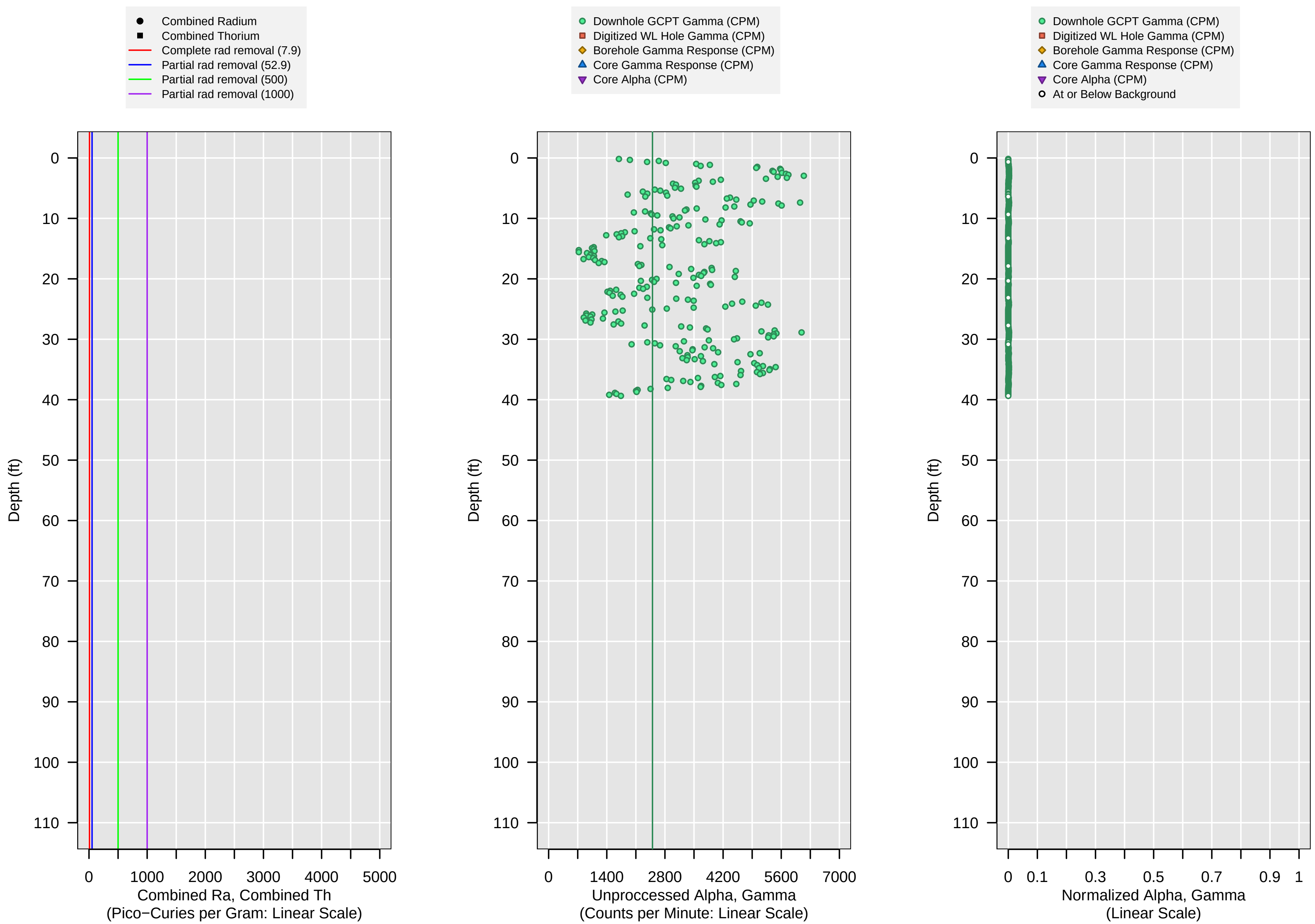
Sonic−1C−06


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

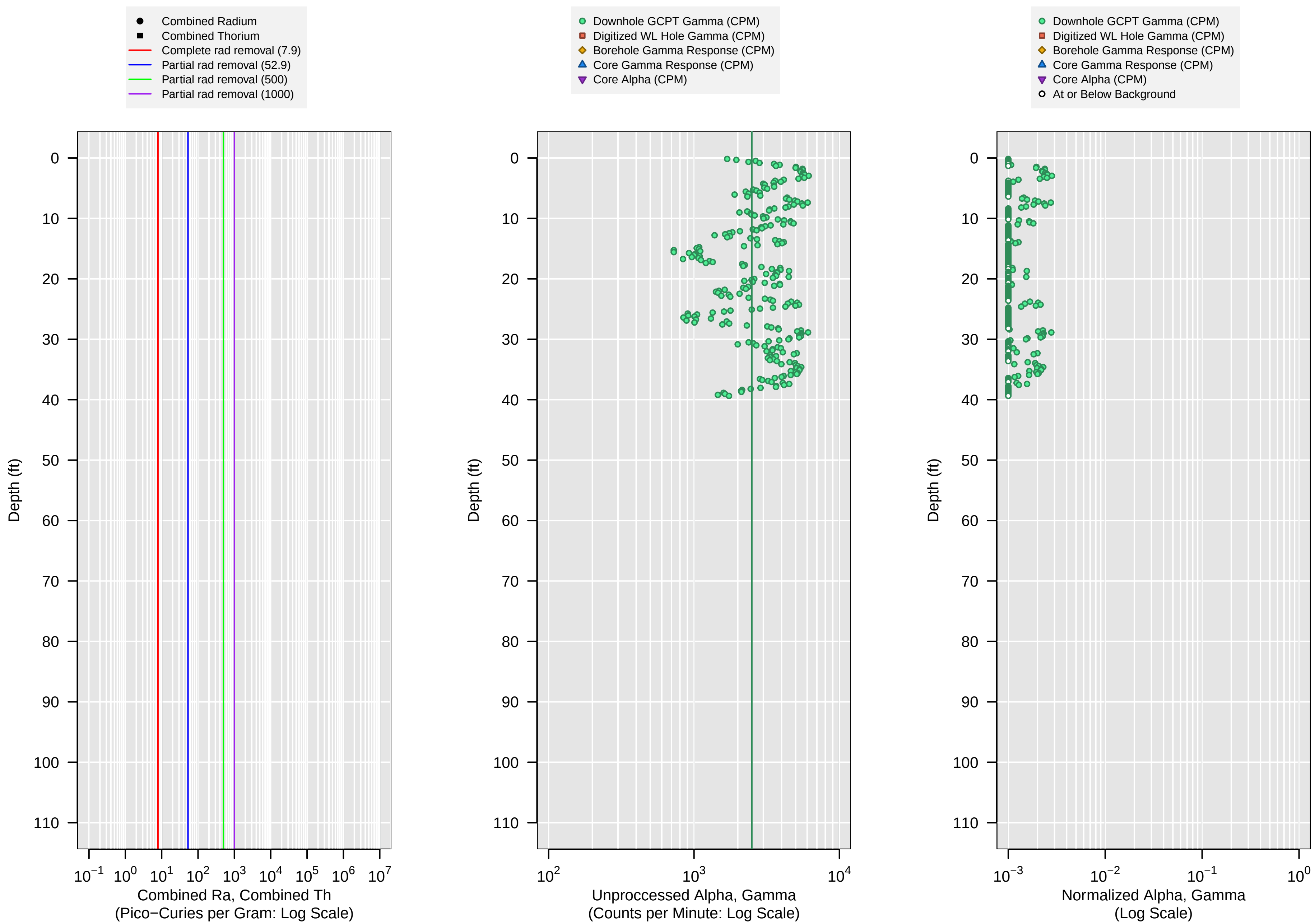

GCPT−1C−07
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Normalized Alpha, Gamma
(Linear Scale)


GCPT−1C−07
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

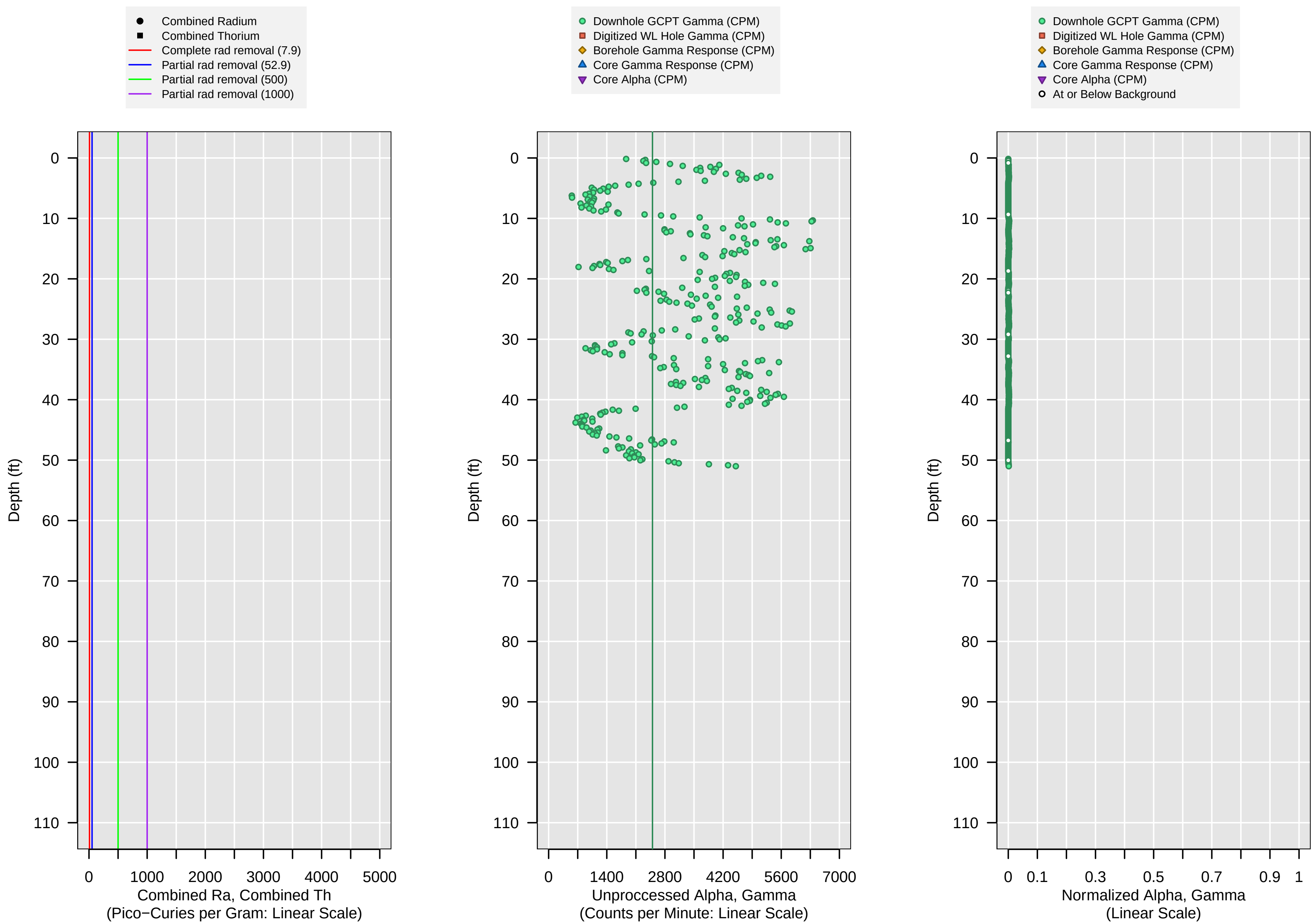
GCPT−1C−08


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1400
2800
4200
5600
7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

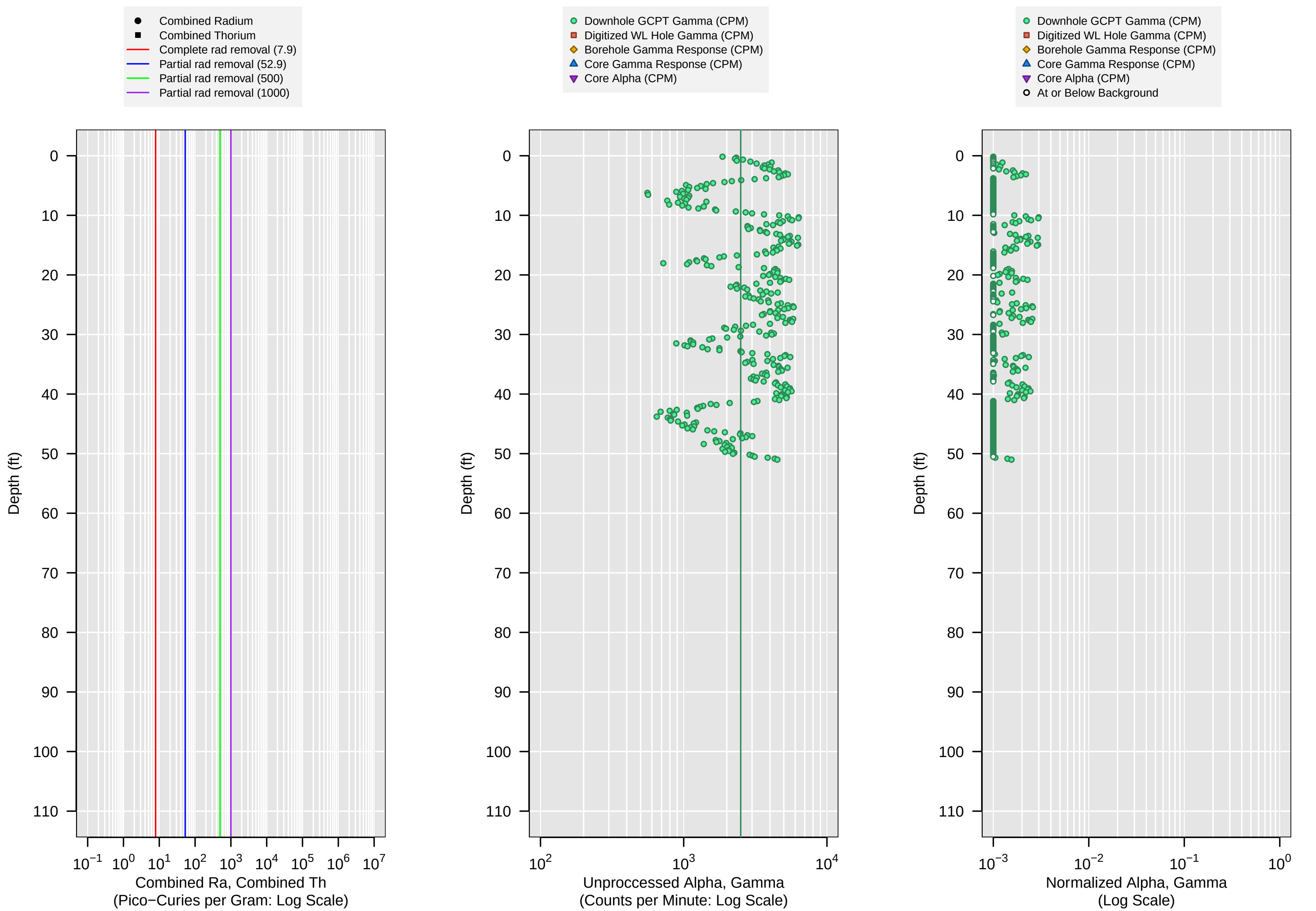
GCPT−1C−08


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

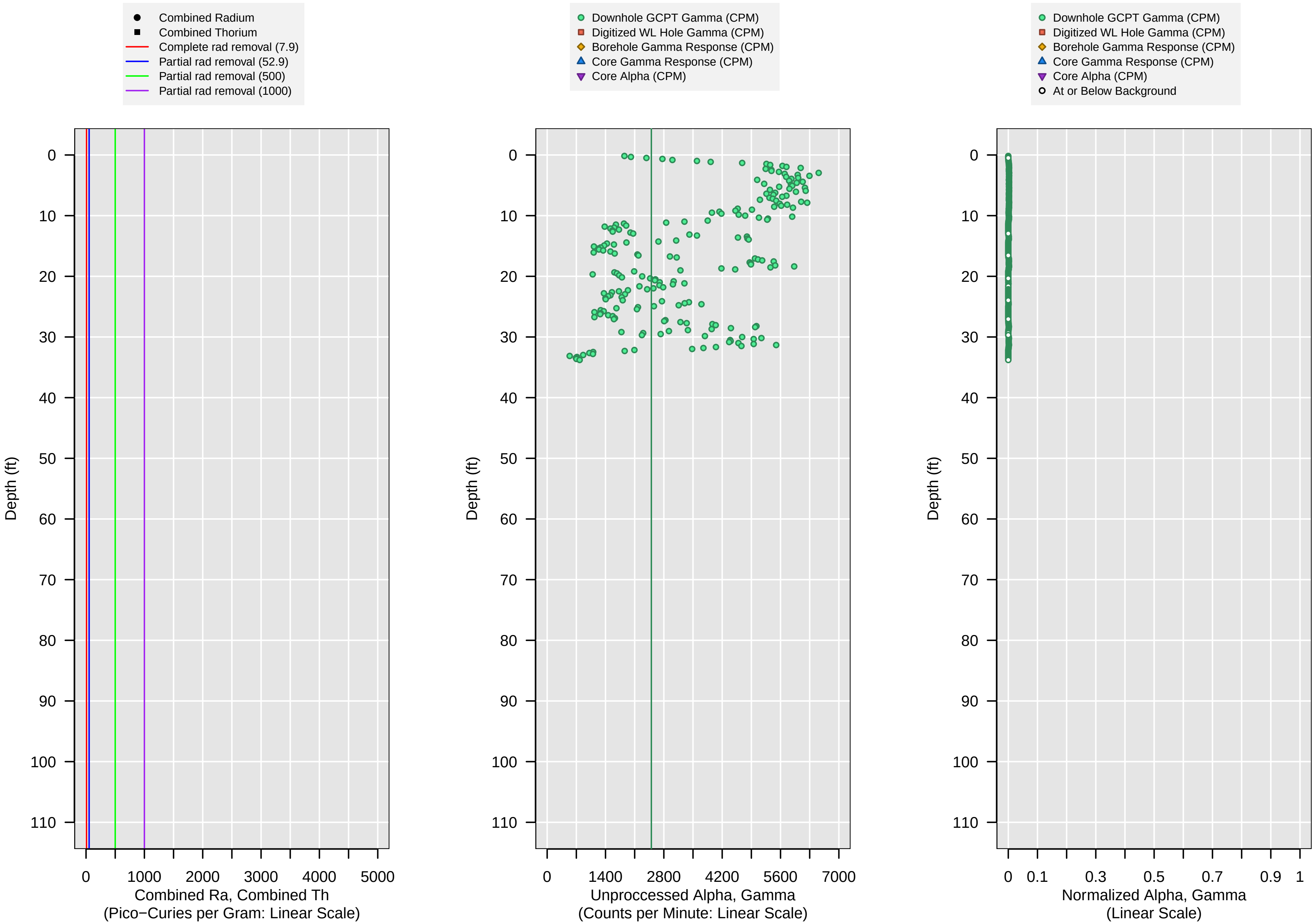
GCPT−1C−09


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 1000 2000 3000 4000 5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0 1400 2800 4200 5600 7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

GCPT−1C−09

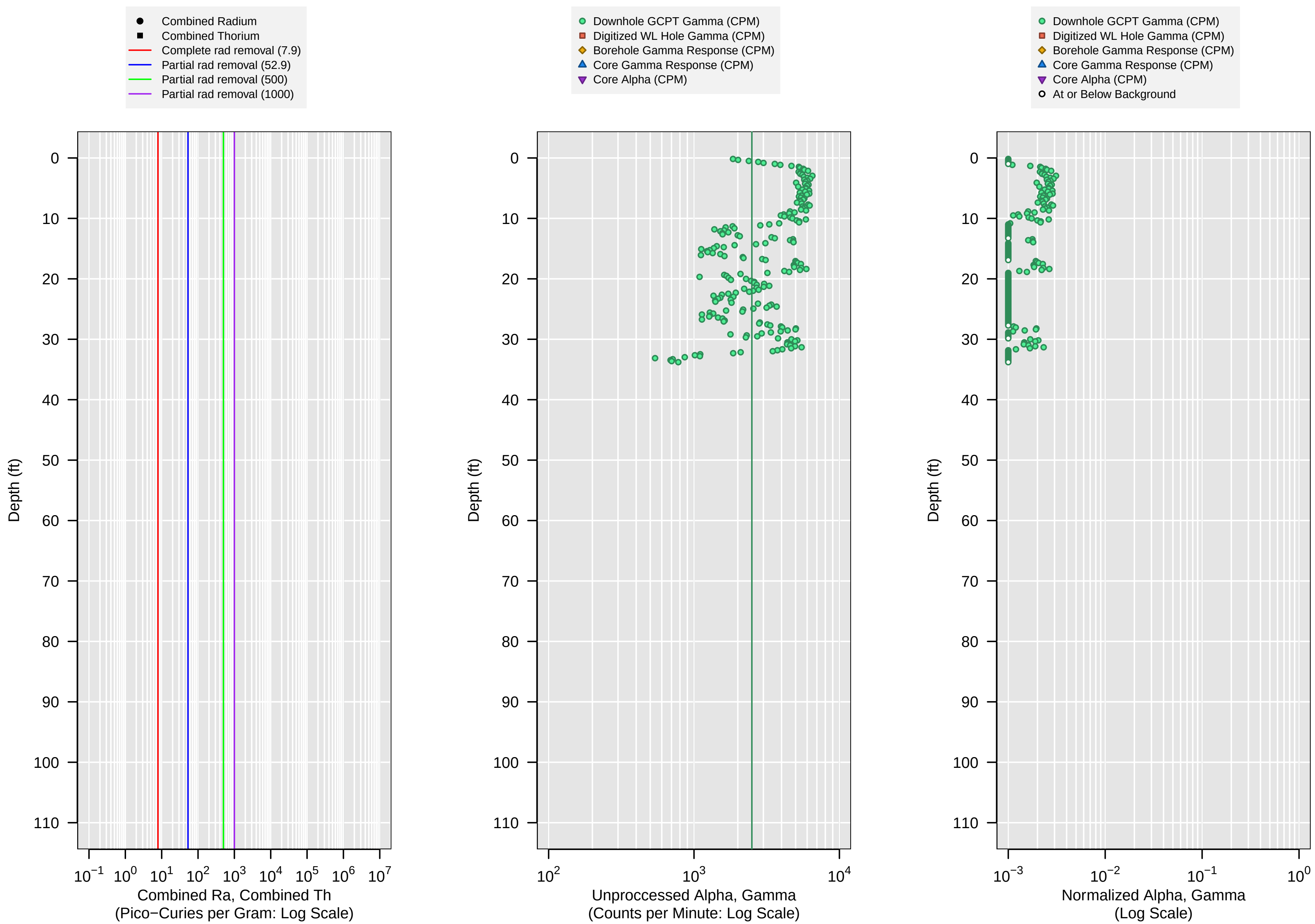

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−1C−11



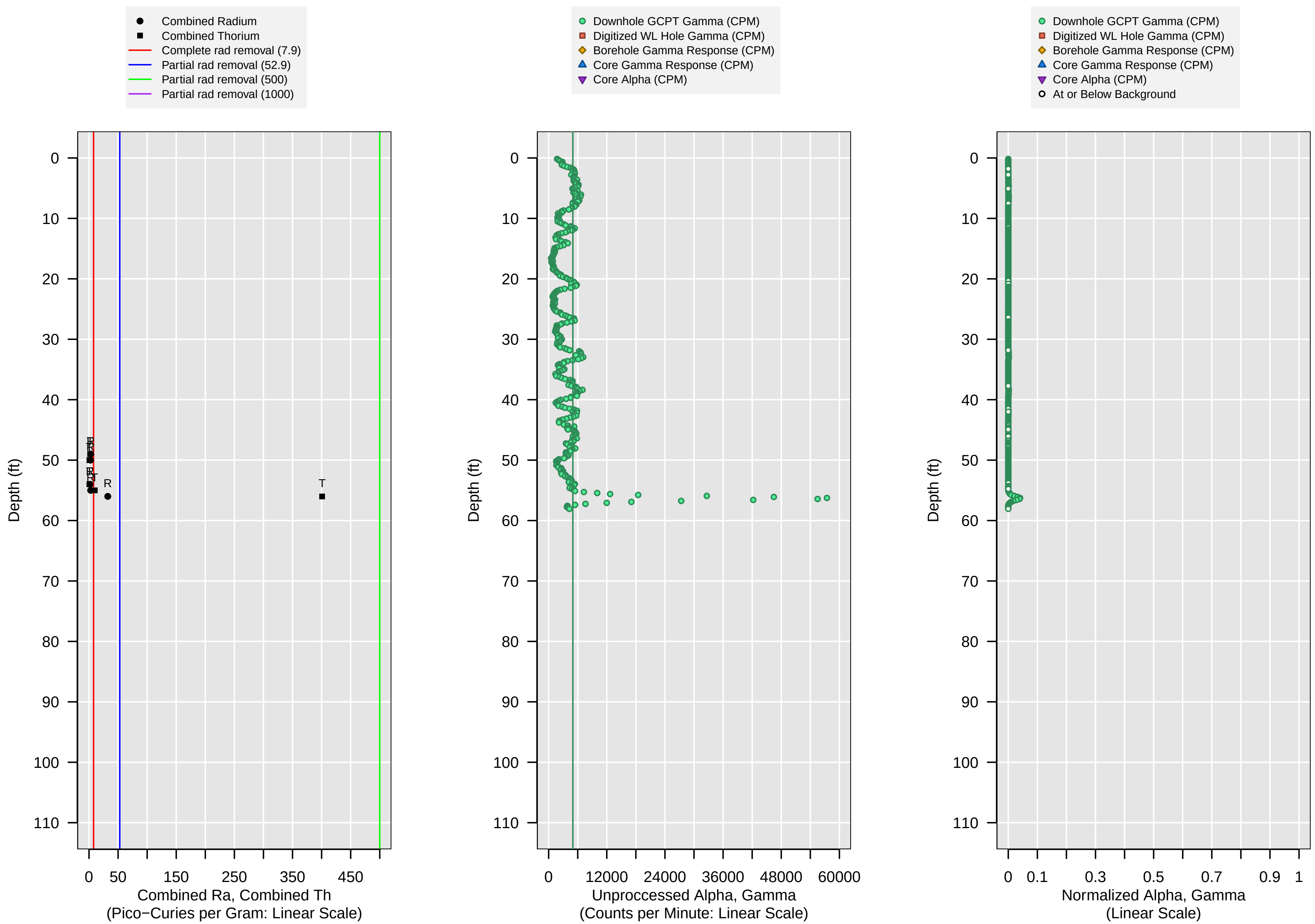
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1400
2800
4200
5600
7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

GCPT−1C−11

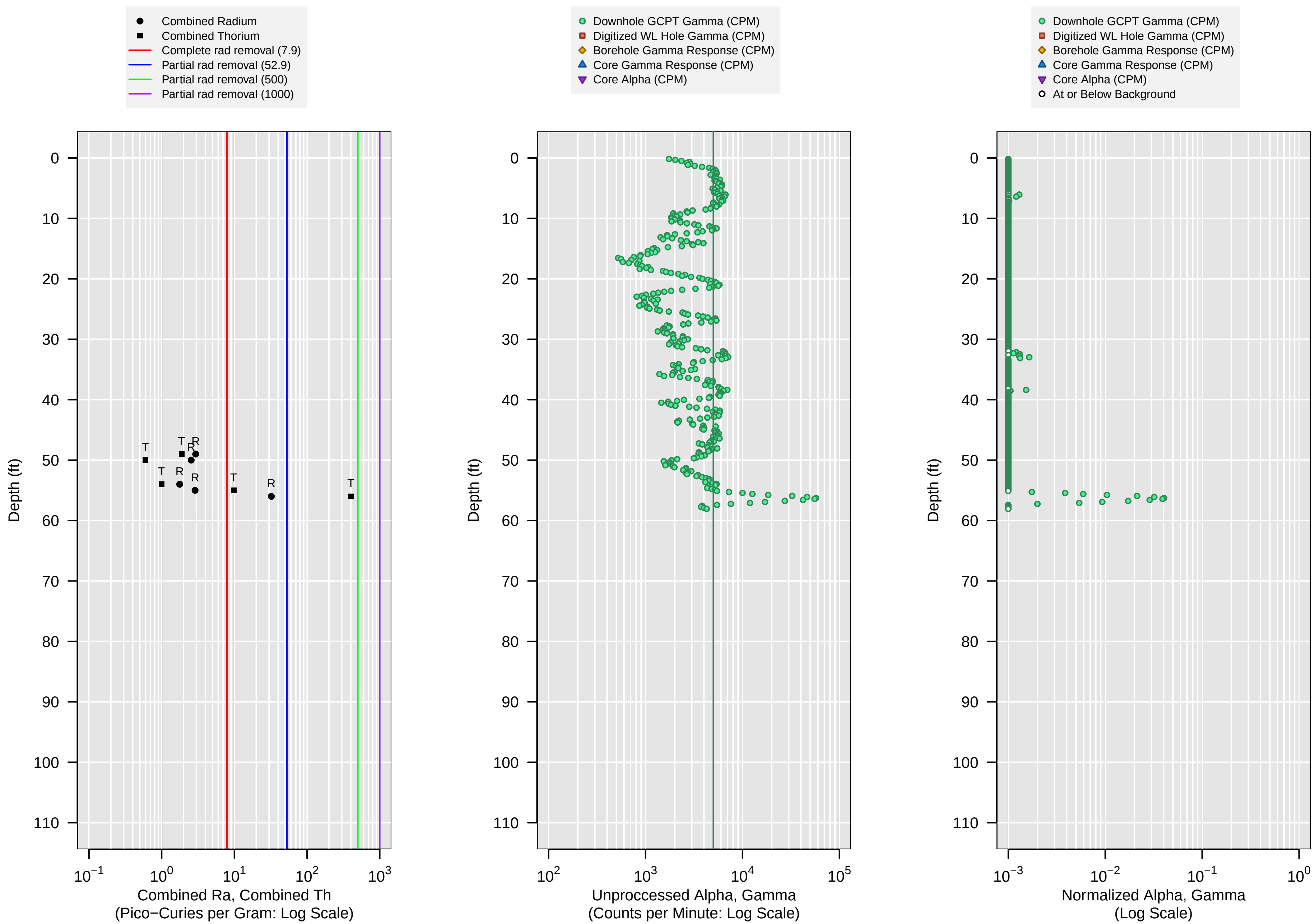


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{-1} 10^{0} 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6} 10^{7}
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
10^{2} 10^{3} 10^{4}
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
10^{-3} 10^{-2} 10^{-1} 10^{0}
Normalized Alpha, Gamma
(Log Scale)

GCPT−1C−12

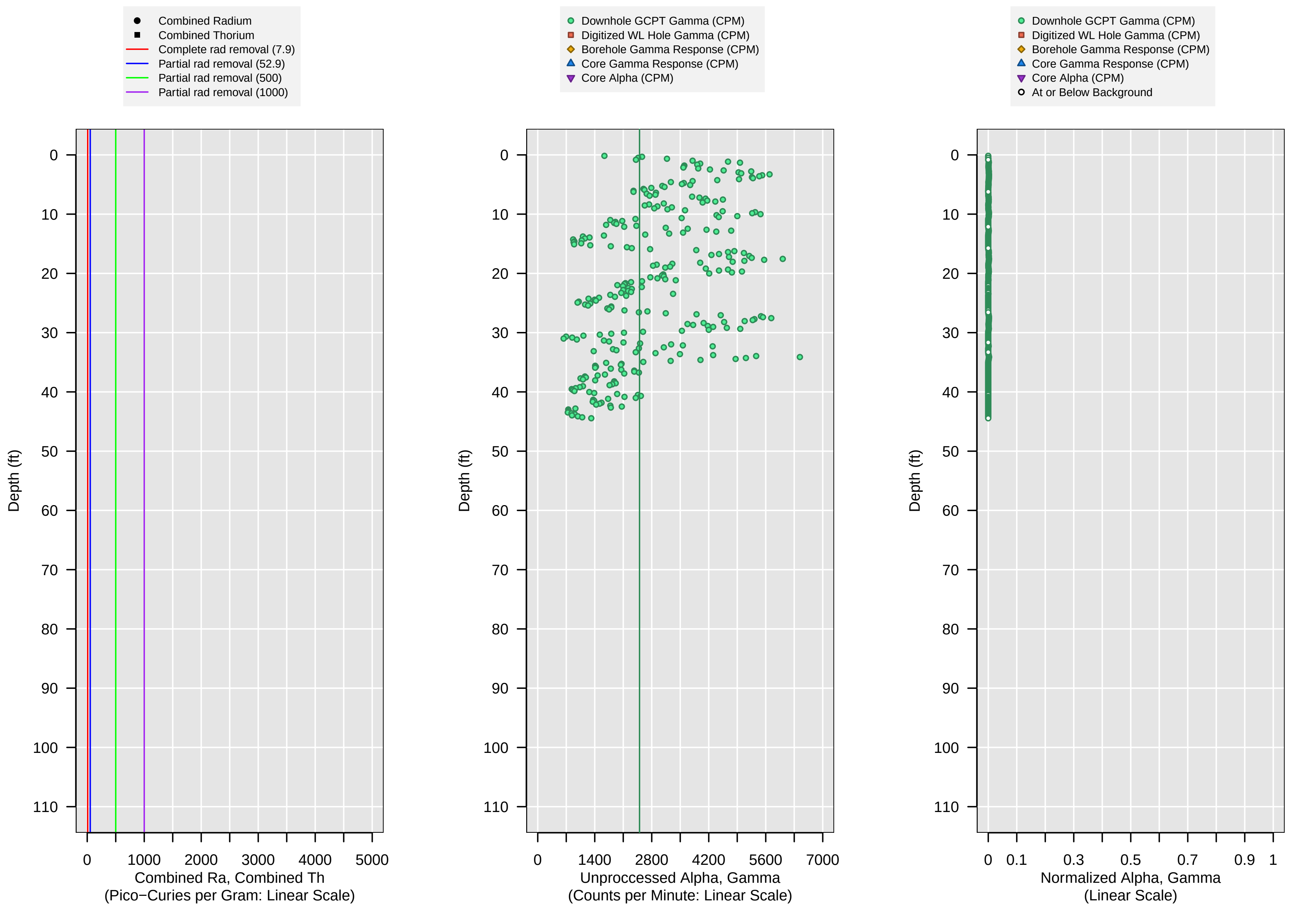

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−1C−12



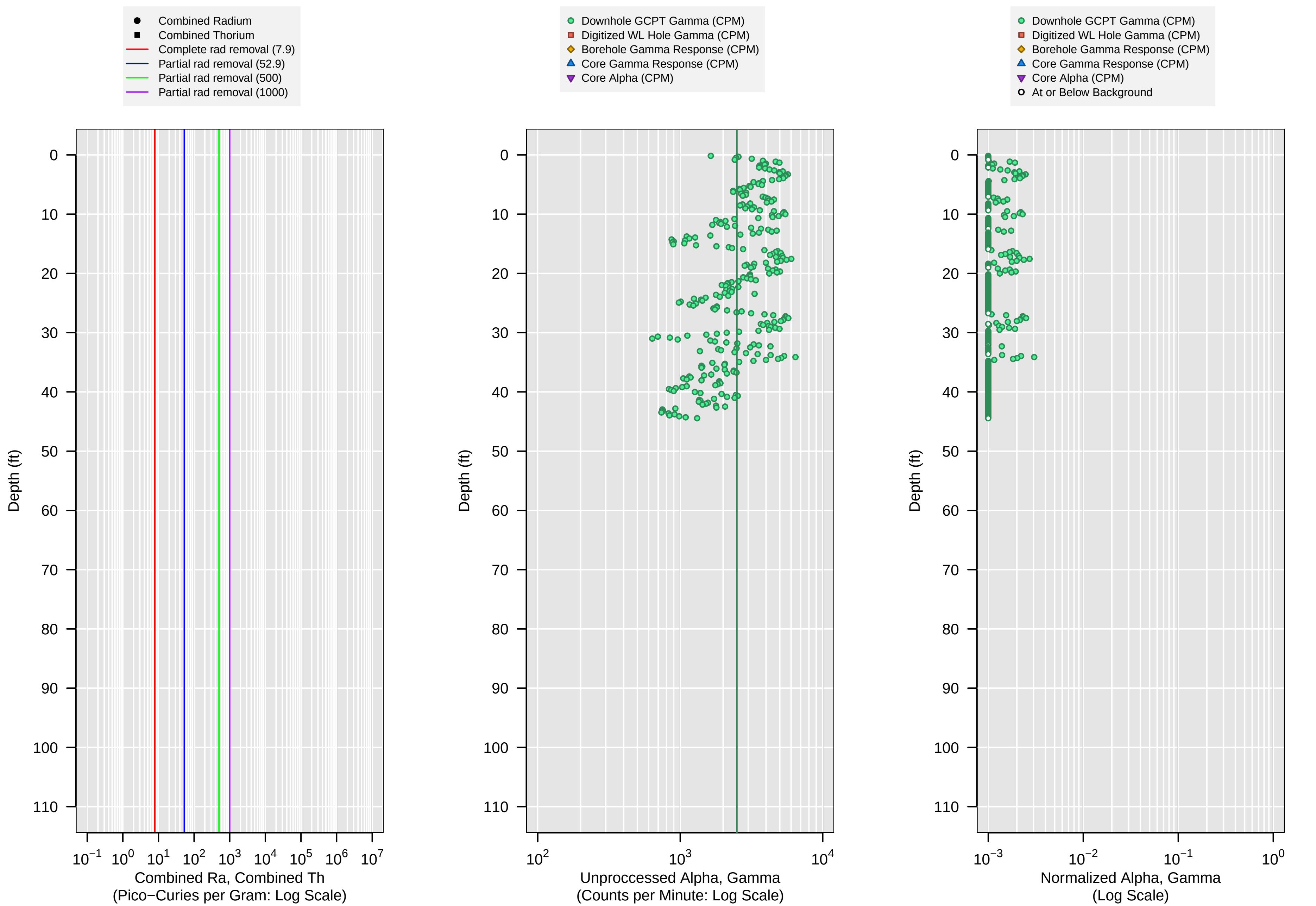
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−1C−13



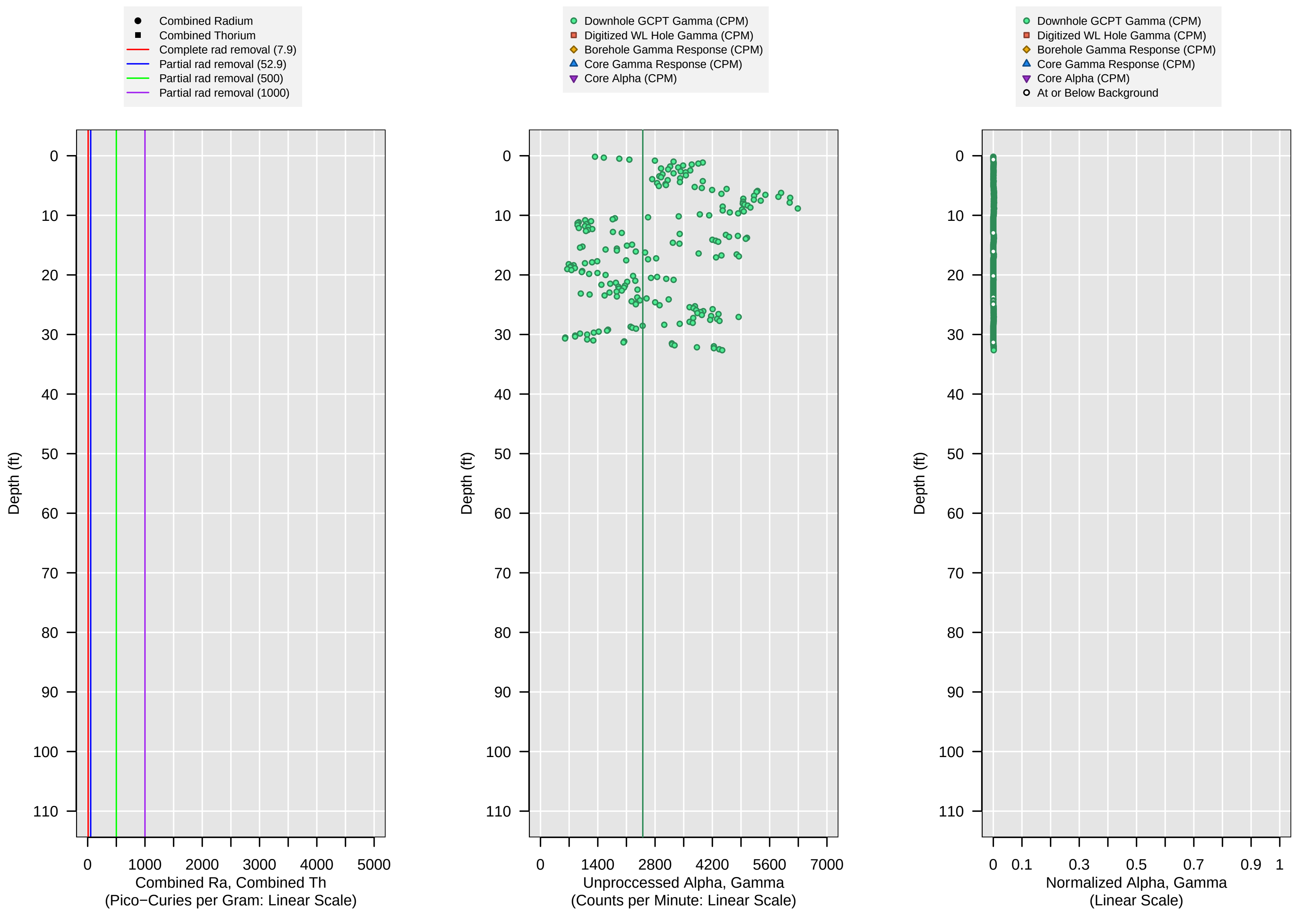
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−1C−13

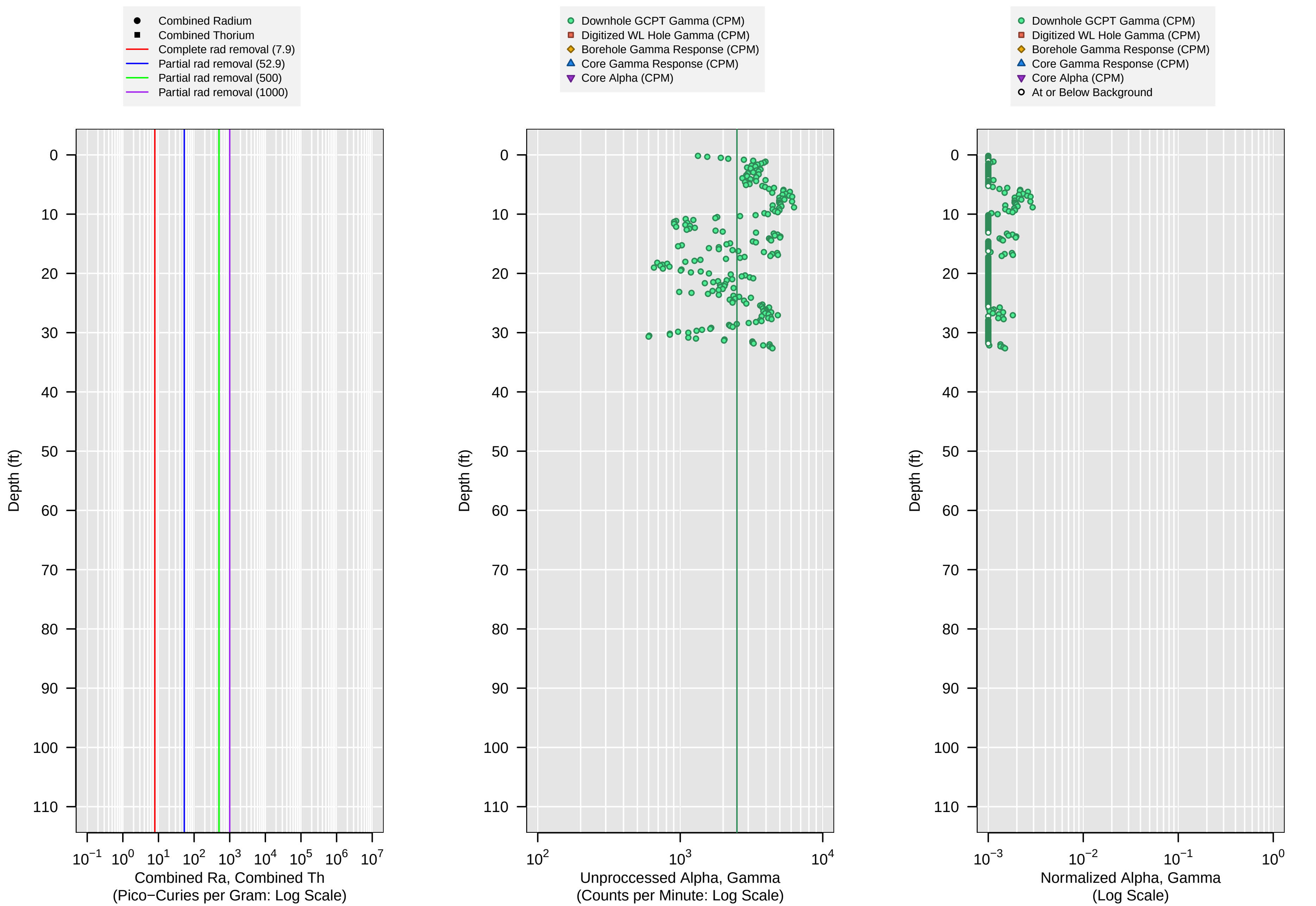


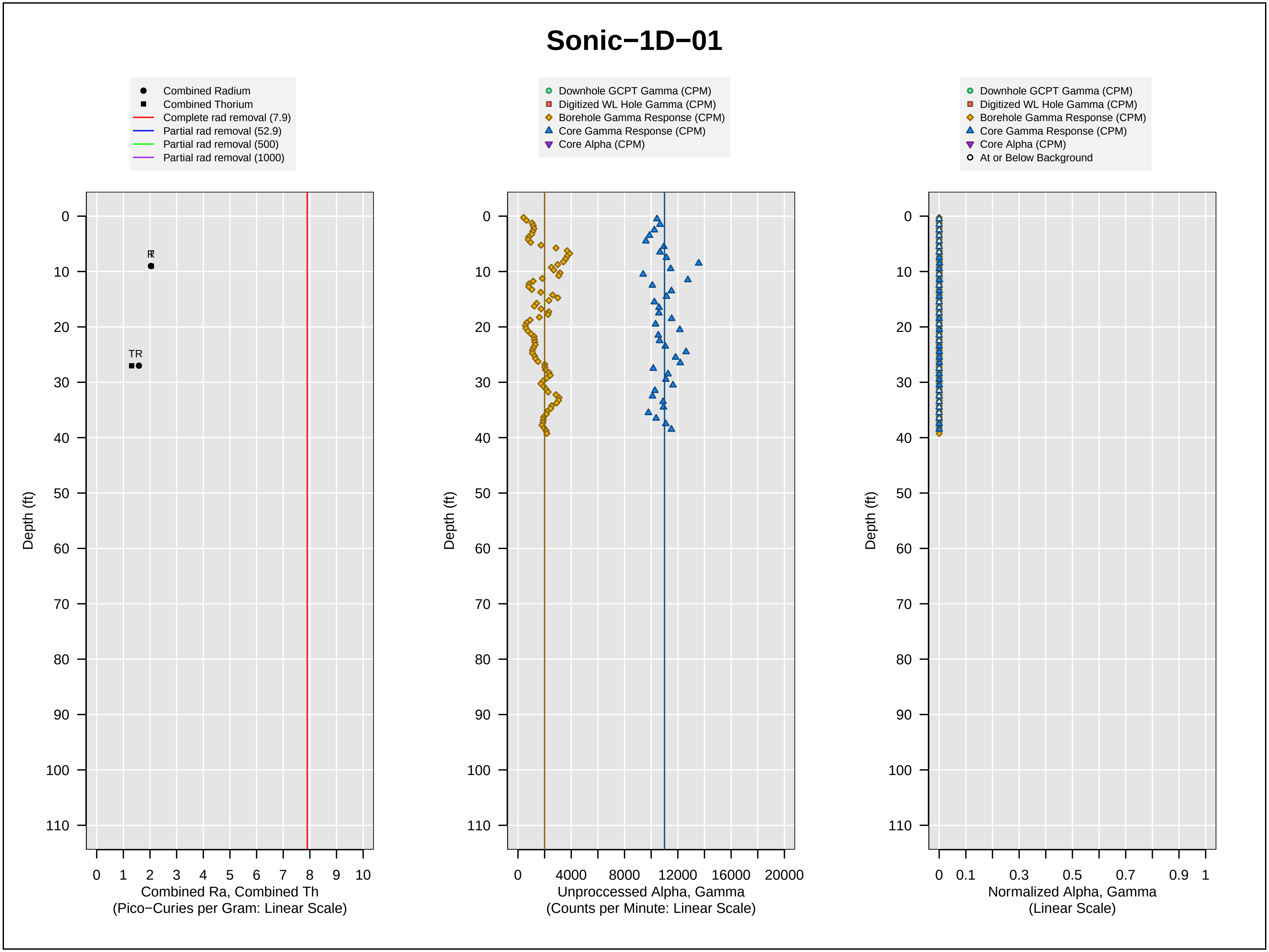
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{-1} 10^{0} 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6} 10^{7}
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
10^{2} 10^{3} 10^{4}
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
10^{-3} 10^{-2} 10^{-1} 10^{0}
Normalized Alpha, Gamma
(Log Scale)

GCPT−1D−01

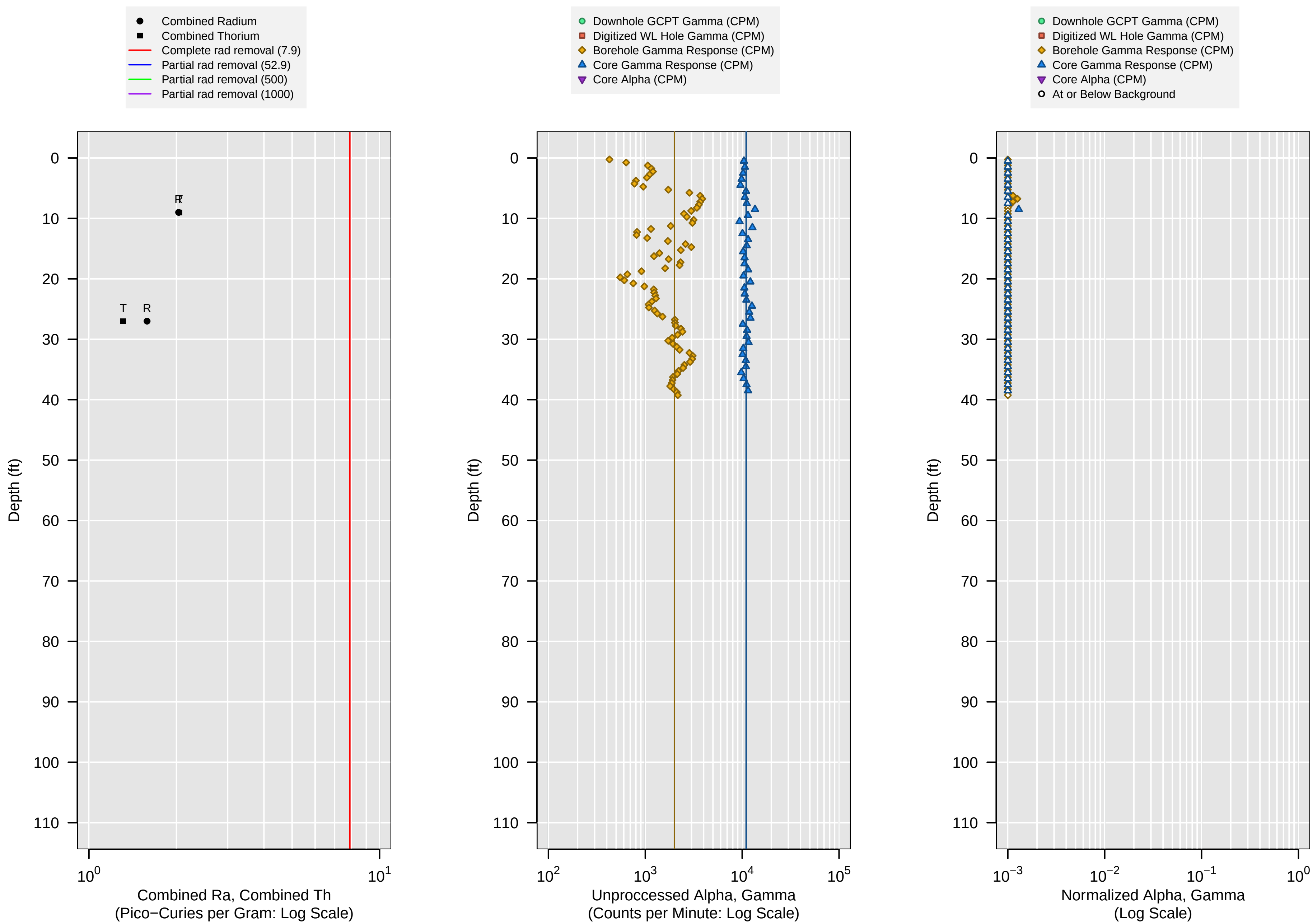

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−1D−01

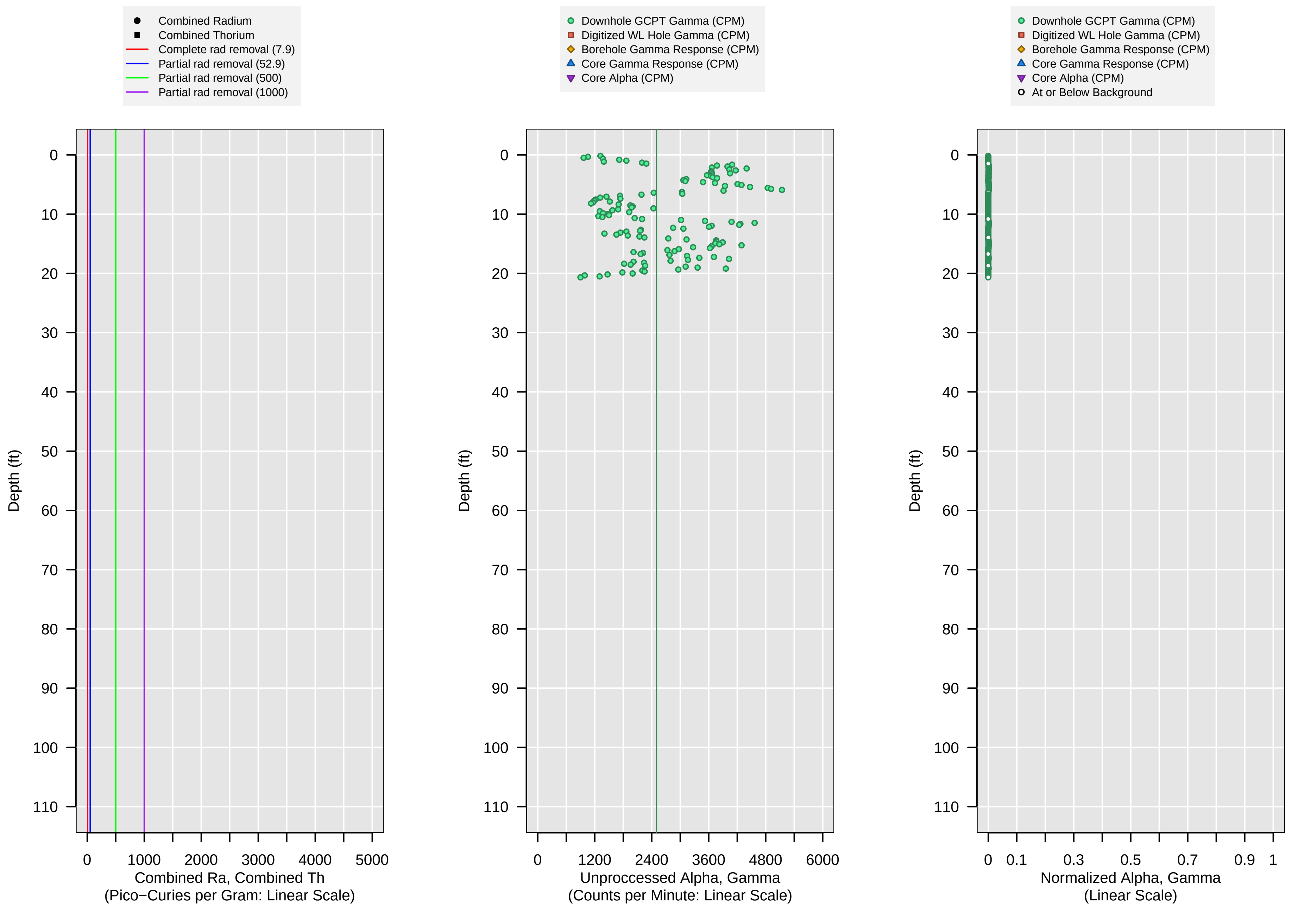

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)


Sonic−1D−01
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
TR
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

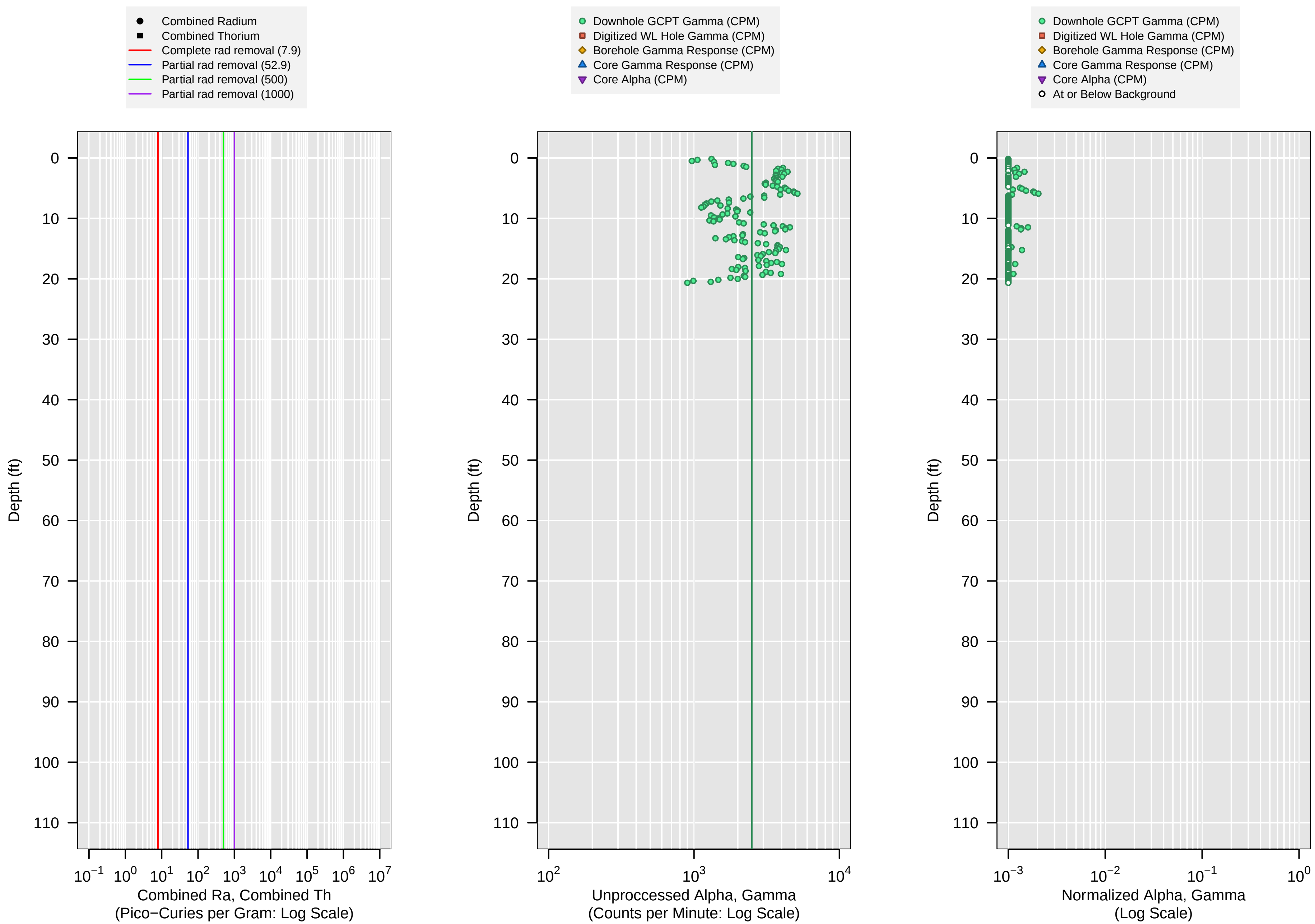
Sonic−1D−01


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

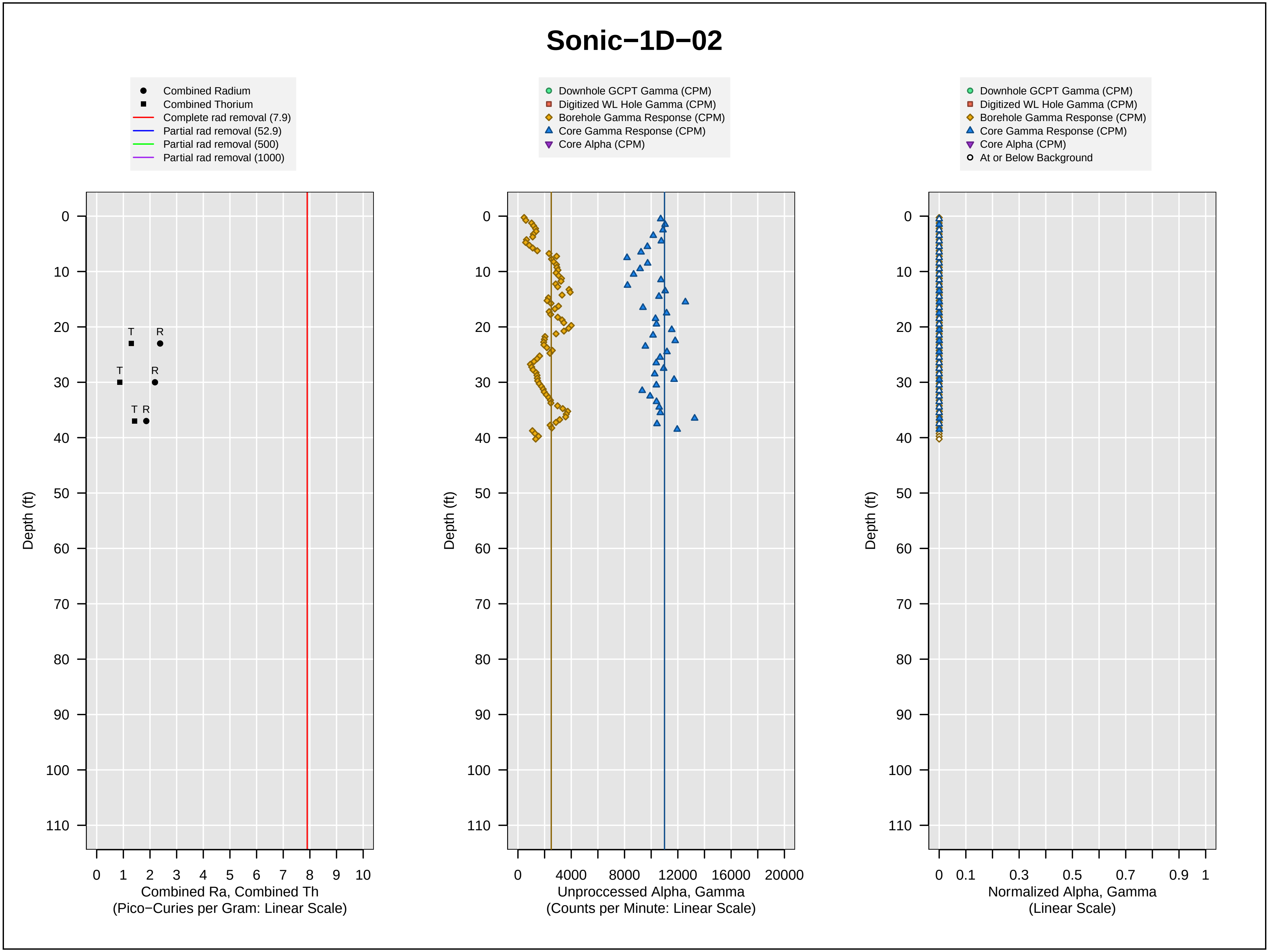
GCPT−1D−02


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1200
2400
3600
4800
6000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

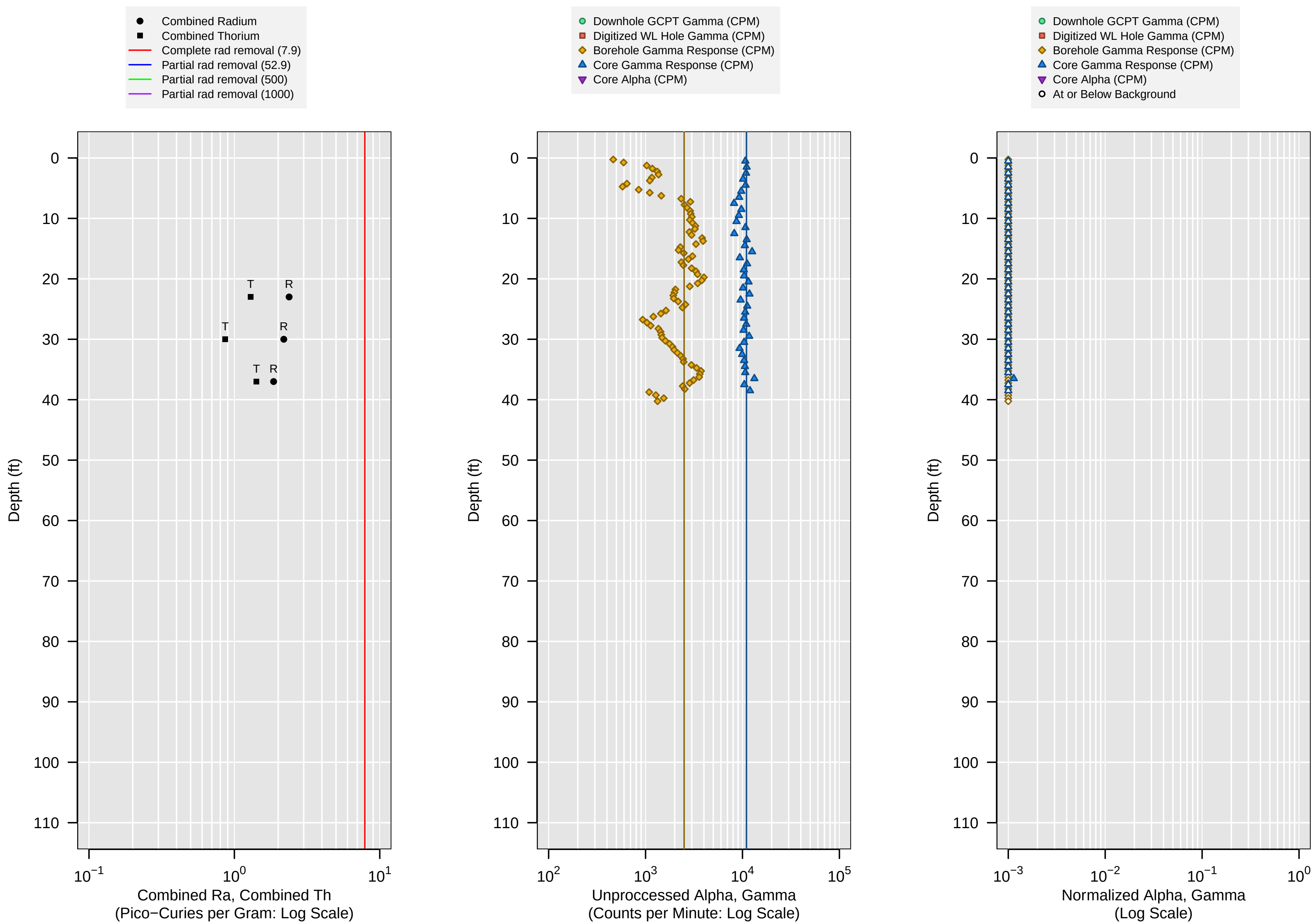
GCPT−1D−02



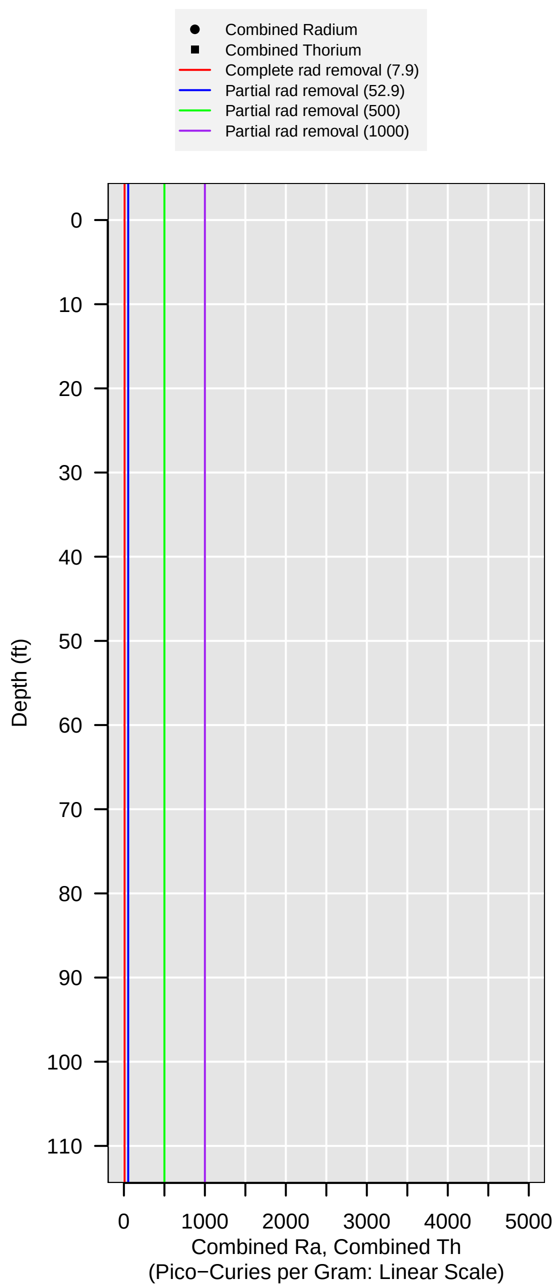
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)


Sonic−1D−02
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

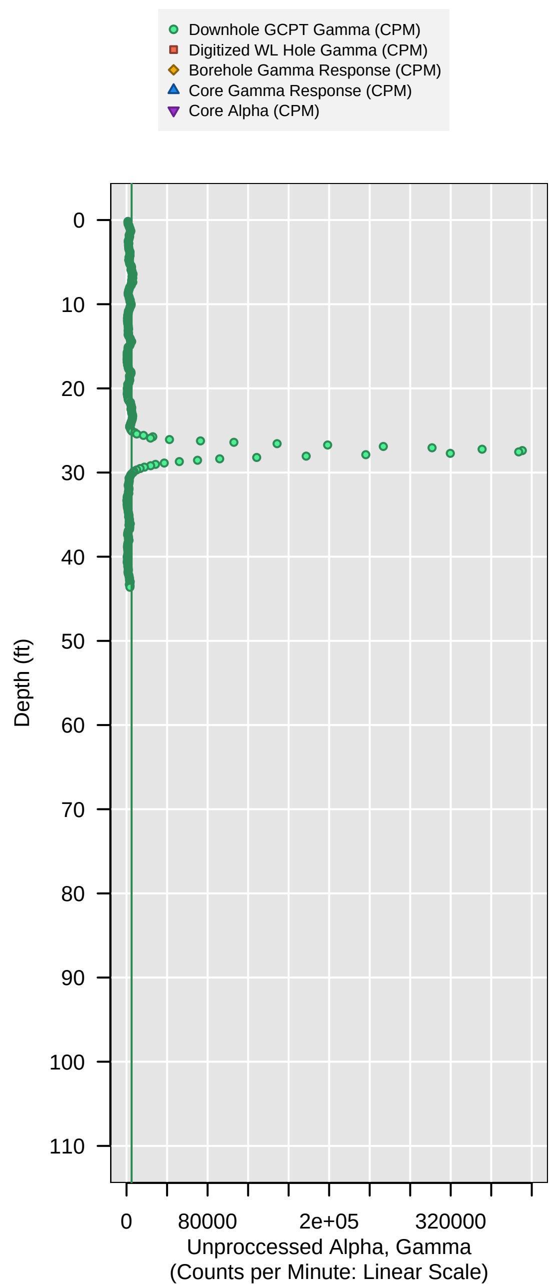
Sonic−1D−02


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

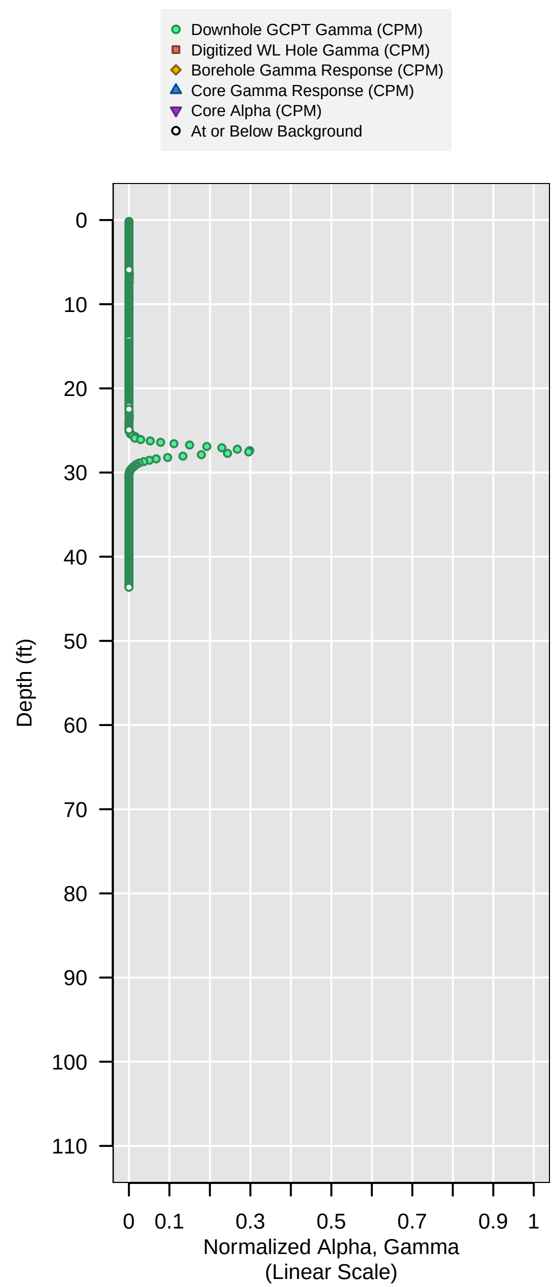
GCPT−1D−03



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)

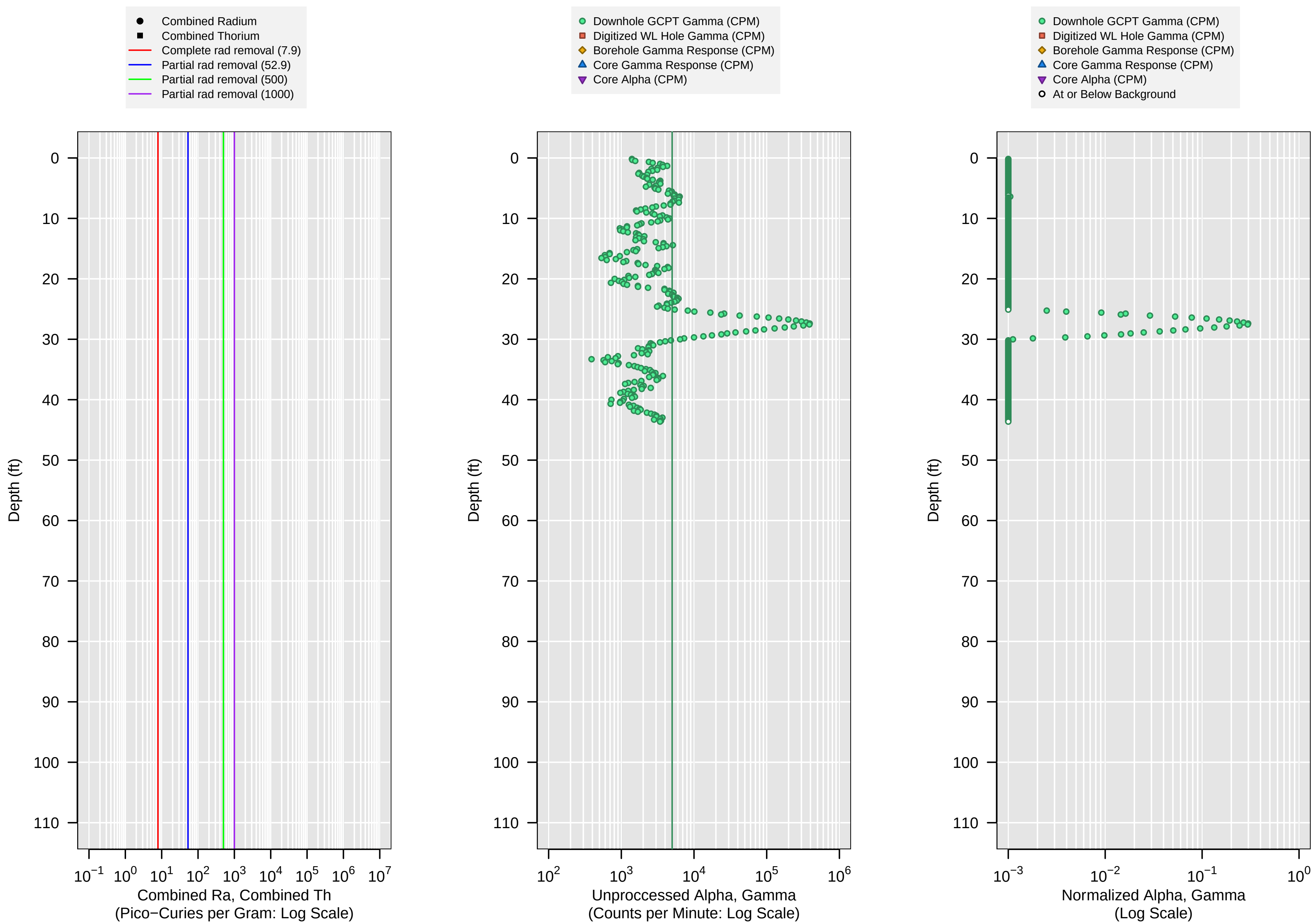


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
80000
2e+05
320000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)

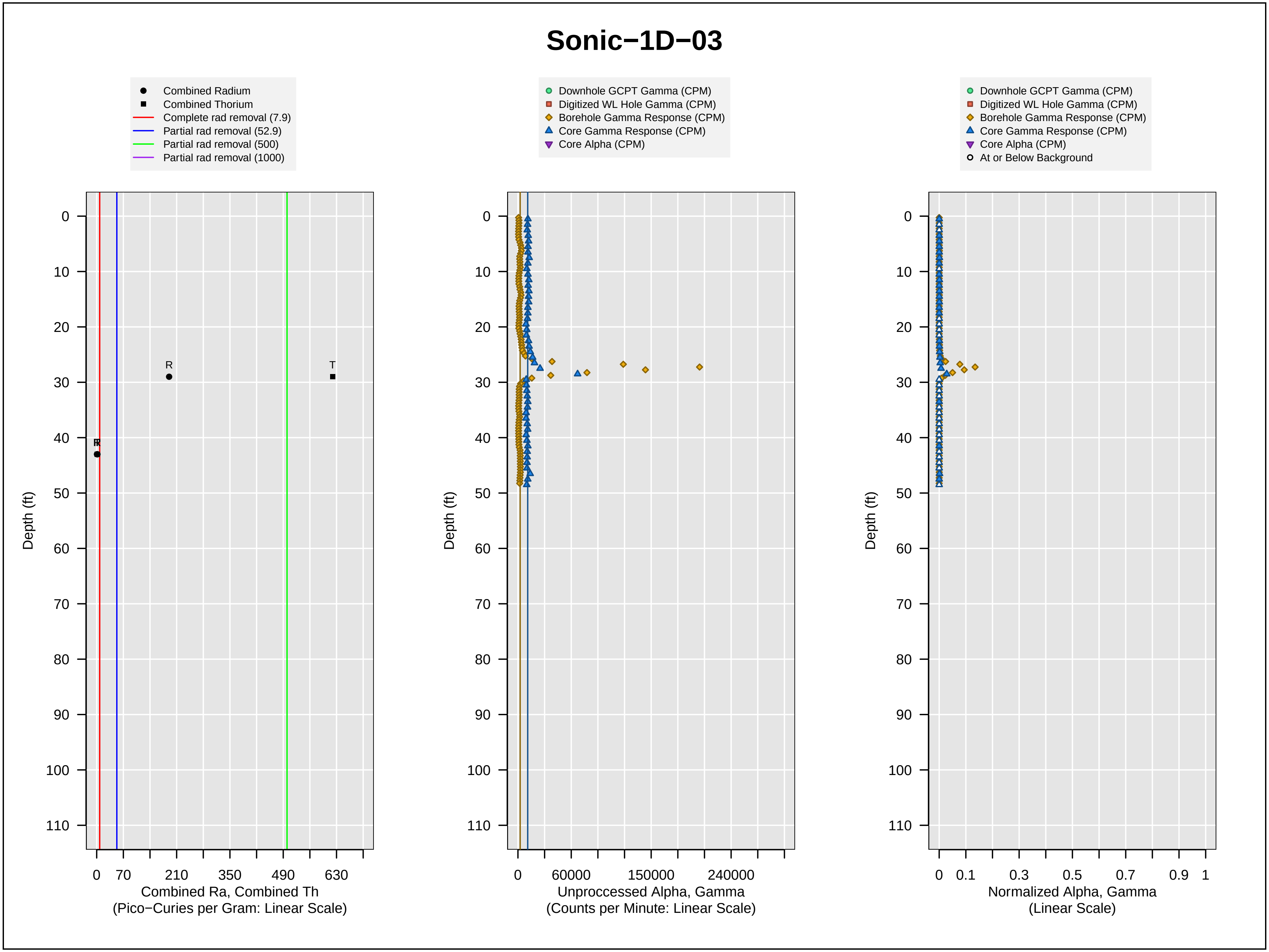


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

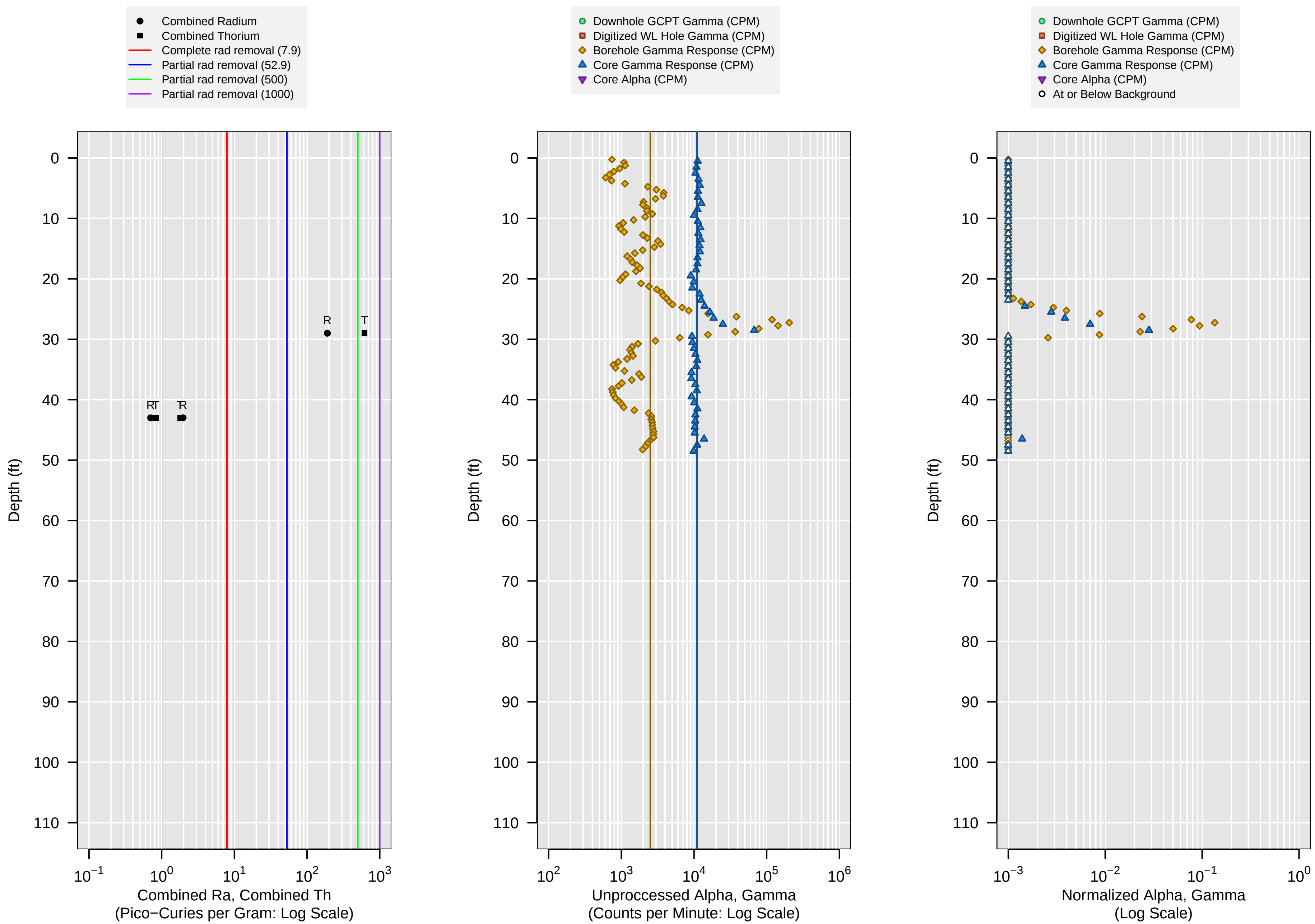
GCPT−1D−03



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

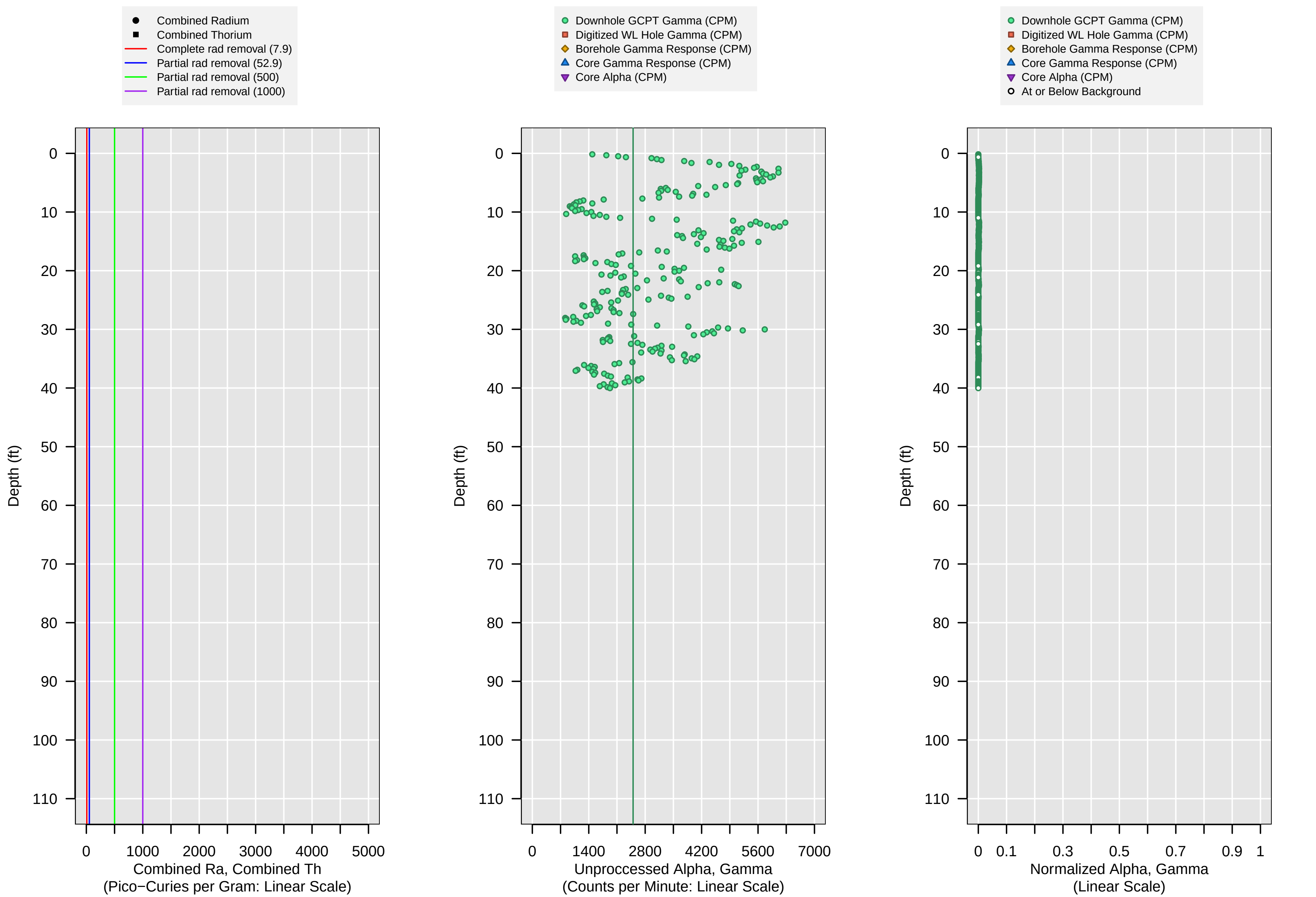

Sonic−1D−03
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
R
T
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Normalized Alpha, Gamma
(Linear Scale)

Sonic−1D−03

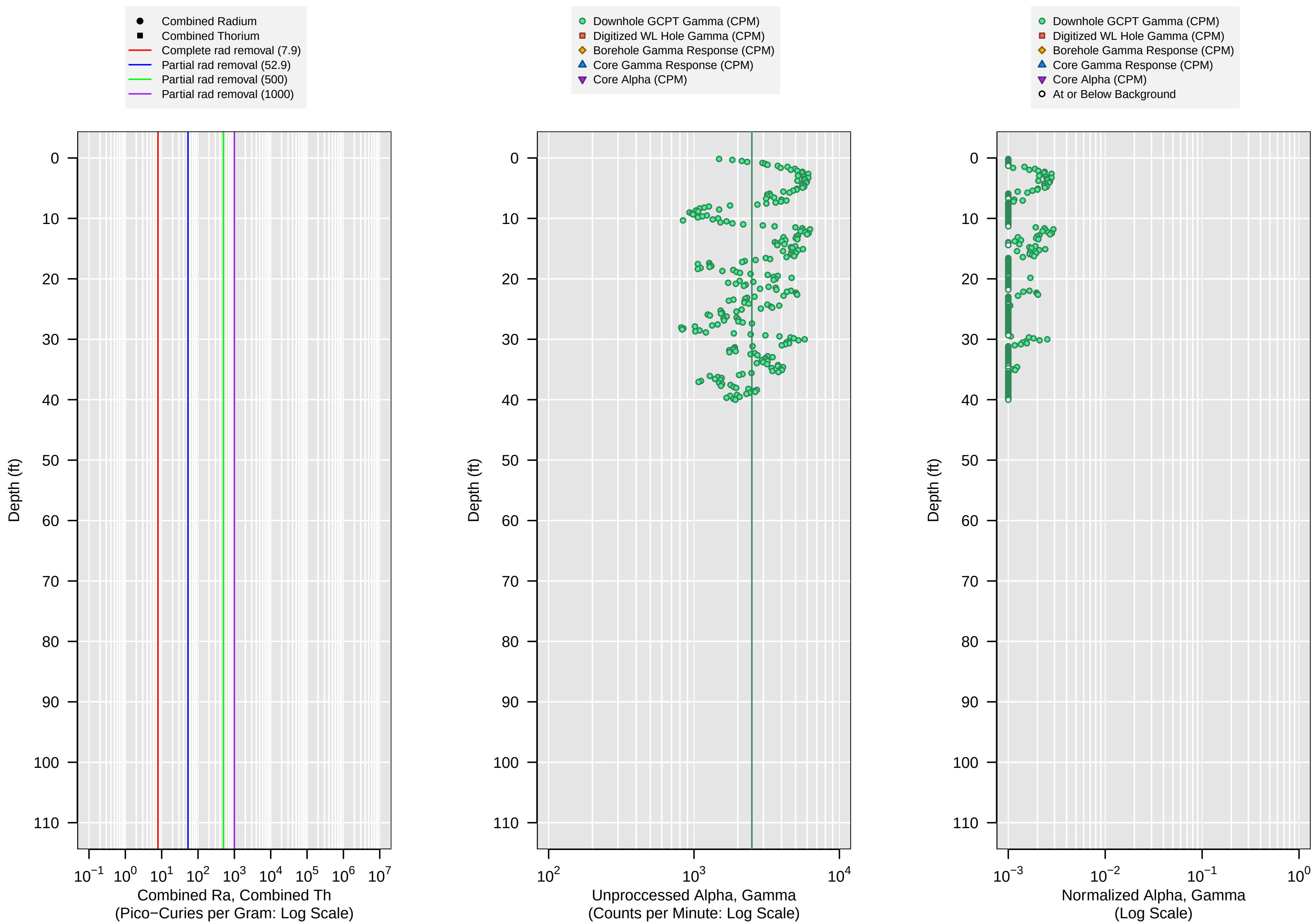


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
R
T
RT
TR
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

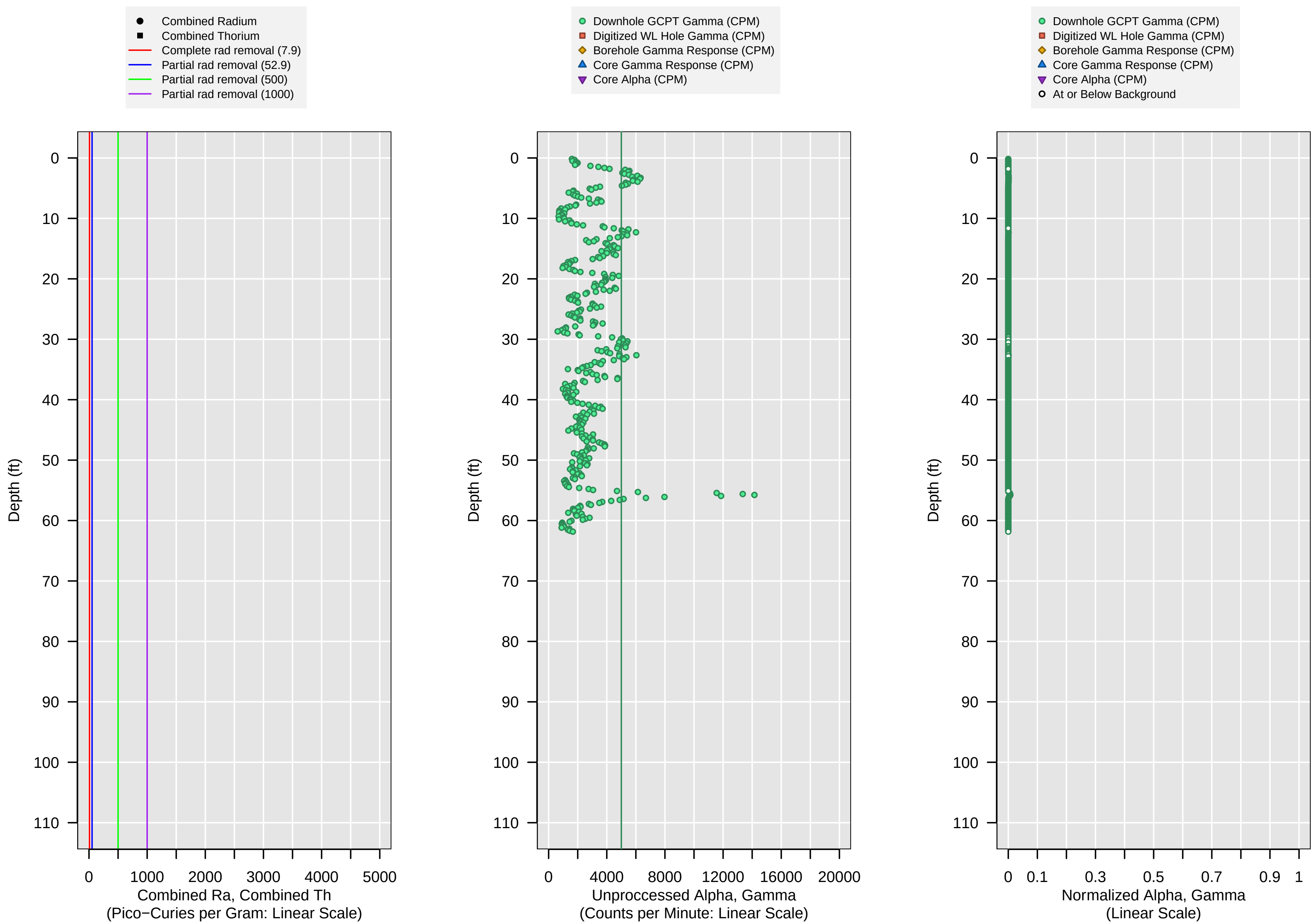
GCPT−1C−10


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−1C−10

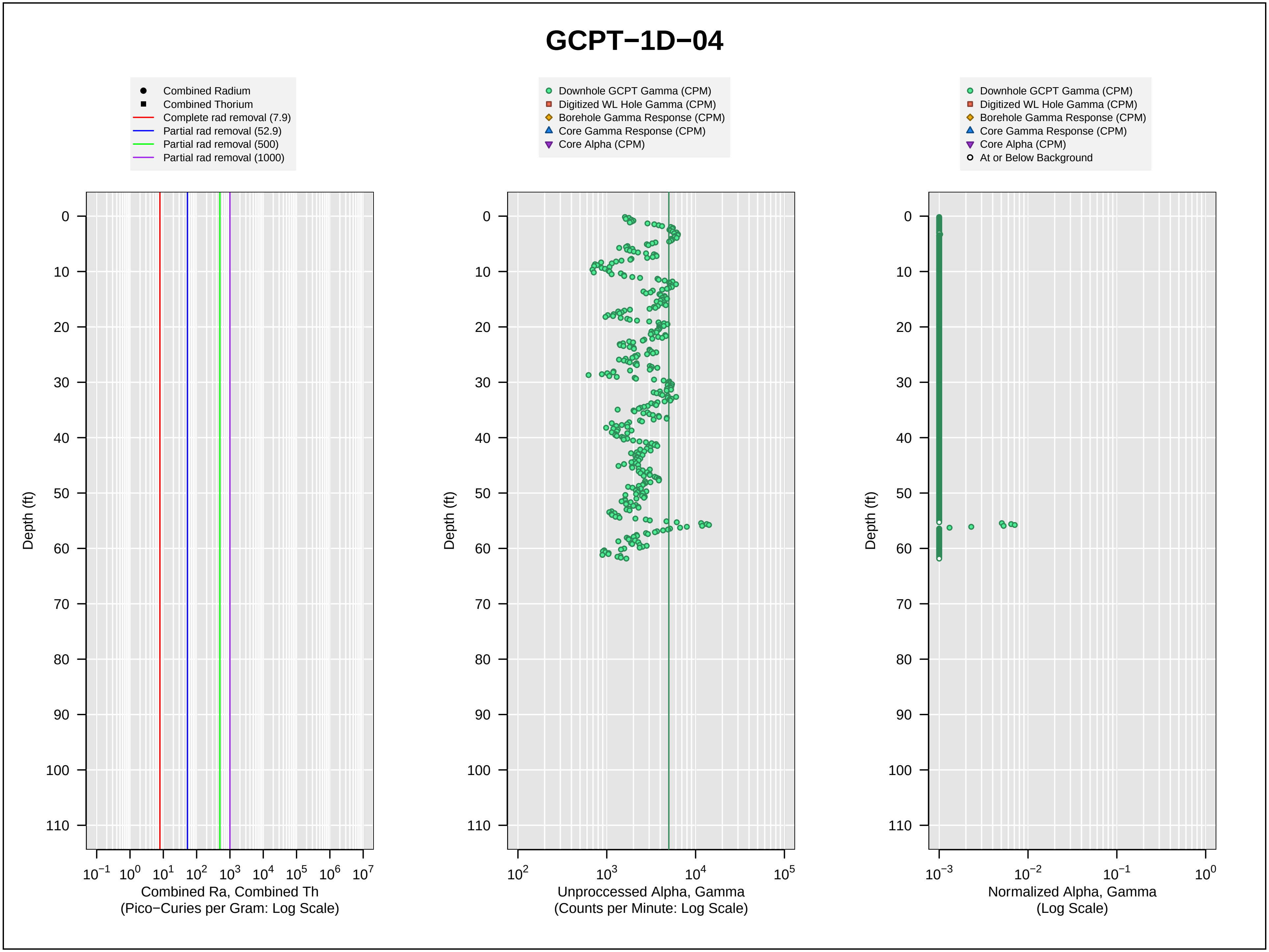

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

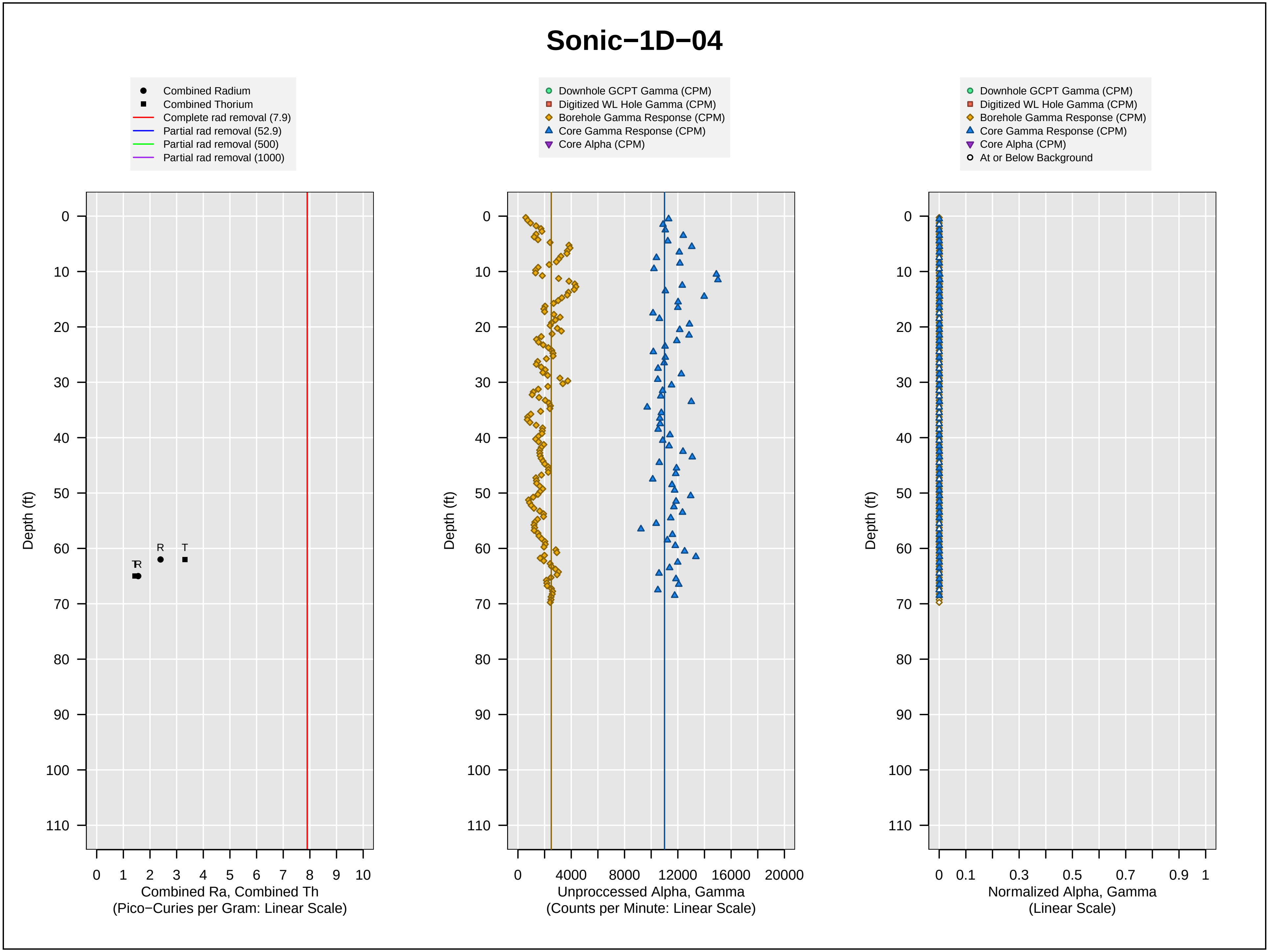
GCPT−1D−04



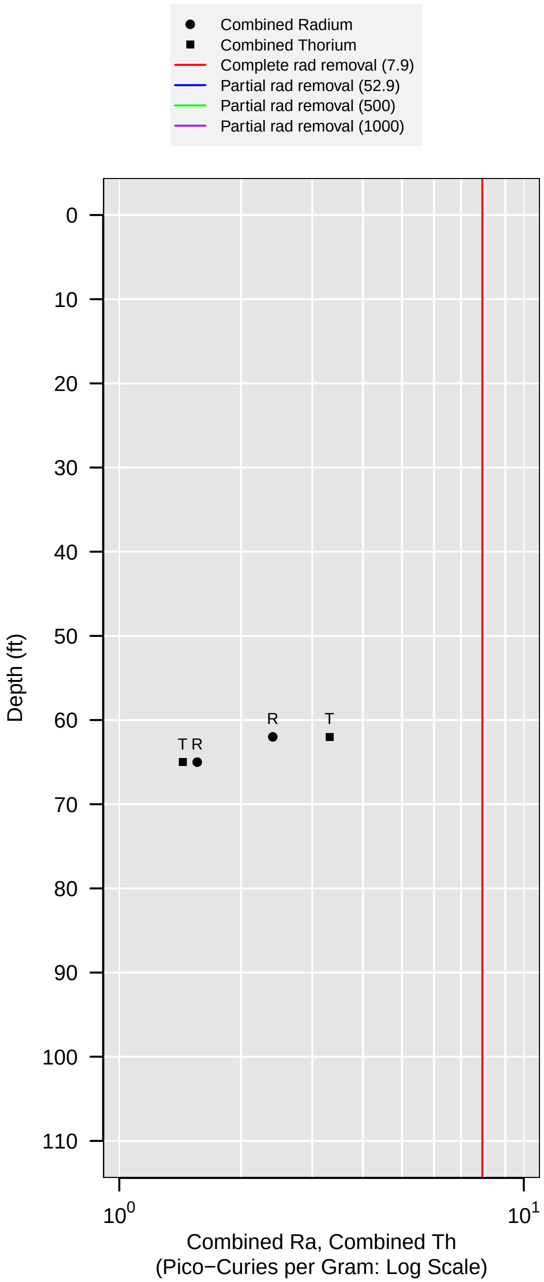
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

S.S. PAPADOPULOS & ASSOCIATES, INC.

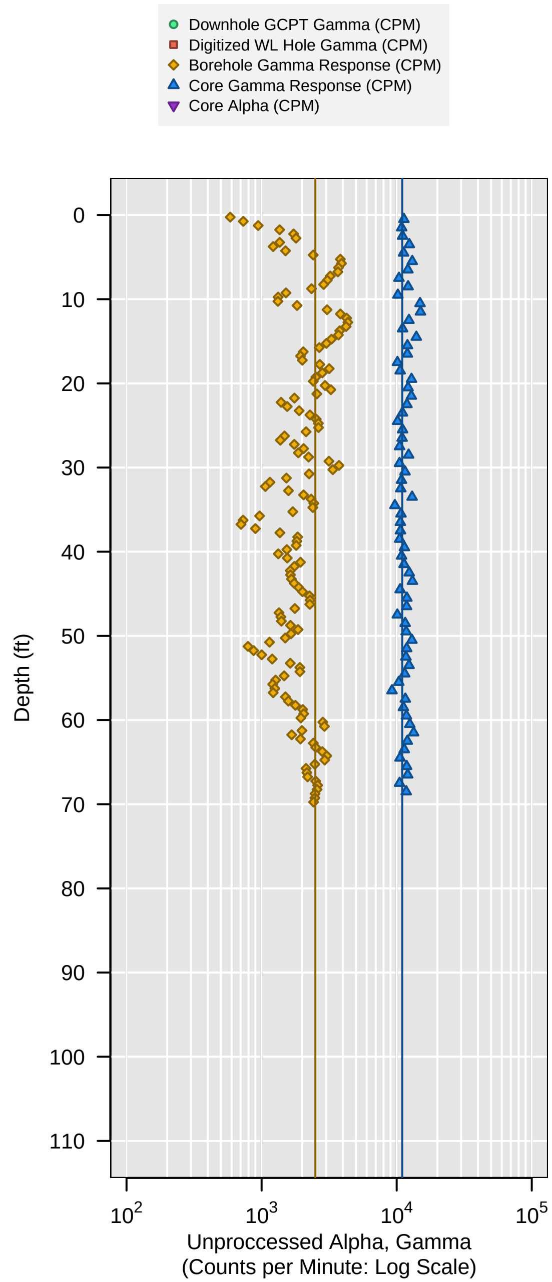



Sonic−1D−04
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
R
T
TR
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

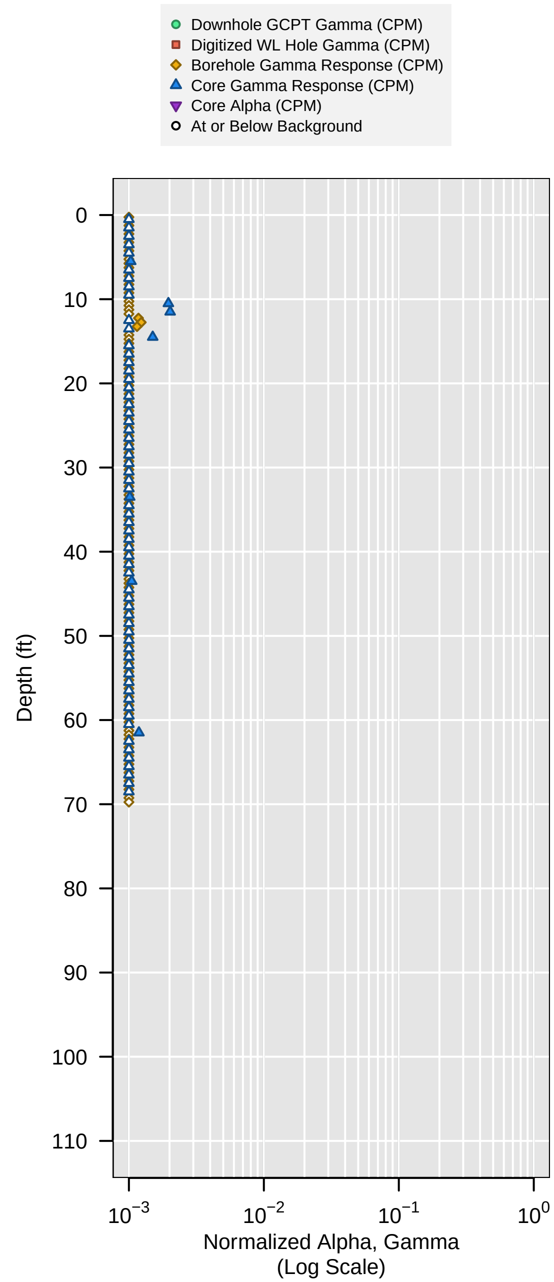
Sonic−1D−04



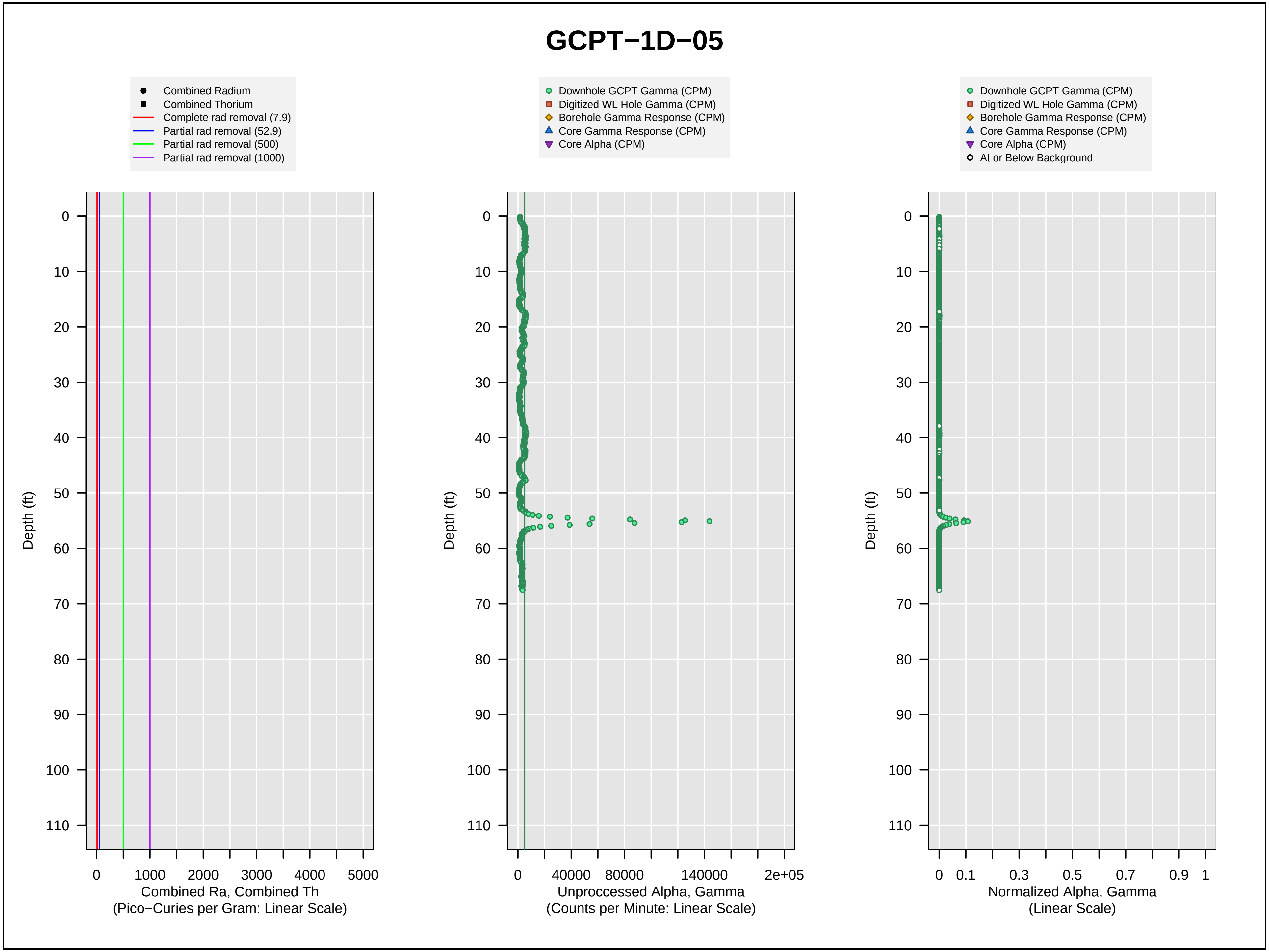
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
T R
R
T
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)



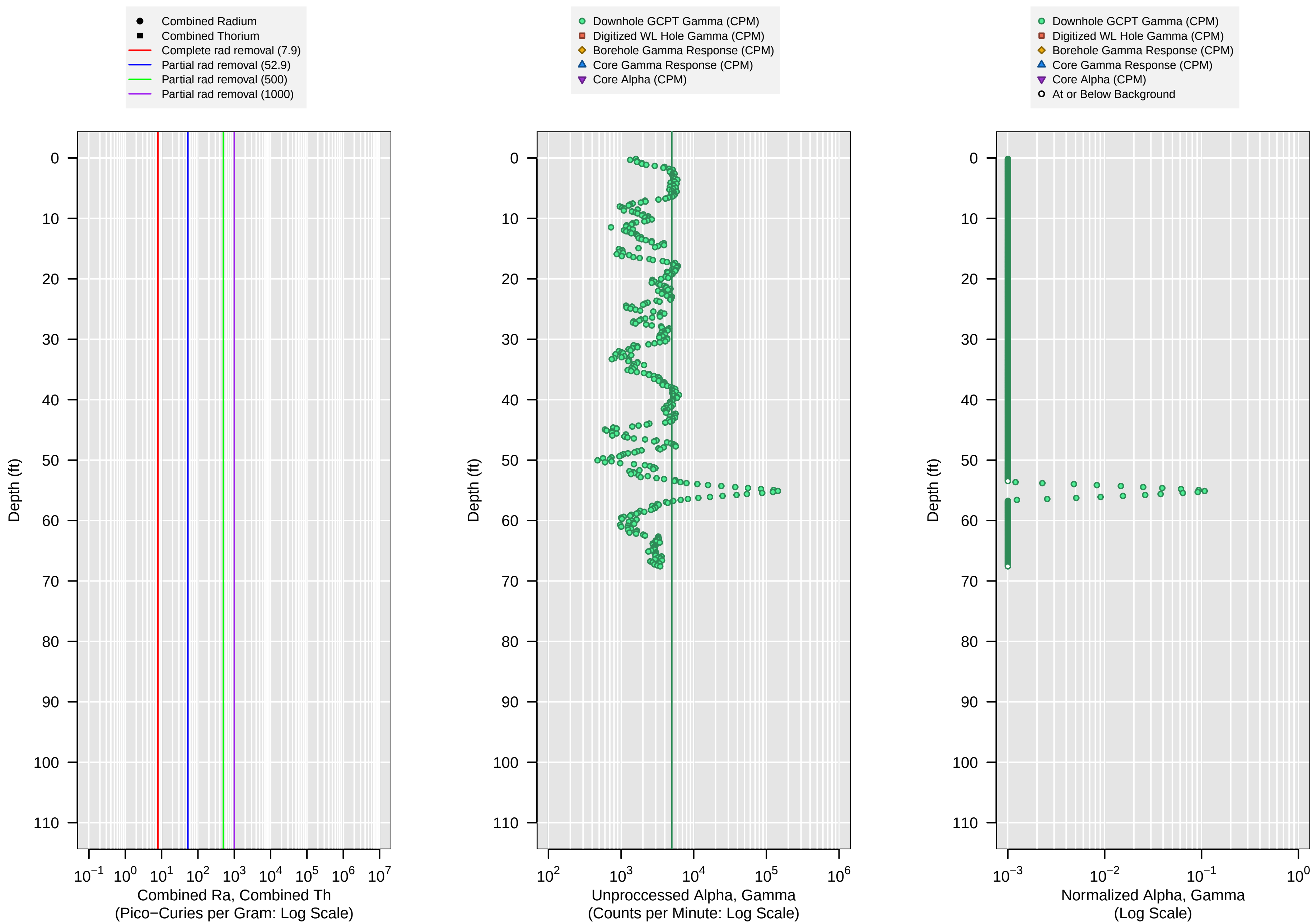
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)



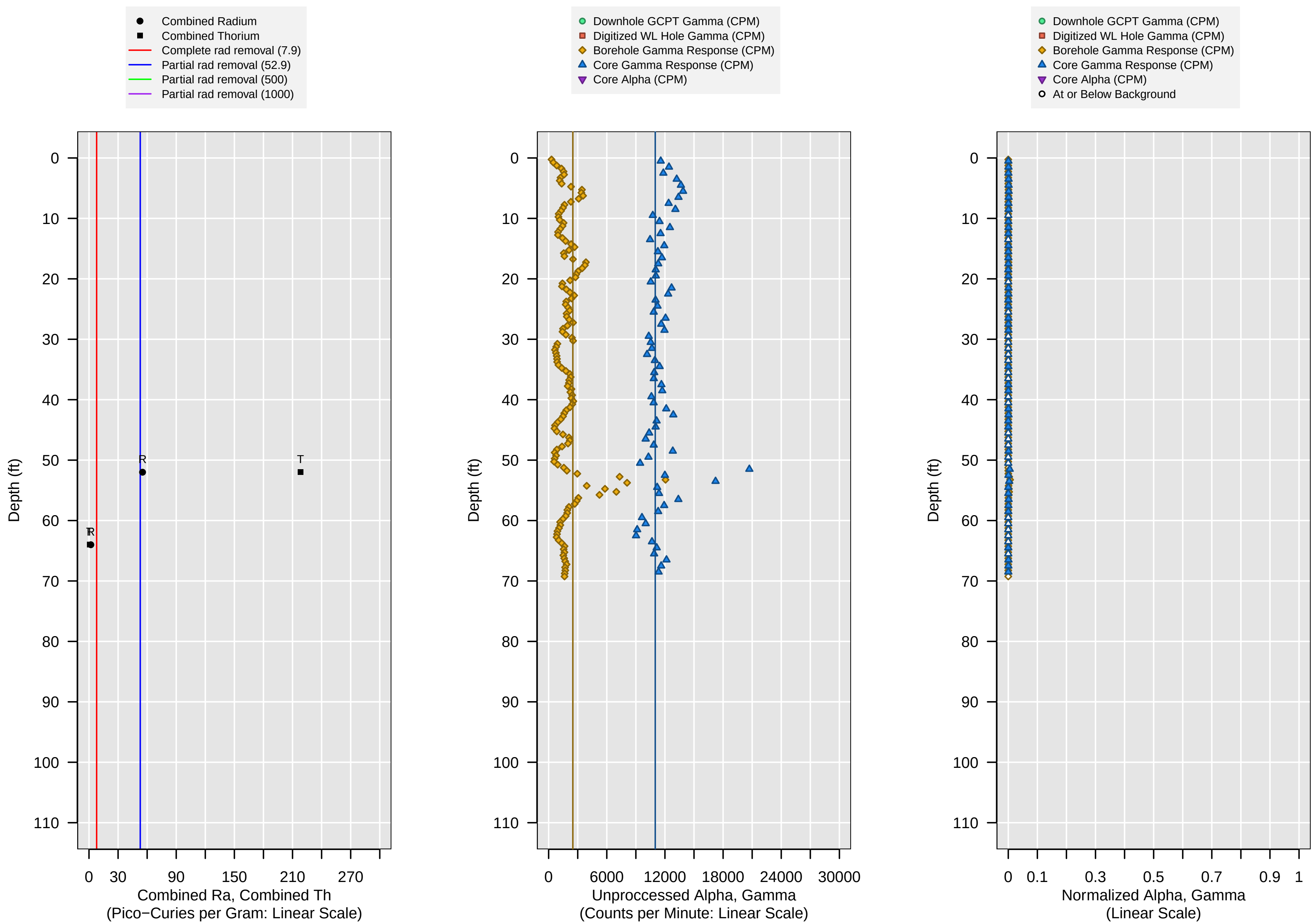
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)


GCPT−1D−05
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Normalized Alpha, Gamma
(Linear Scale)

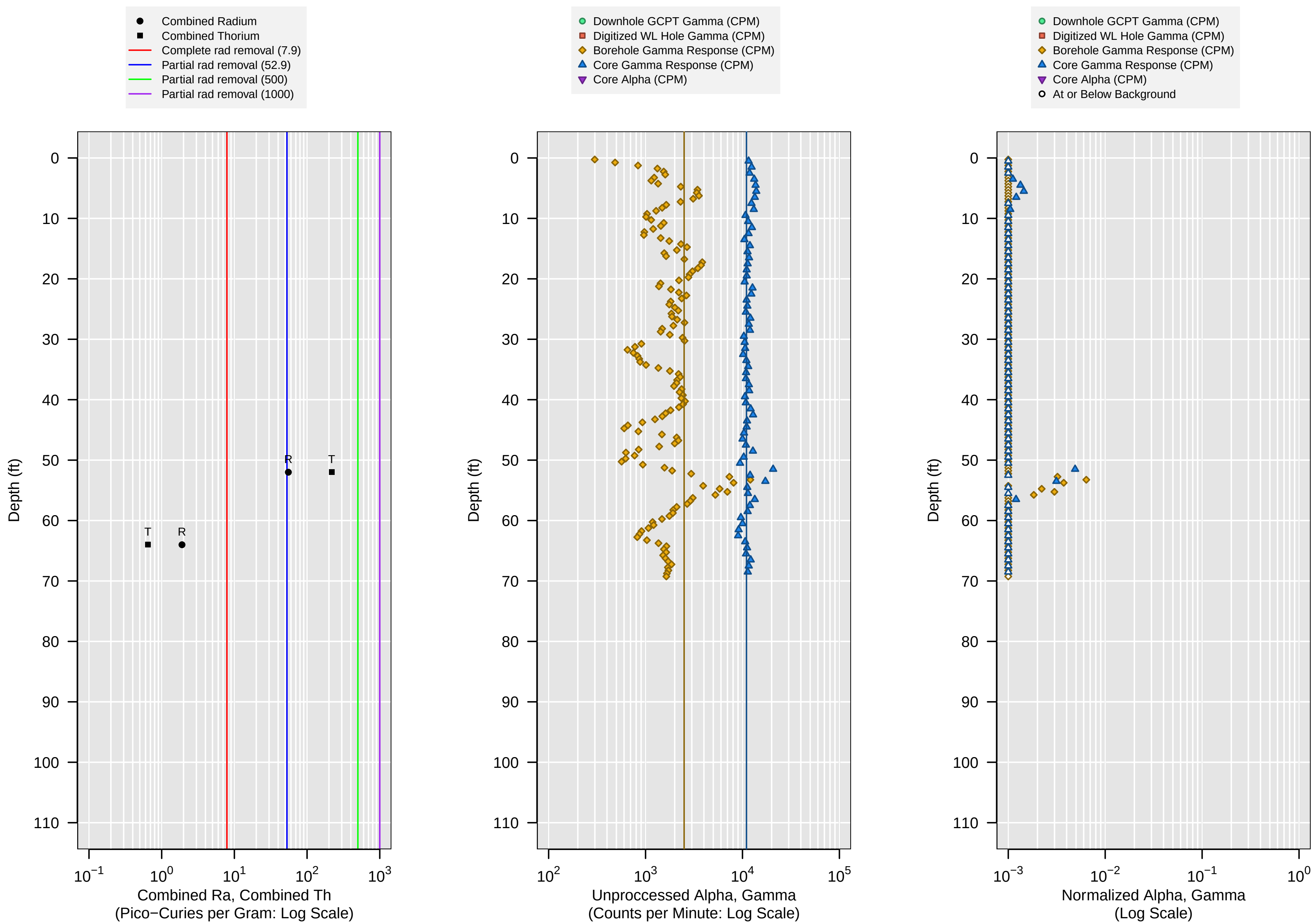
GCPT−1D−05


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

Sonic−1D−05

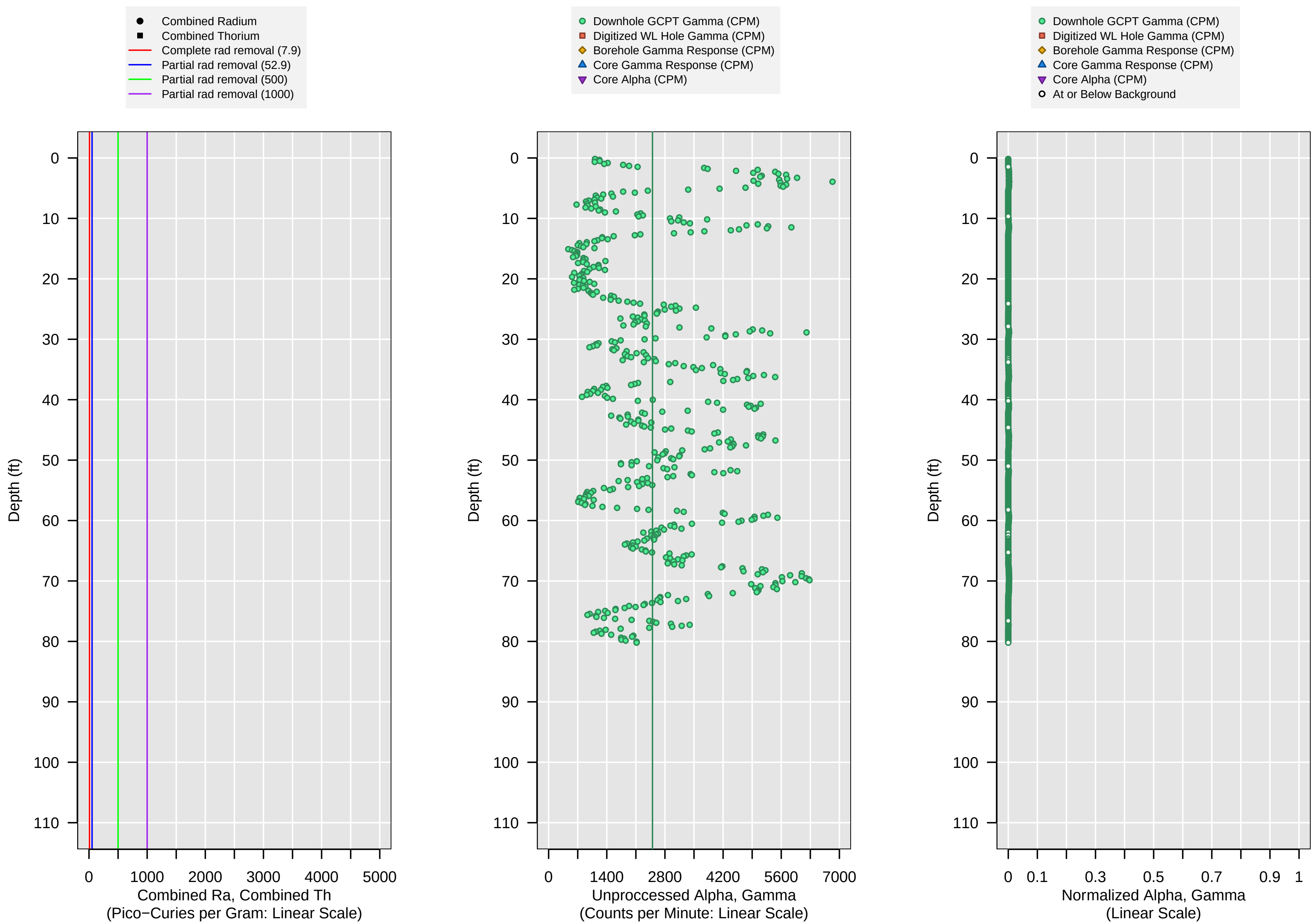

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

Sonic−1D−05

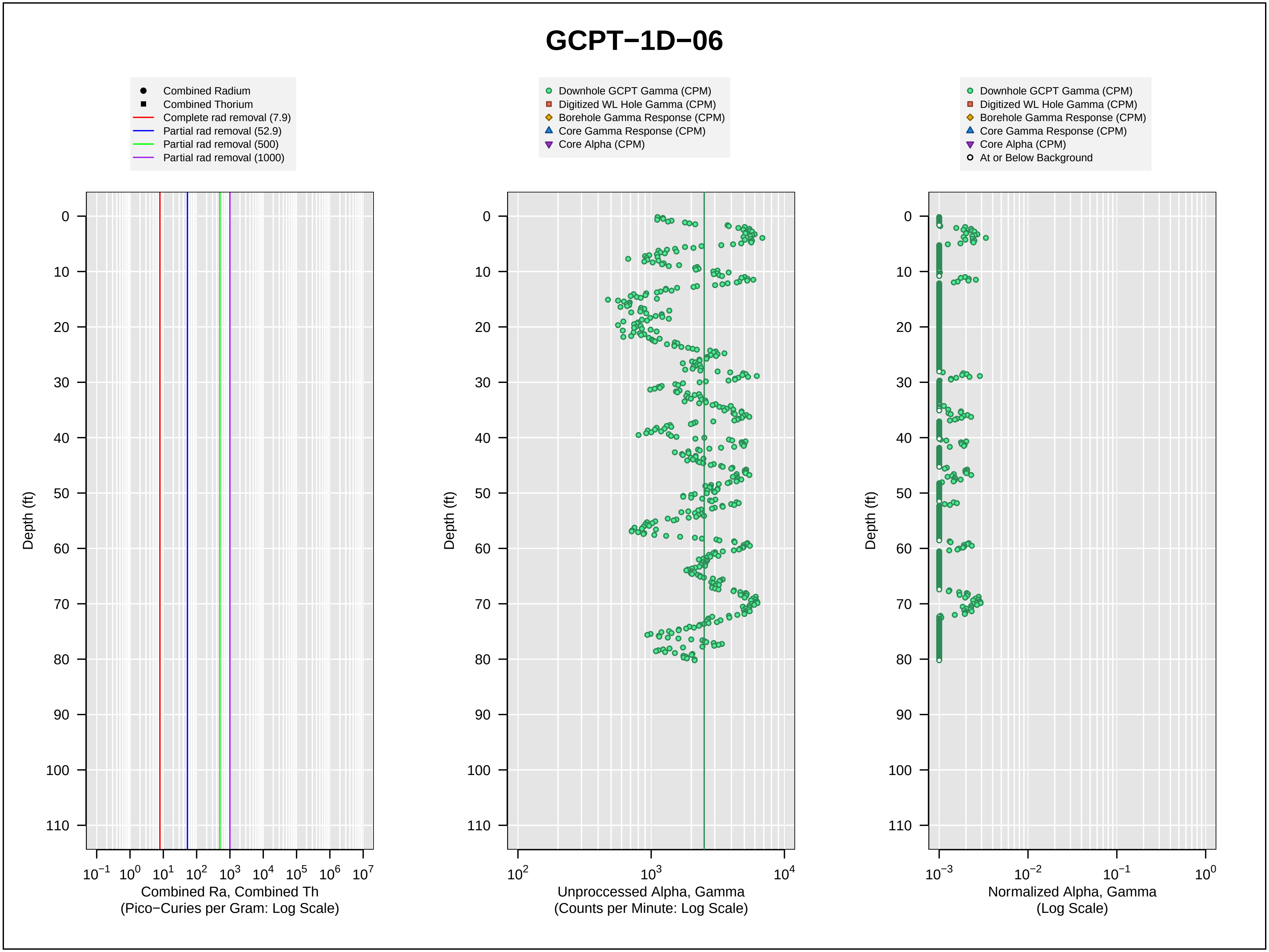


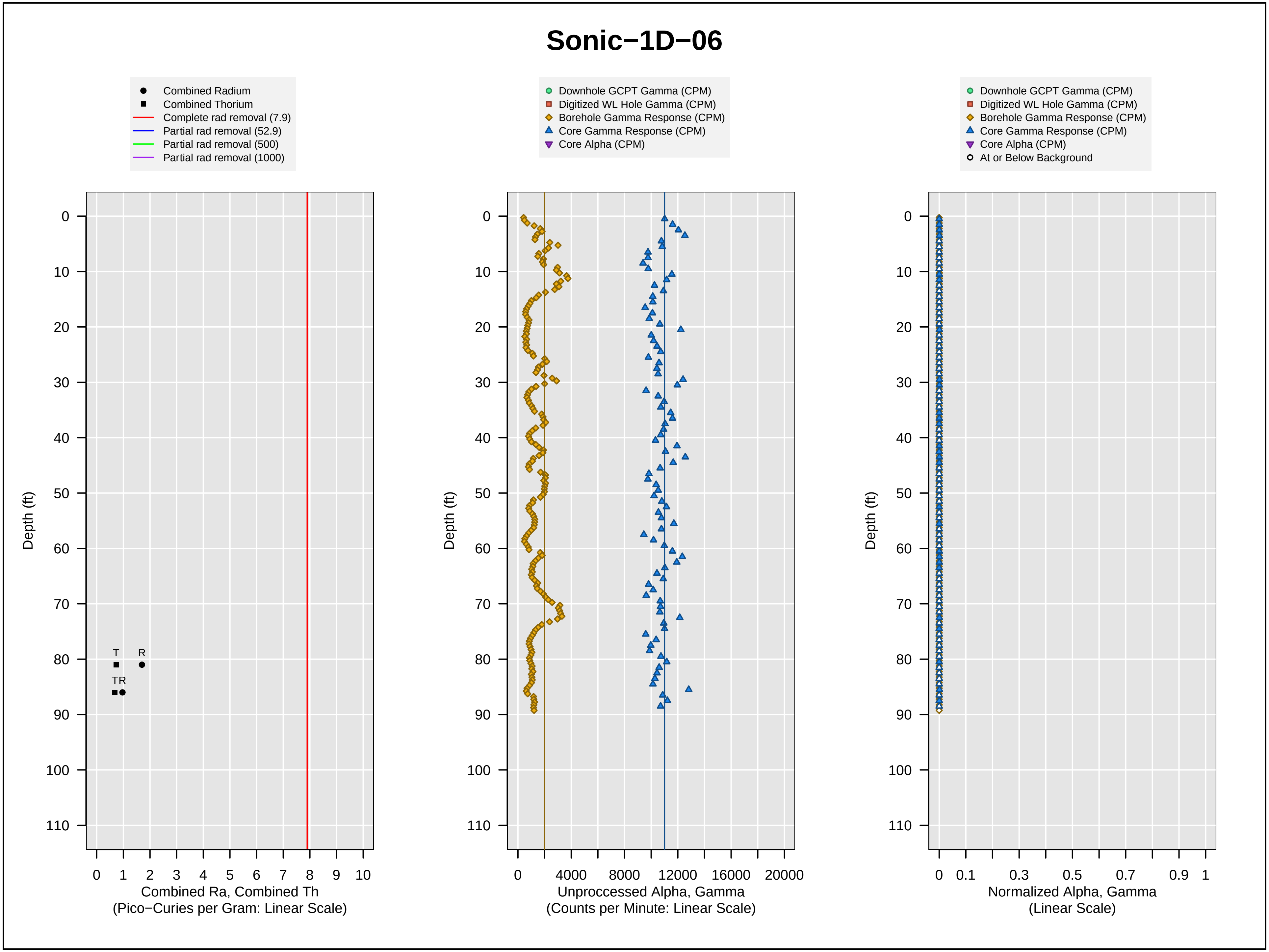
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−1D−06

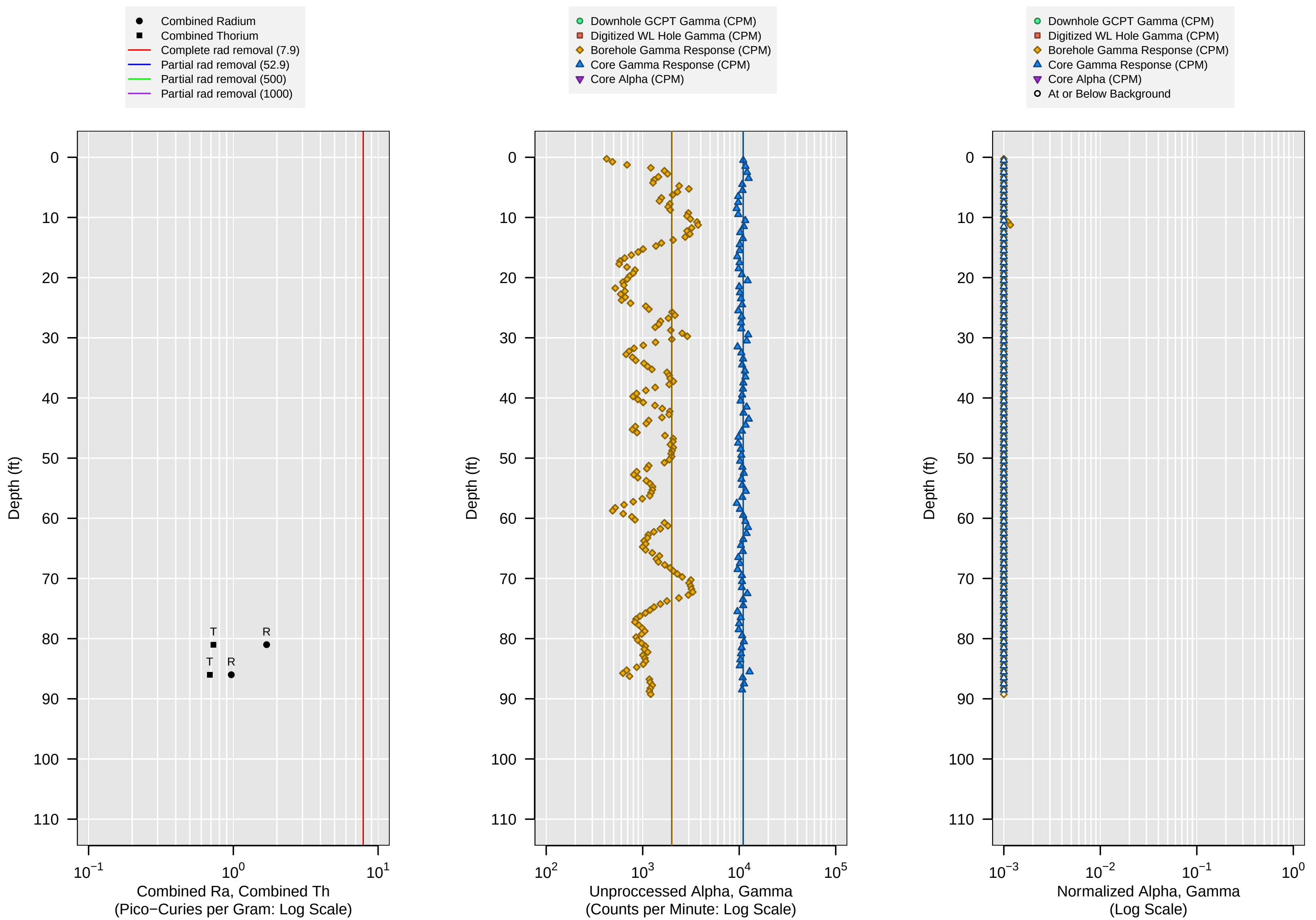


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Linear Scale)

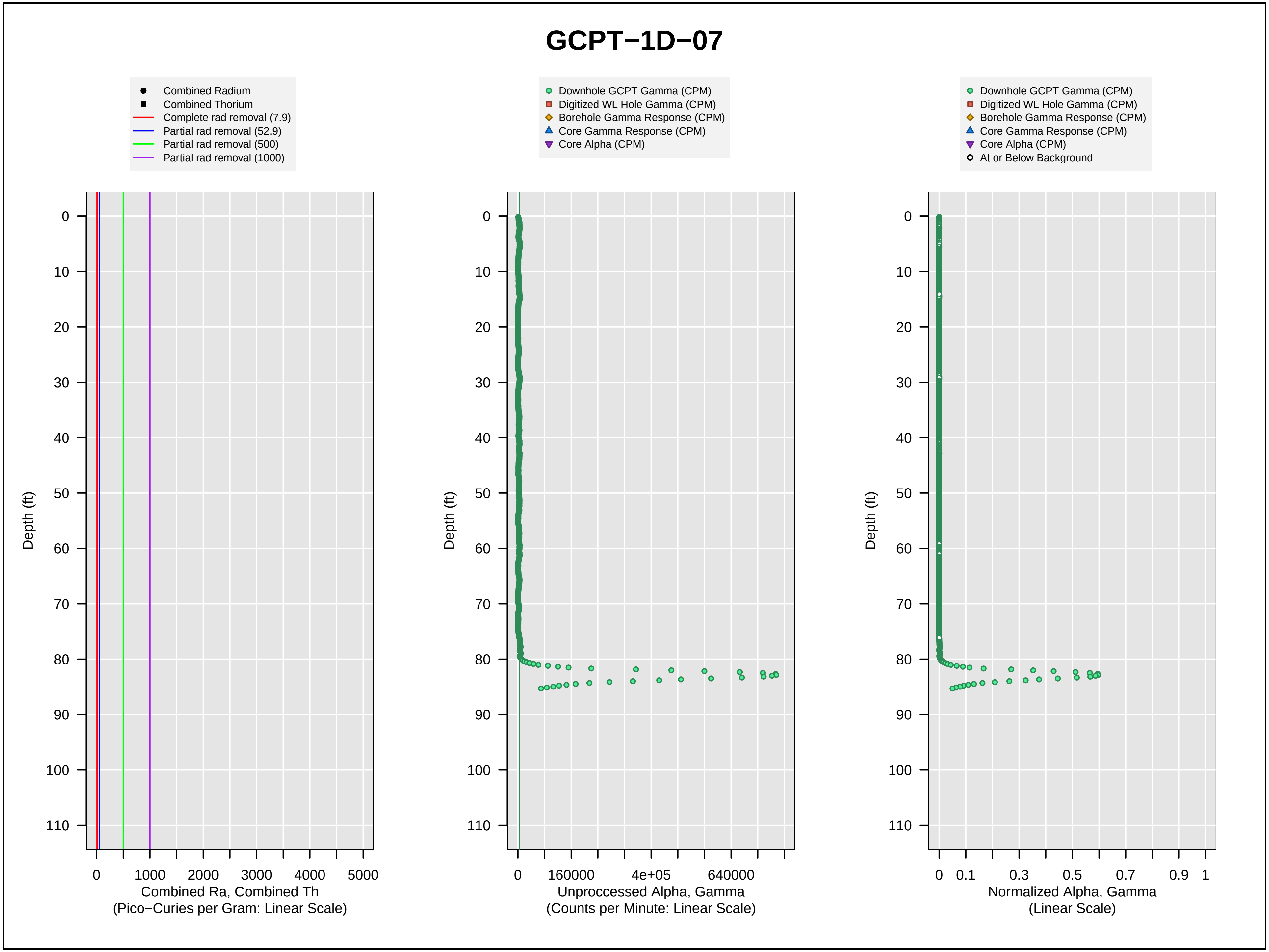

GCPT−1D−06
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)


Sonic−1D−06
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Normalized Alpha, Gamma
(Linear Scale)
T
R
TR

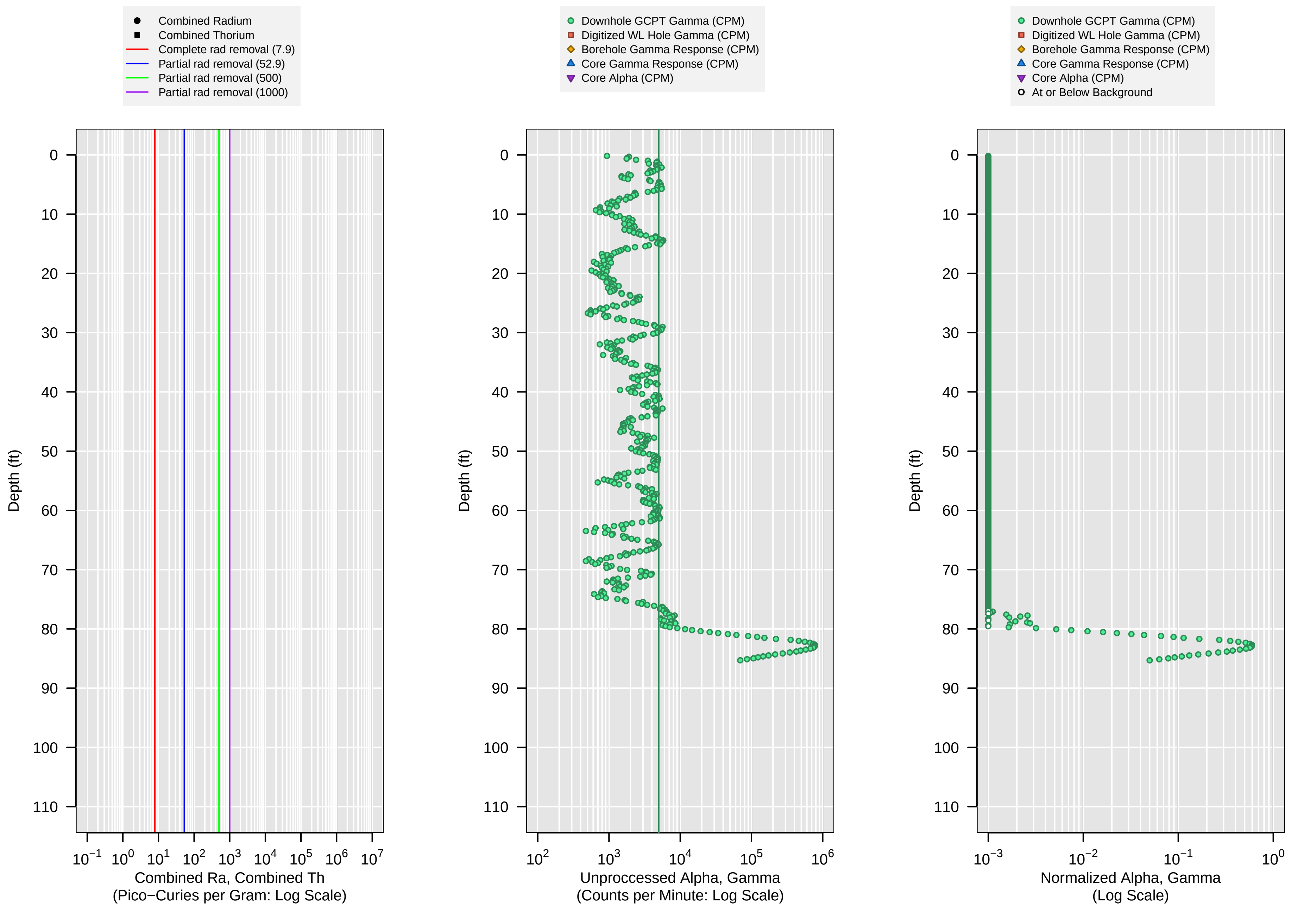
Sonic−1D−06



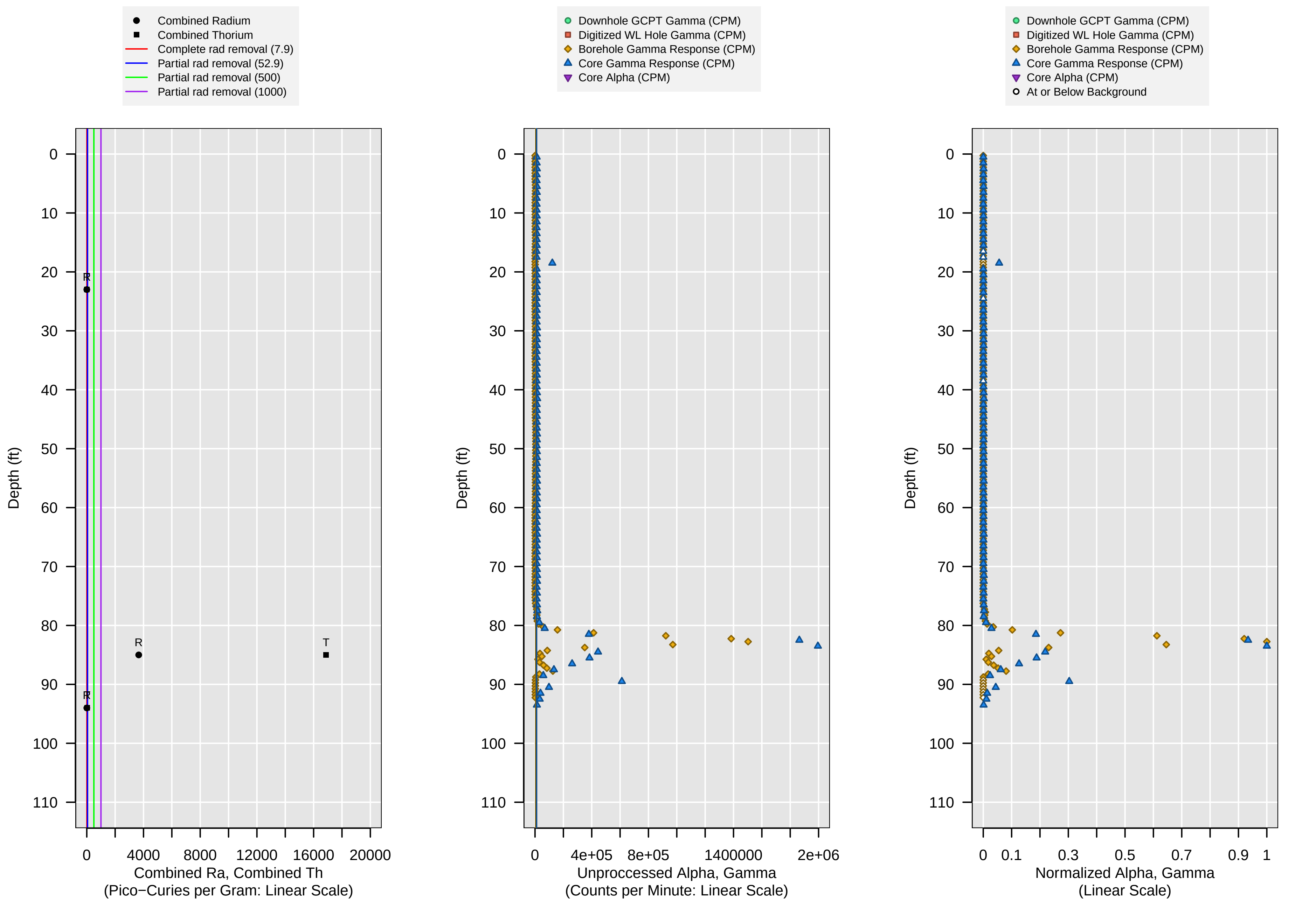
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)


GCPT−1D−07
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

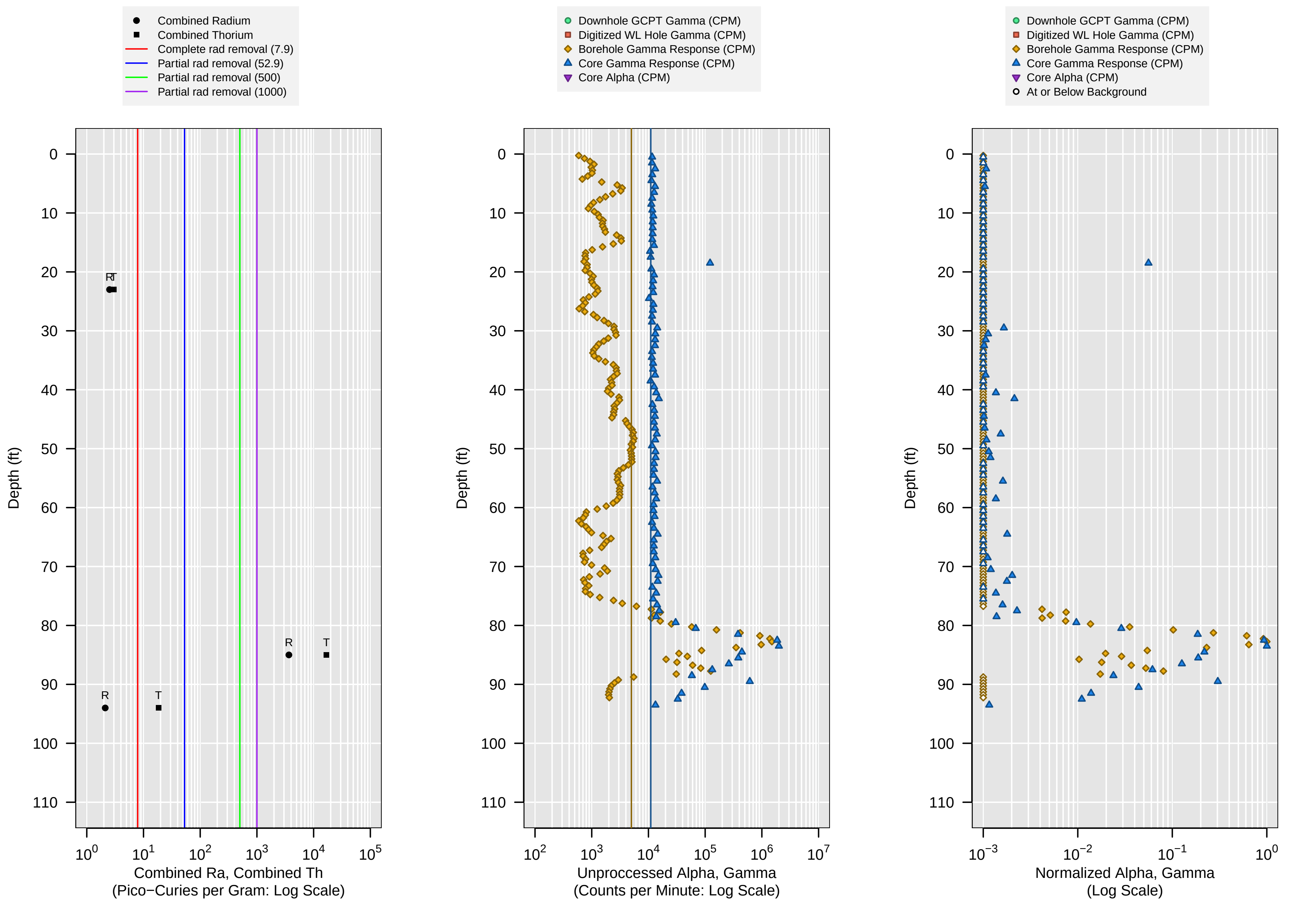
GCPT−1D−07


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

Sonic−1D−07

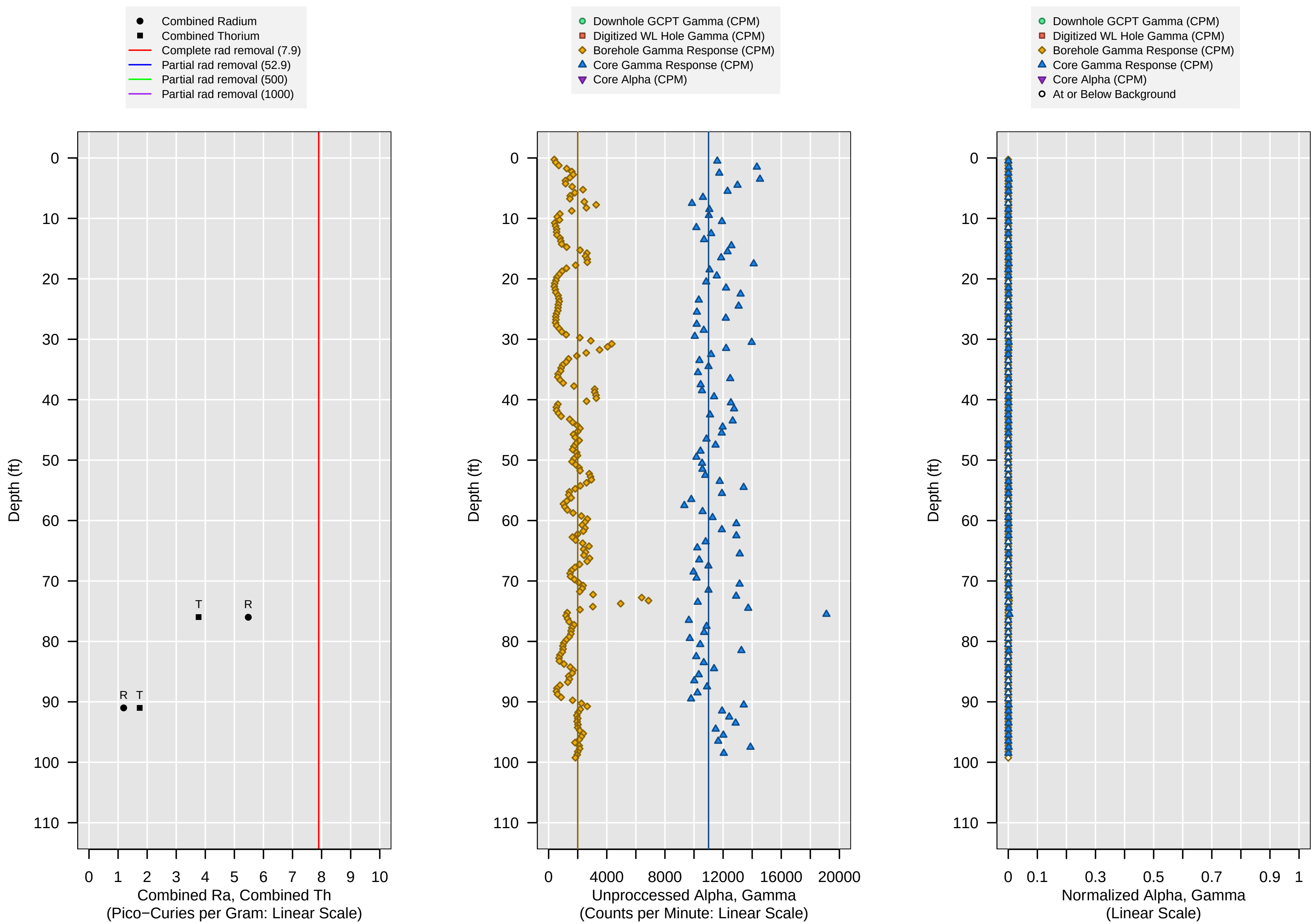

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
R
T
0
4000
8000
12000
16000
20000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
4e+05
8e+05
1400000
2e+06
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

Sonic−1D−07



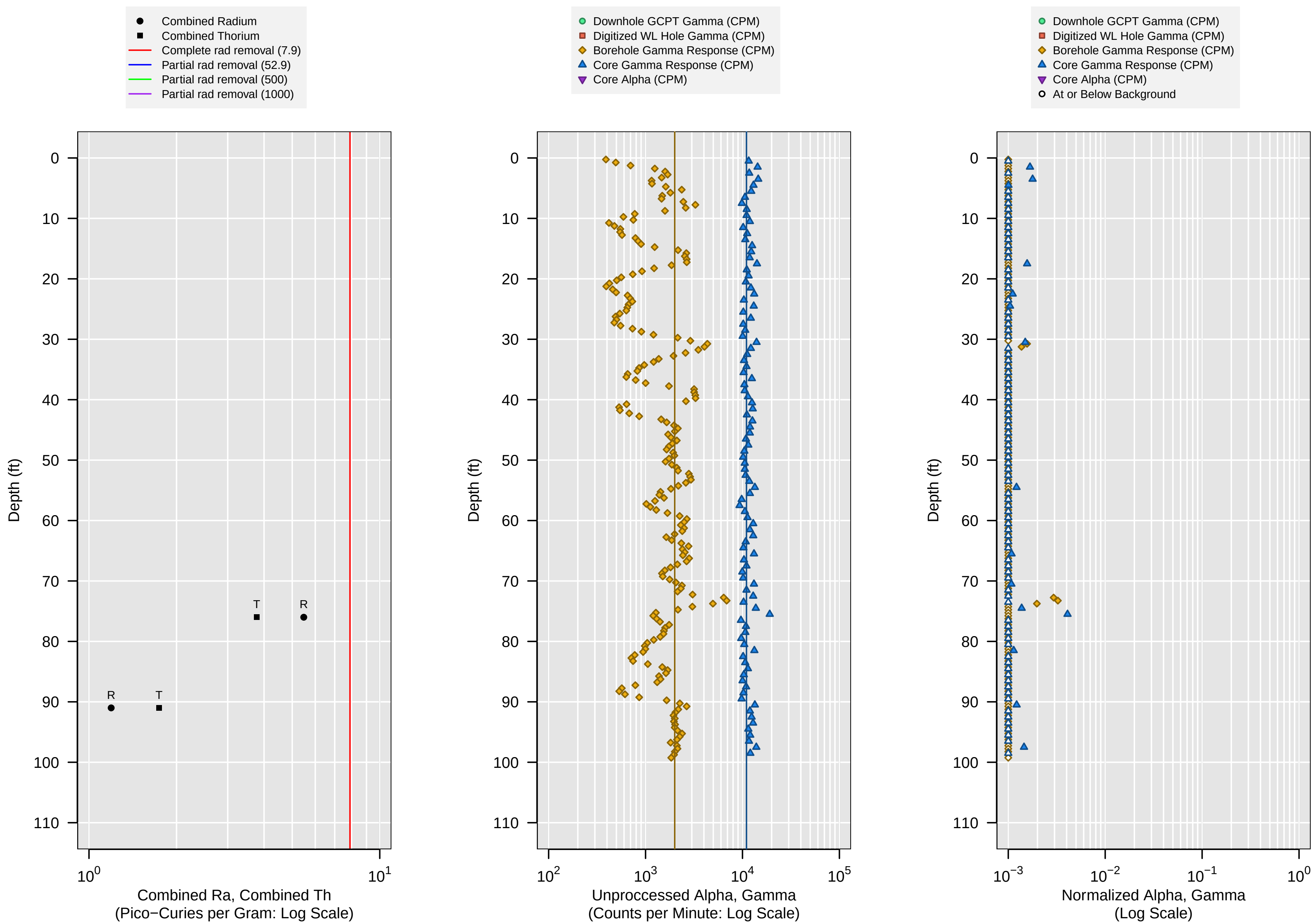
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

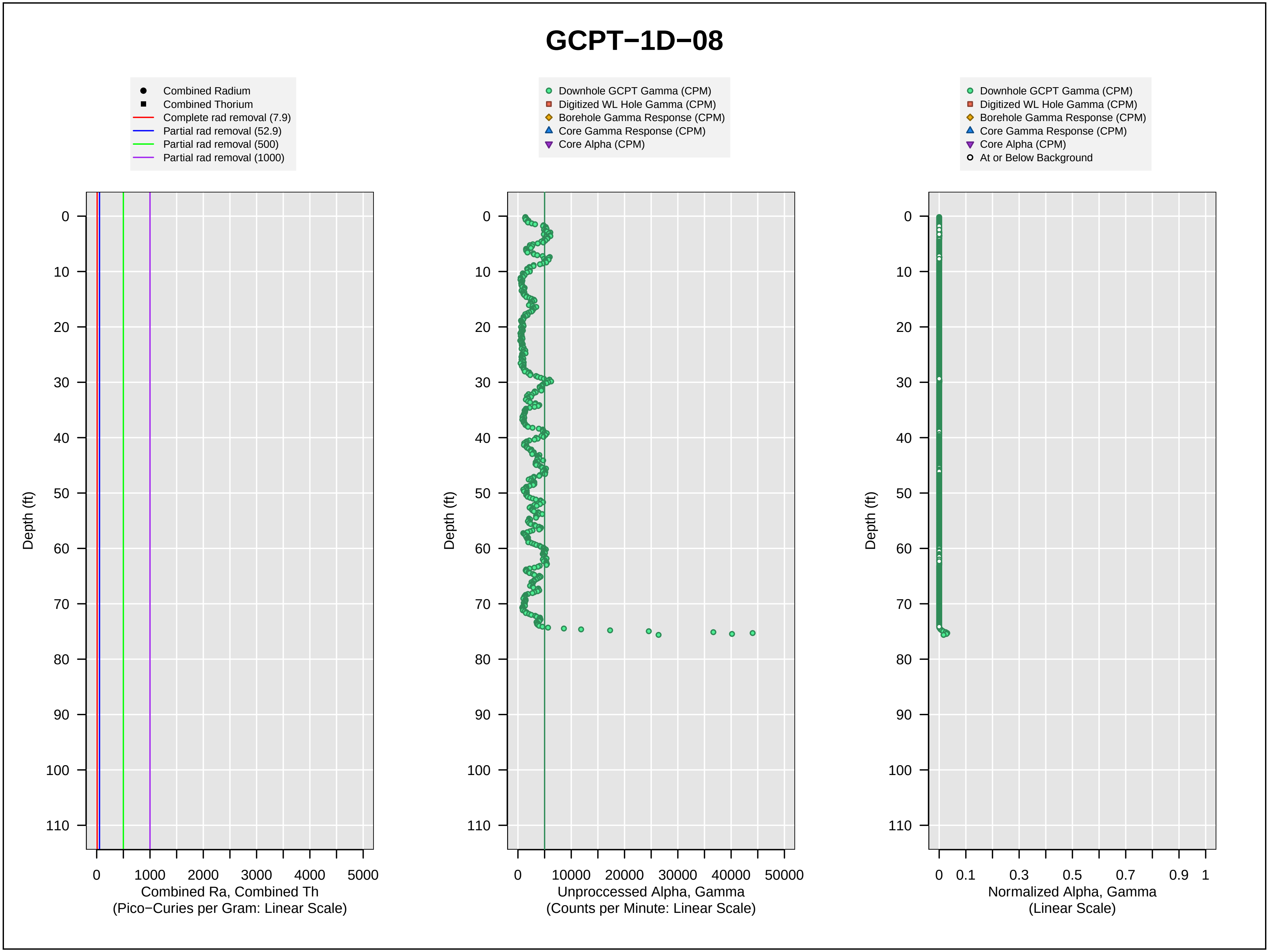
Sonic−1D−08



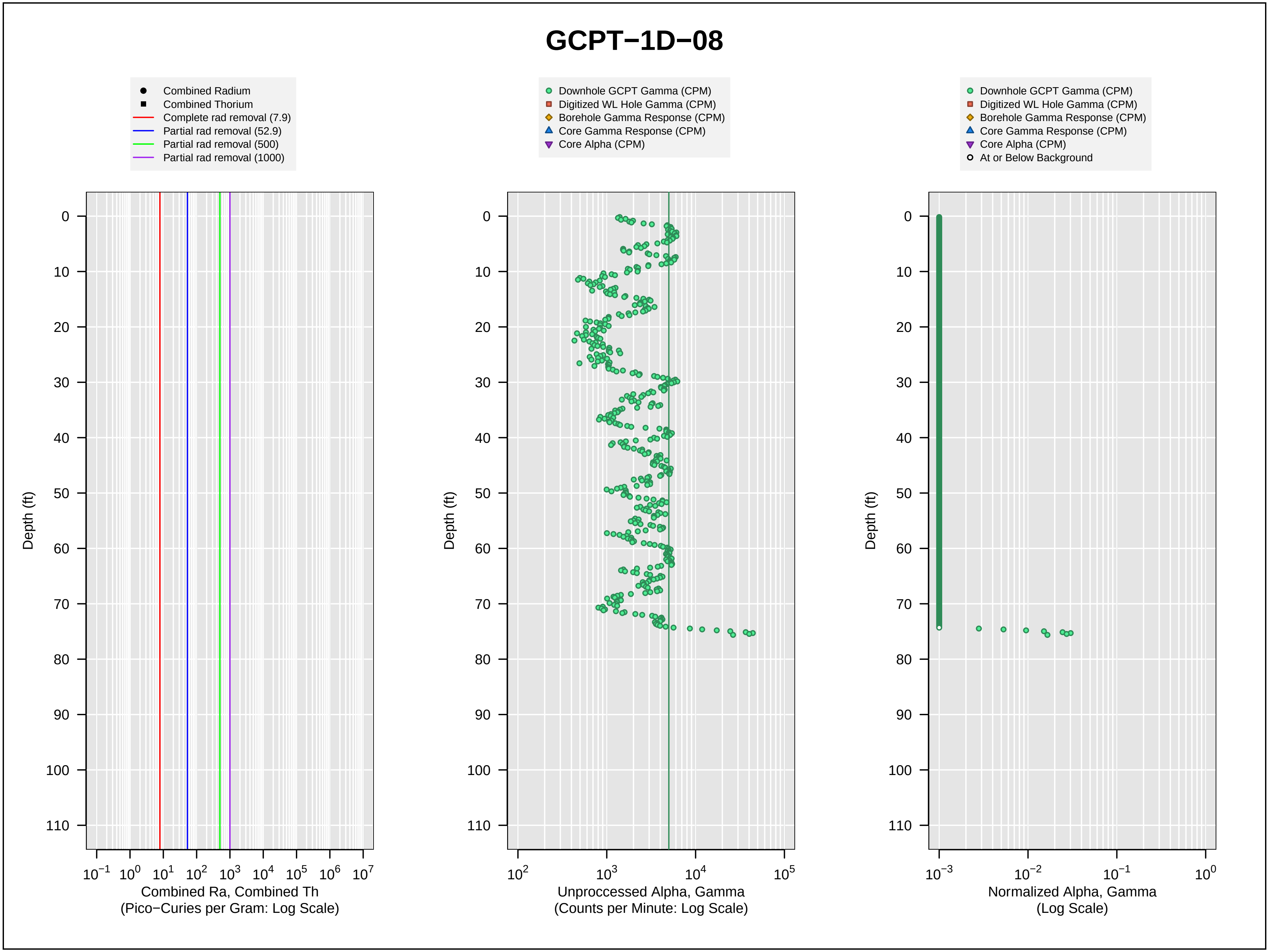
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
T
R
R
T
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

Sonic−1D−08

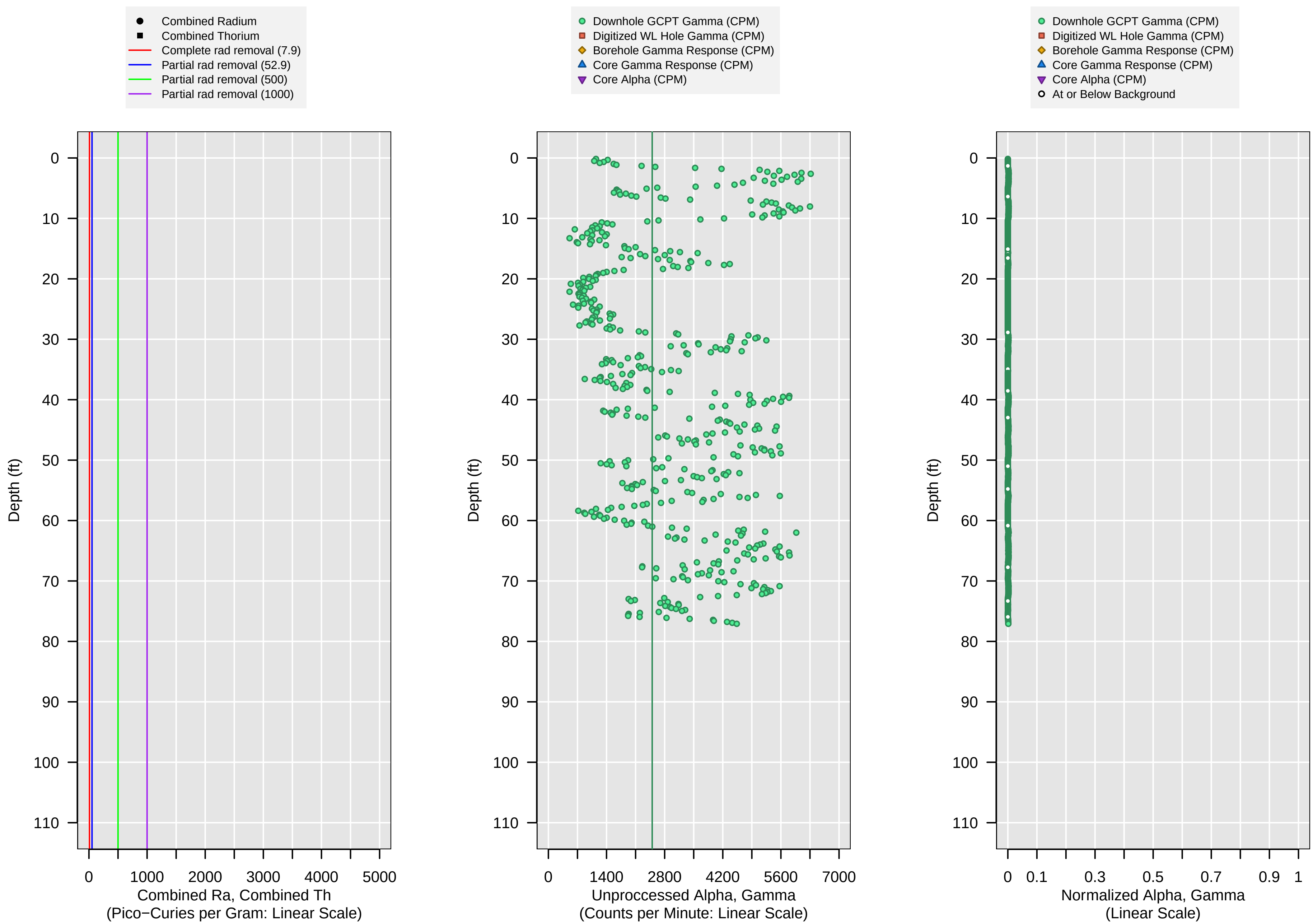

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
R
T
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)



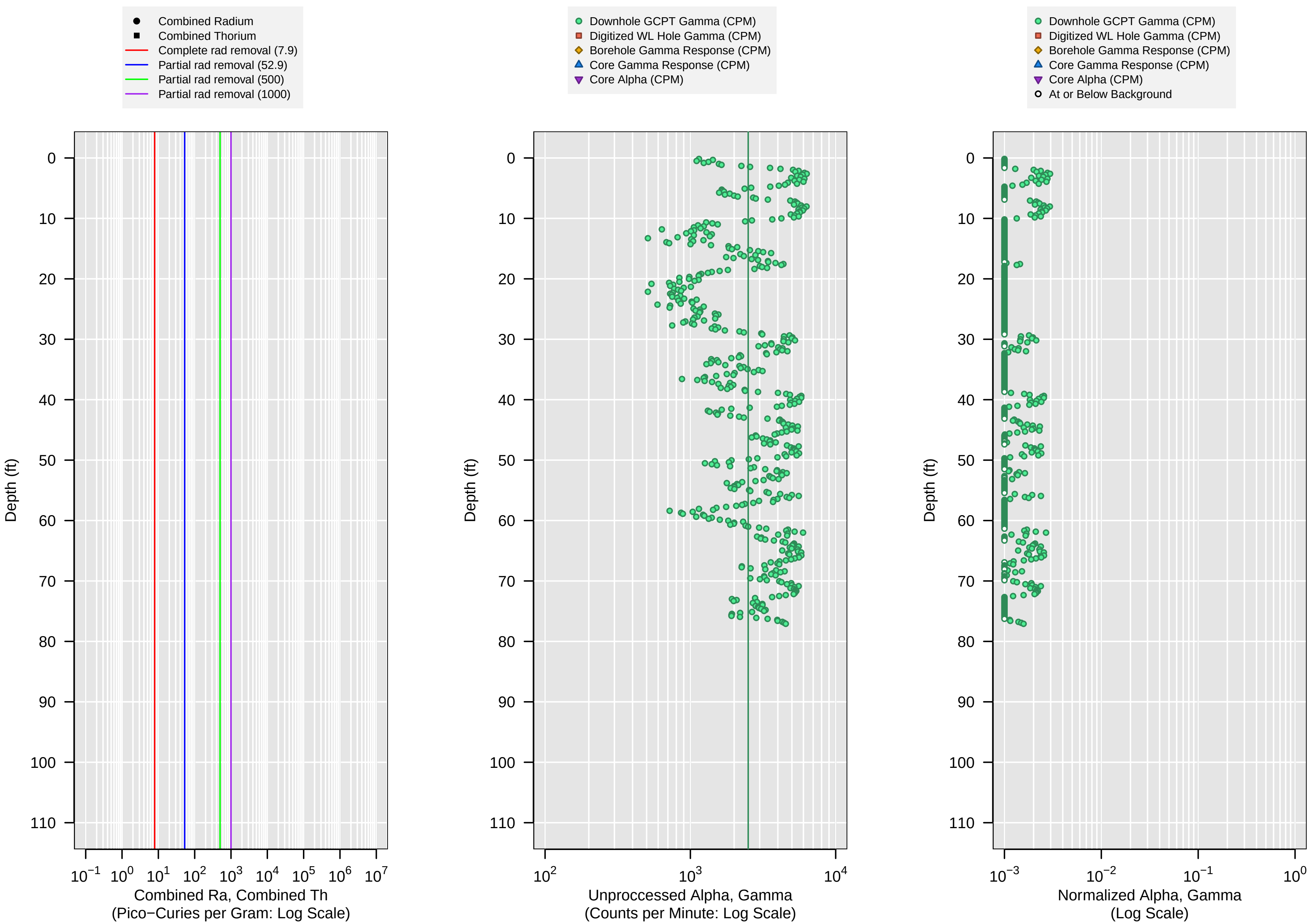
GCPT−1D−08
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)


GCPT−1D−08
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

GCPT−1D−8A

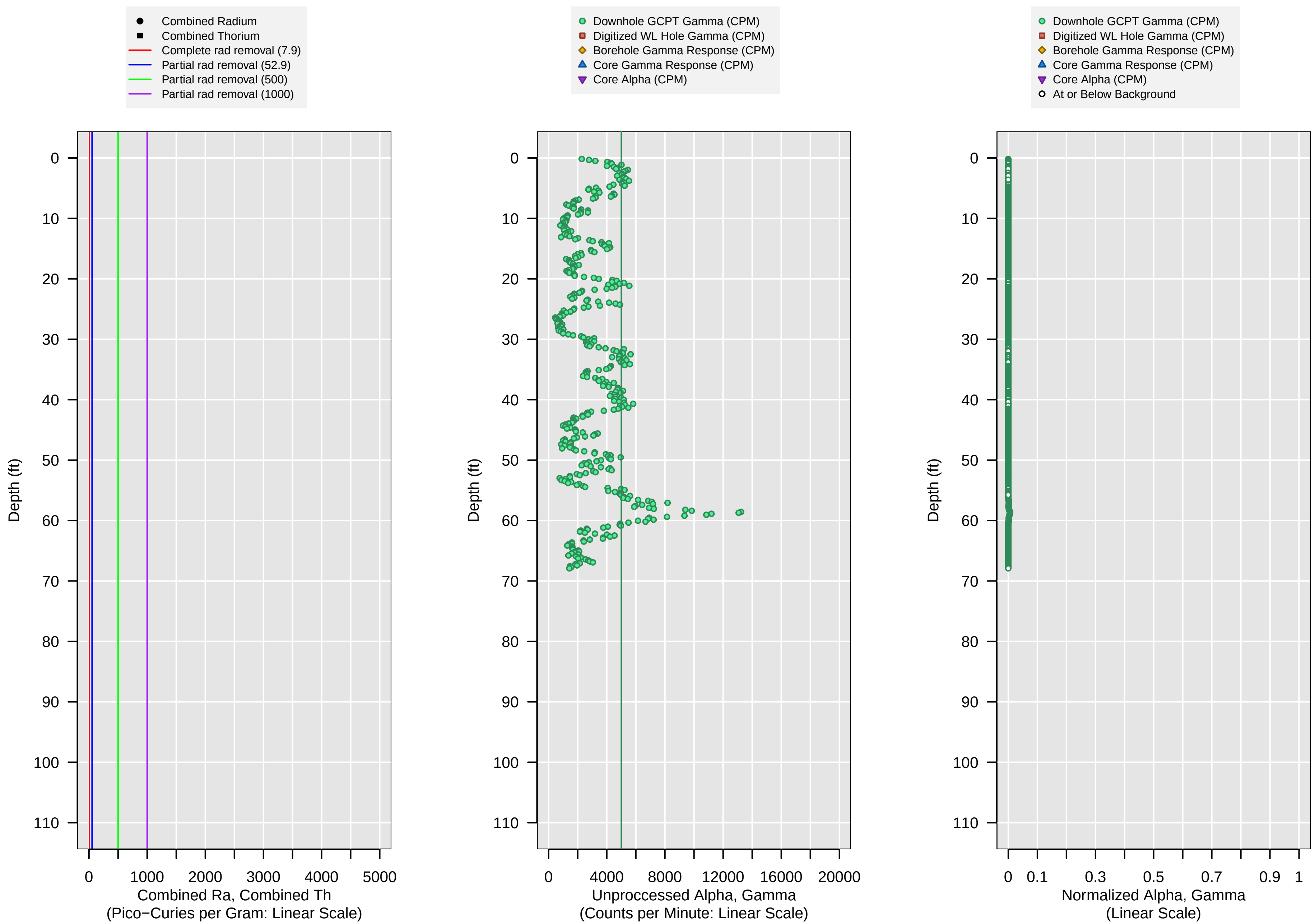

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
1400
2800
4200
5600
7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

GCPT−1D−8A

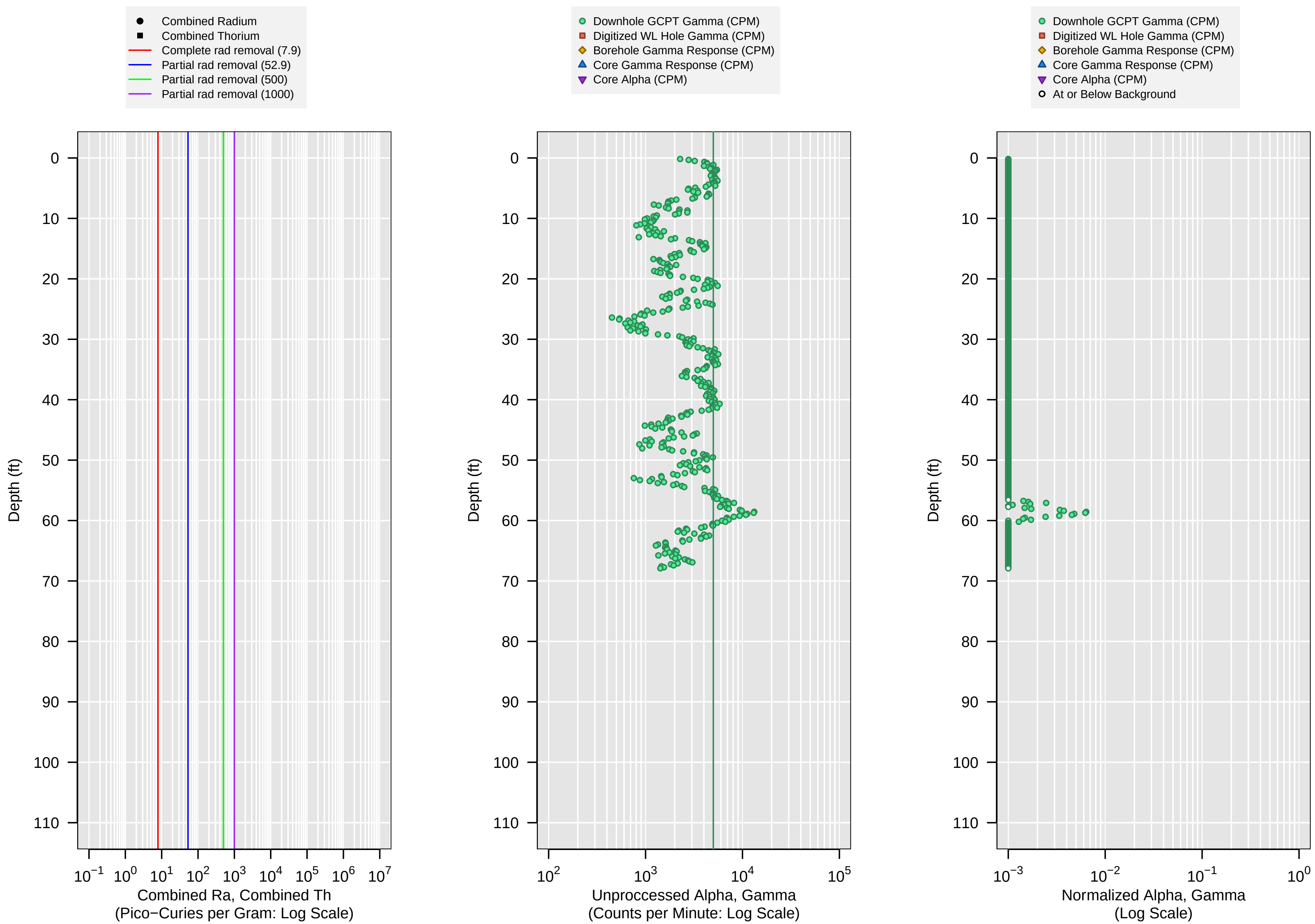


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

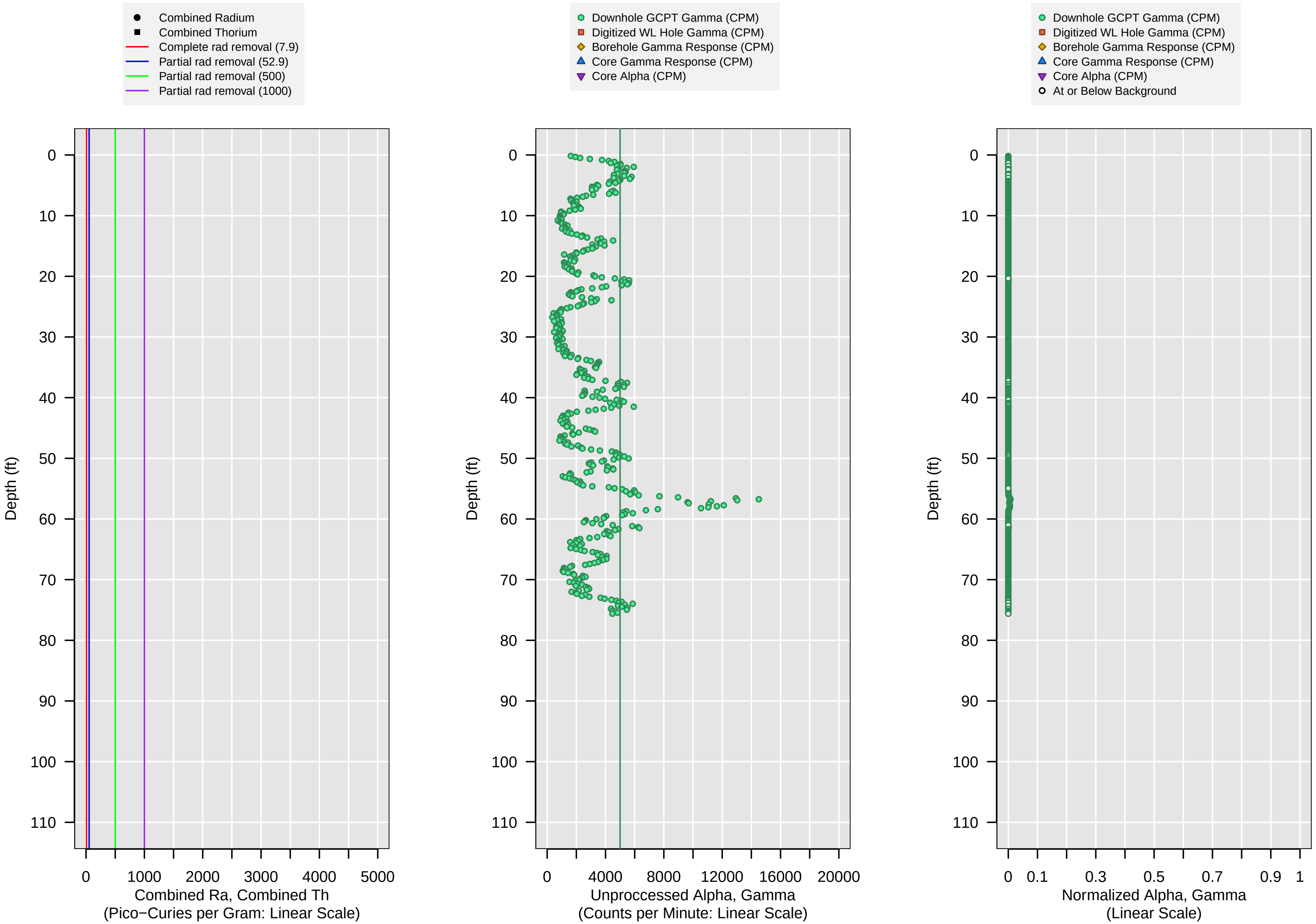
GCPT−1D−09

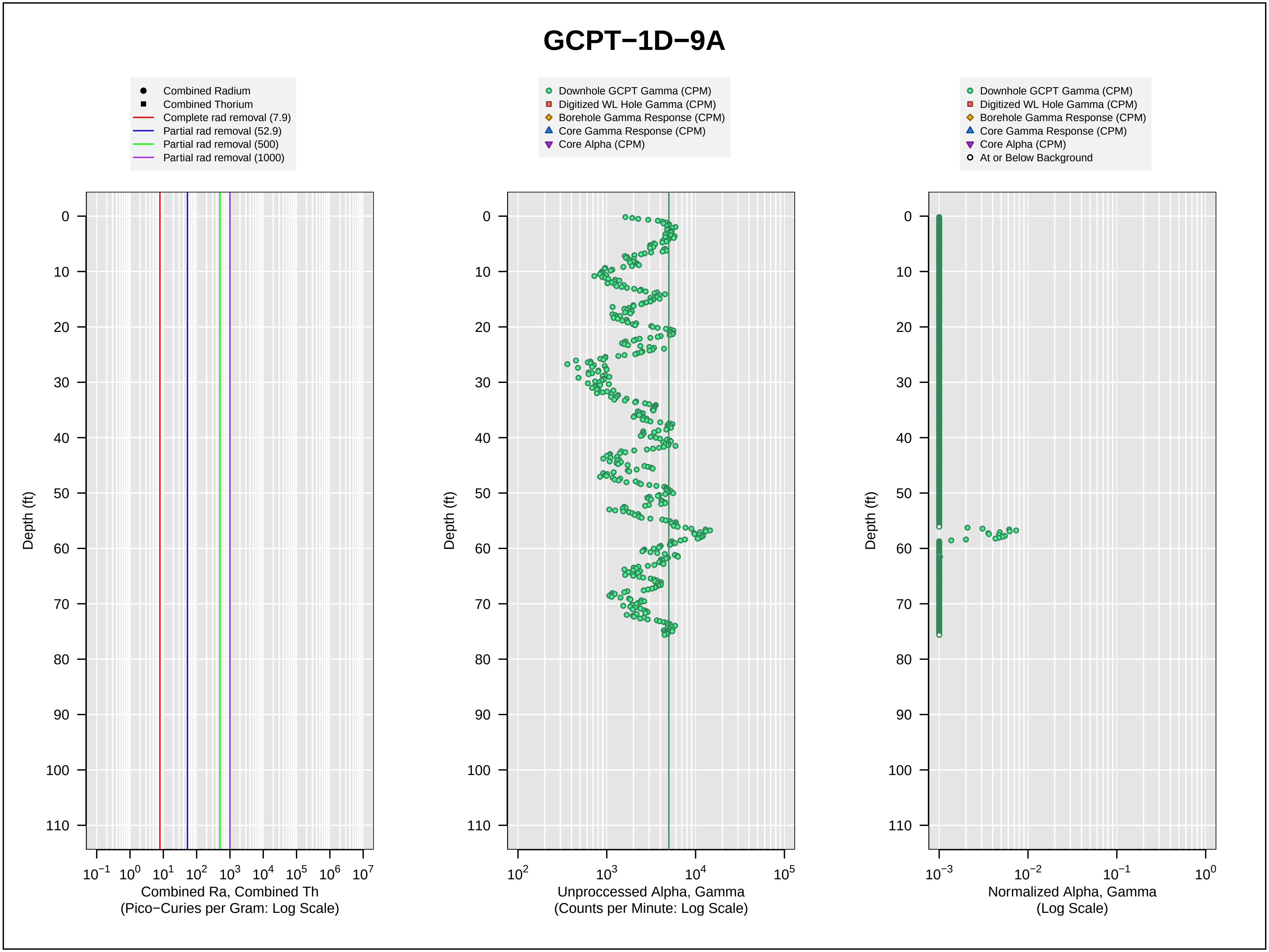

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Linear Scale)

GCPT−1D−09

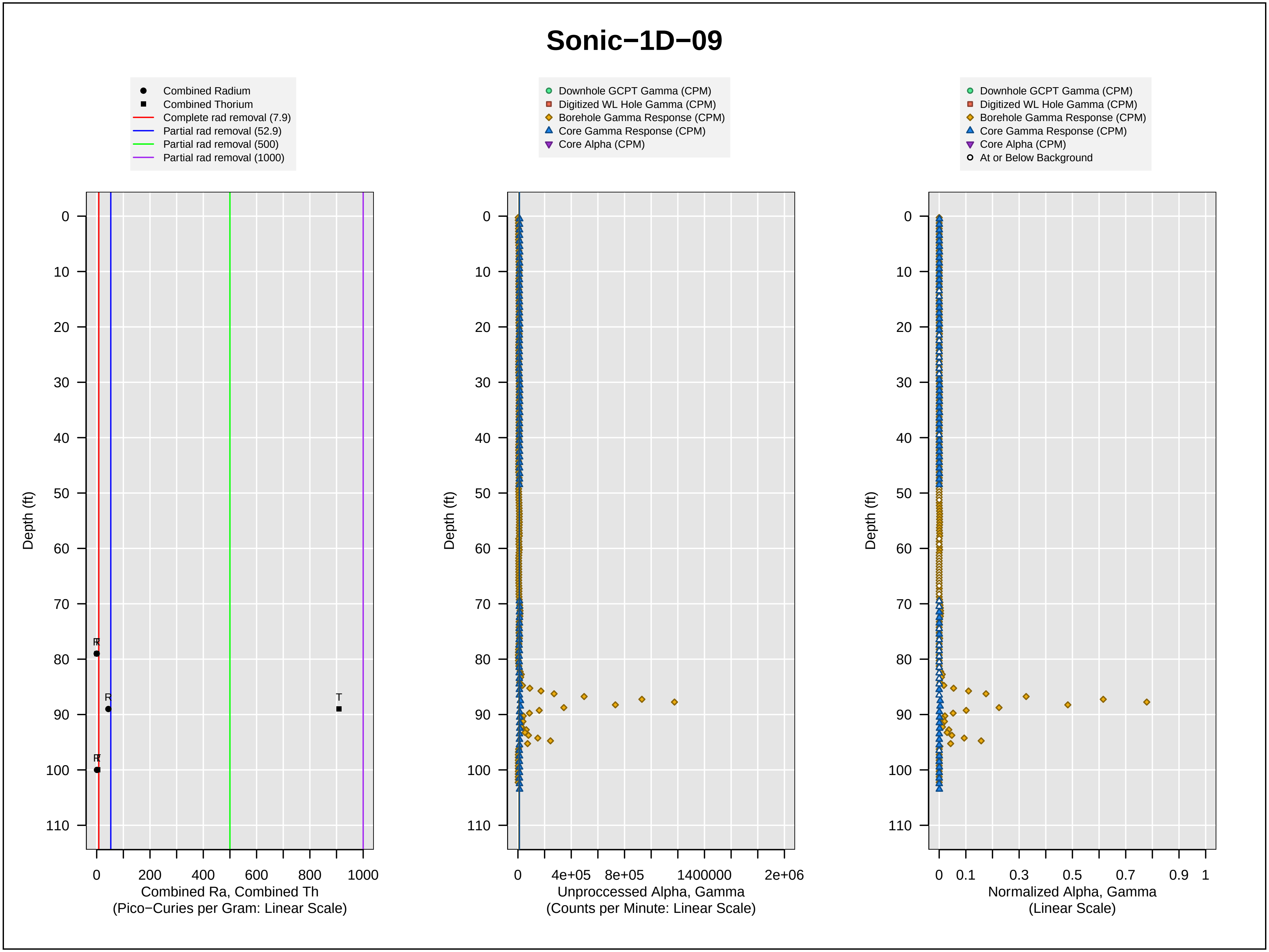

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−1D−9A

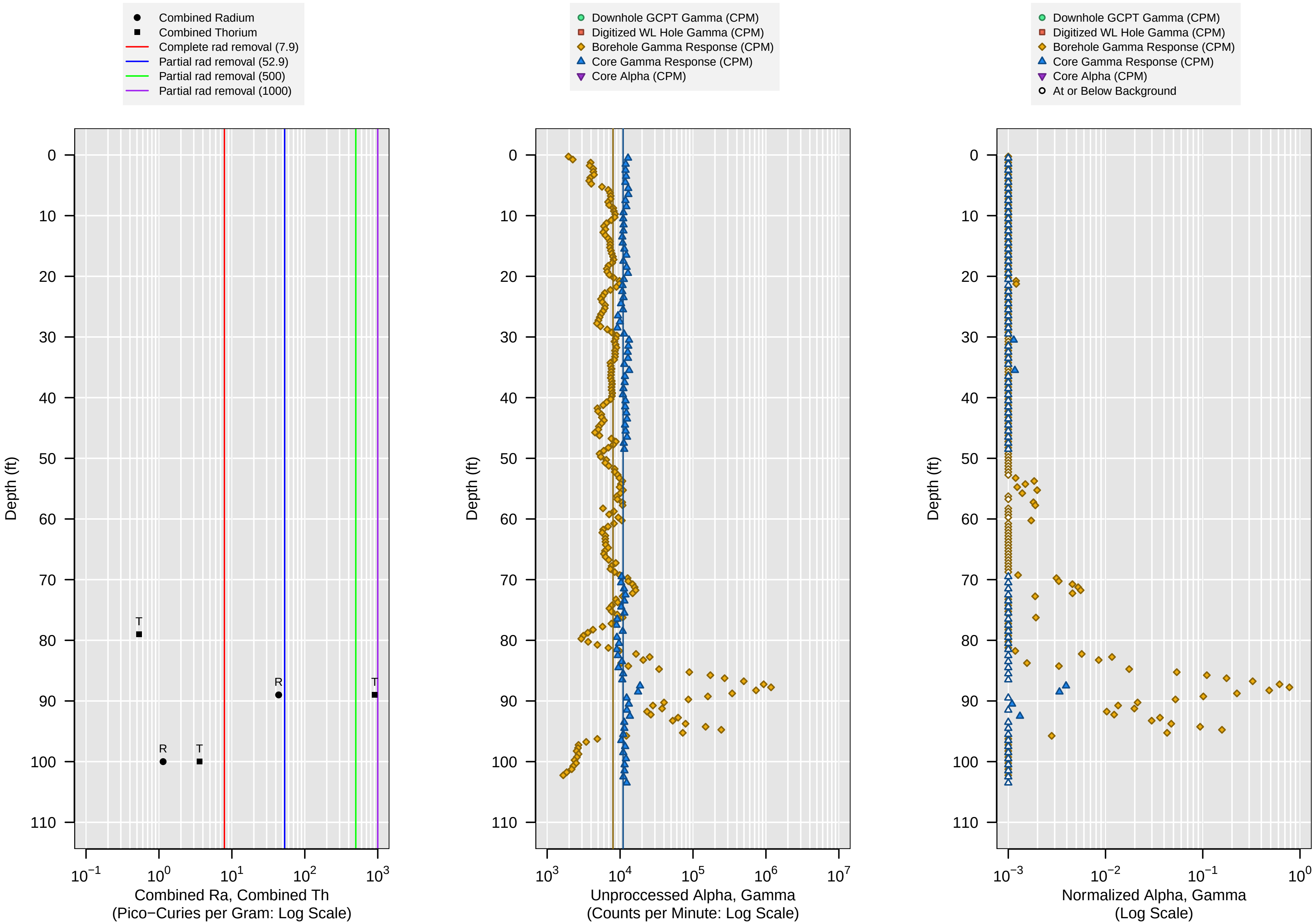

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
4000
8000
12000
16000
20000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)



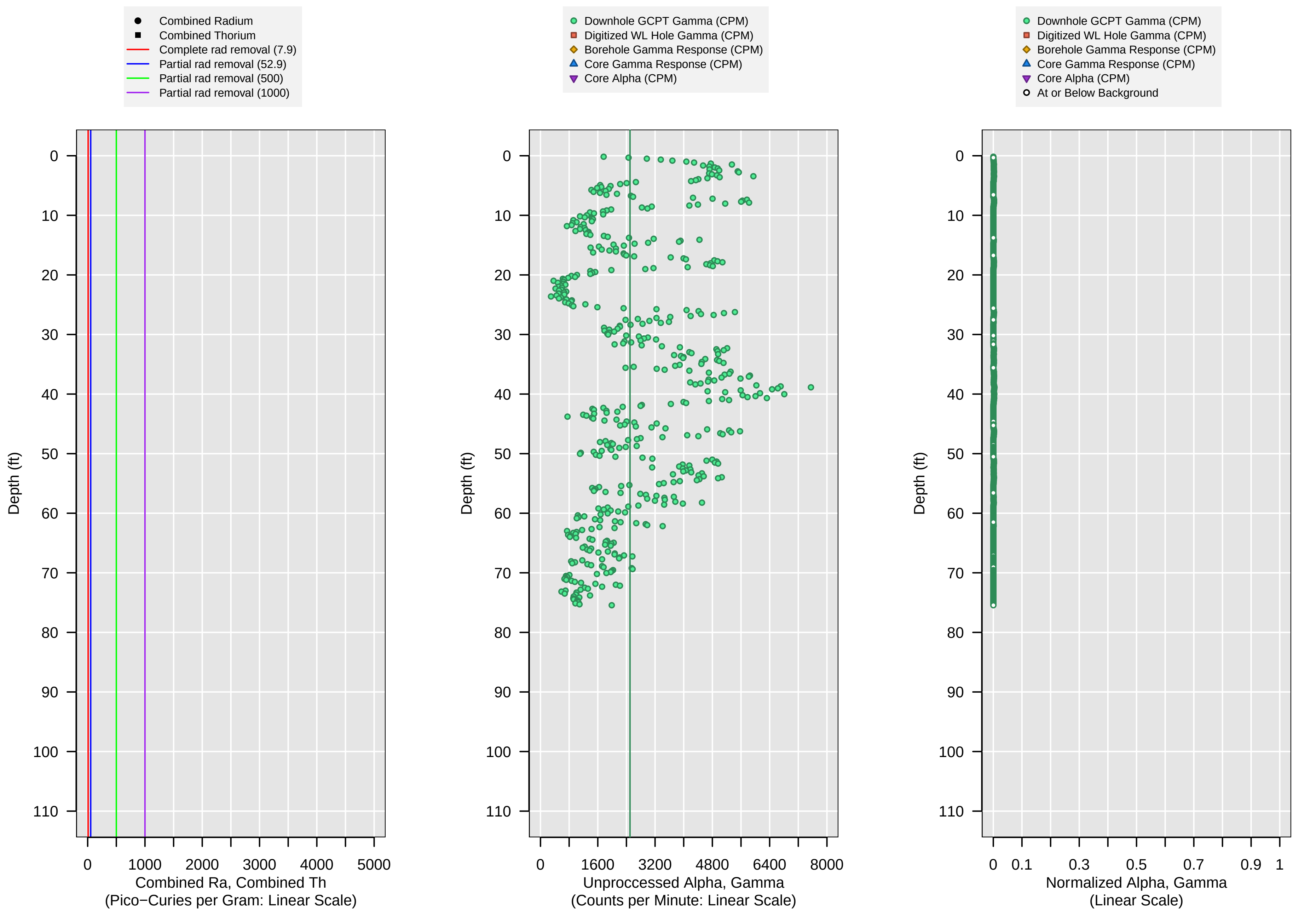
GCPT−1D−9A
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

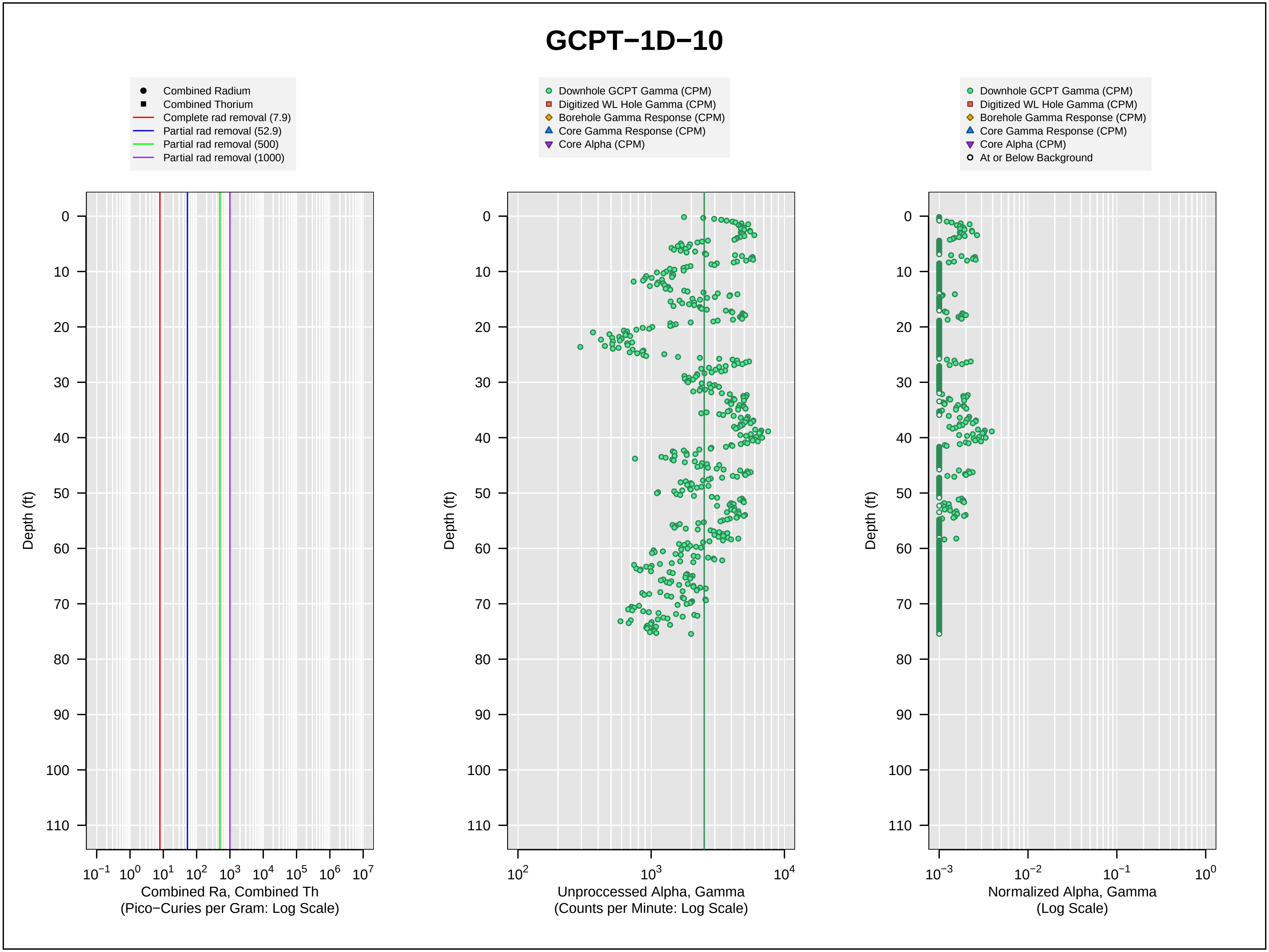

Sonic−1D−09
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

Sonic−1D−09


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
T
R
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

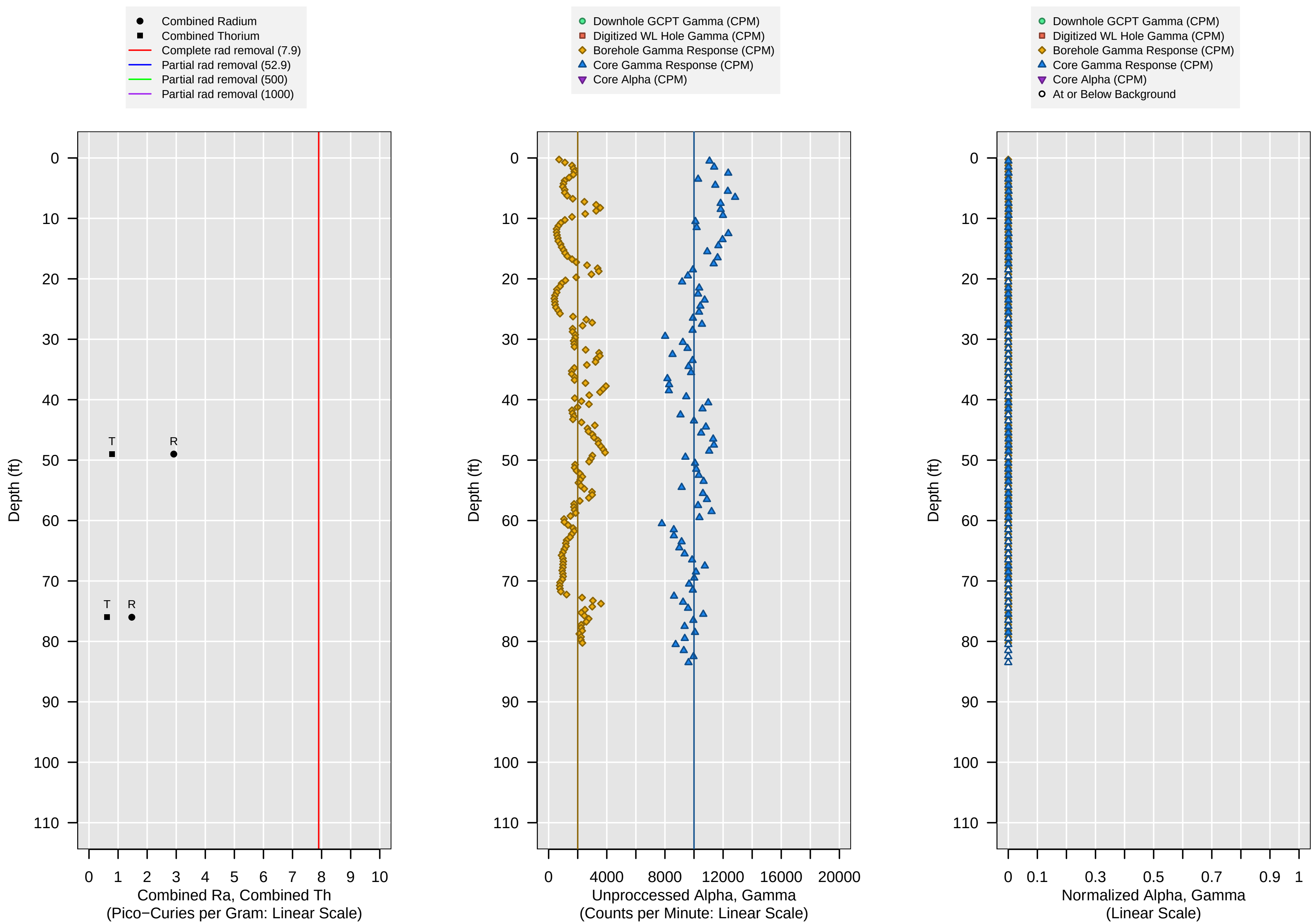
GCPT−1D−10


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Linear Scale)



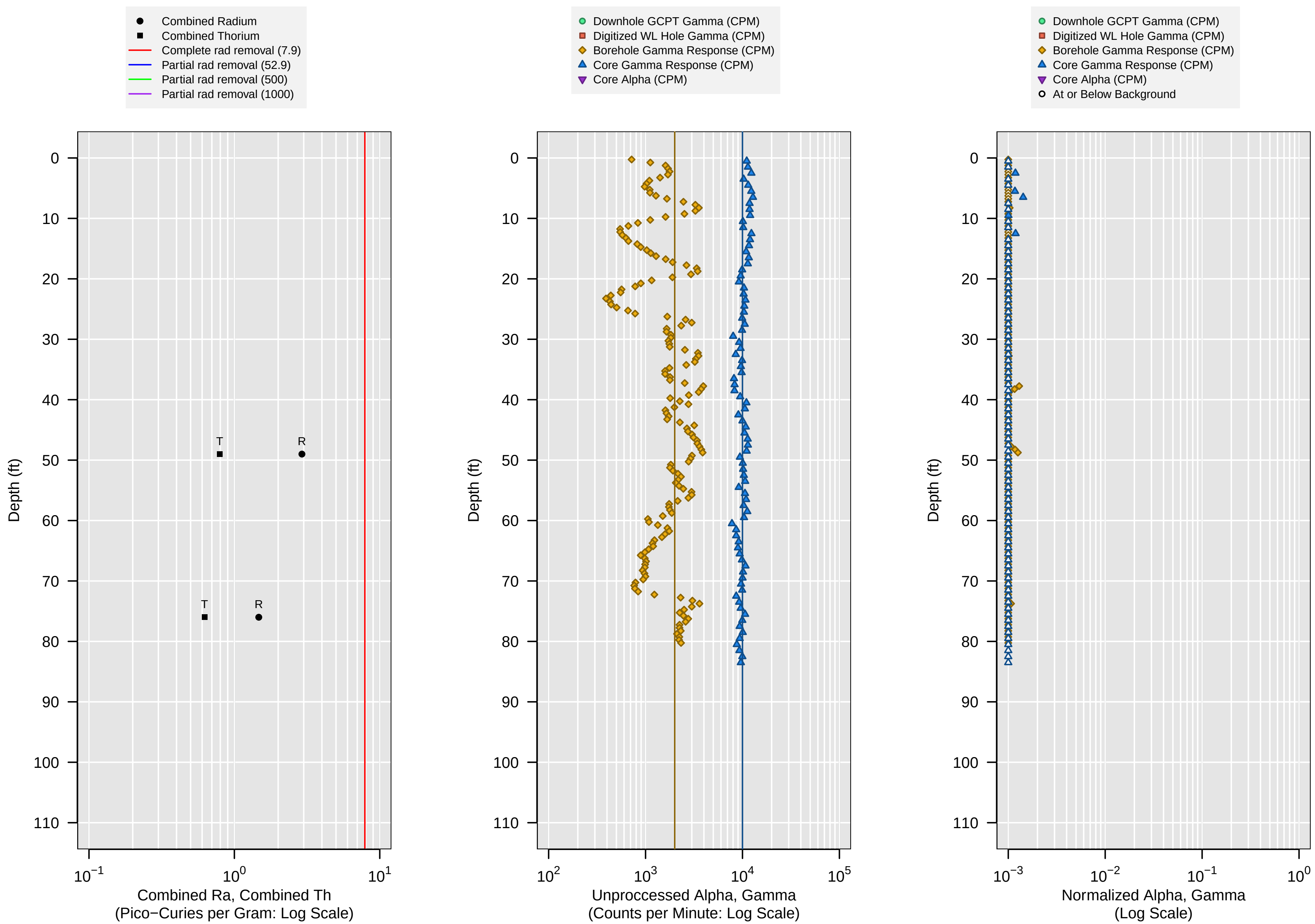
GCPT−1D−10
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

Sonic−1D−10

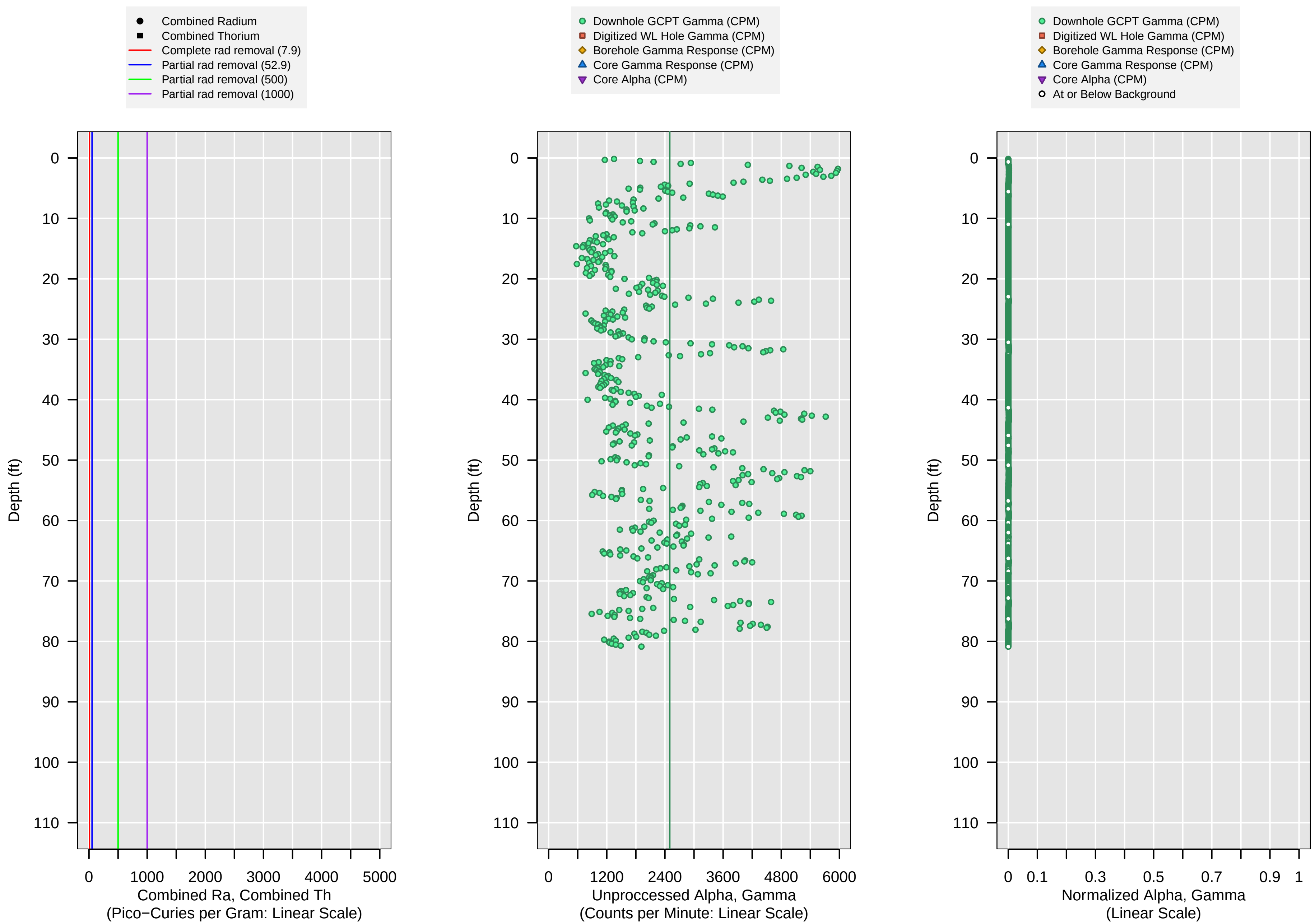


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
T
R
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

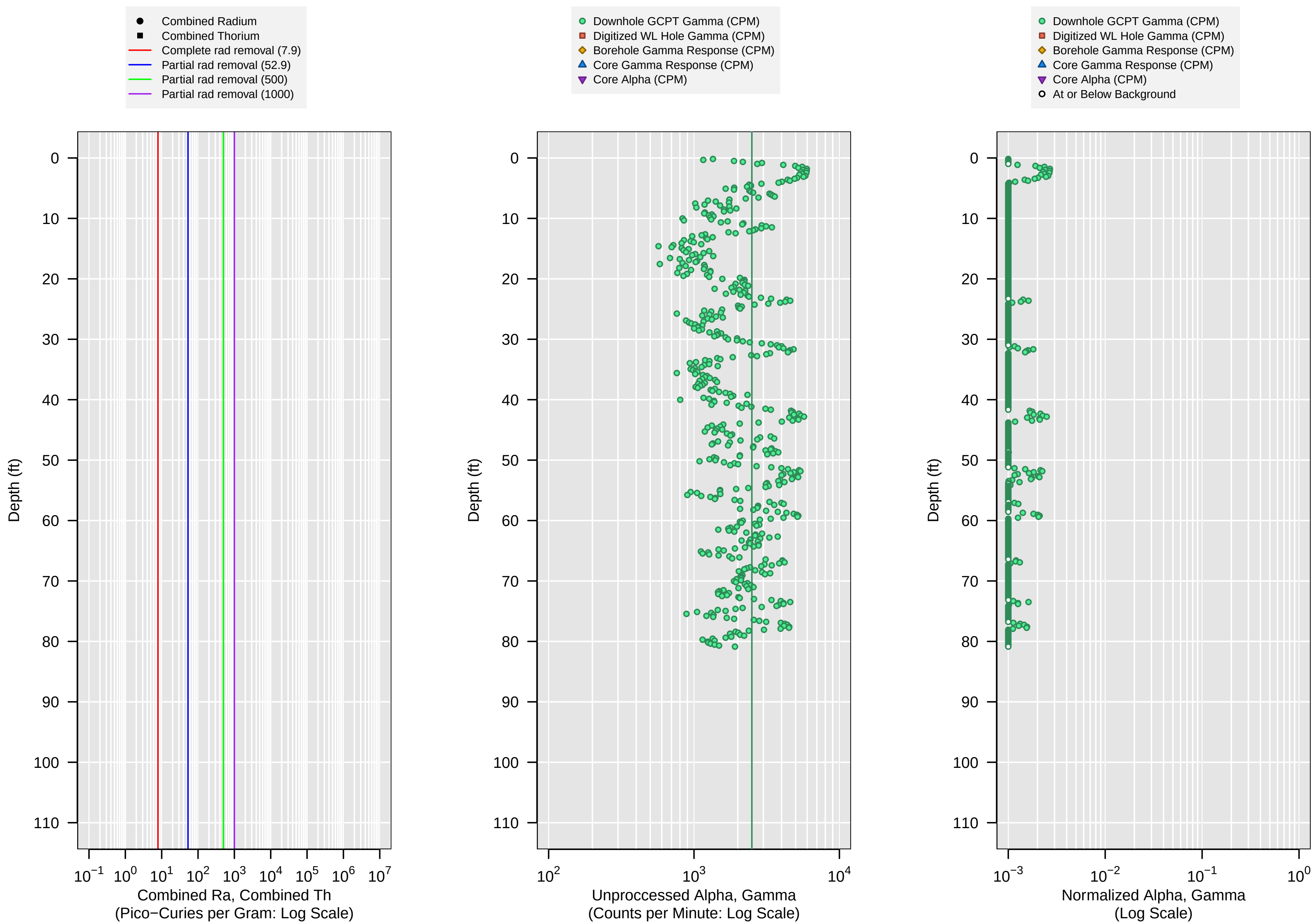
Sonic−1D−10


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
T
R
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

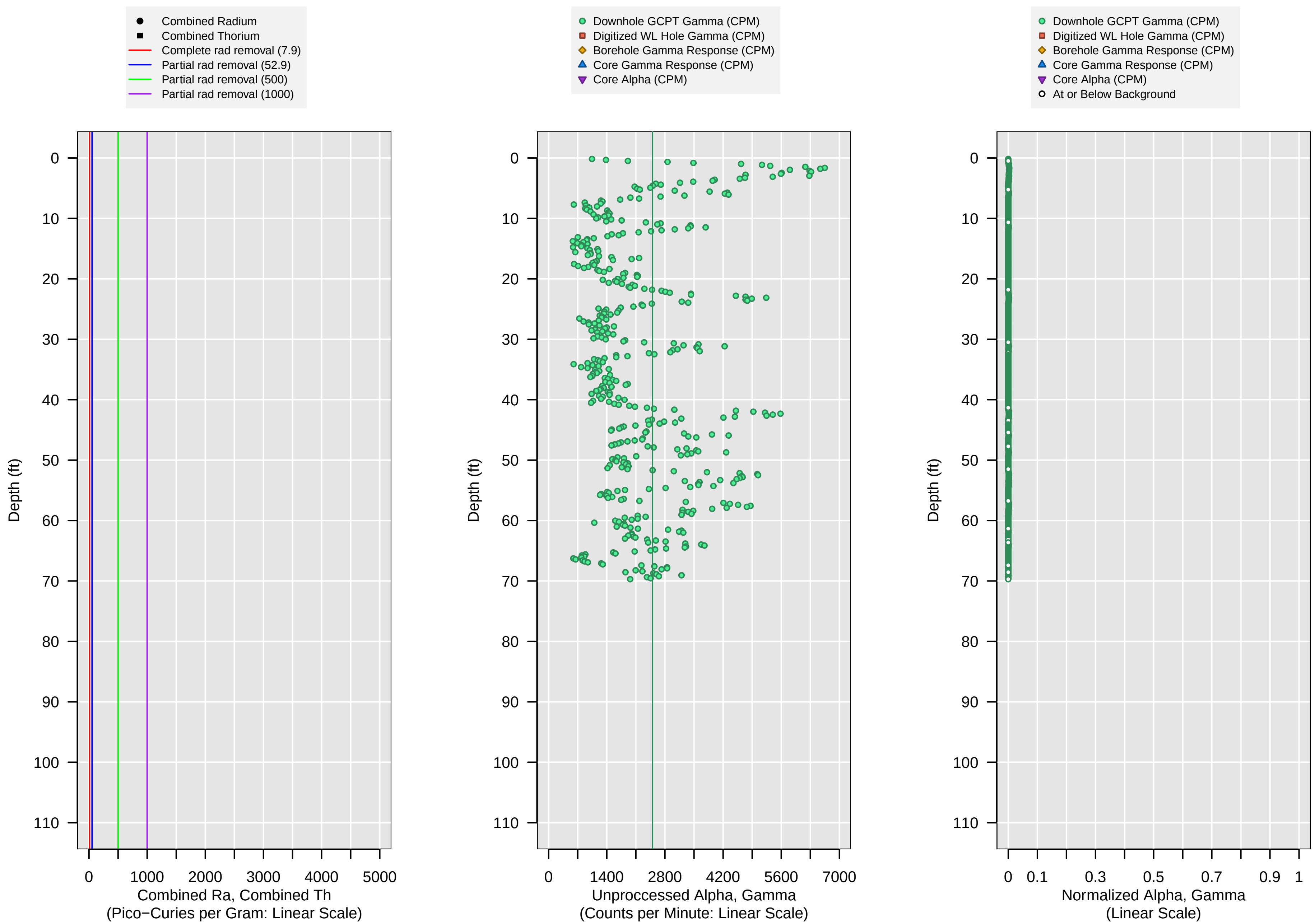
GCPT−1D−11


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−1D−11

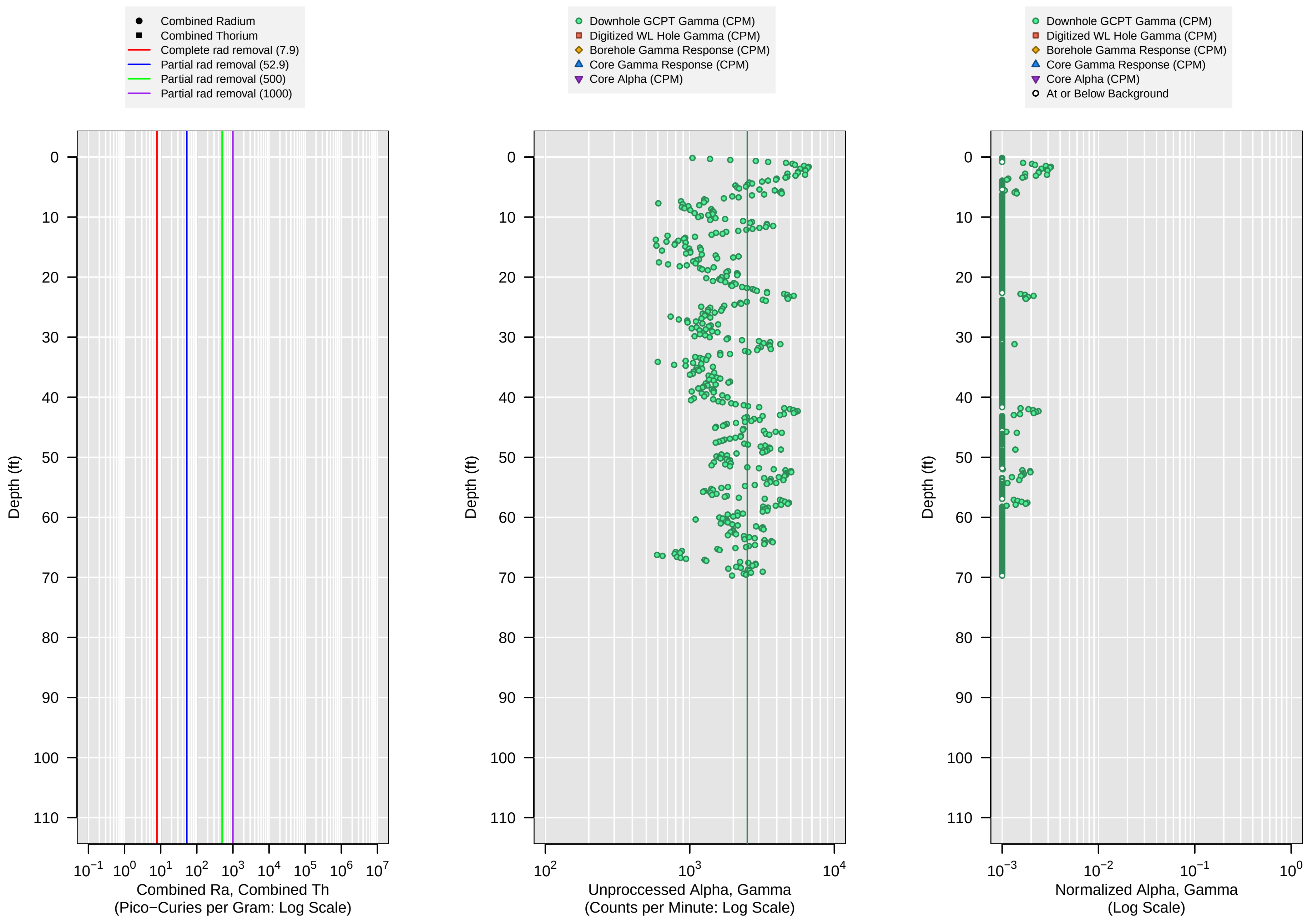

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−1D−11A

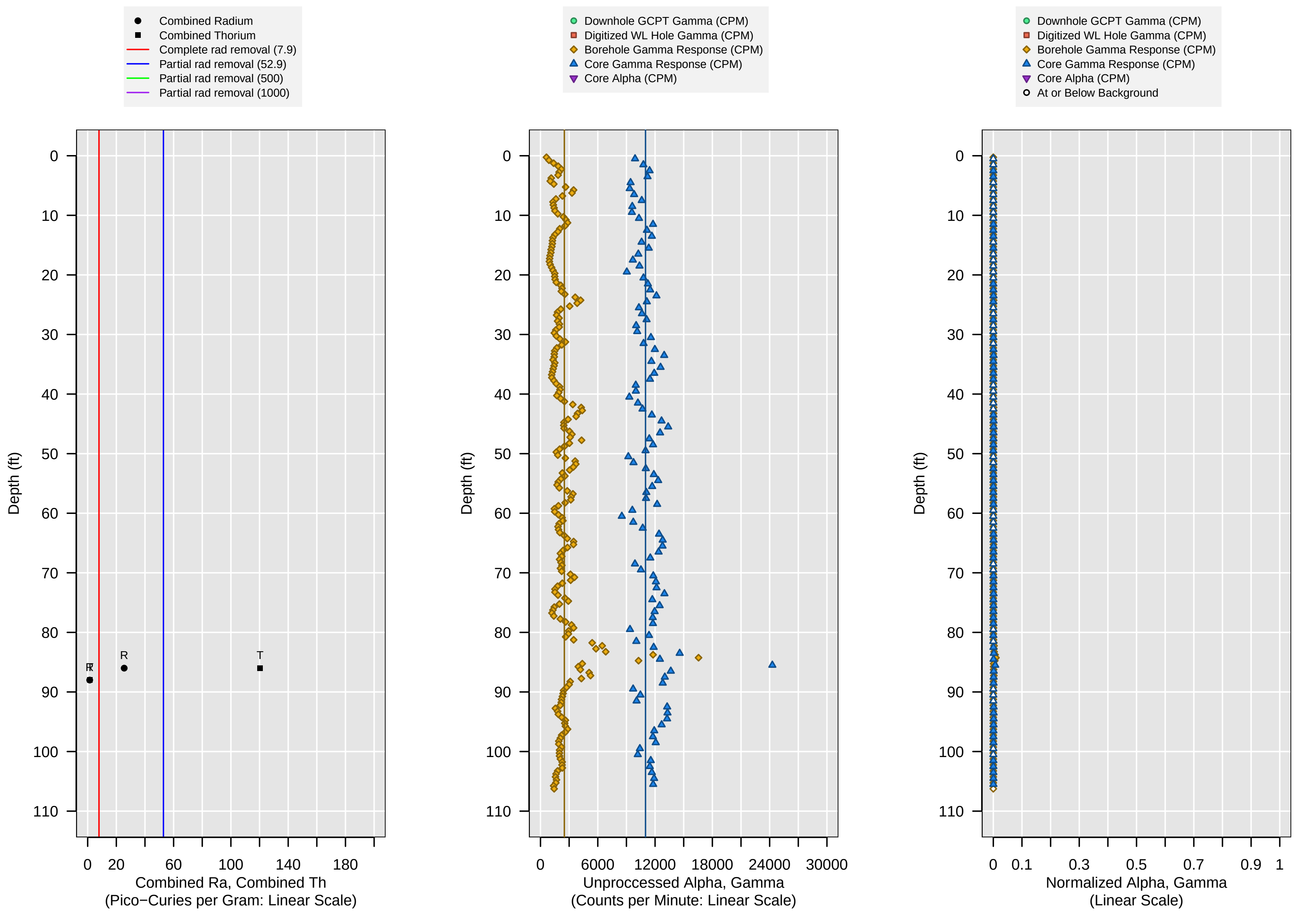


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1400
2800
4200
5600
7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

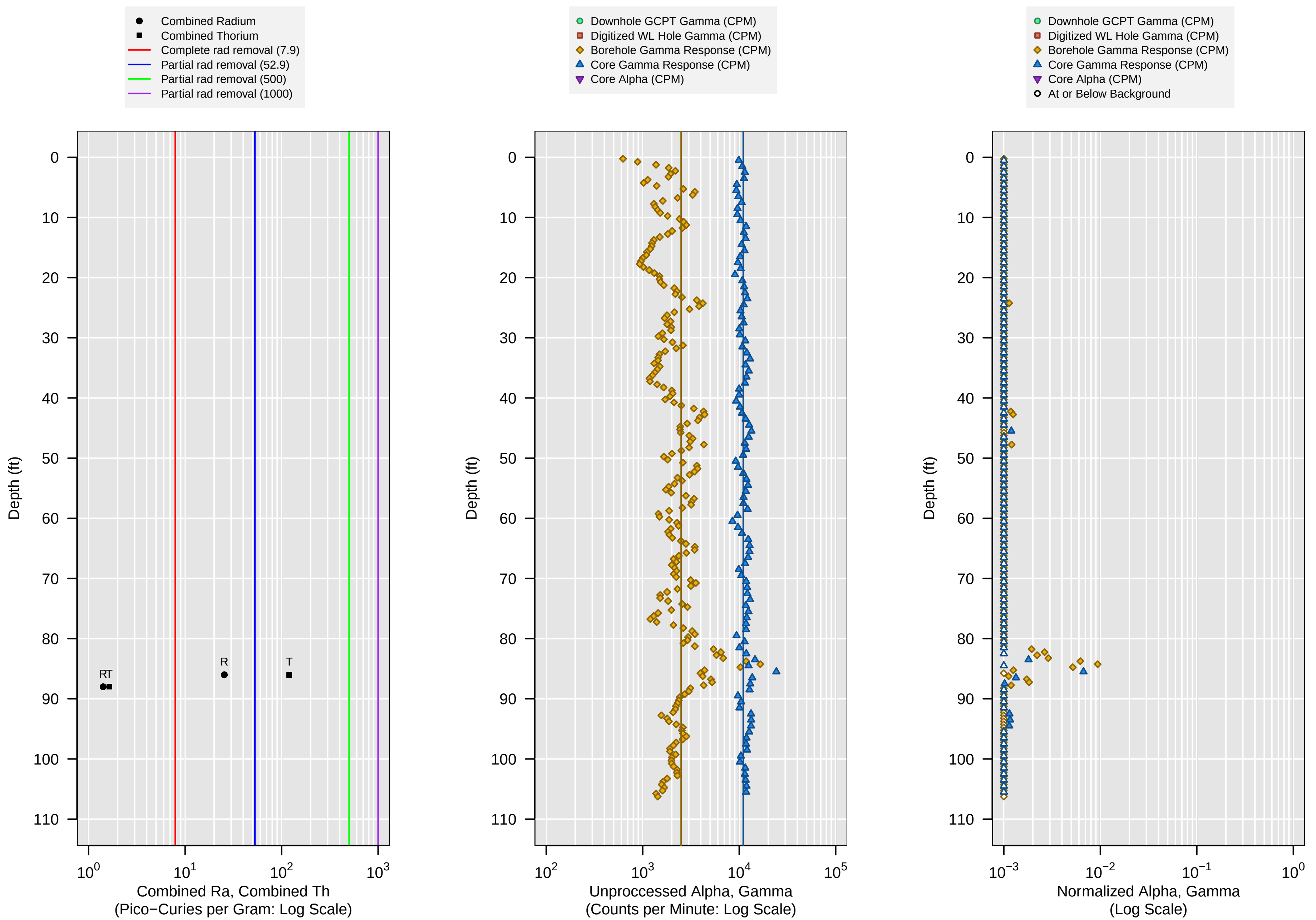
GCPT−1D−11A


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{-1} 10^{0} 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6} 10^{7}
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
10^{2} 10^{3} 10^{4}
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
10^{-3} 10^{-2} 10^{-1} 10^{0}
Normalized Alpha, Gamma
(Log Scale)

Sonic−1D−11

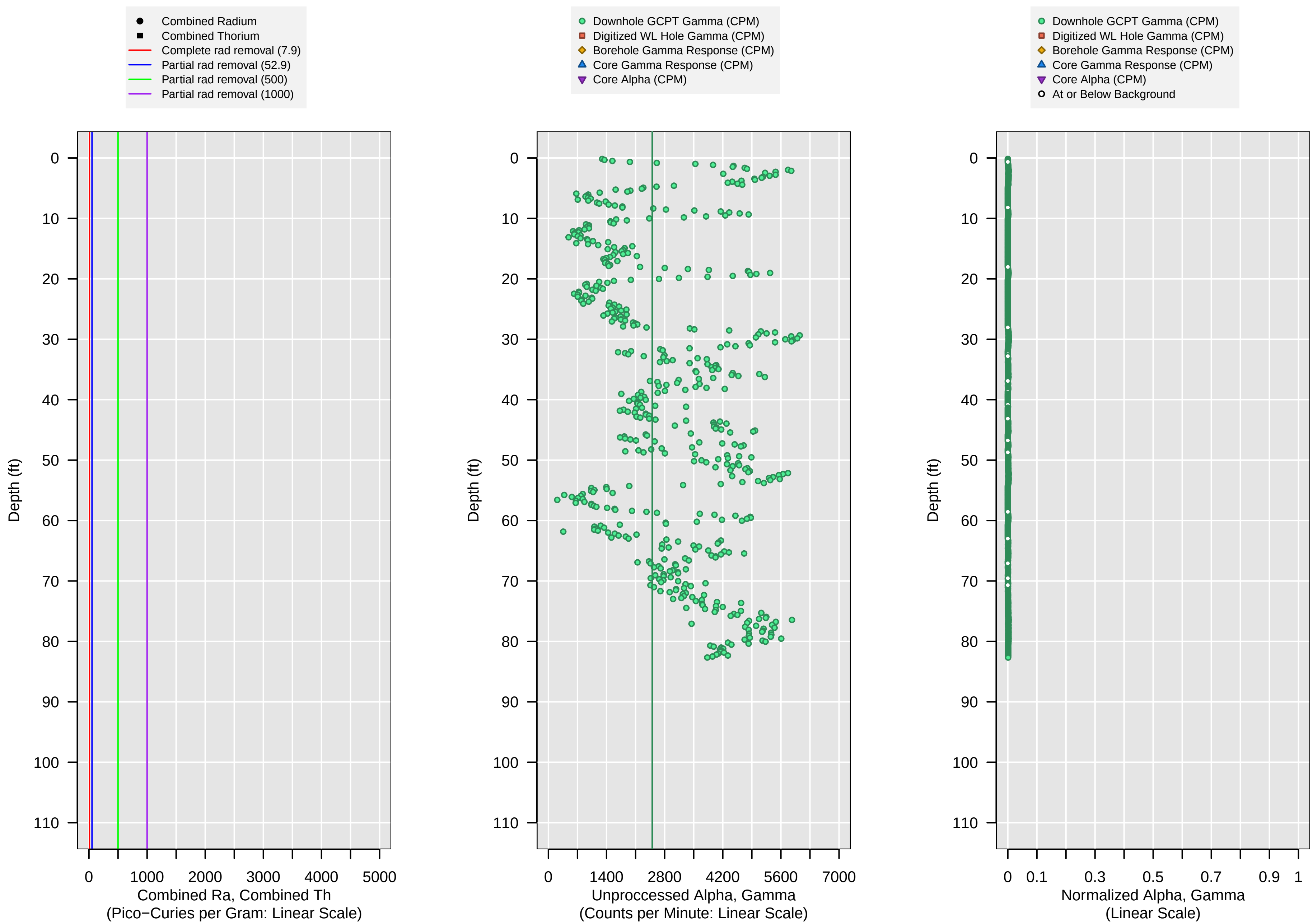

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
R
T
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

Sonic−1D−11

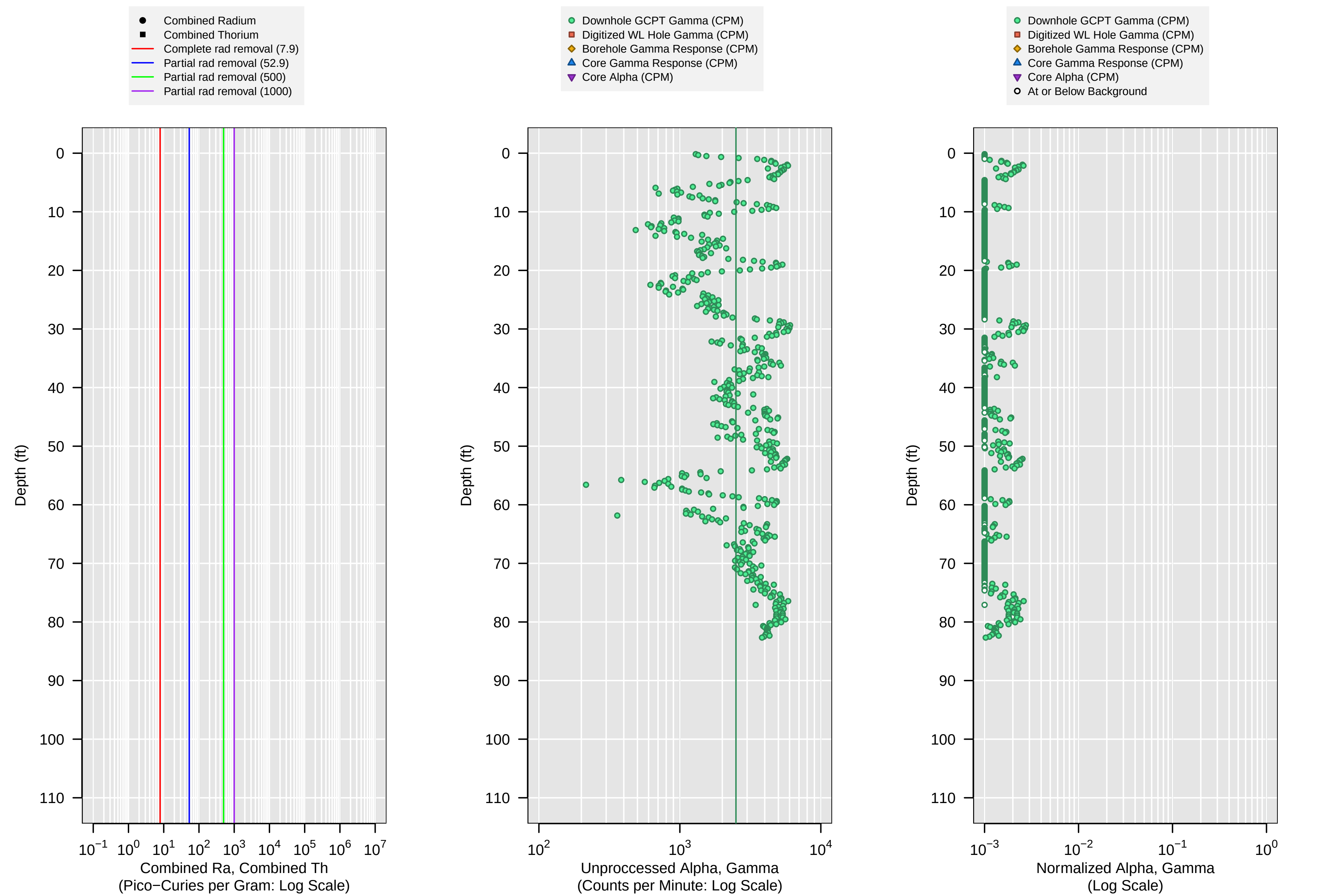


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
RT
R
T
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

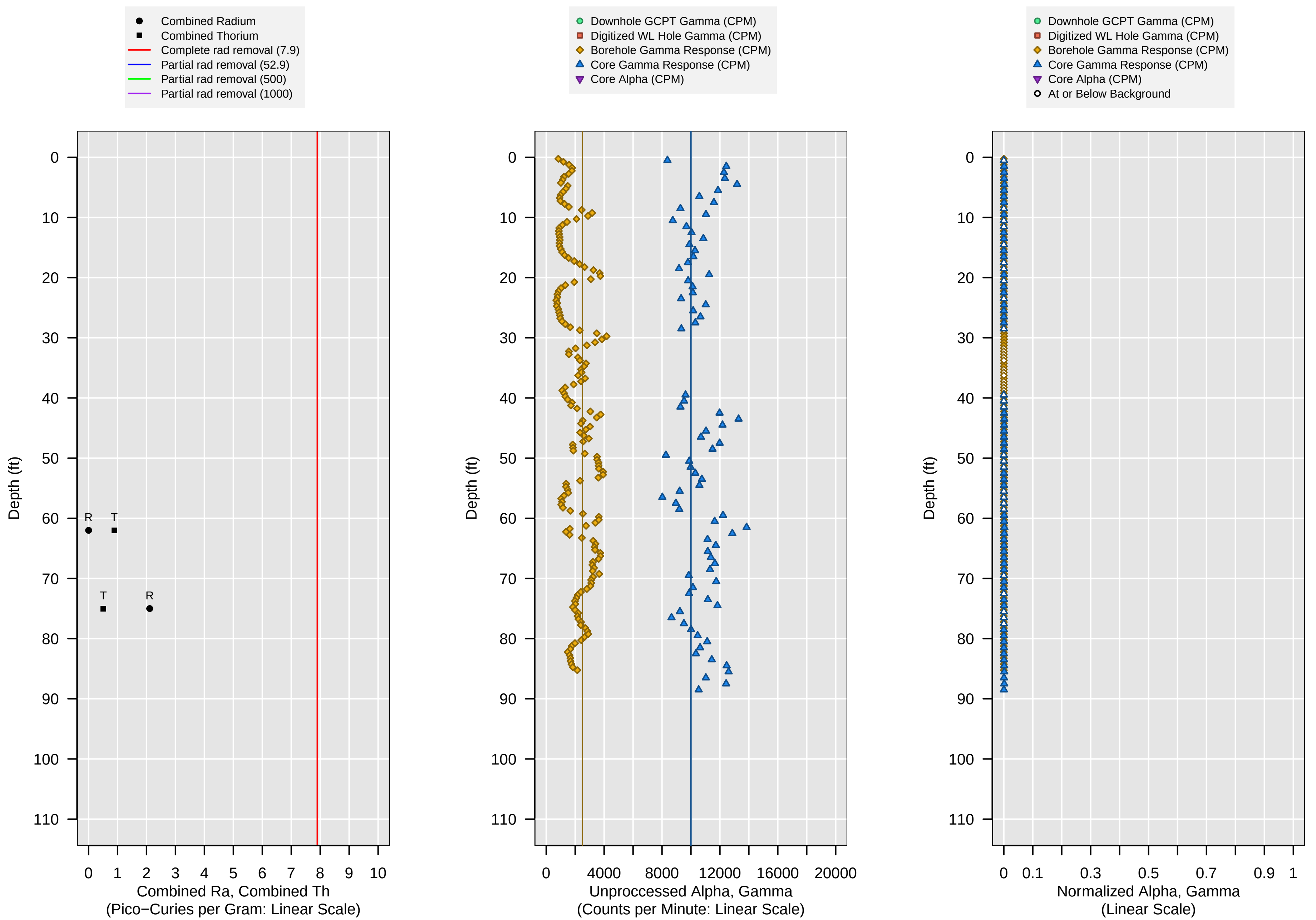
GCPT−1D−12

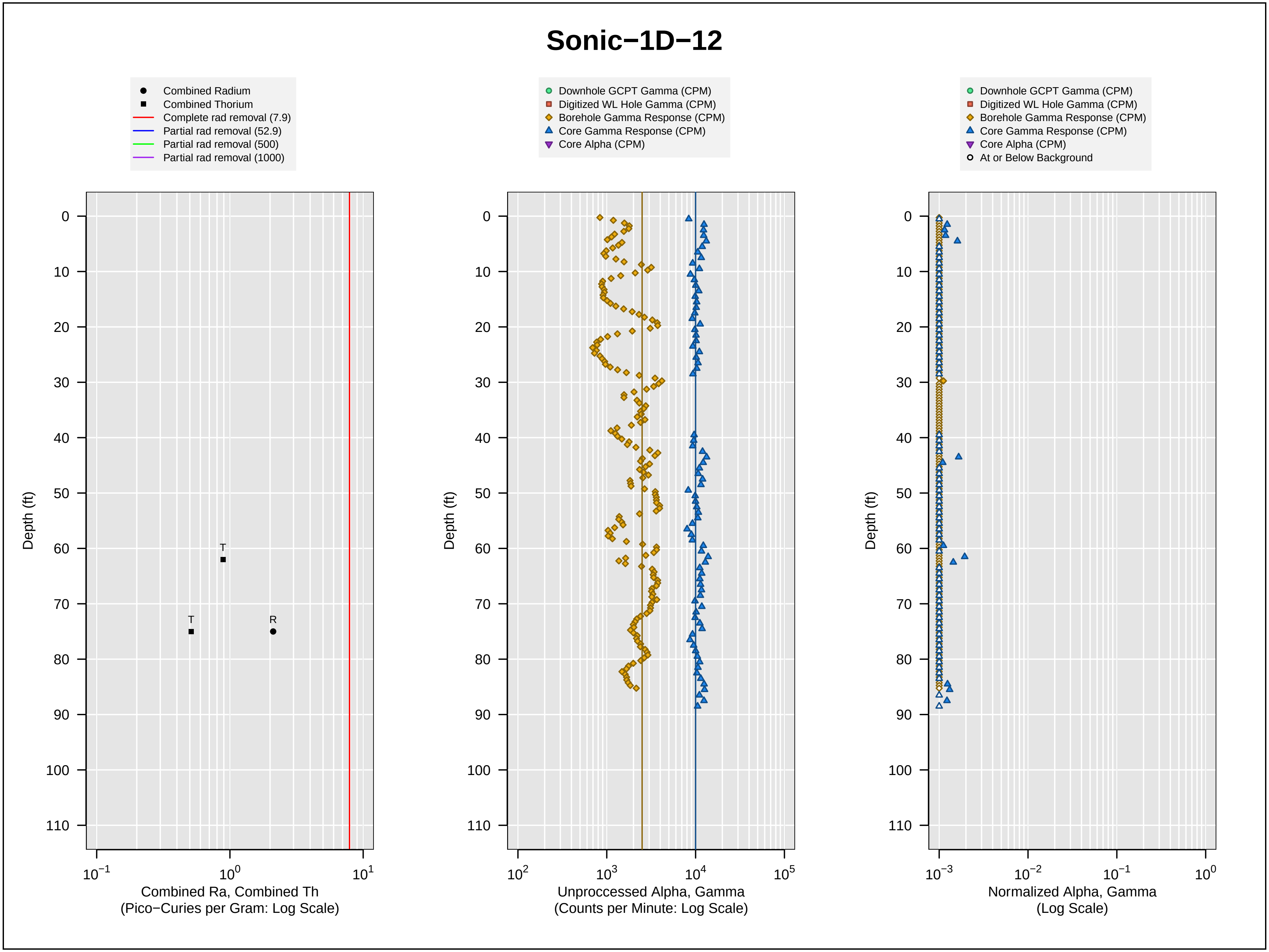

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 1000 2000 3000 4000 5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0 1400 2800 4200 5600 7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

GCPT−1D−12

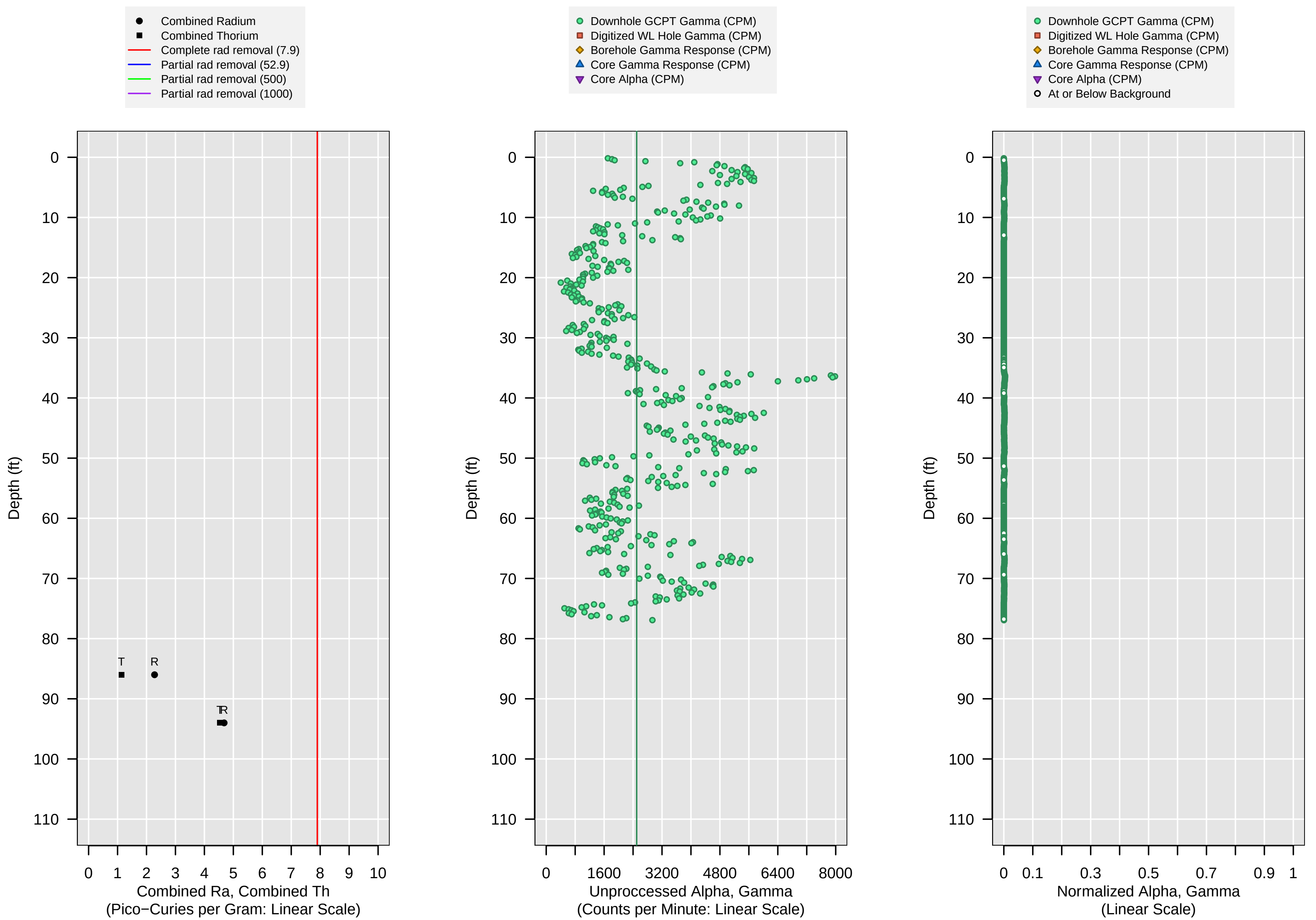

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

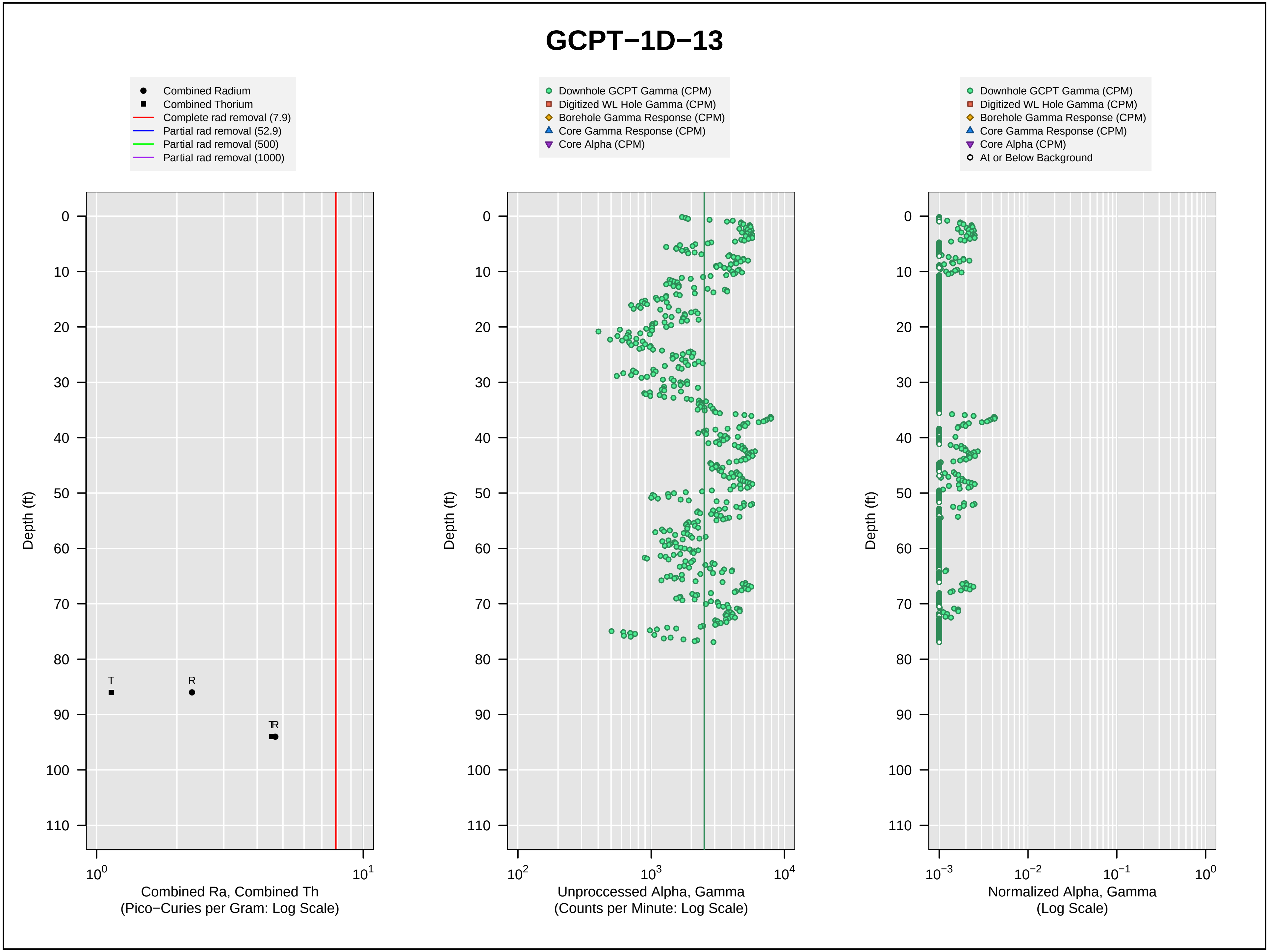
Sonic−1D−12

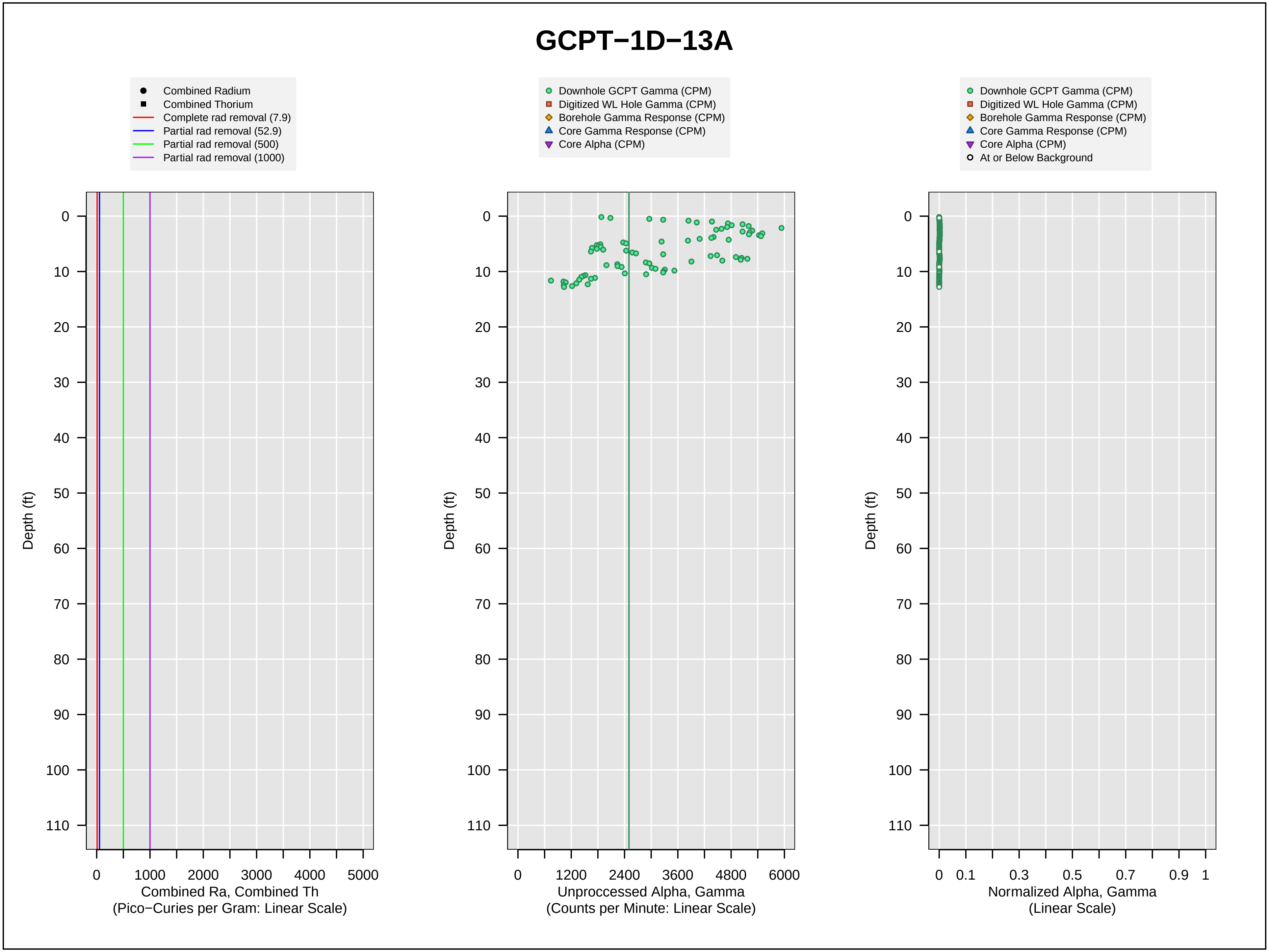

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
R
T
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)


Sonic−1D−12
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
T
T
R
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

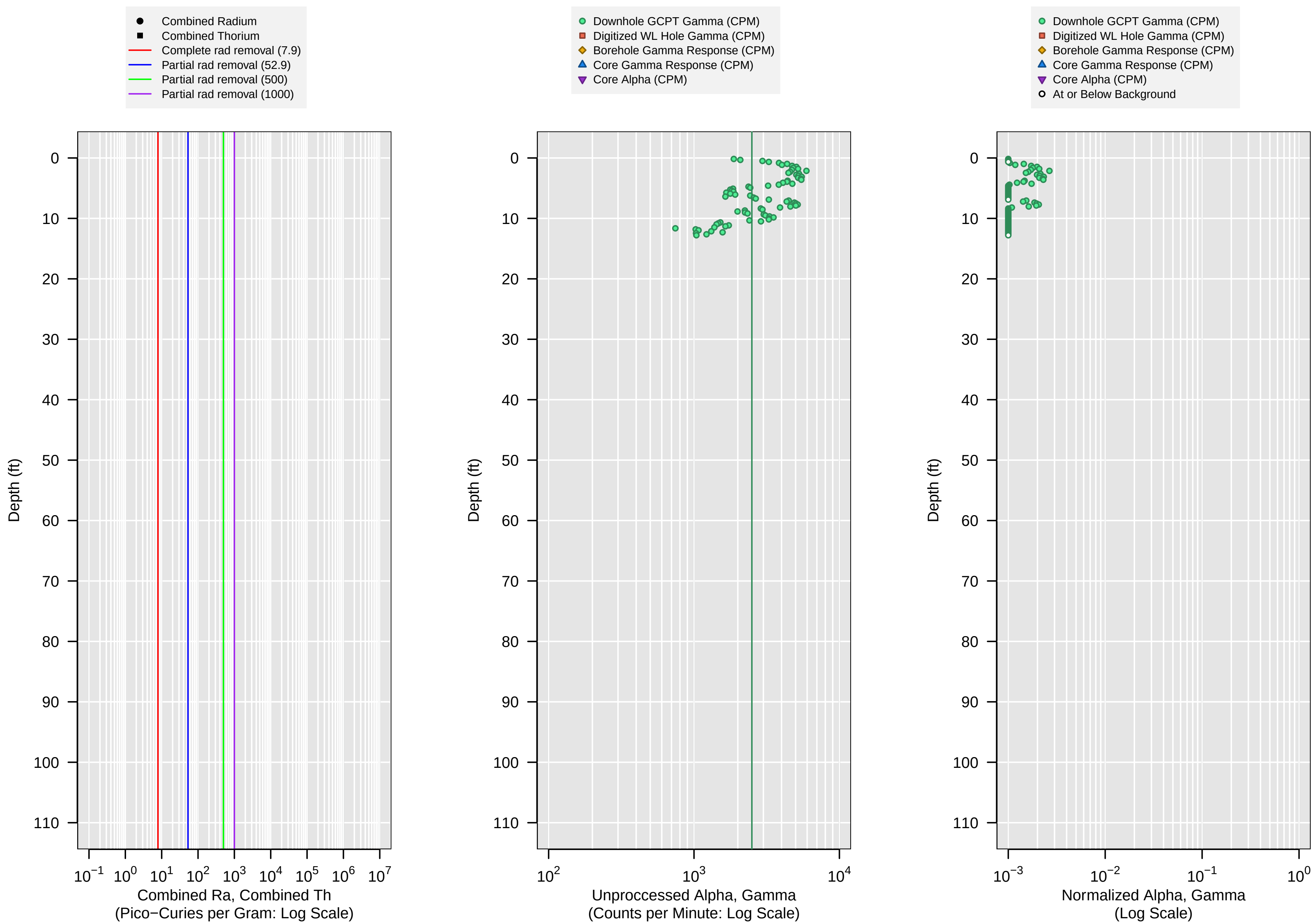
GCPT−1D−13


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
T
R
TR
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Linear Scale)

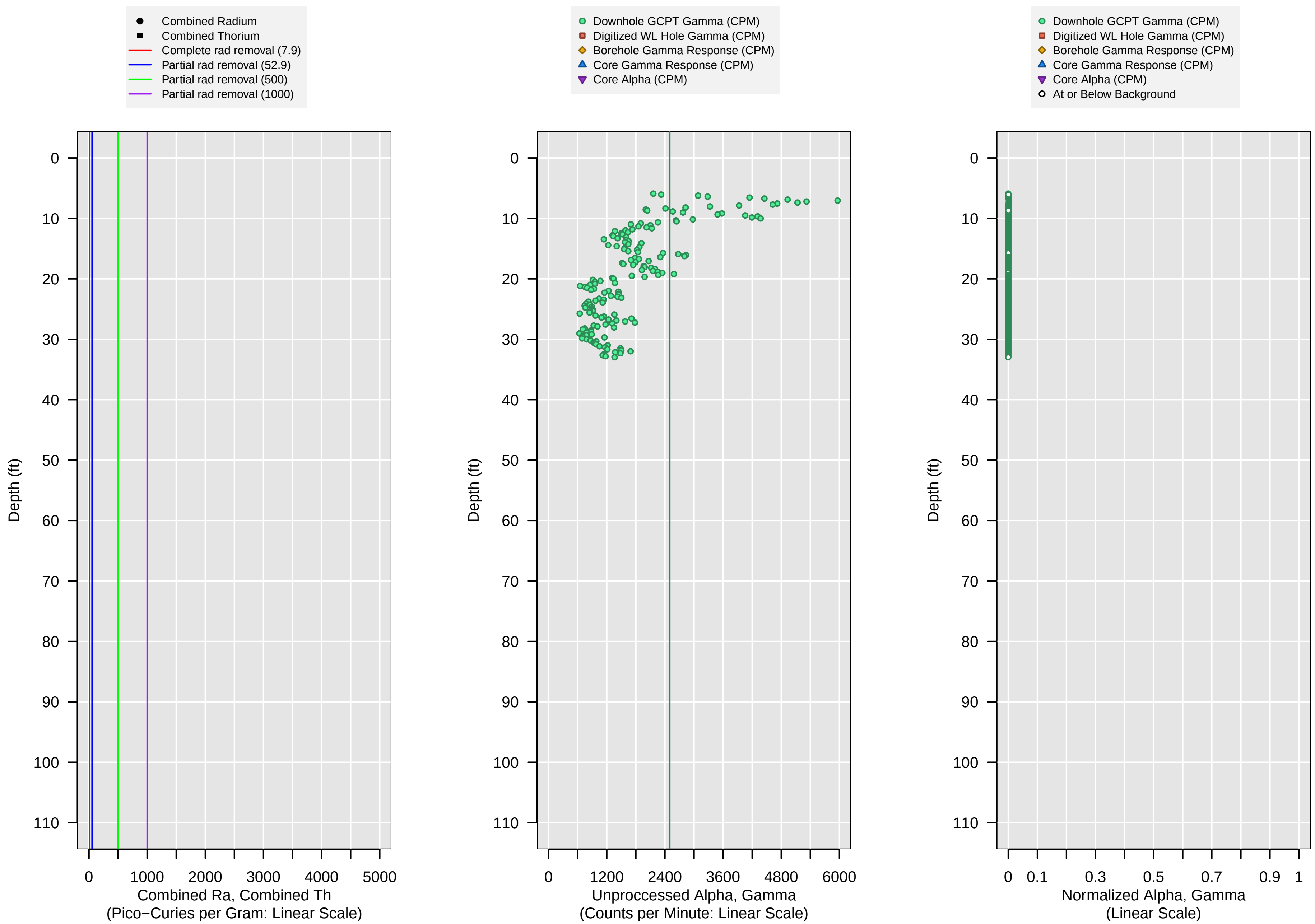

GCPT−1D−13
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
T
R
TR
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)


GCPT−1D−13A
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Linear Scale)

GCPT−1D−13A

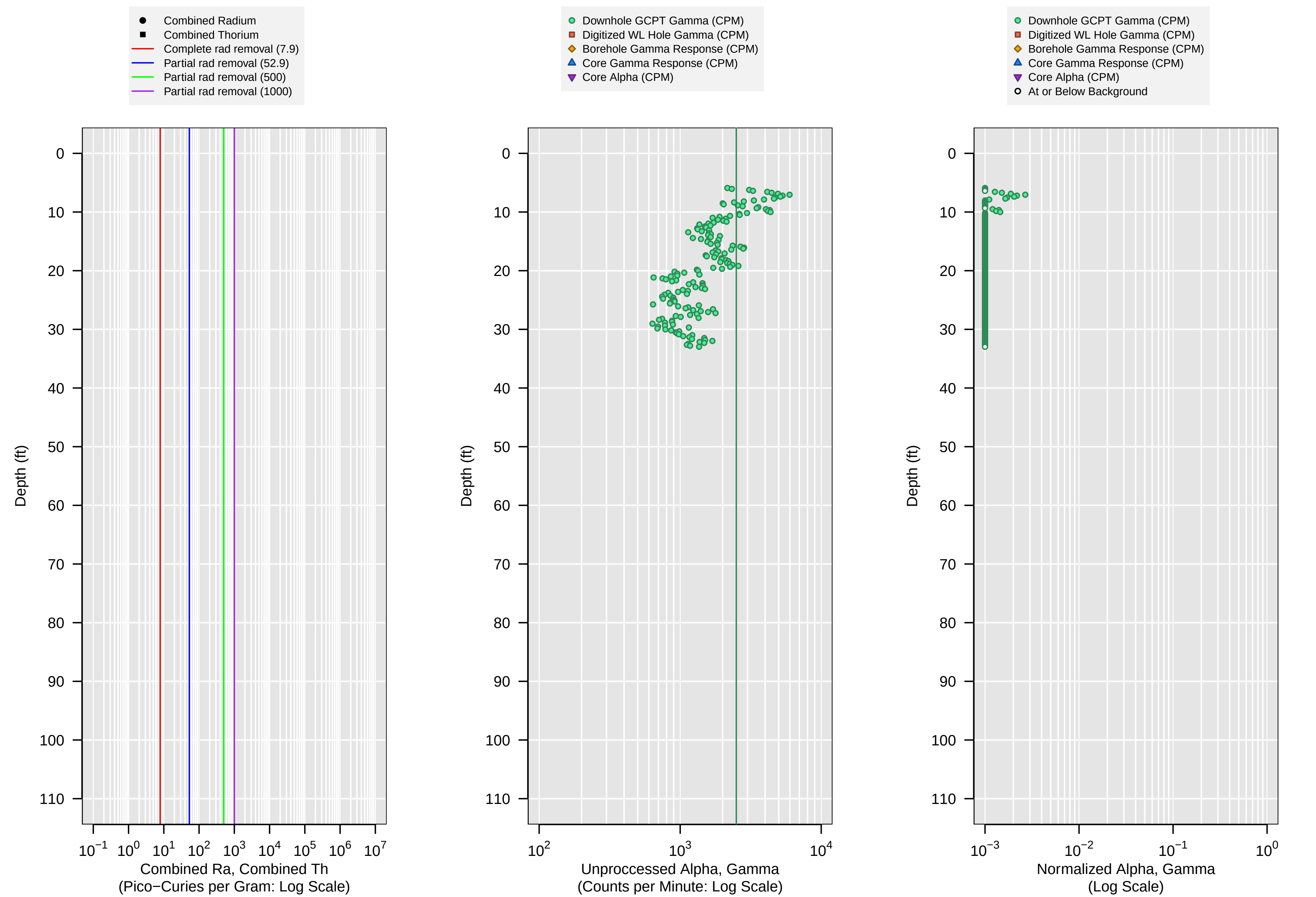

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−1D−13B

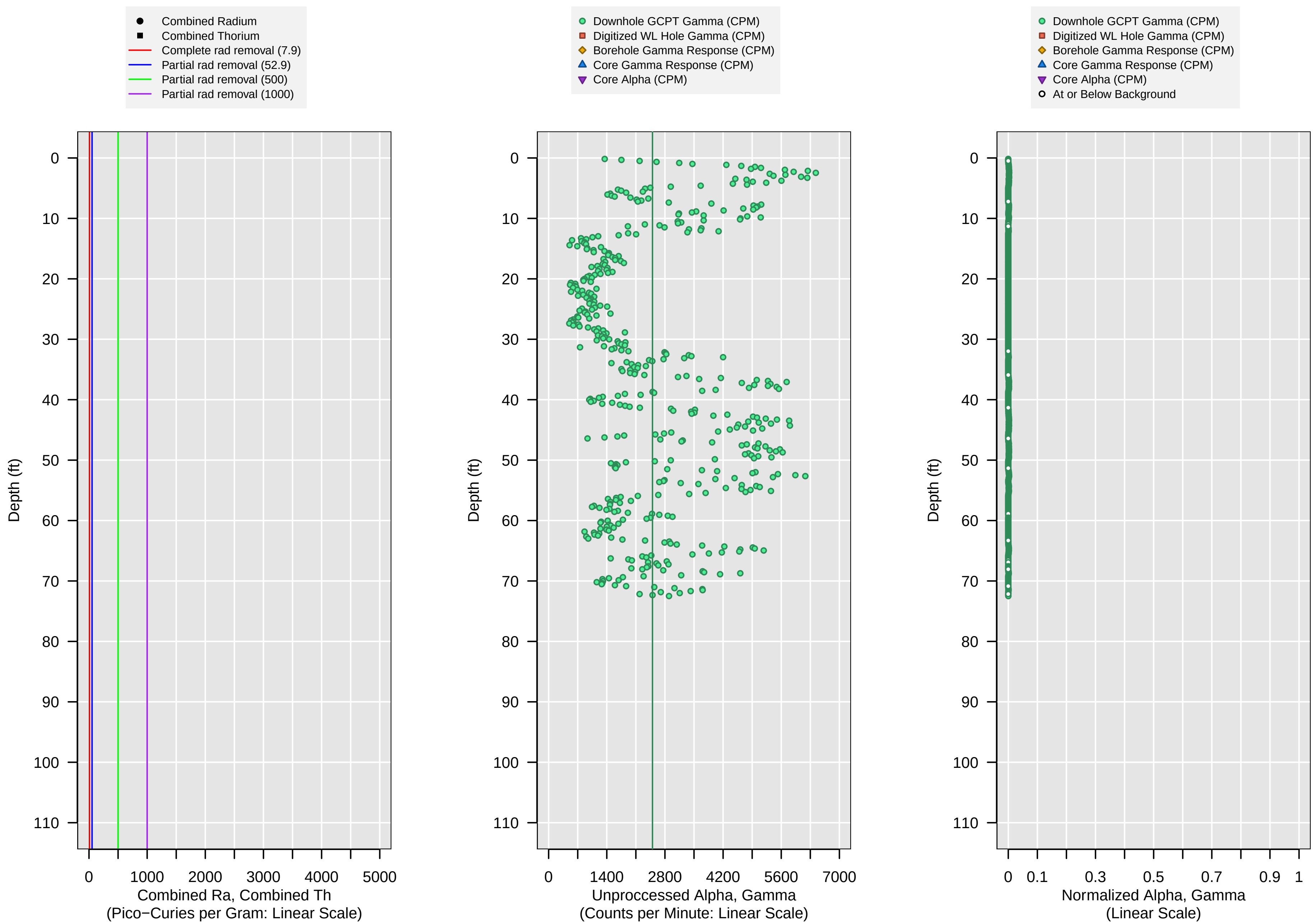


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−1D−13B

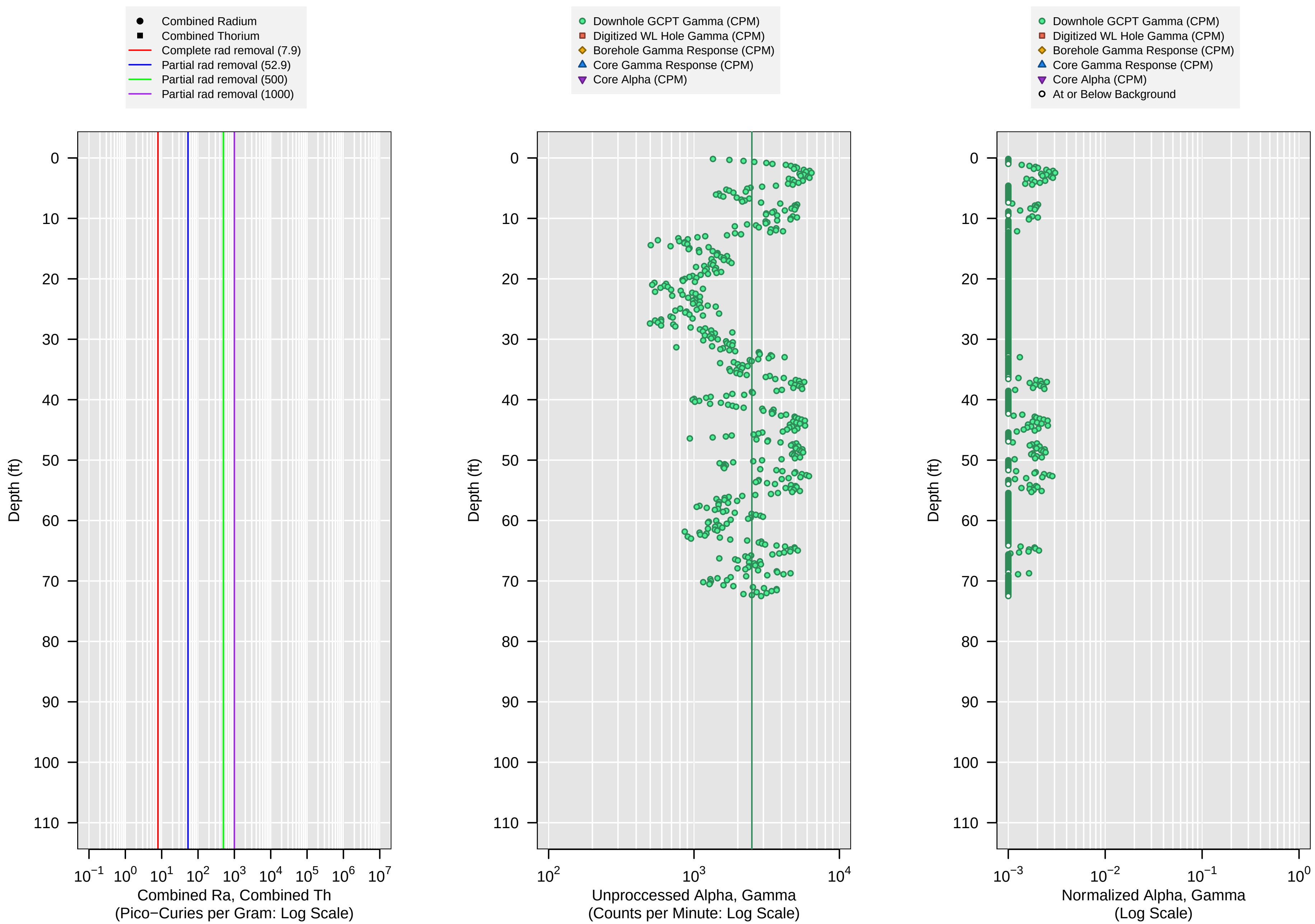

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−1D−13C



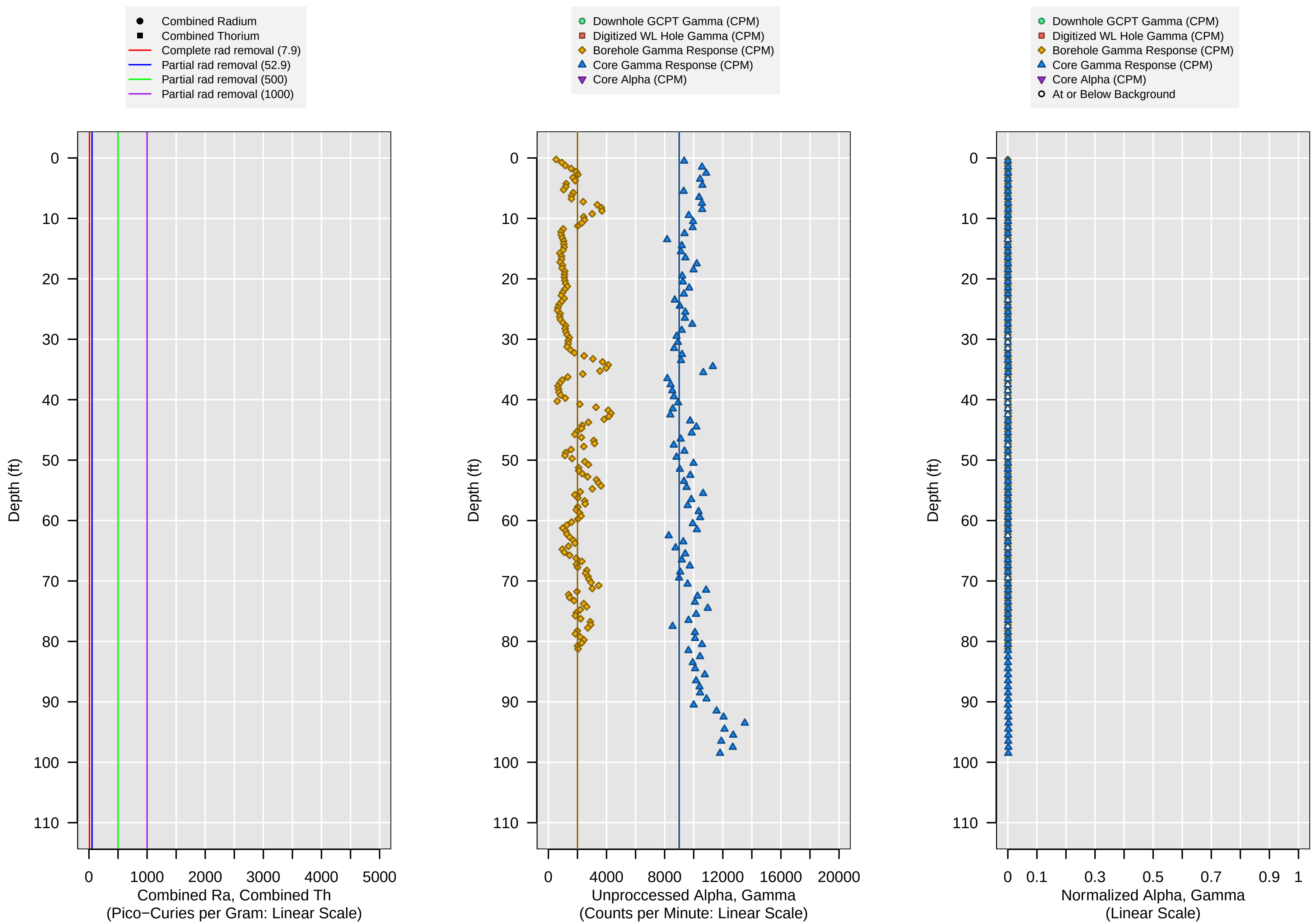
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1400
2800
4200
5600
7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

GCPT−1D−13C



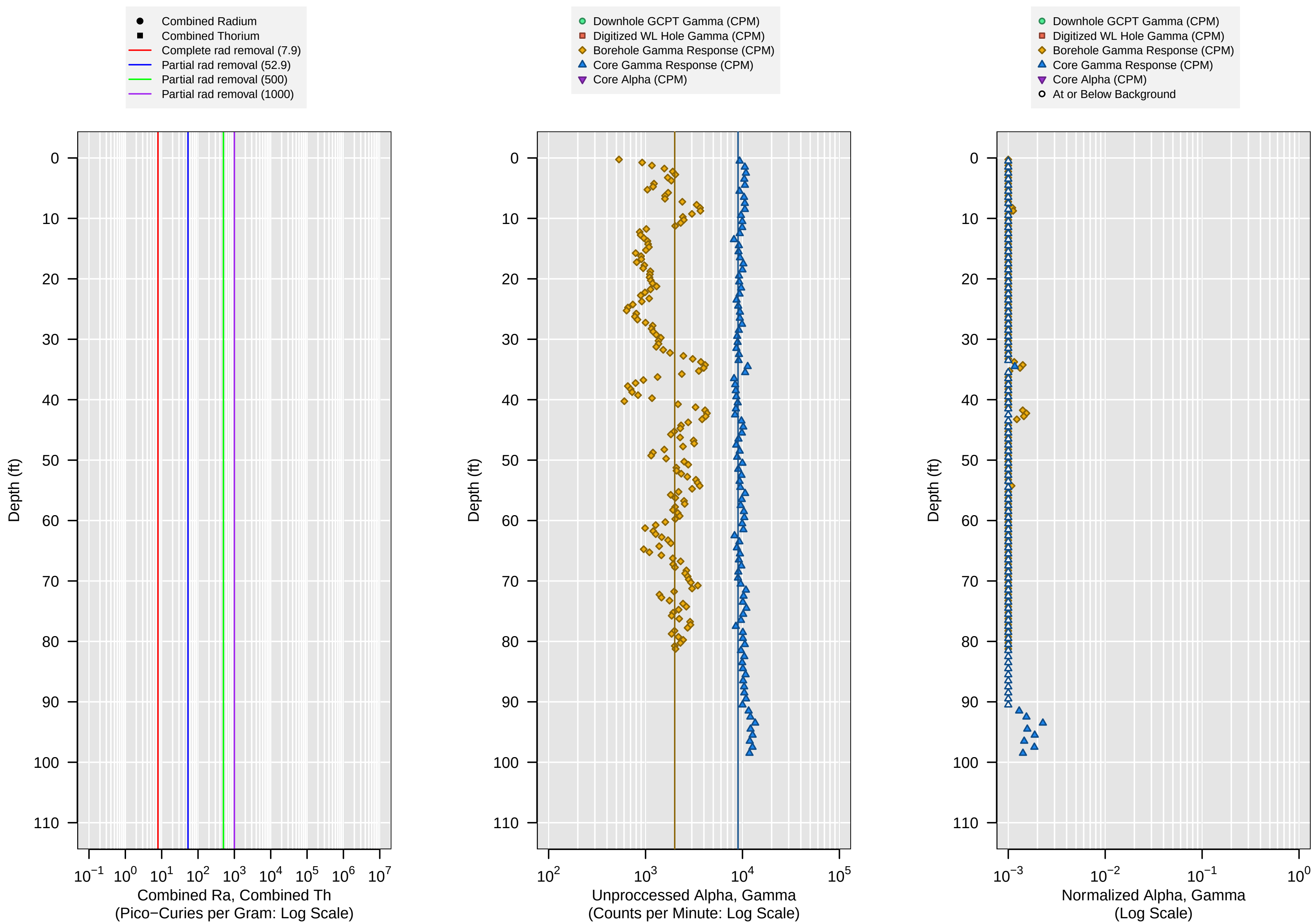
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

Sonic−1D−13



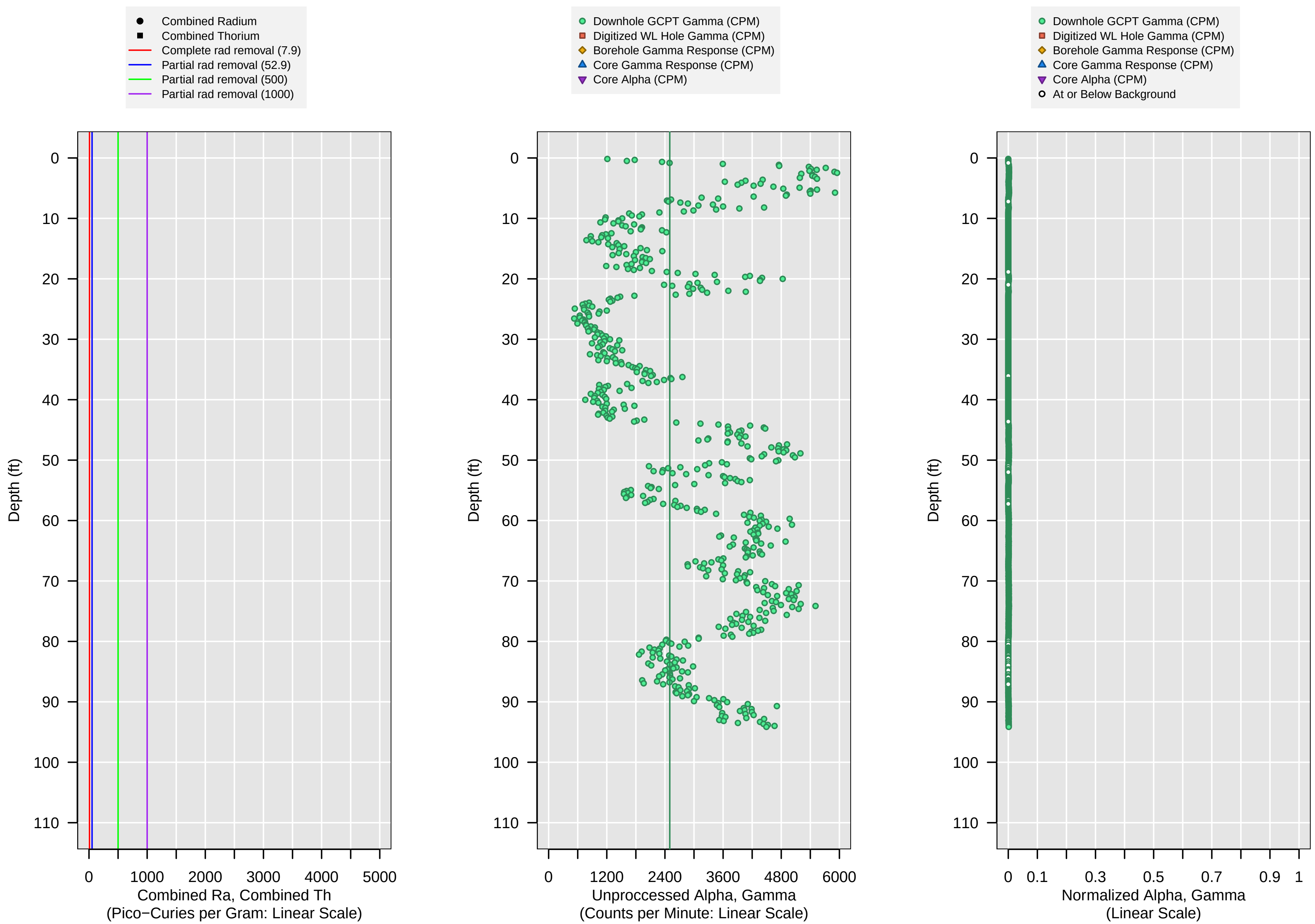
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

Sonic−1D−13

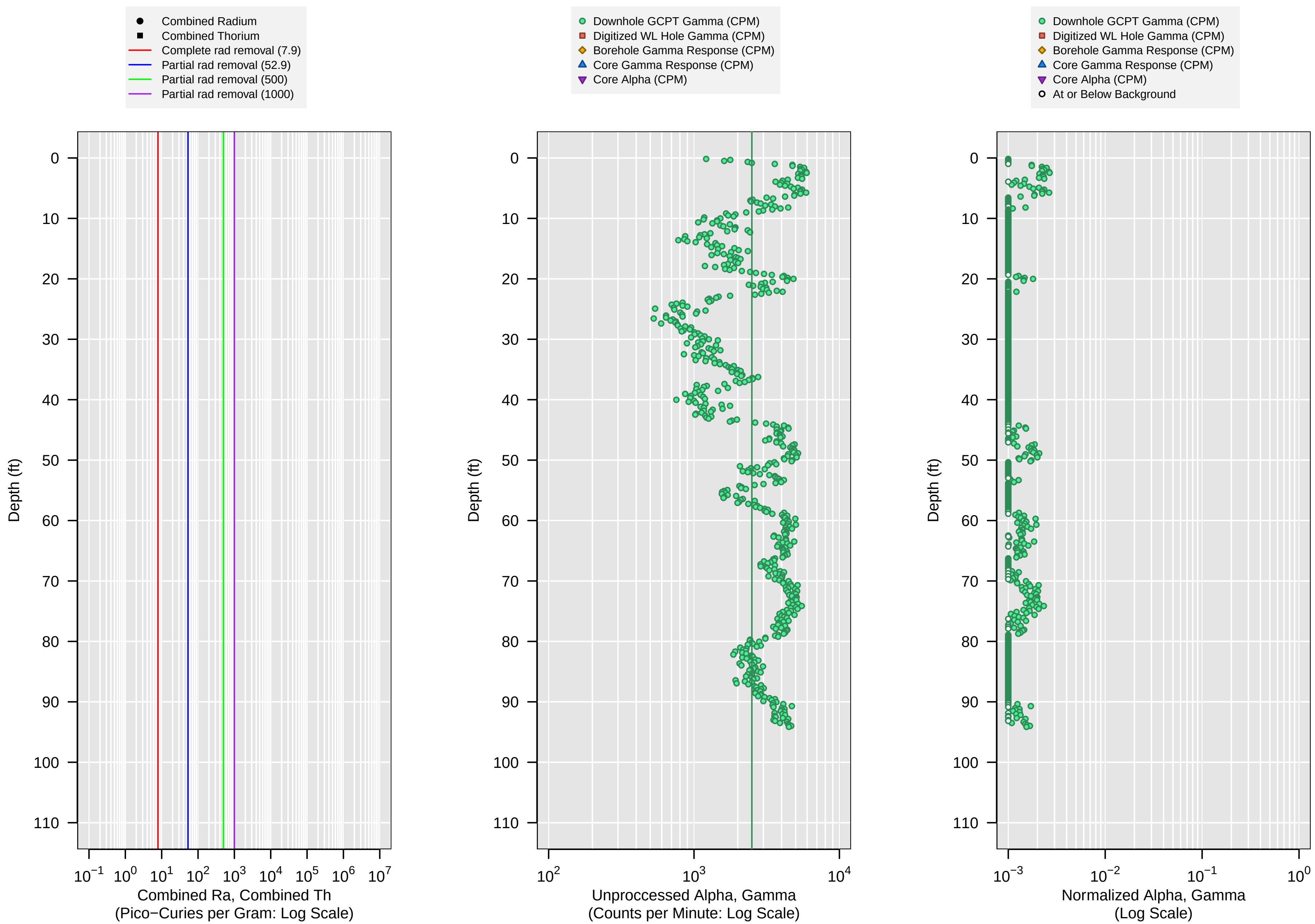


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−1D−14

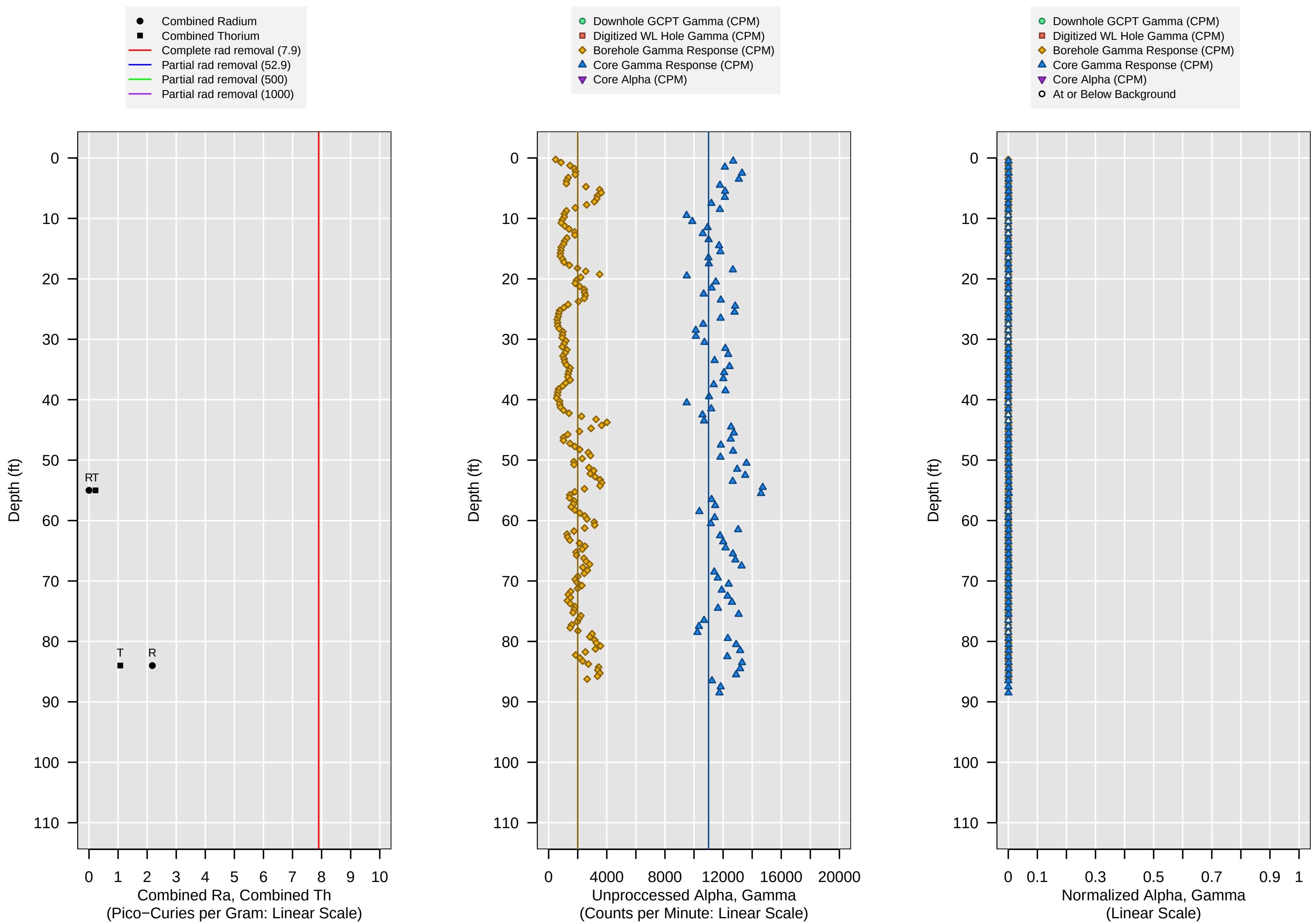

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−1D−14



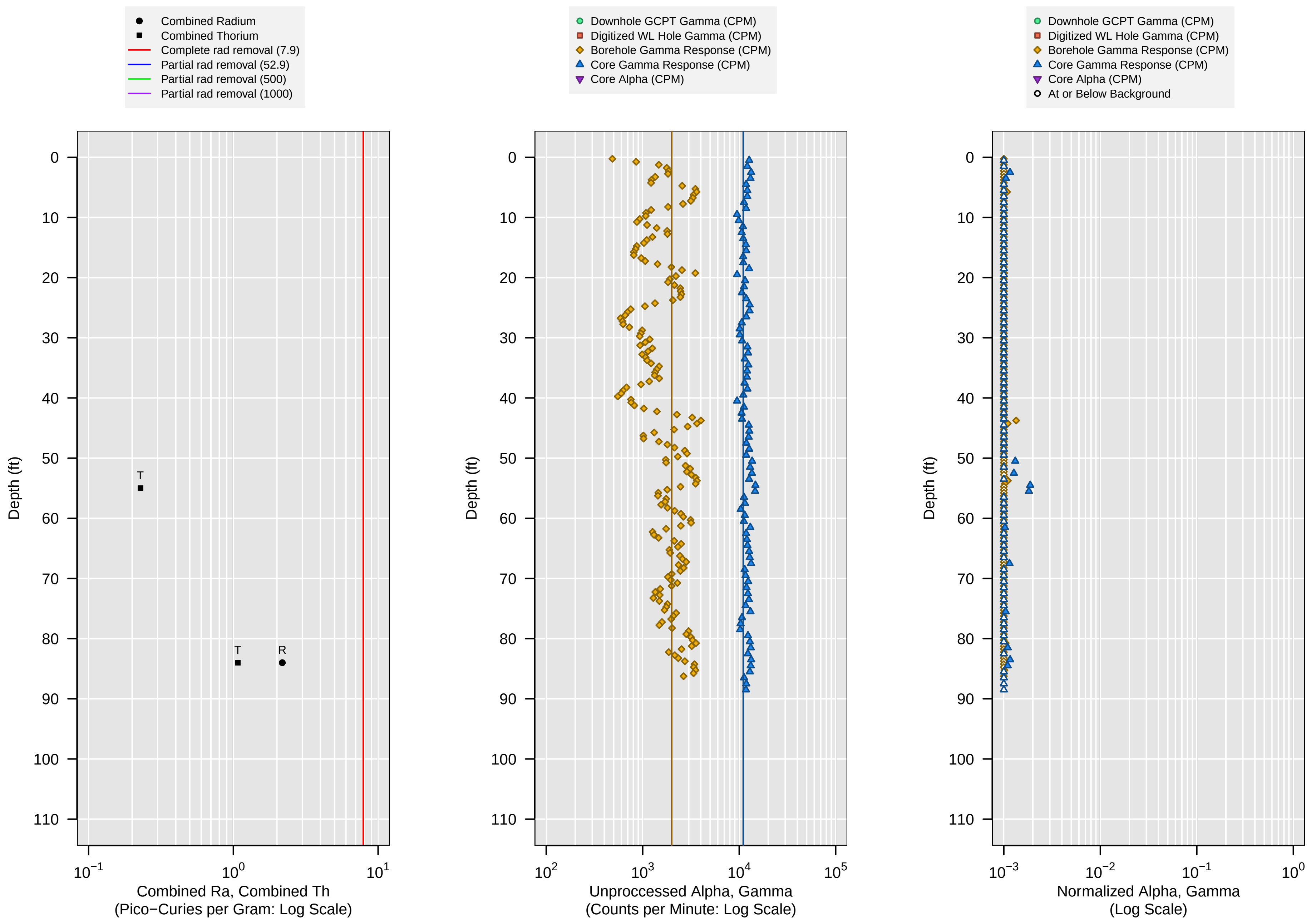
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

Sonic−1D−14



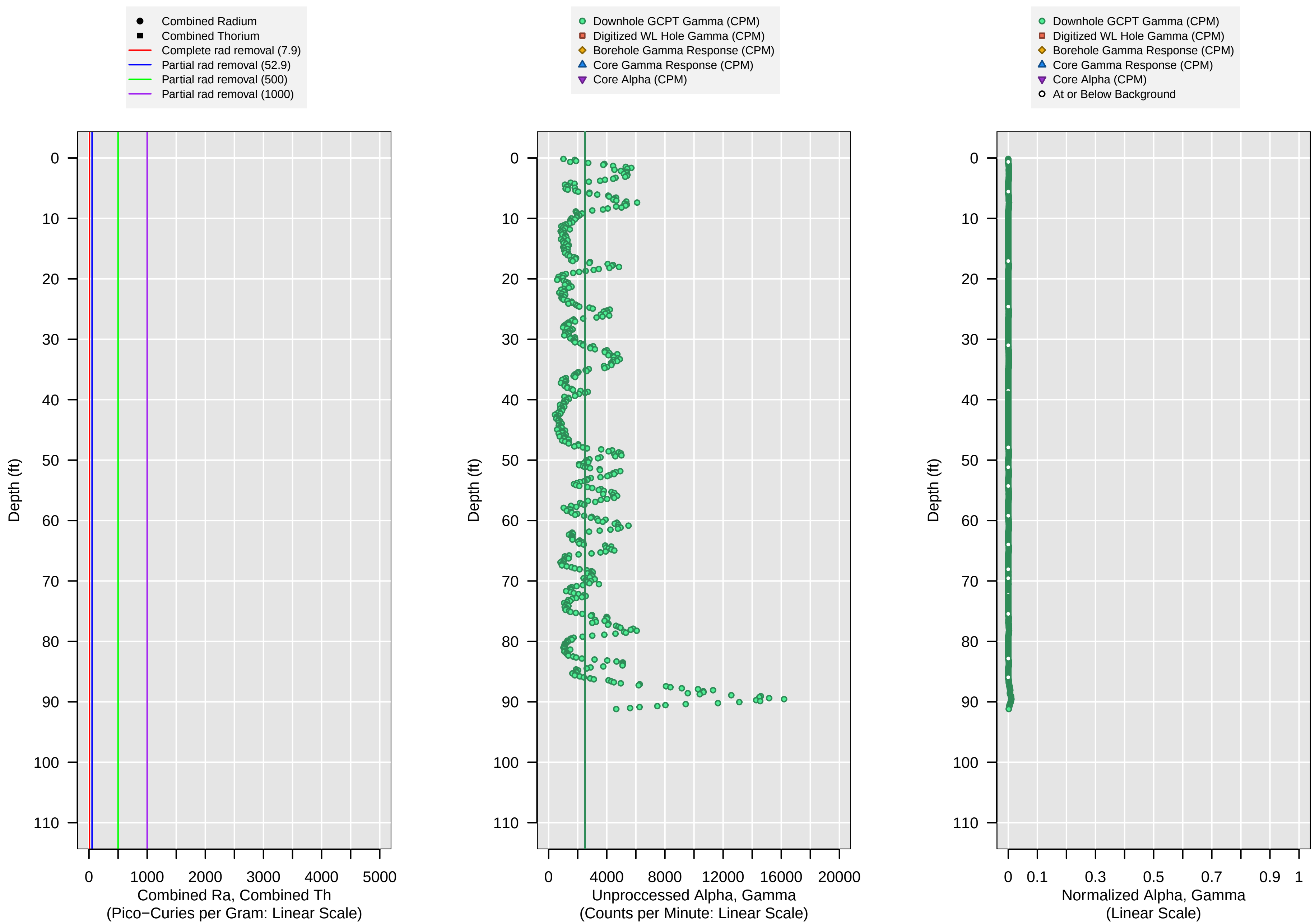
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
RT
T
R
0
10
20
30
40
50
60
70
80
90
100
110
0 1 2 3 4 5 6 7 8 9 10
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0 4000 8000 12000 16000 20000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

Sonic−1D−14



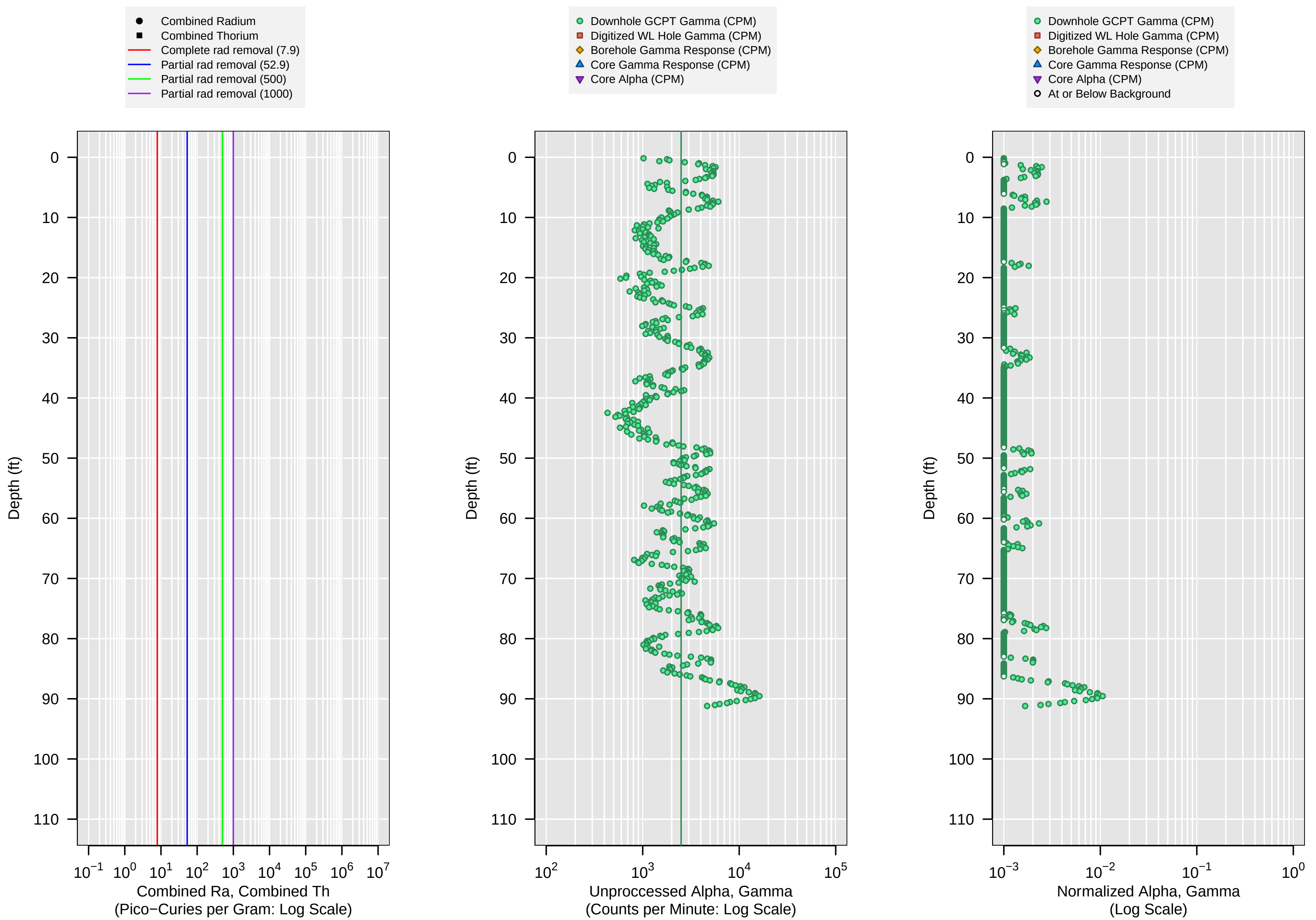
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
T
T
R
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

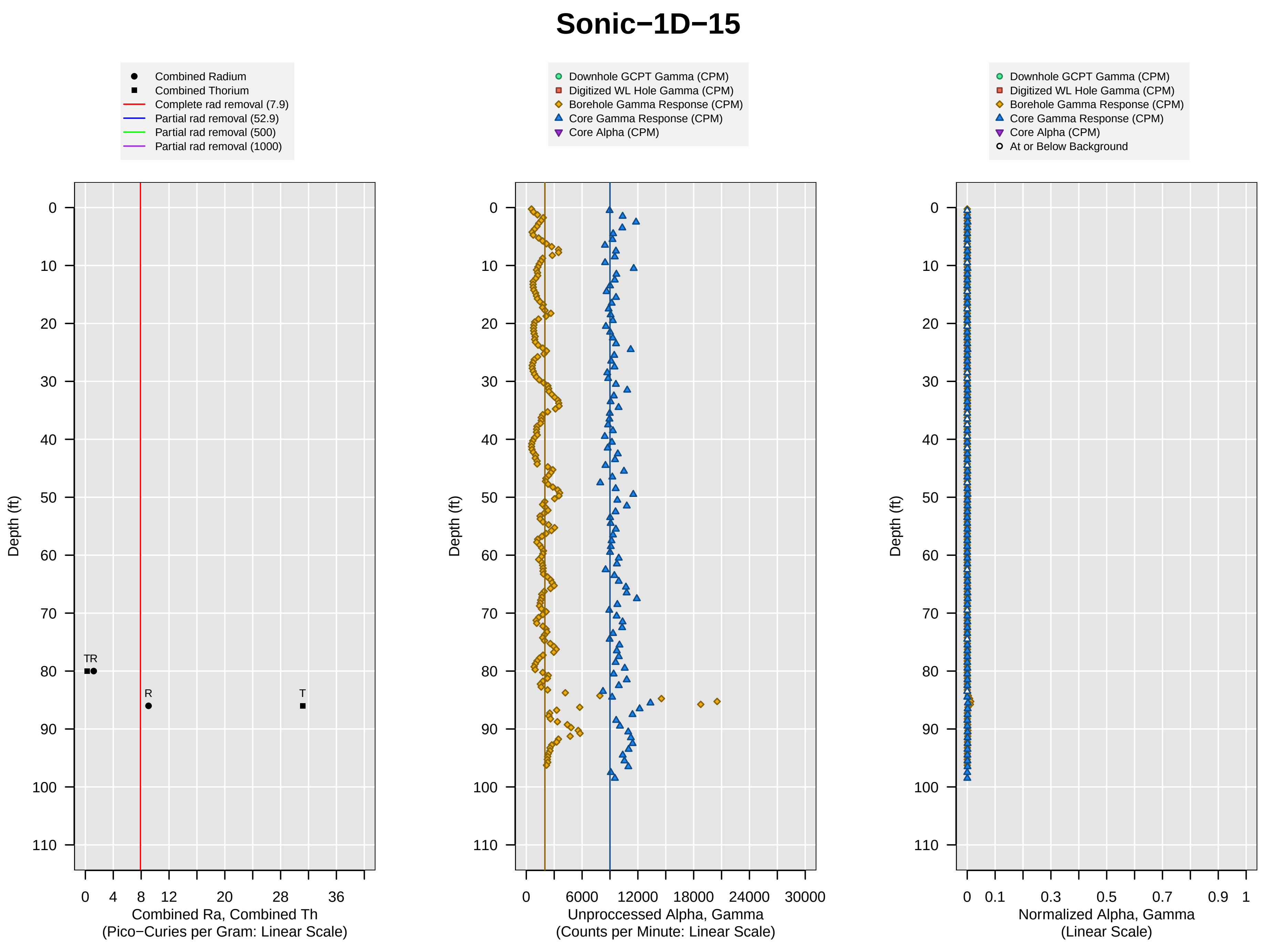
GCPT−1D−15



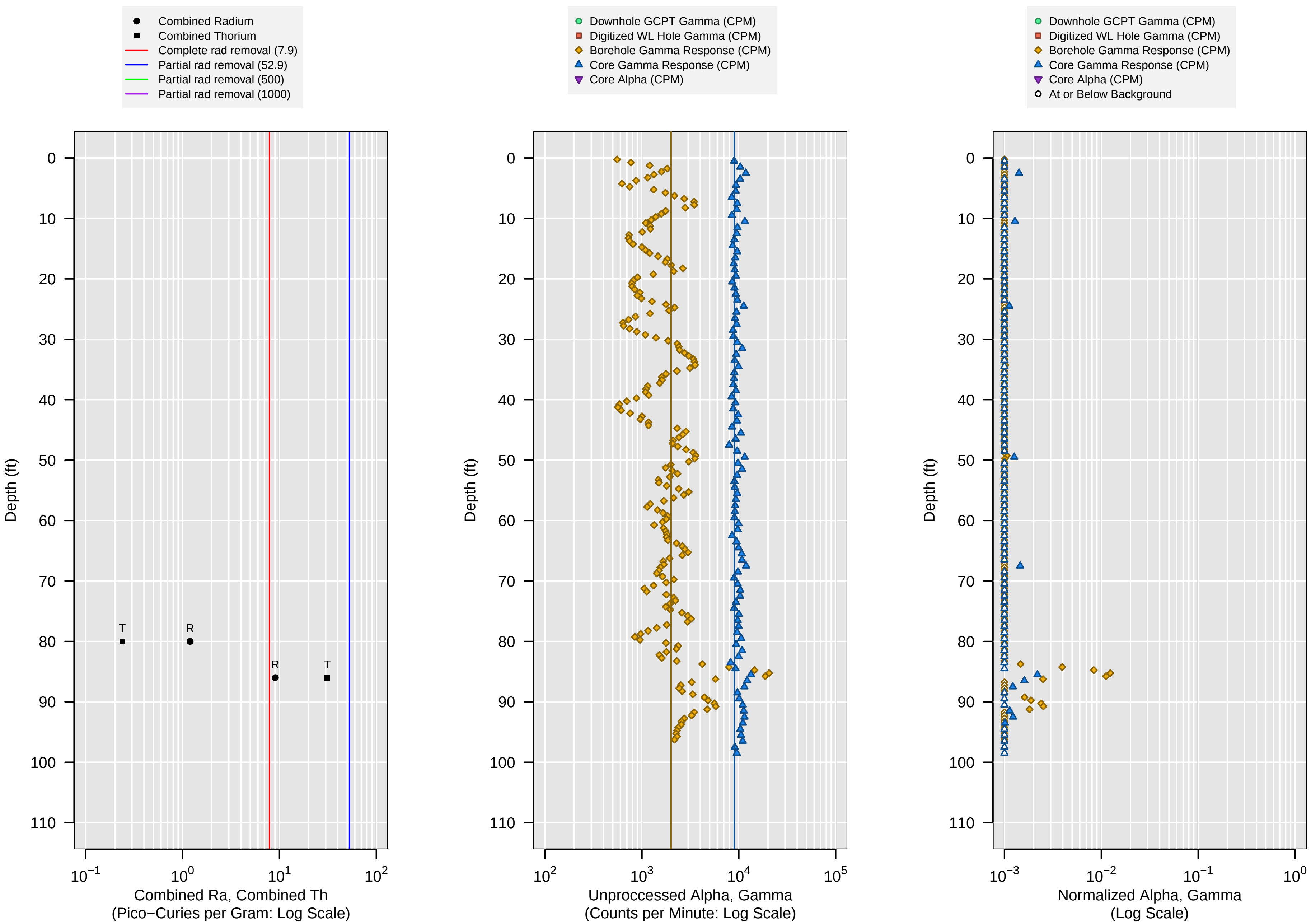
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
4000
8000
12000
16000
20000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

GCPT−1D−15

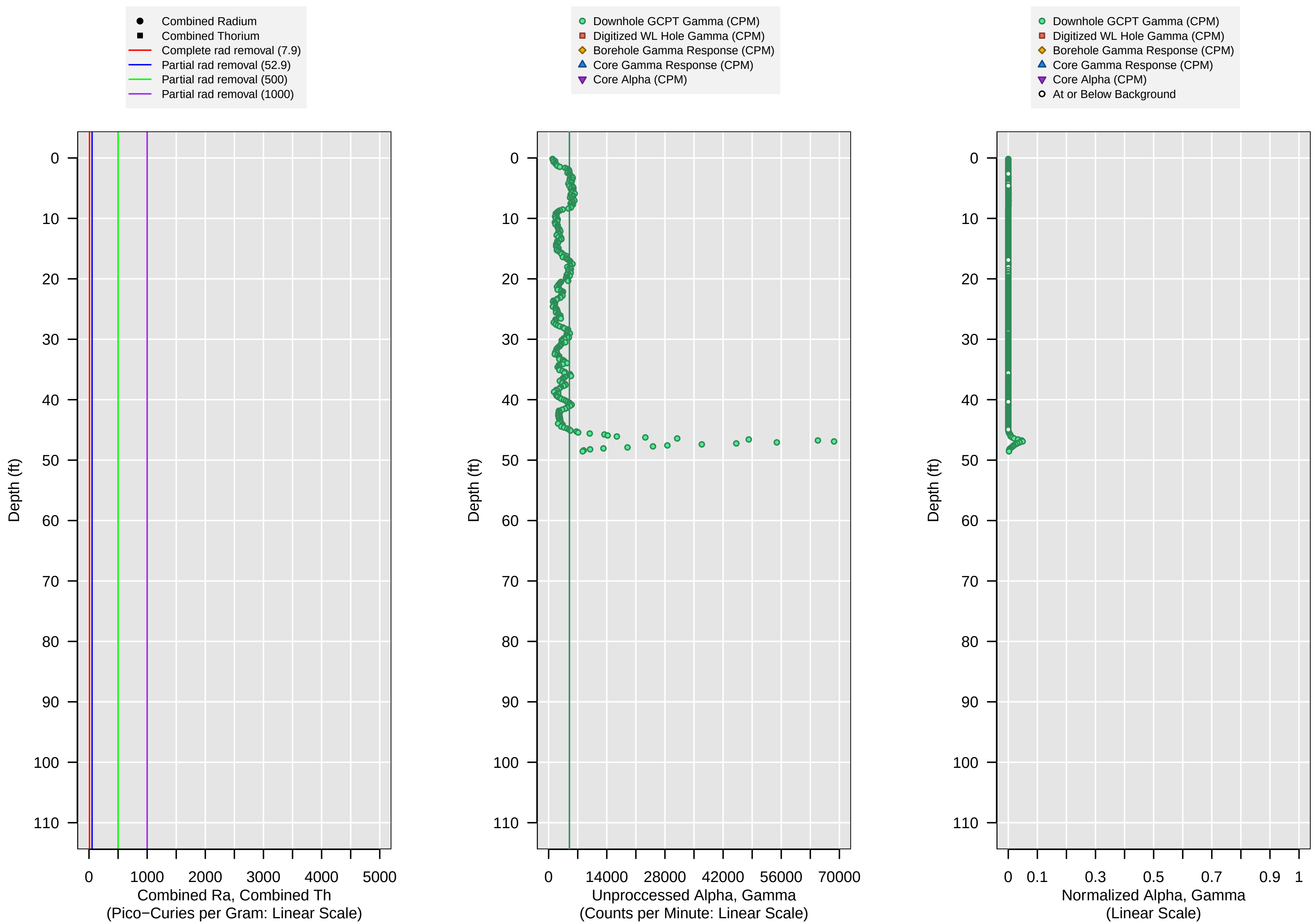

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

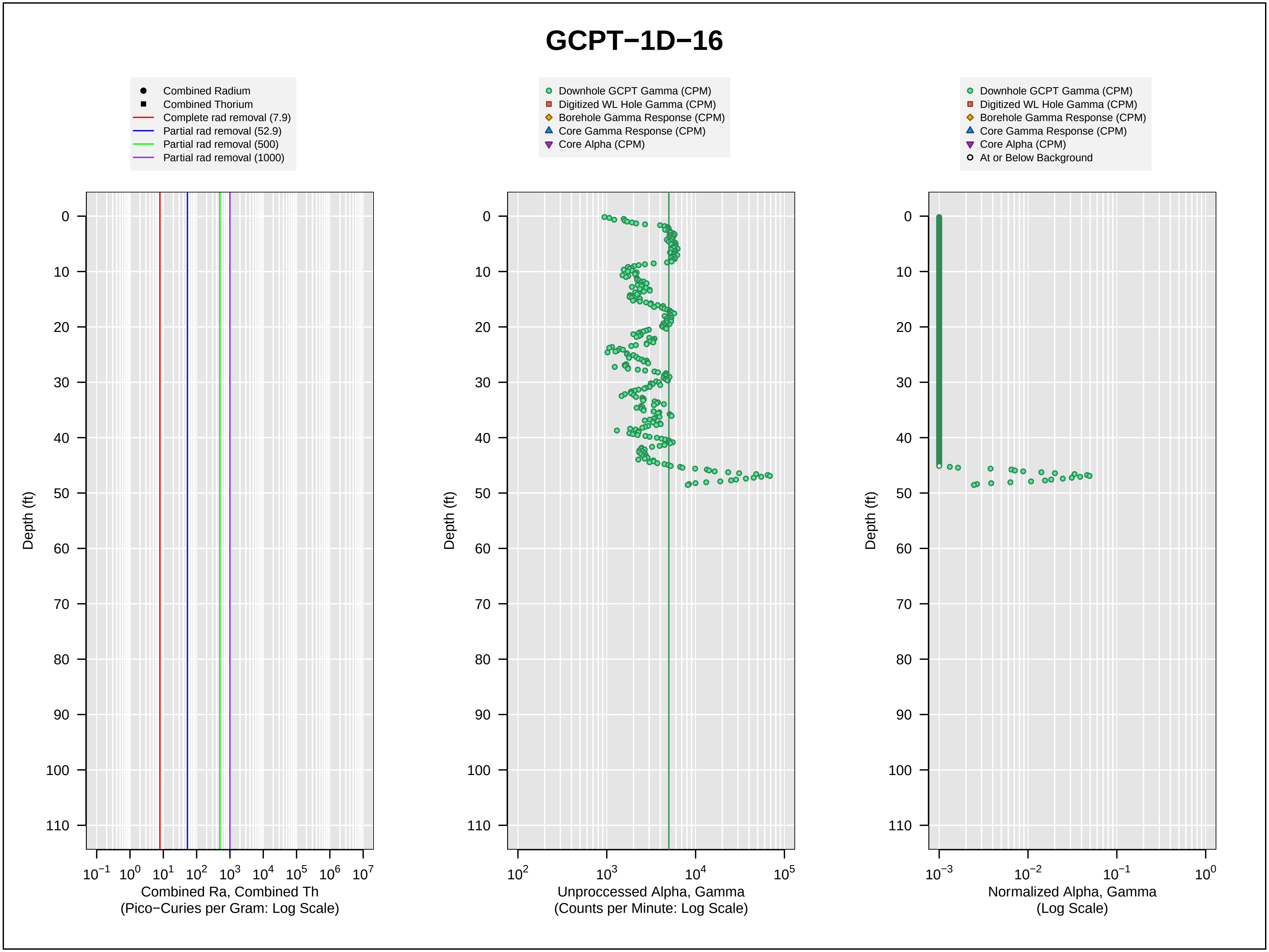

Sonic−1D−15
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
TR
R
T
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

Sonic−1D−15


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
T
R
R
T
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

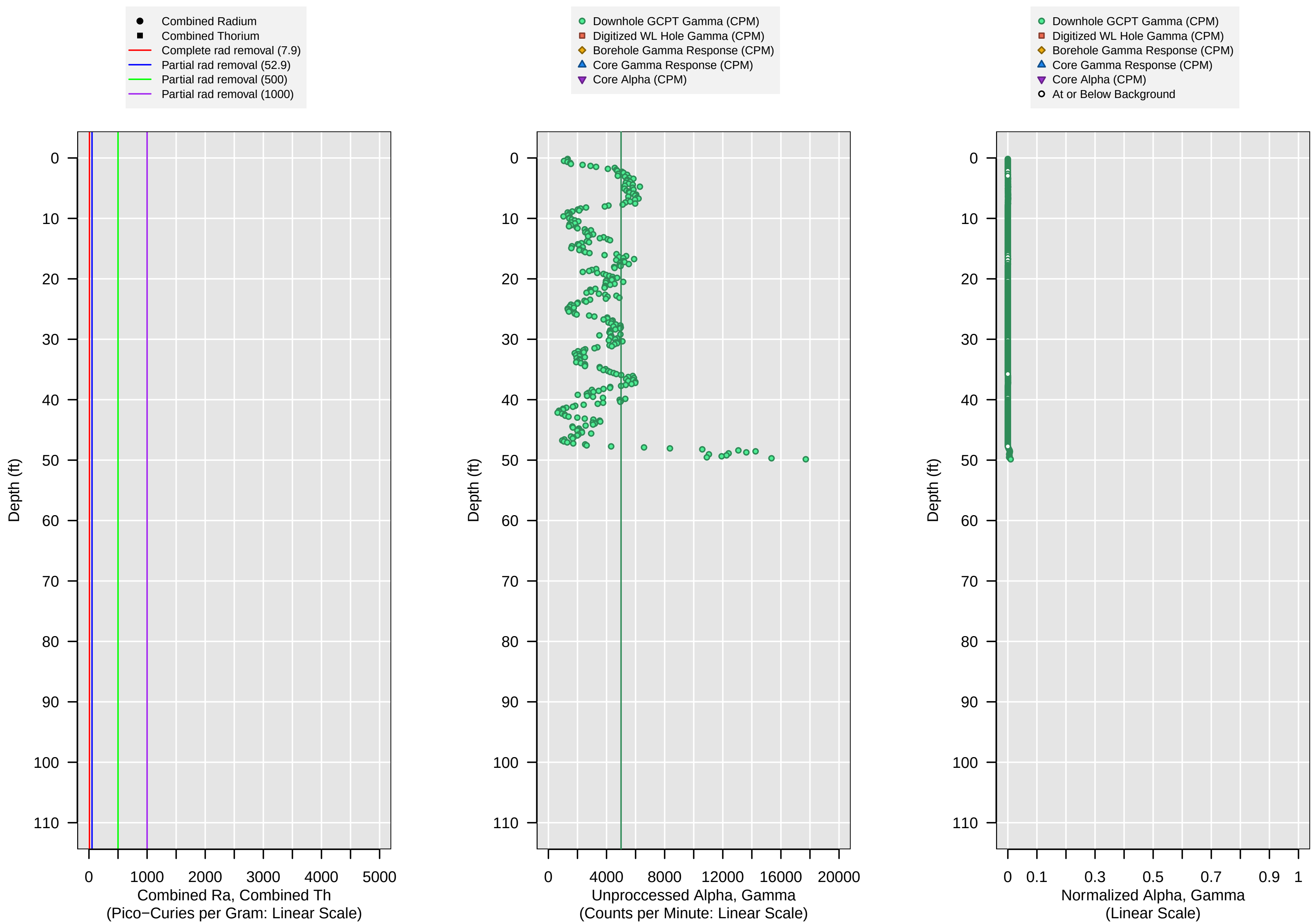
GCPT−1D−16


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0 10 20 30 40 50 60 70 80 90 100 110
0 1000 2000 3000 4000 5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0 14000 28000 42000 56000 70000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

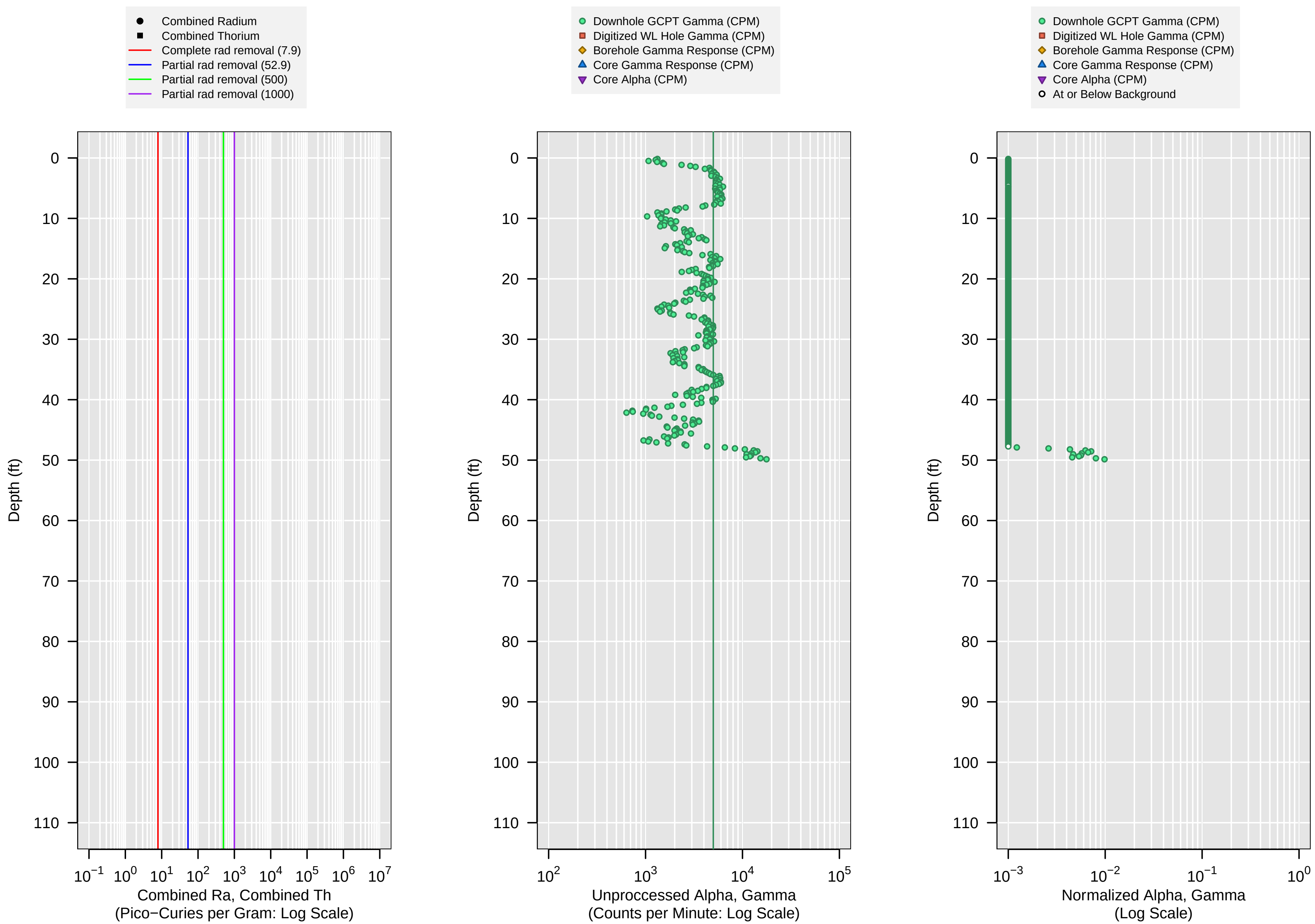


GCPT−1D−16
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

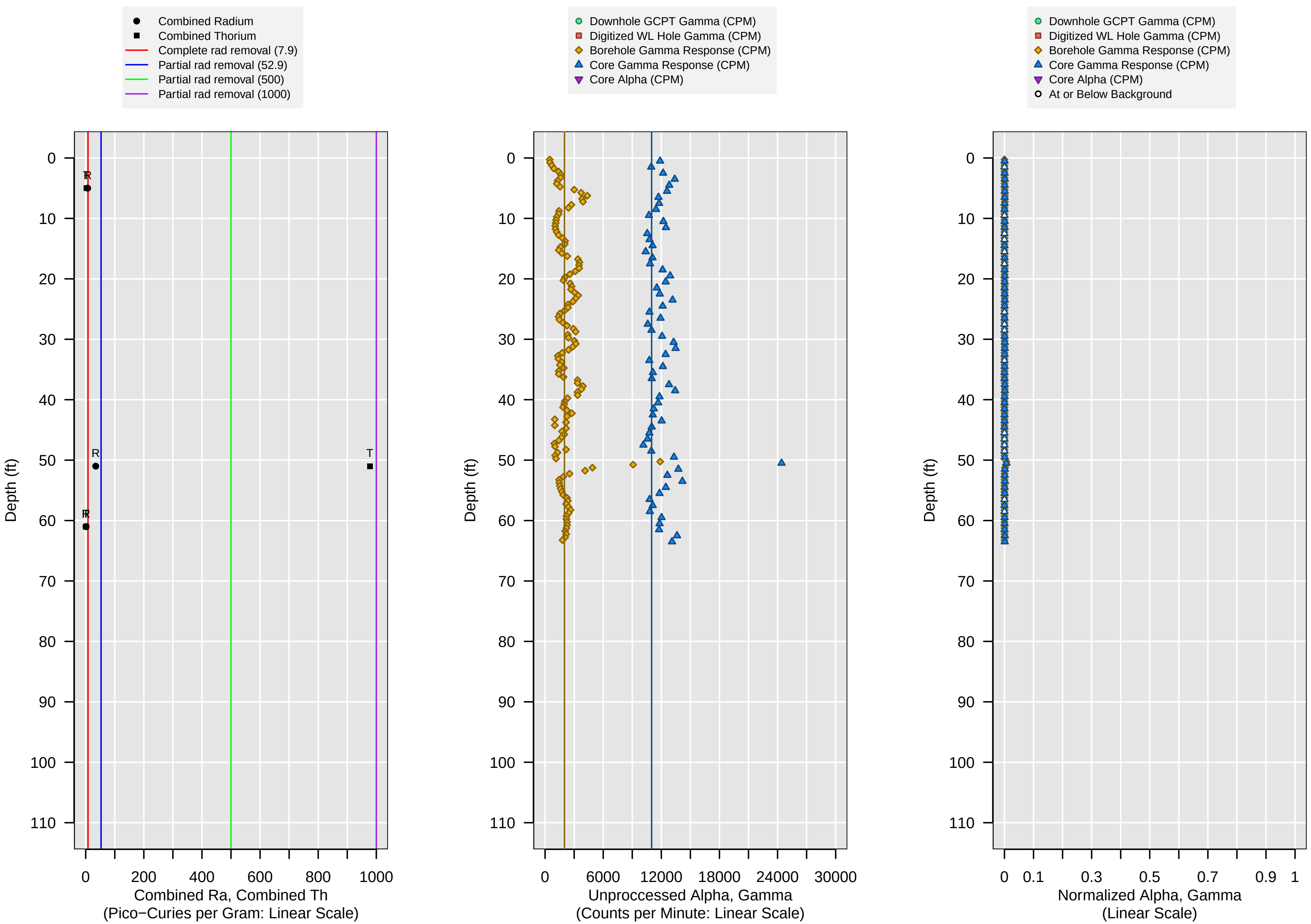
GCPT−1D−16A


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
4000
8000
12000
16000
20000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

GCPT−1D−16A

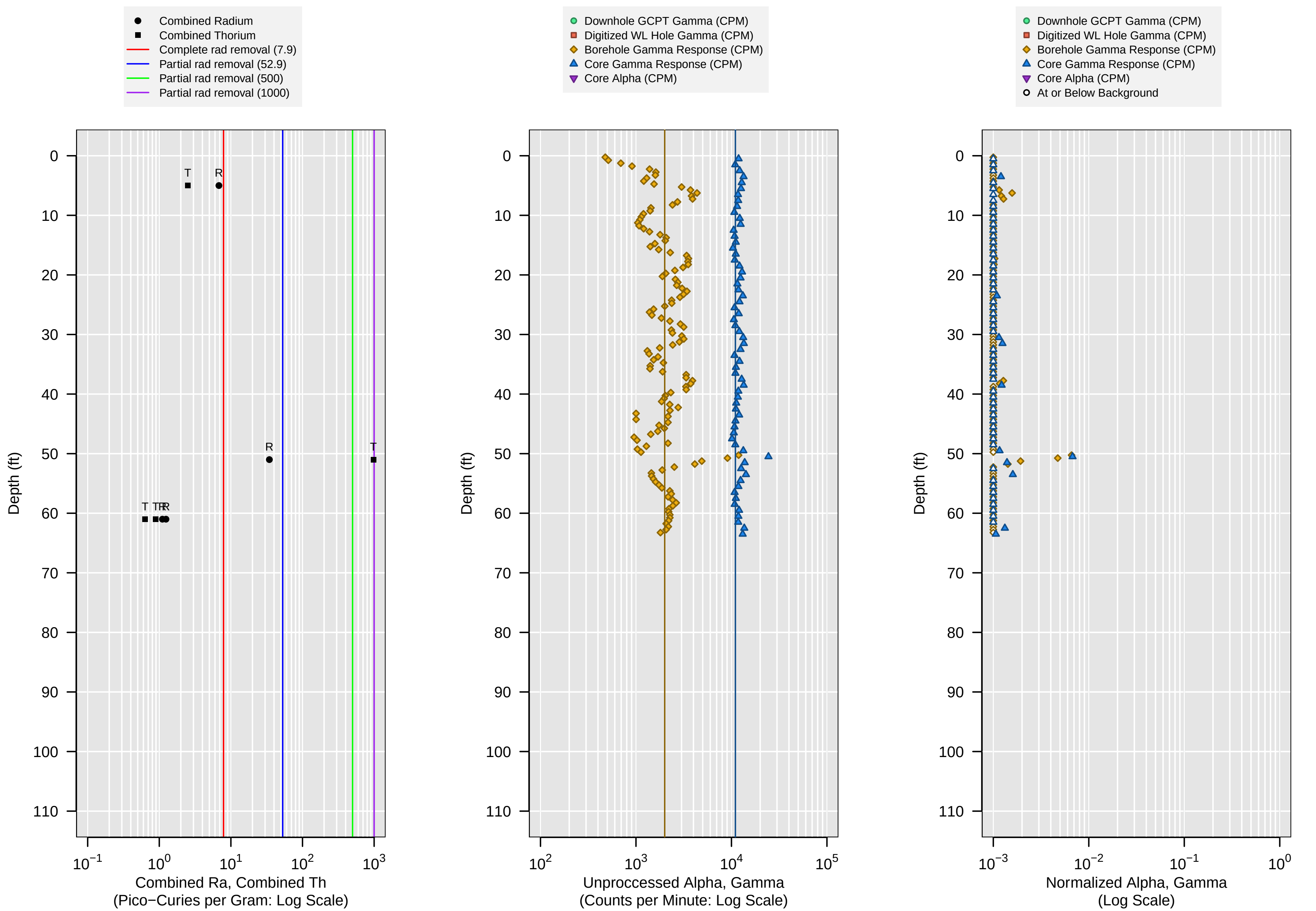

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

Sonic−1D−16

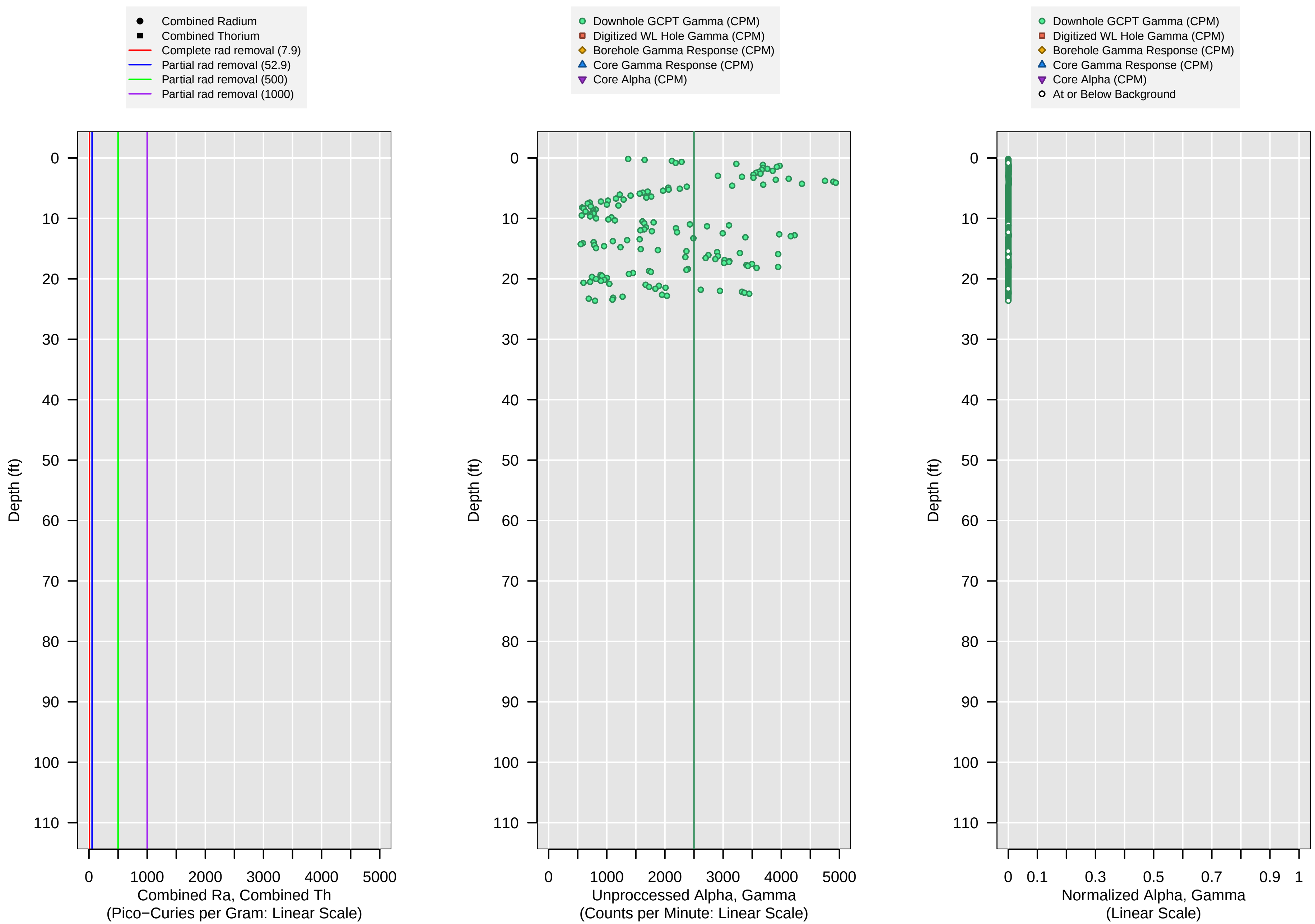


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

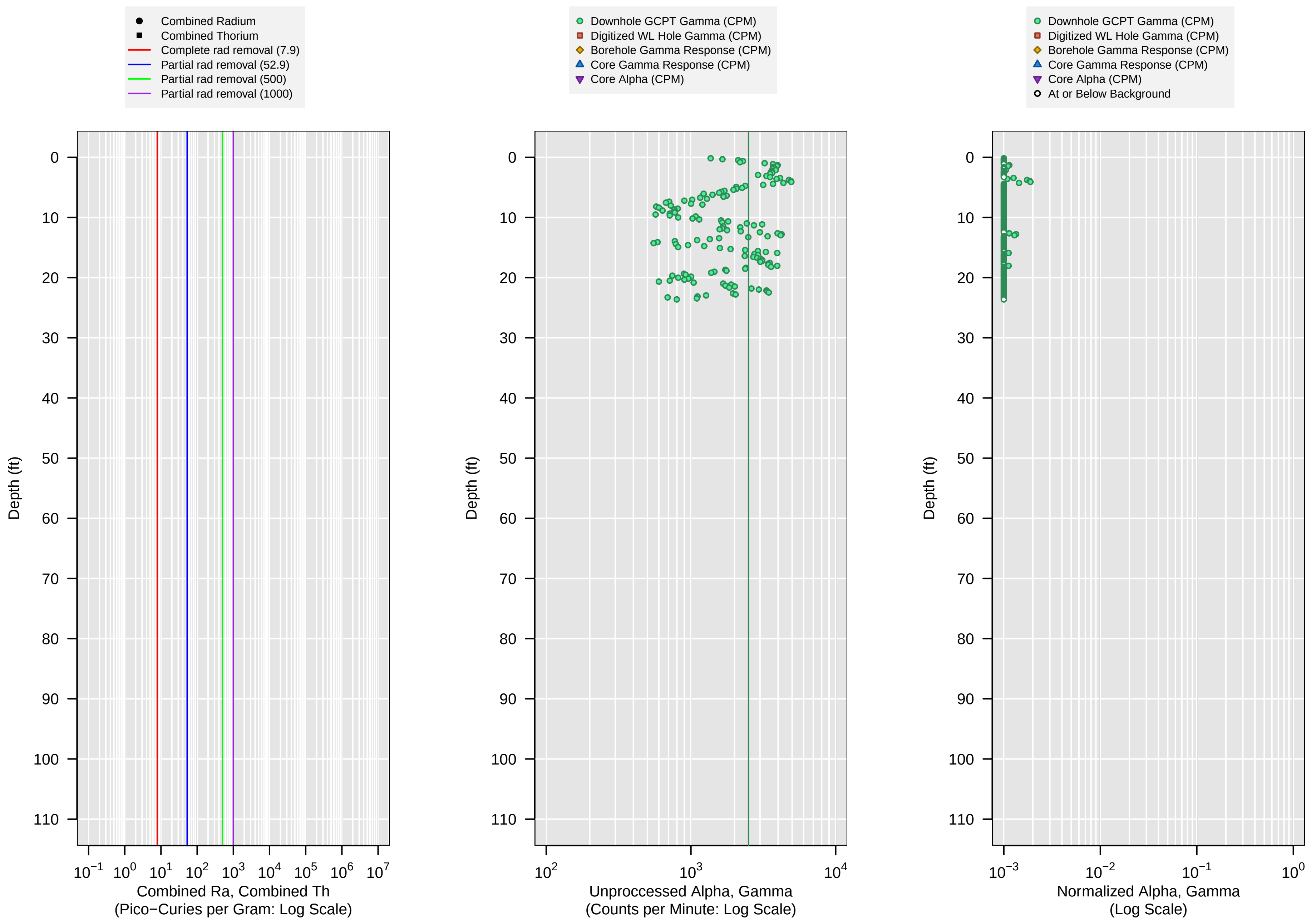
Sonic−1D−16


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−1D−17

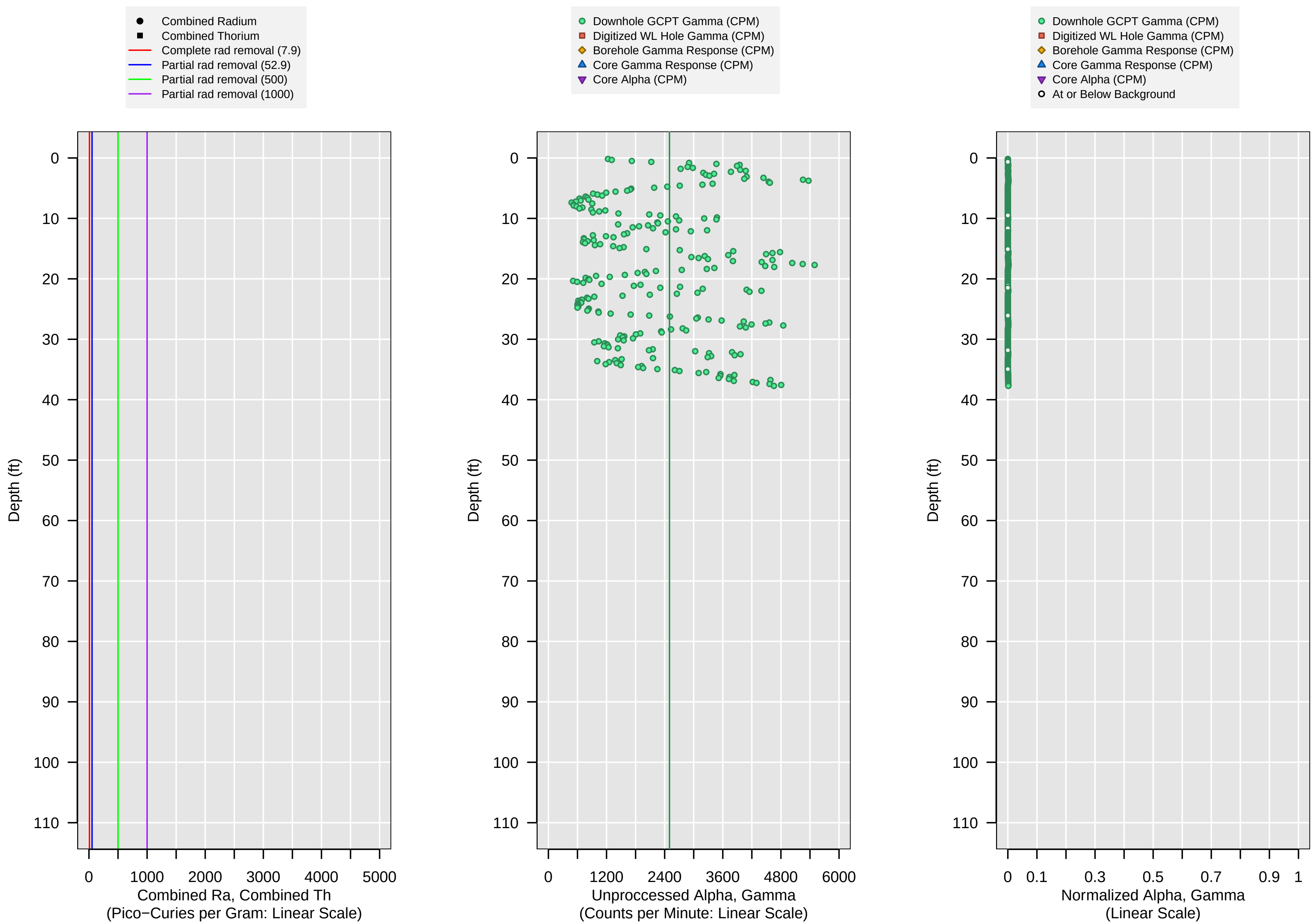

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Linear Scale)

GCPT−1D−17

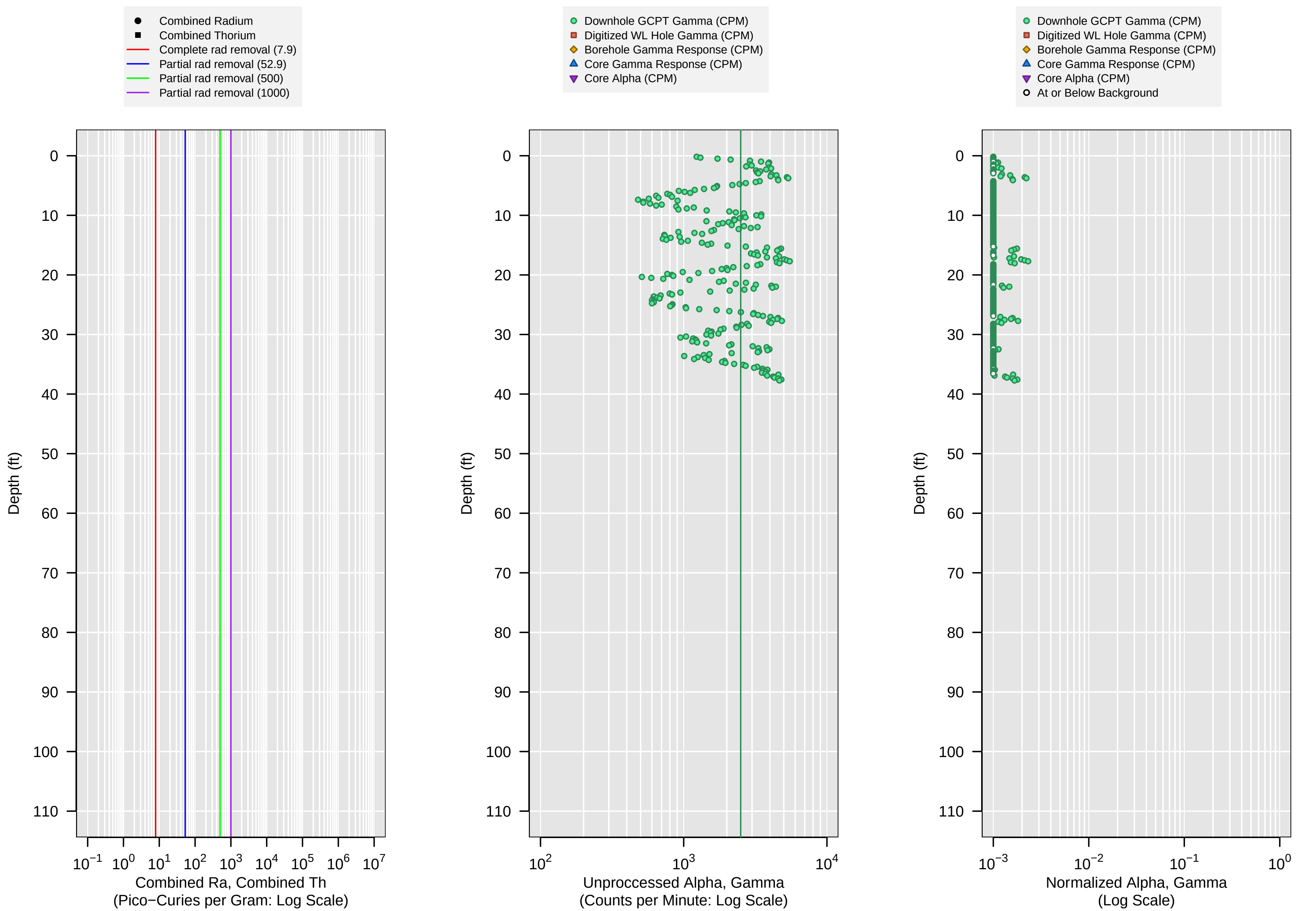


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

GCPT−1D−17A

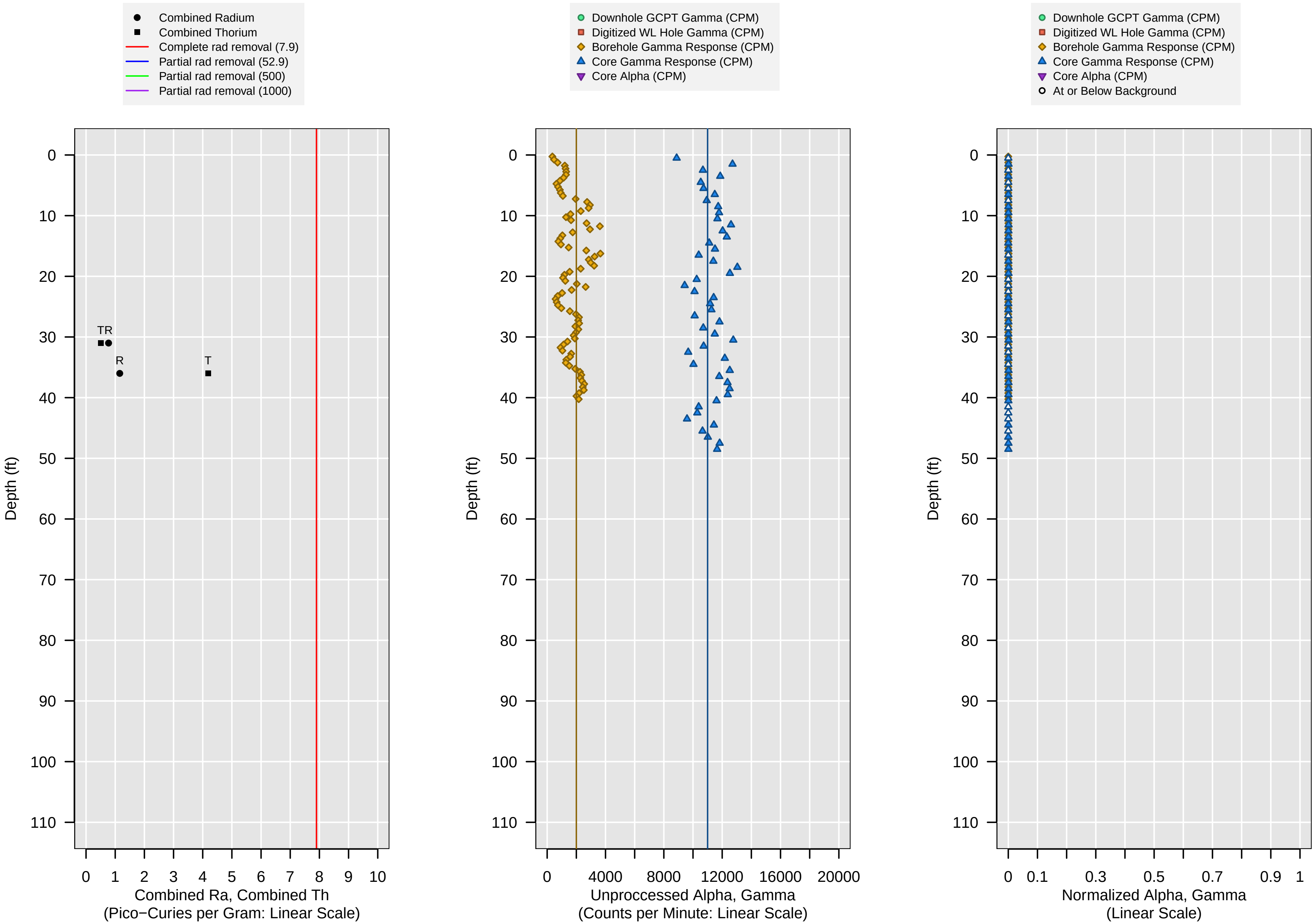

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−1D−17A



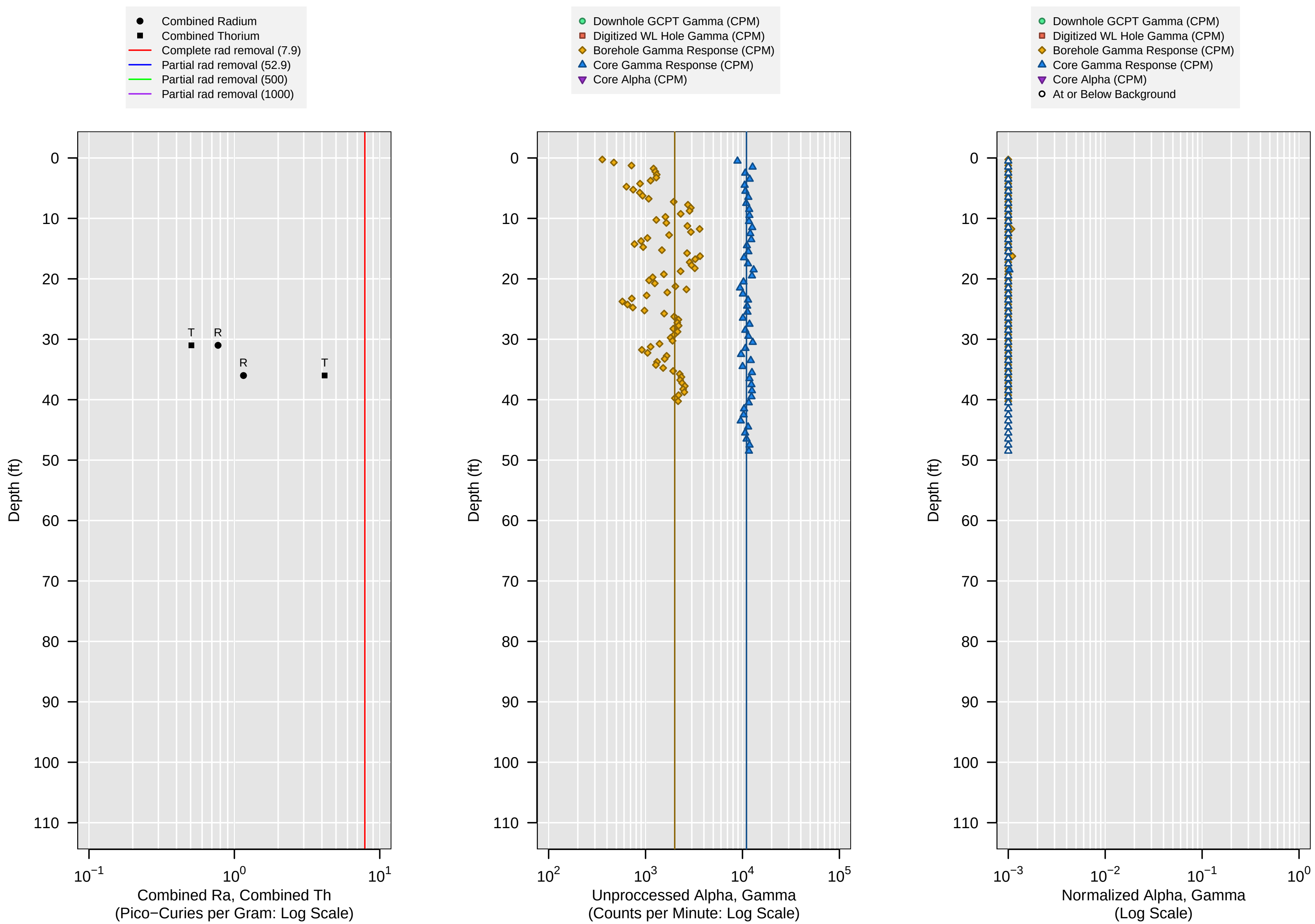
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

Sonic−1D−17

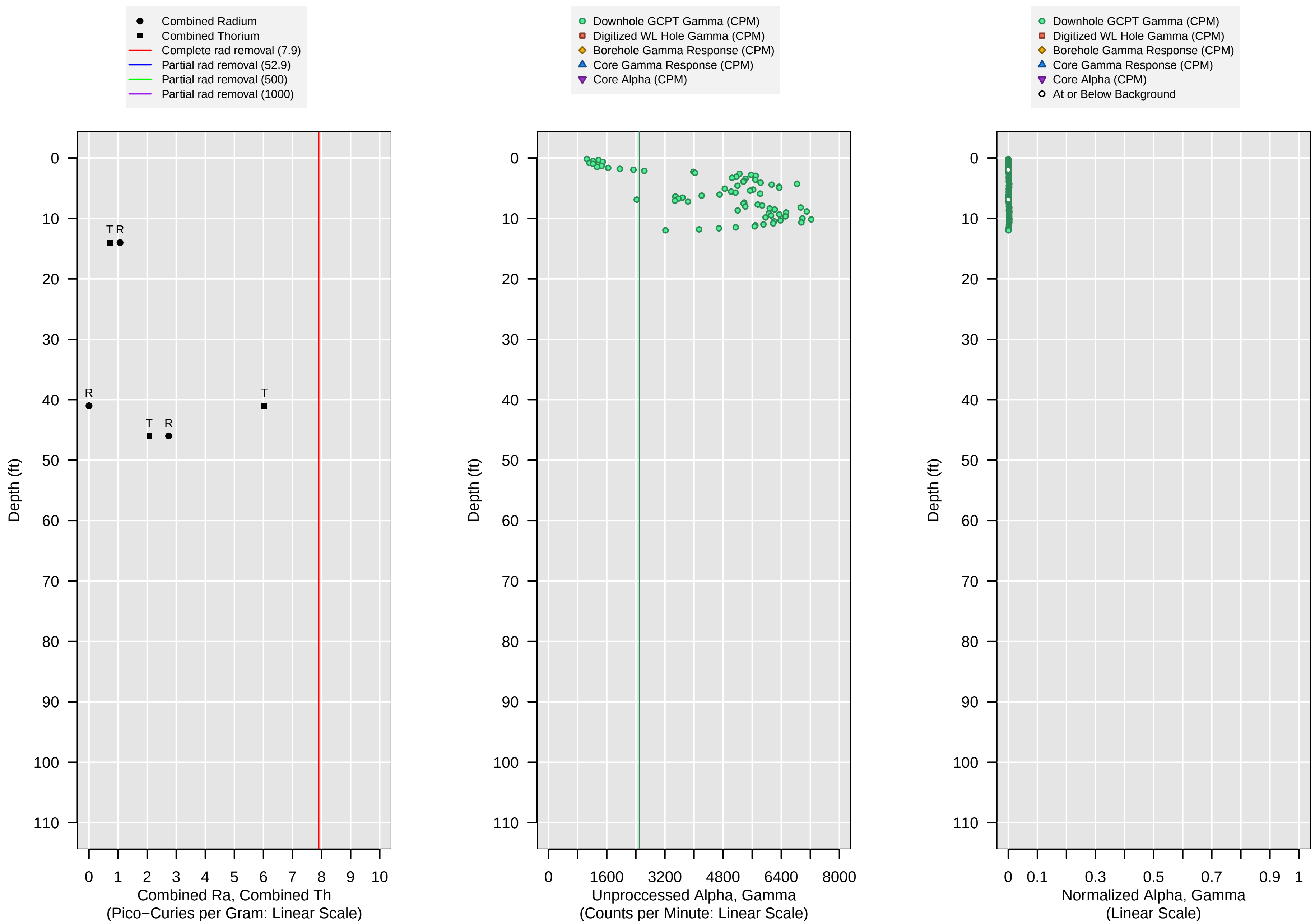


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
TR
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

Sonic−1D−17

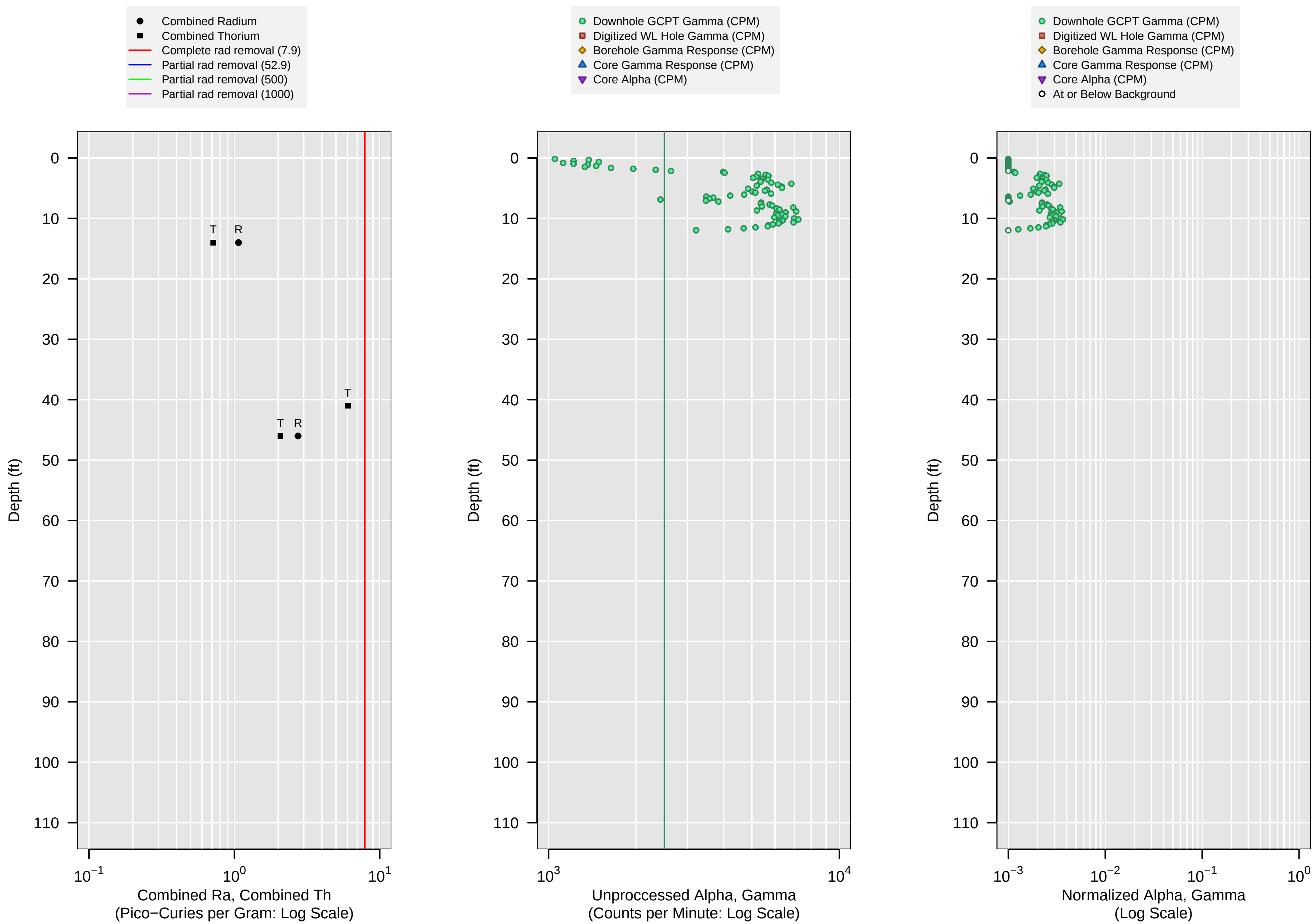

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
T
R
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−1D−18



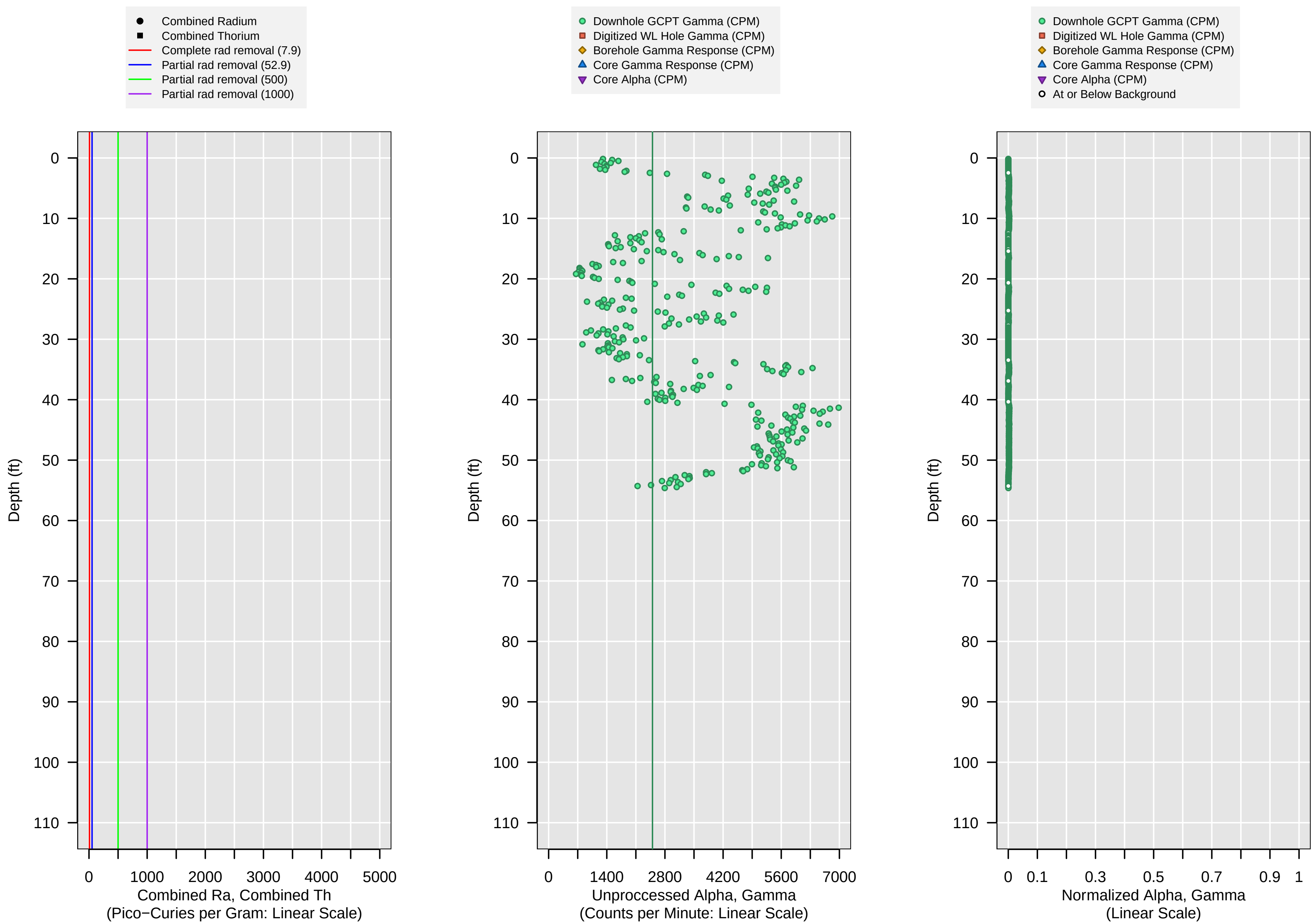
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−1D−18

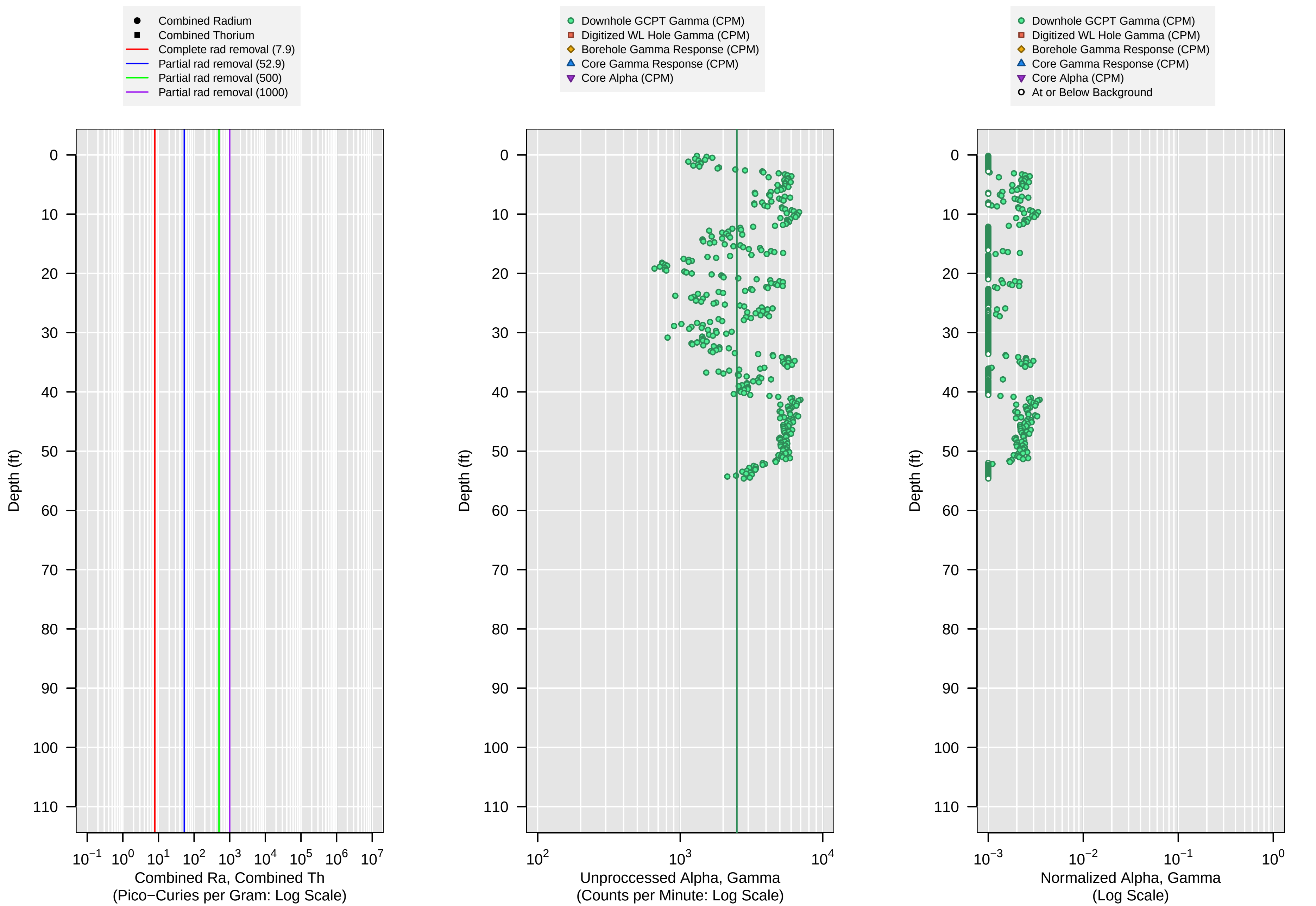


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
T
R
T
T
R
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

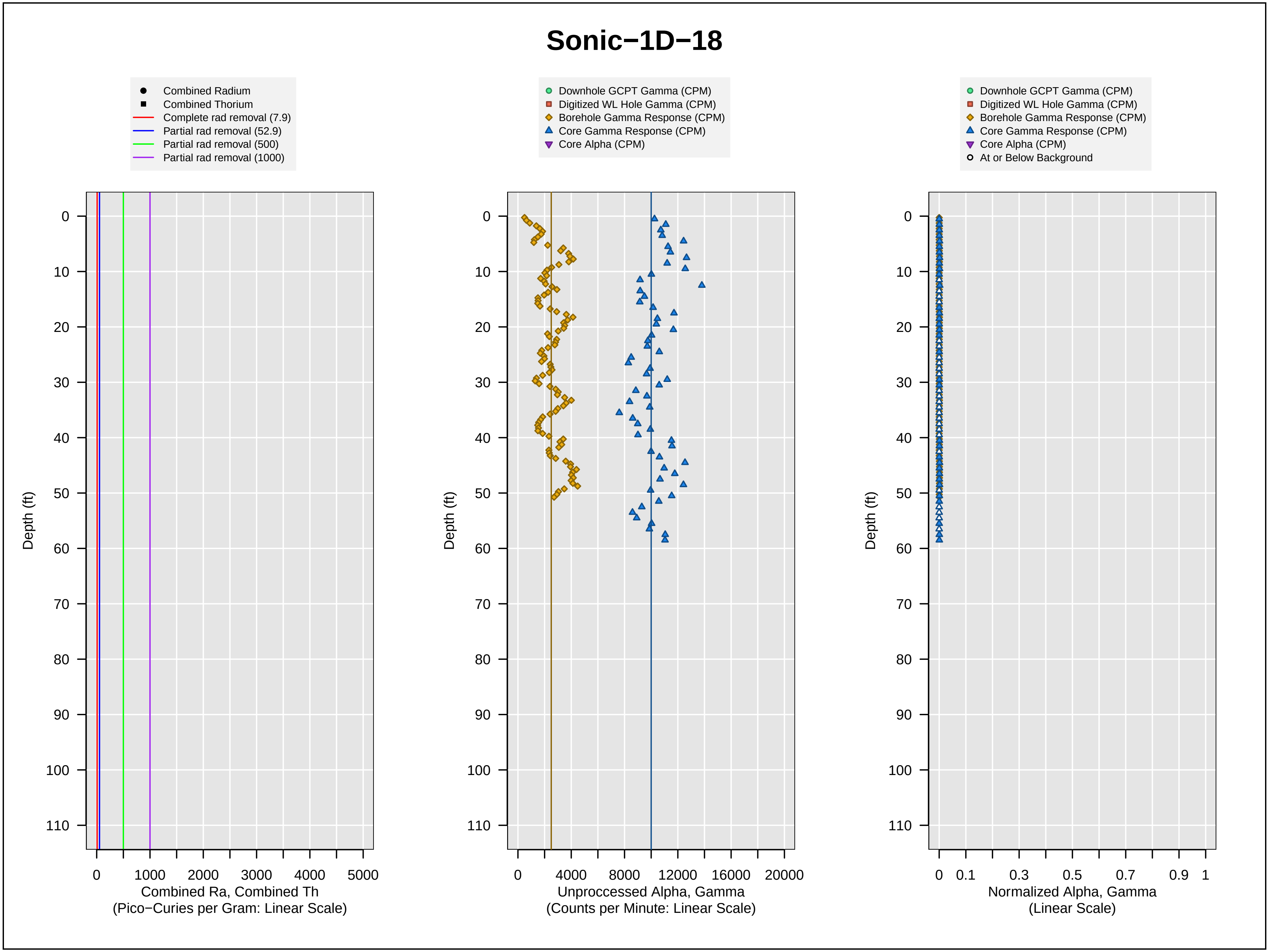
GCPT−1D−18A


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−1D−18A

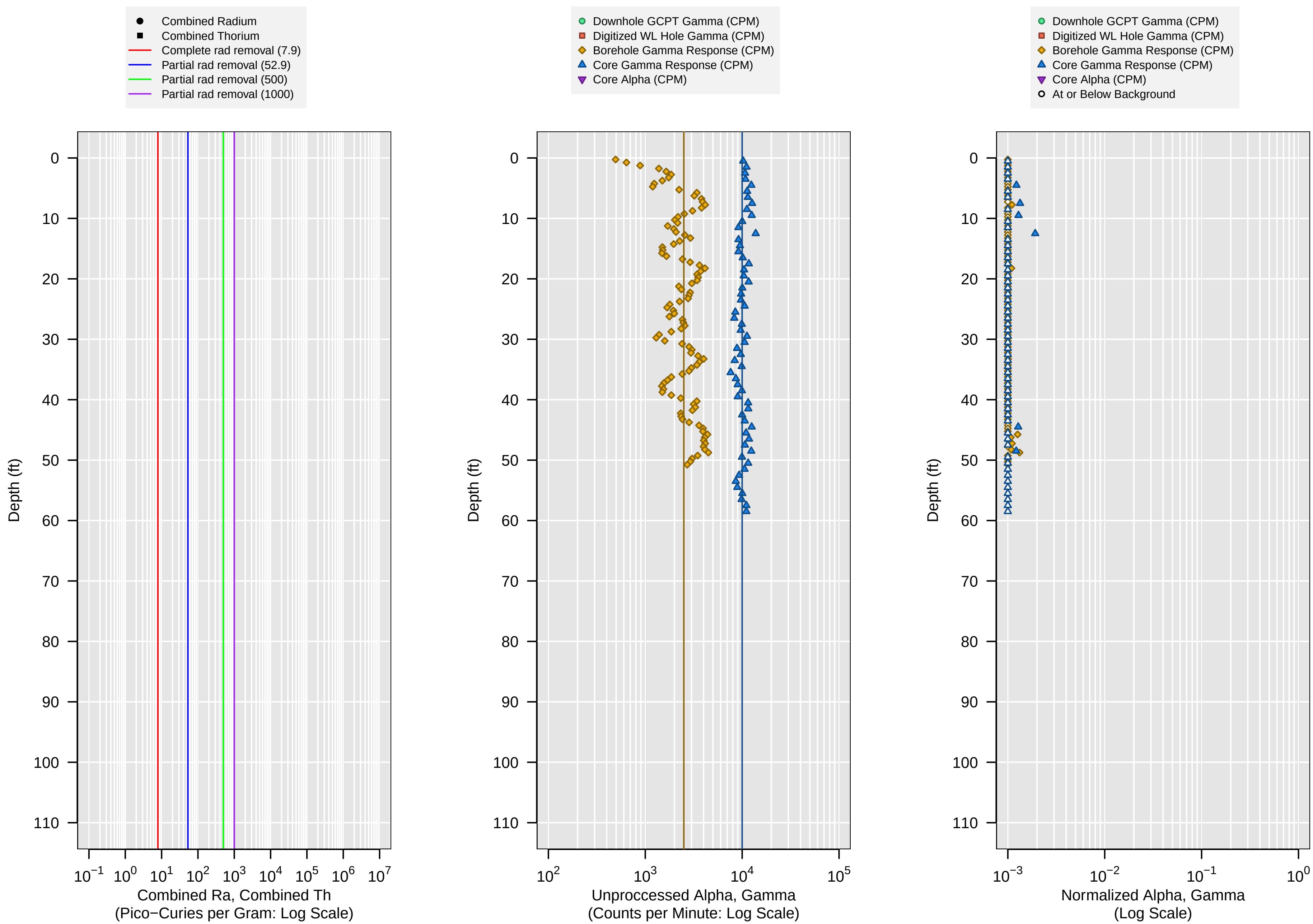


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)



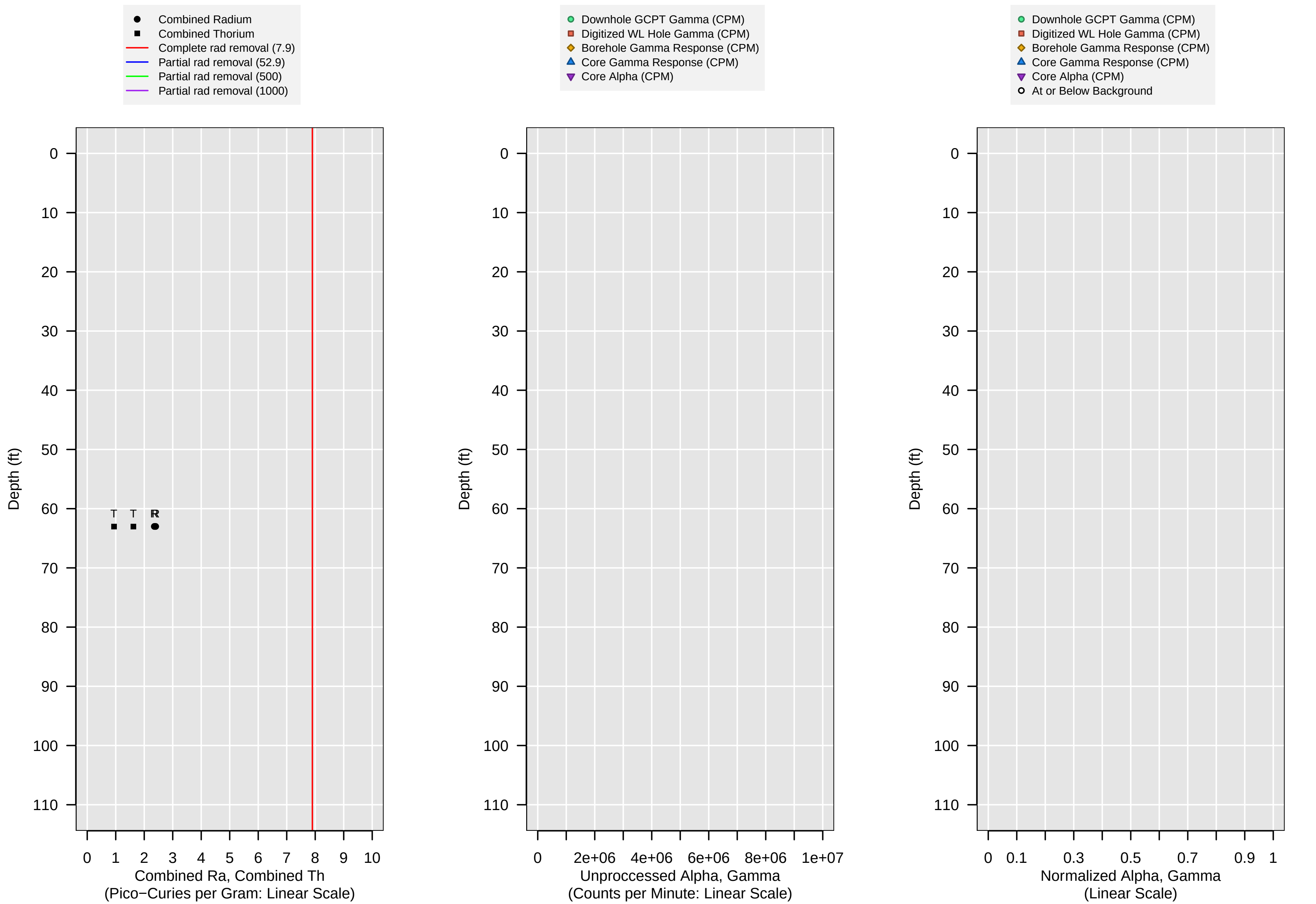
Sonic−1D−18
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

Sonic−1D−18

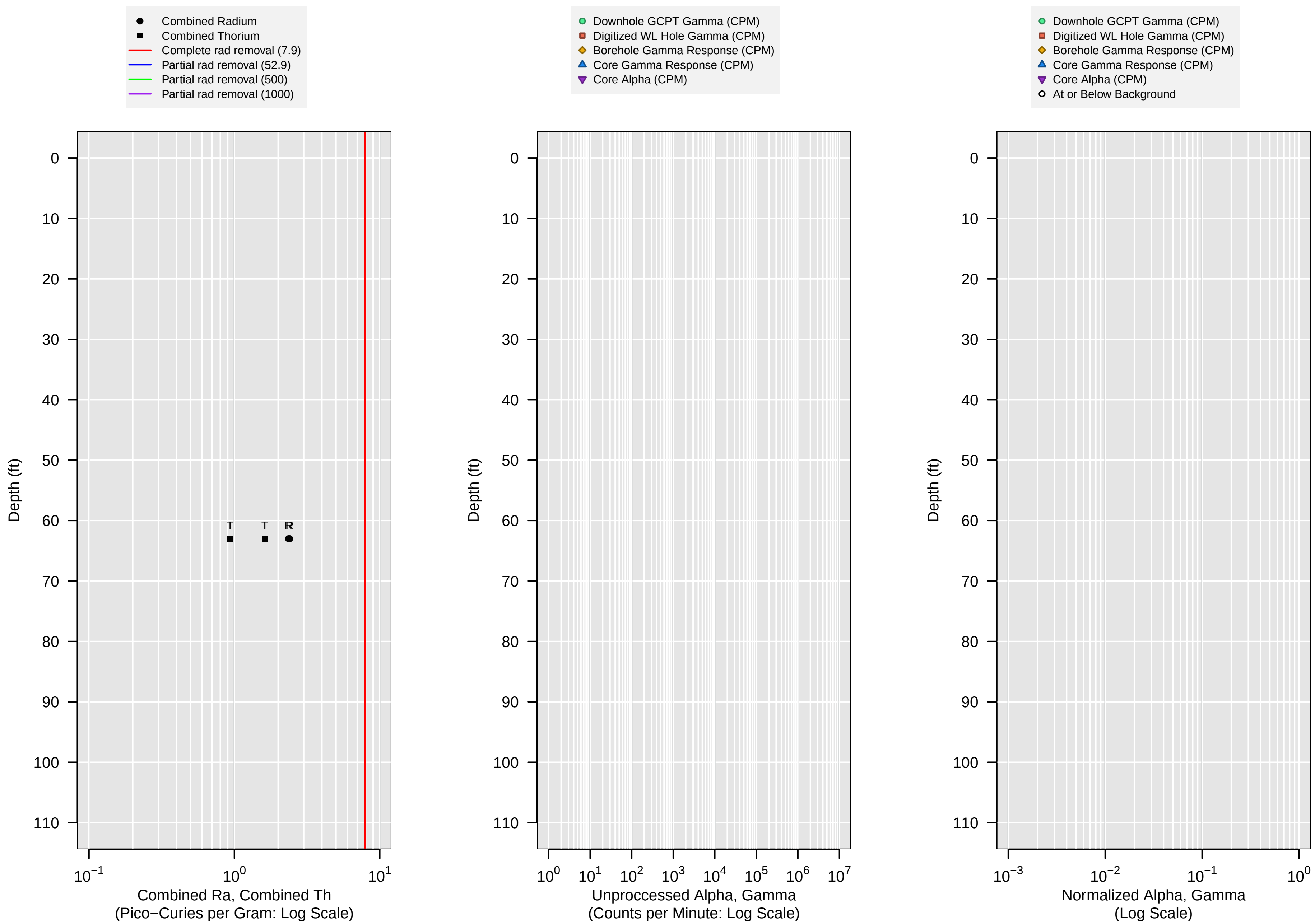


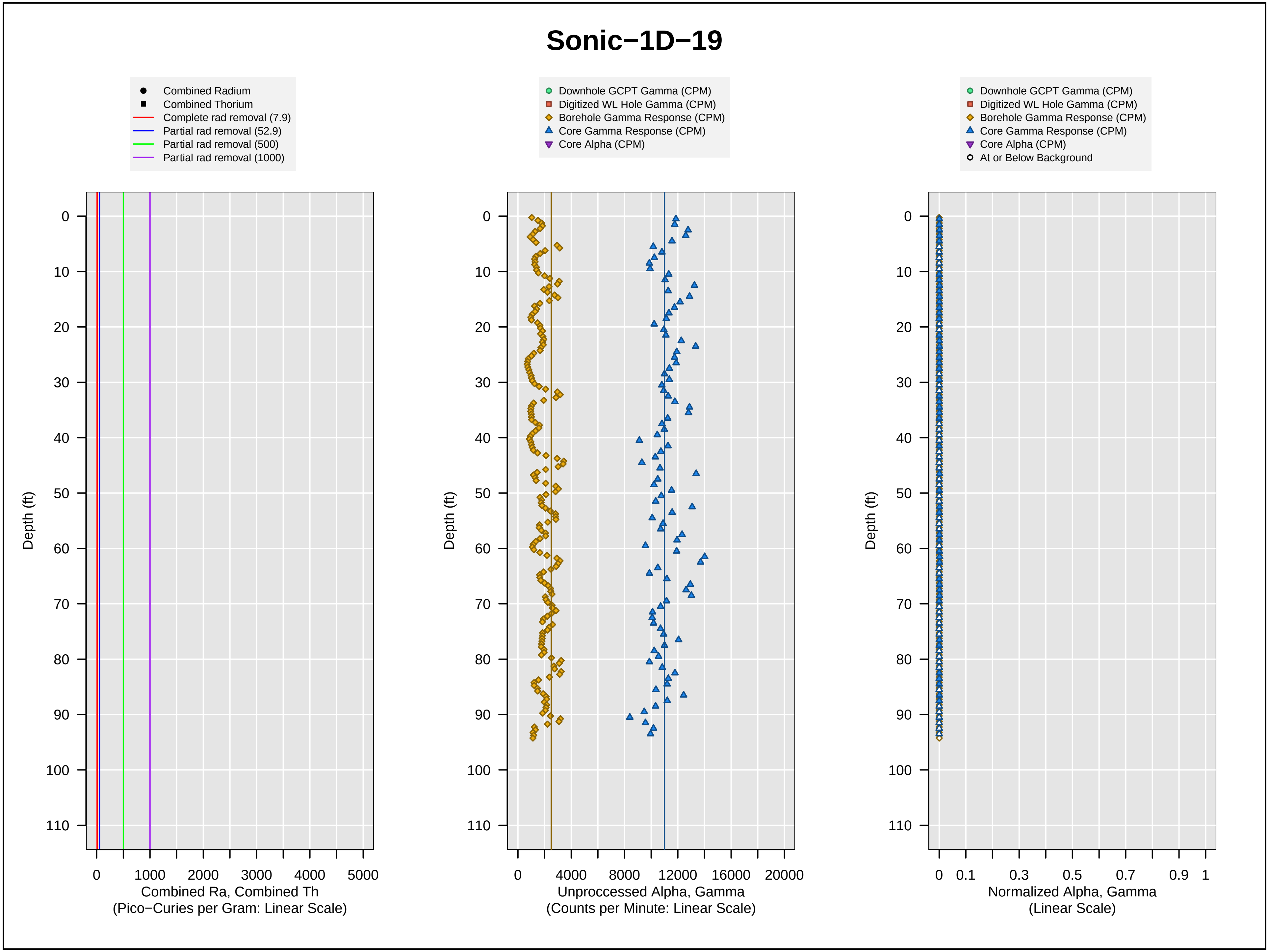
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

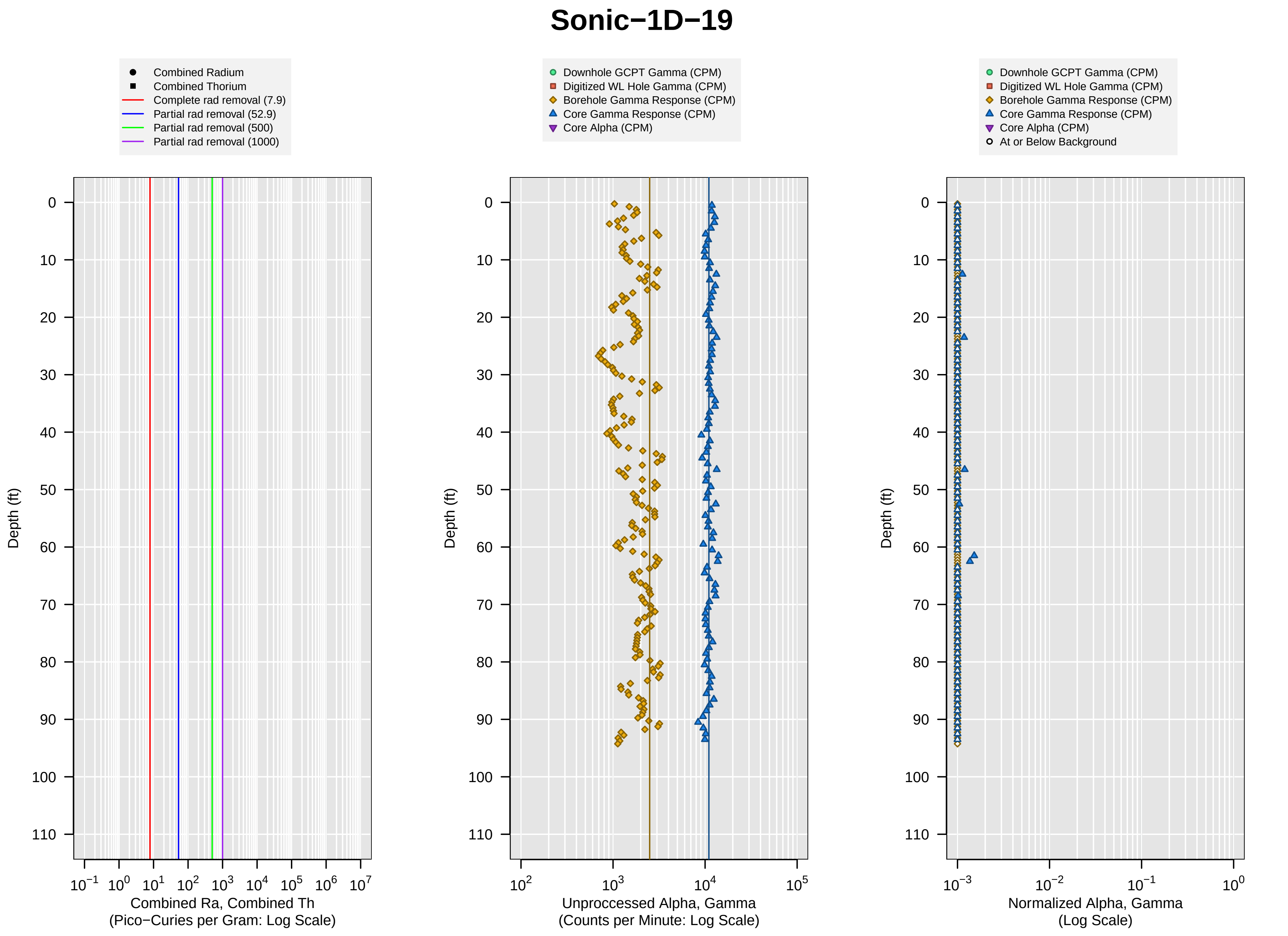
1D−19S


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
T T R
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

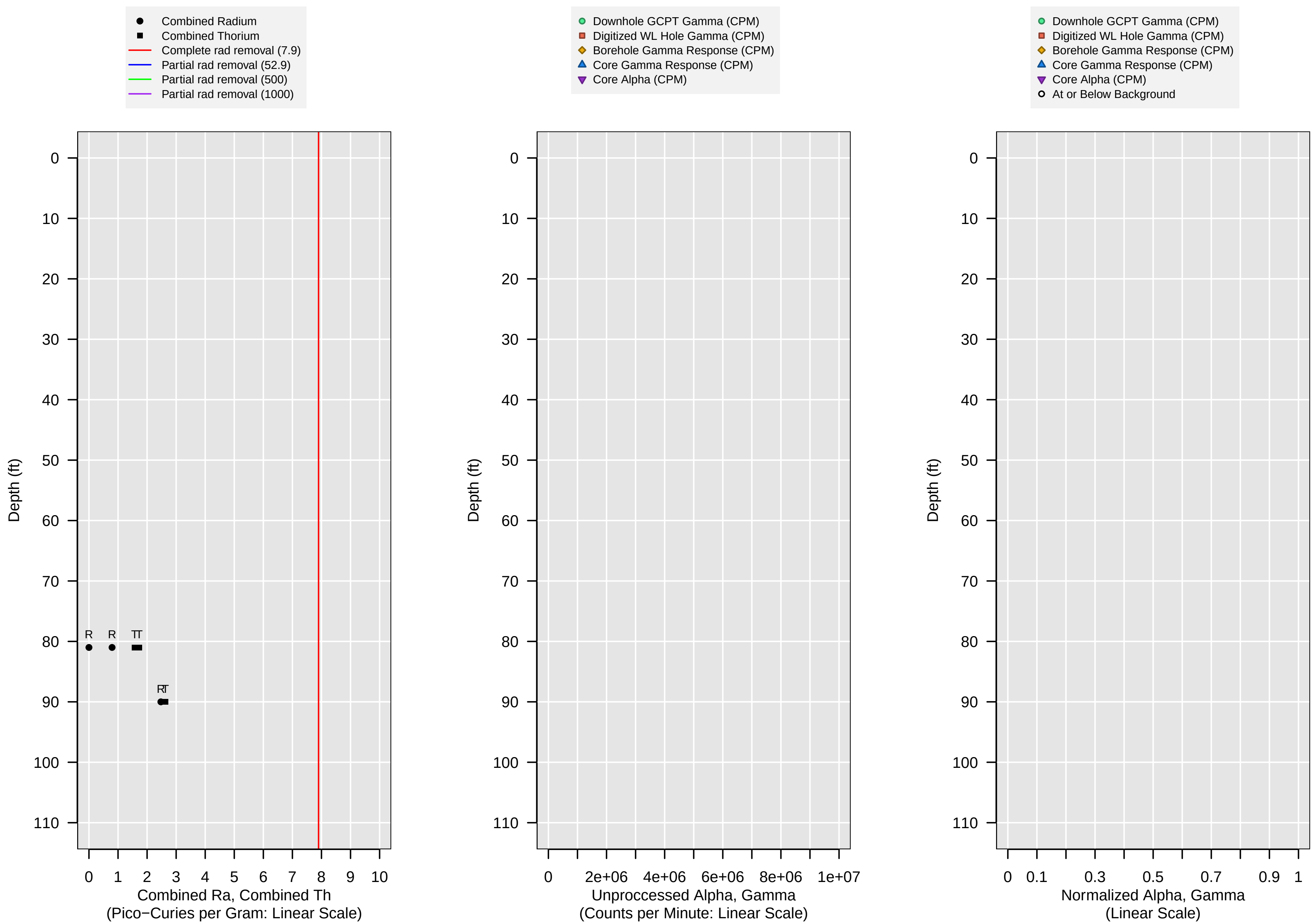
1D−19S


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
T
T
R
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

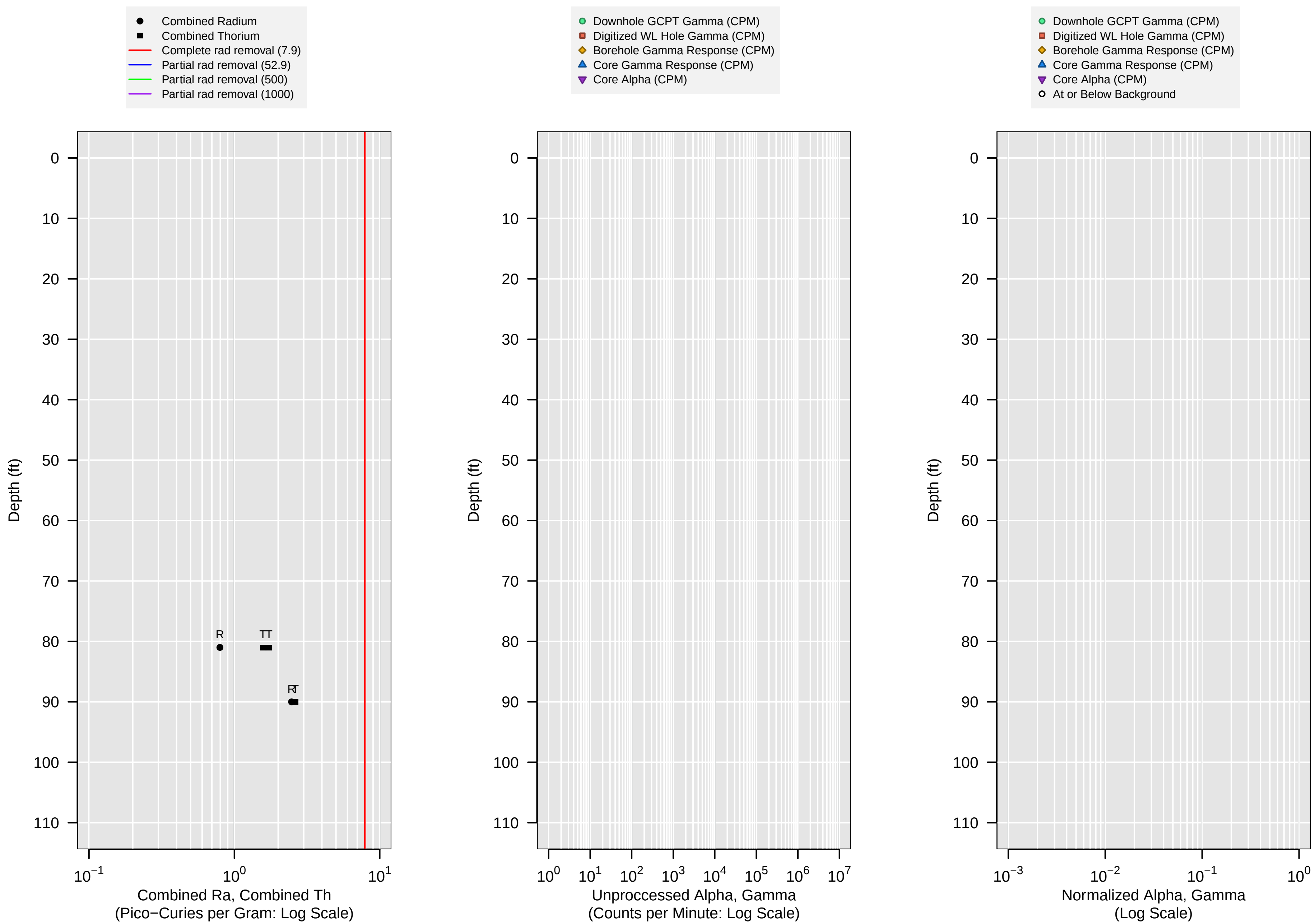

Sonic−1D−19
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)


Sonic−1D−19
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

1D−20S

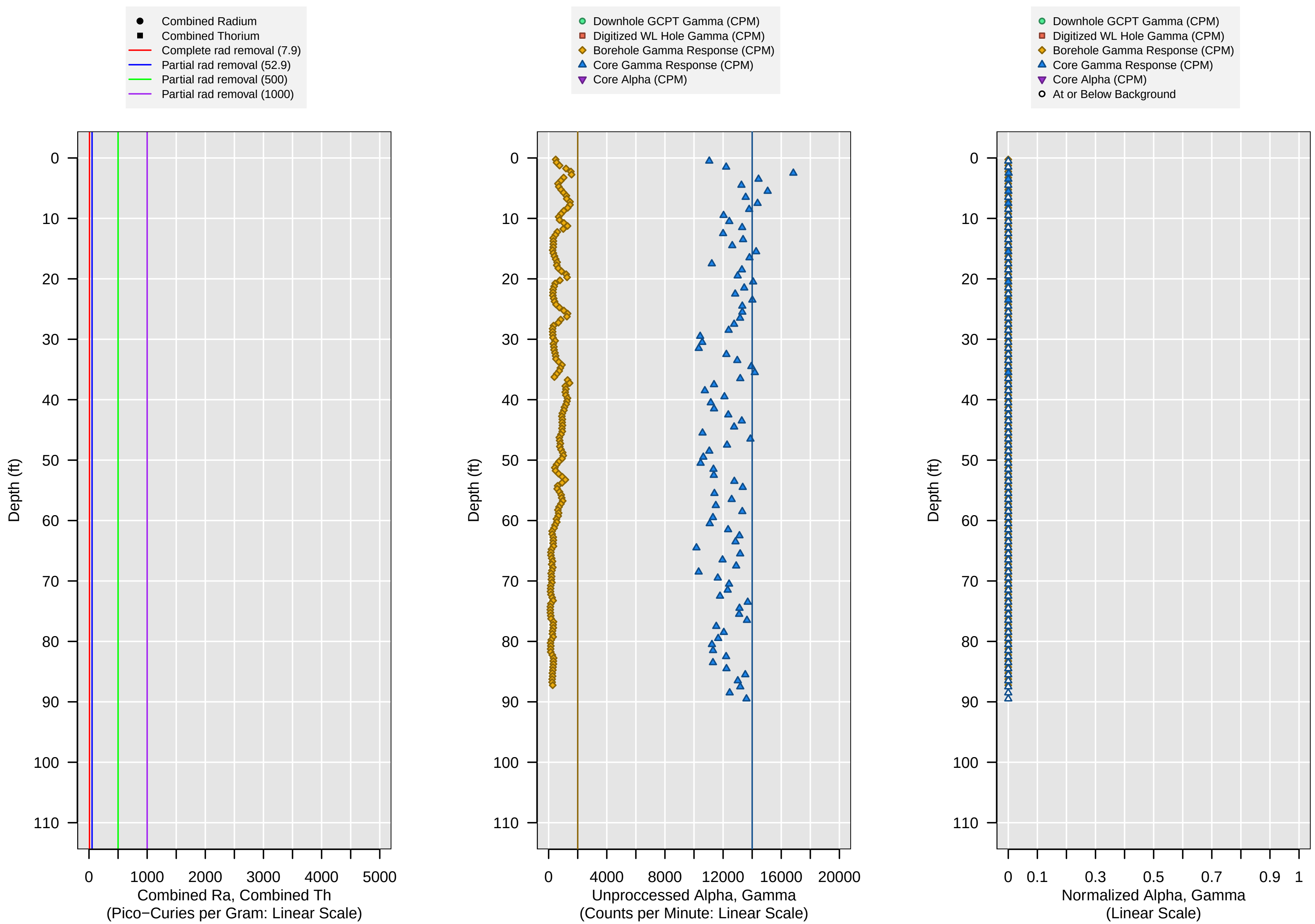

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

1D−20S

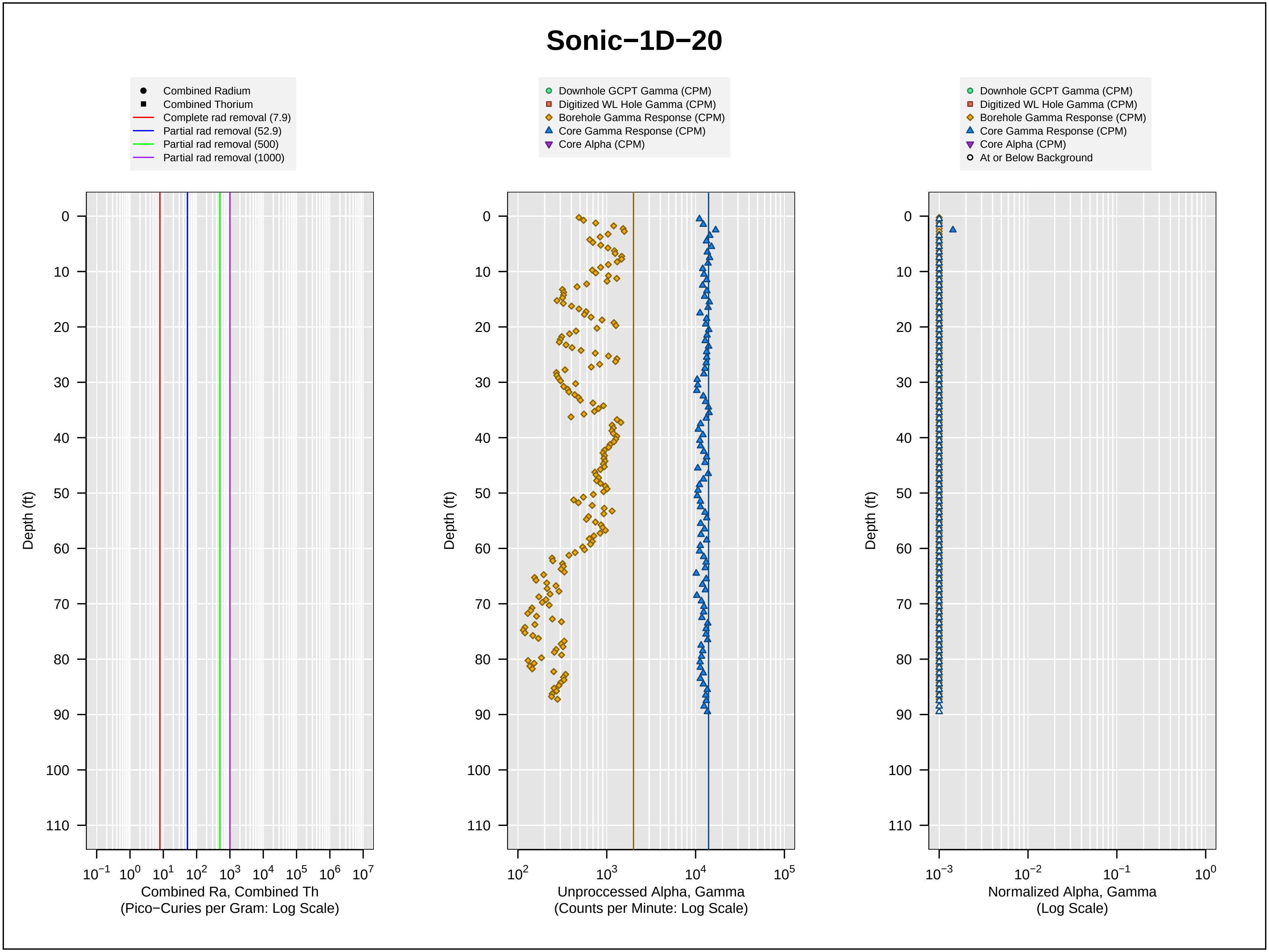


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
R
TT
RT
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Normalized Alpha, Gamma
(Log Scale)

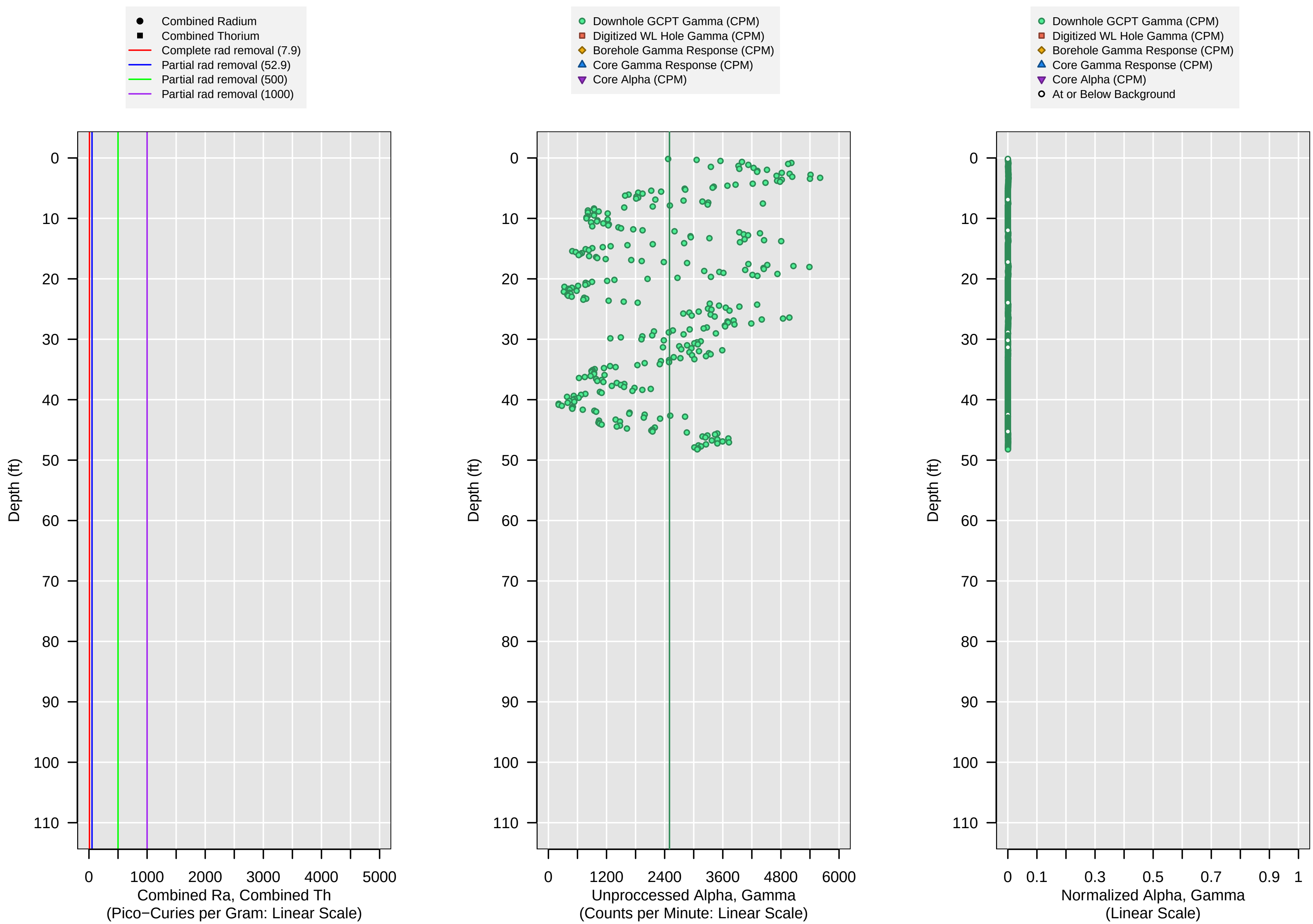
Sonic−1D−20



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

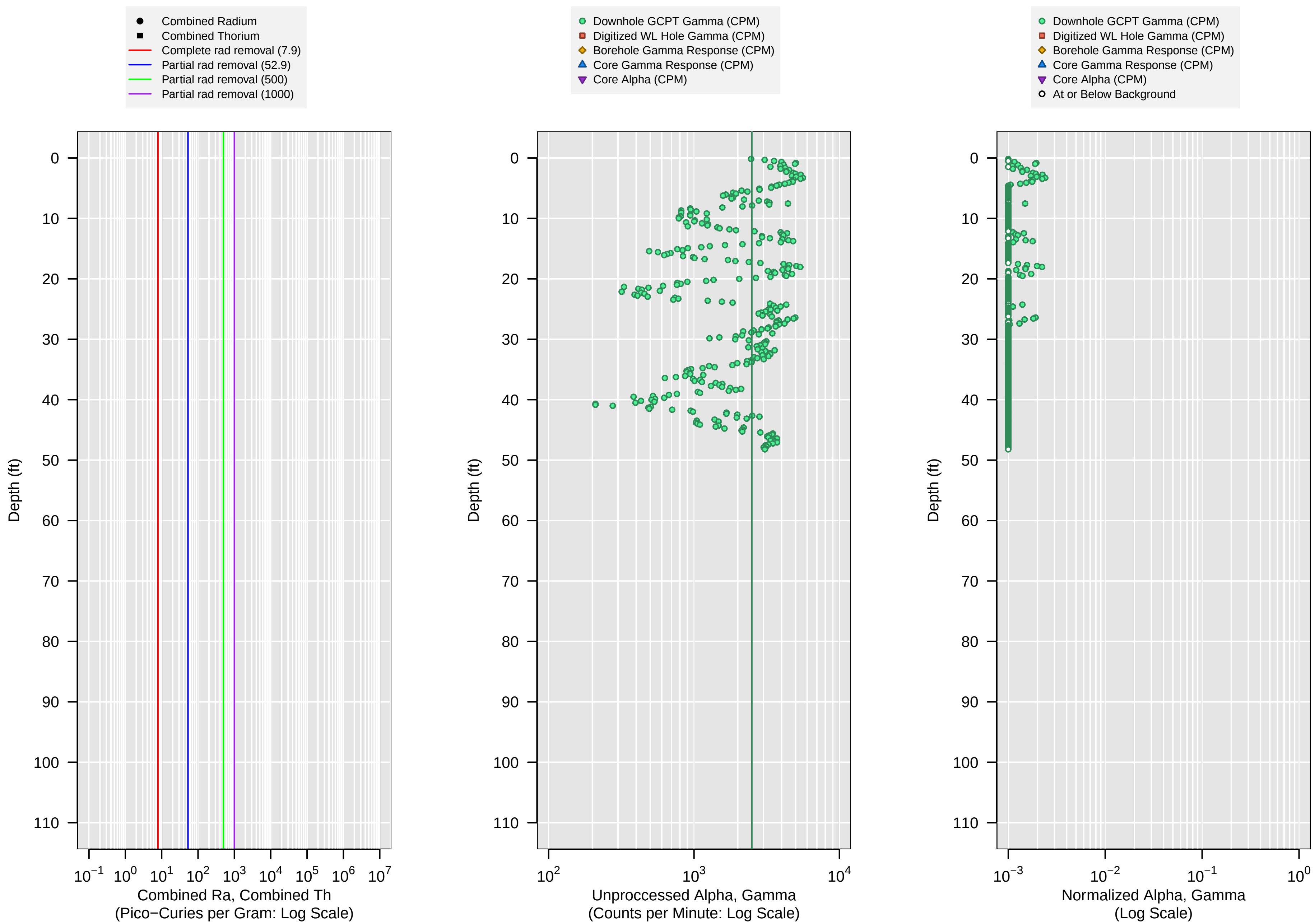

Sonic−1D−20
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−2−1



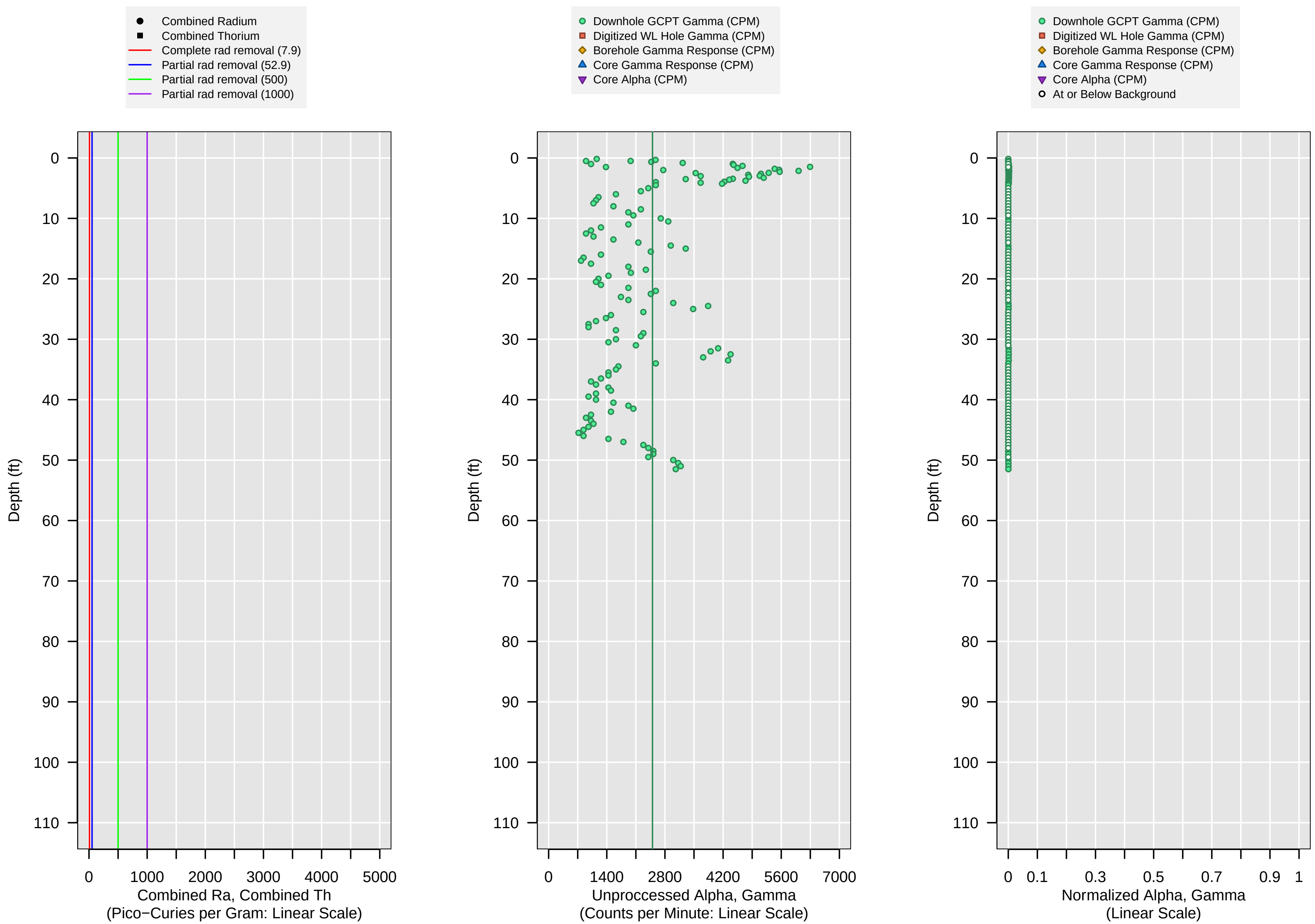
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−2−1

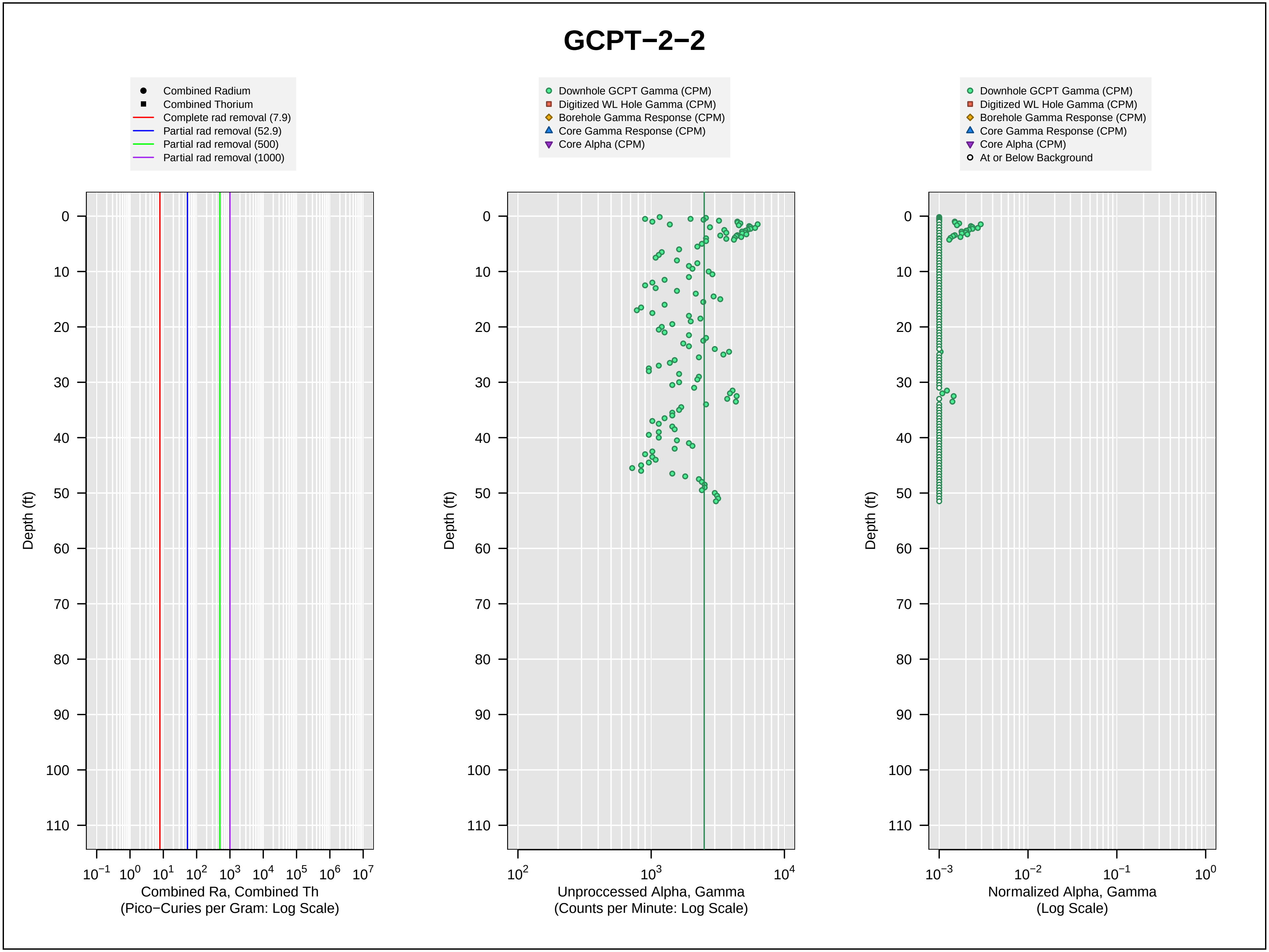


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

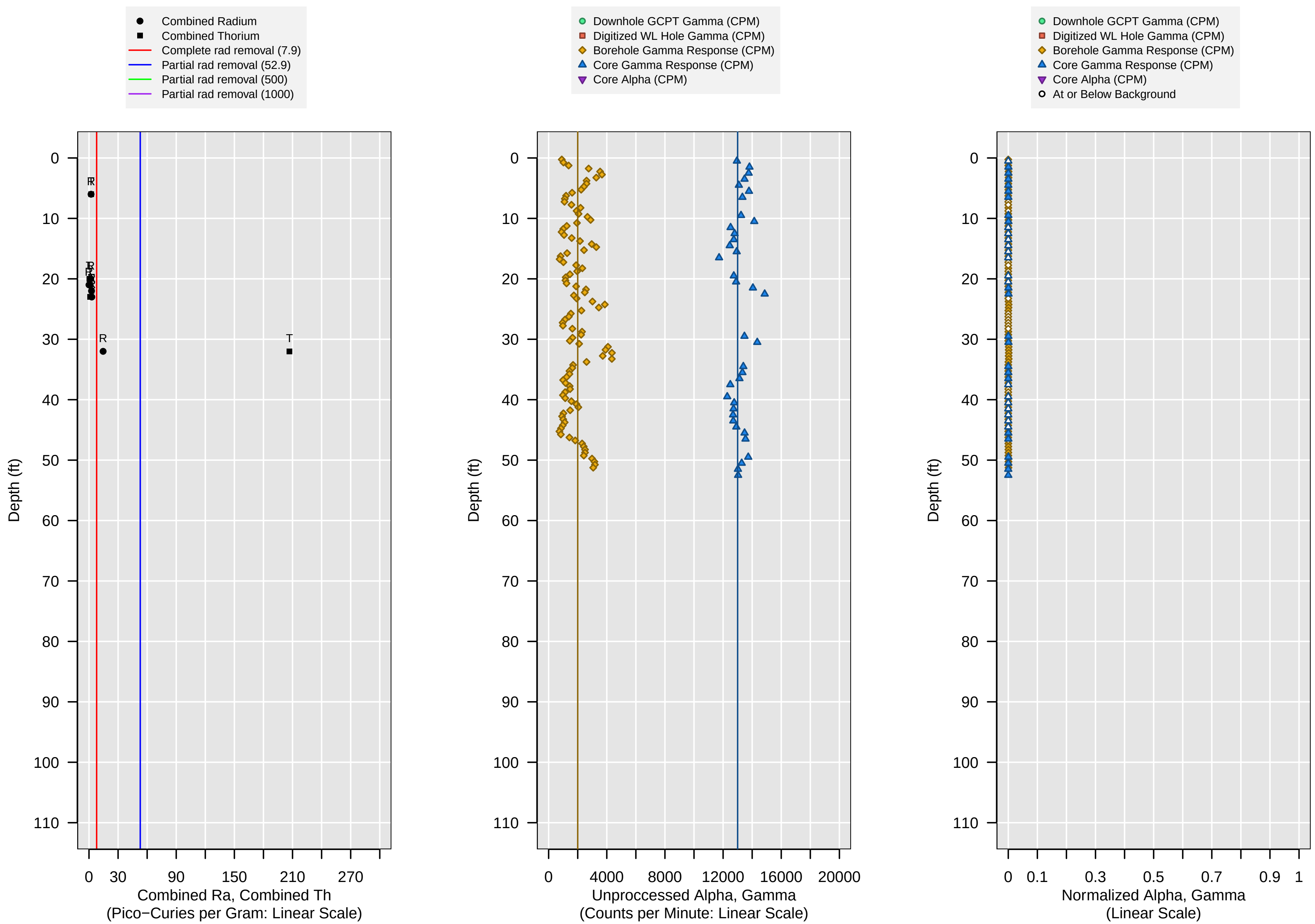
GCPT−2−2



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
1400
2800
4200
5600
7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

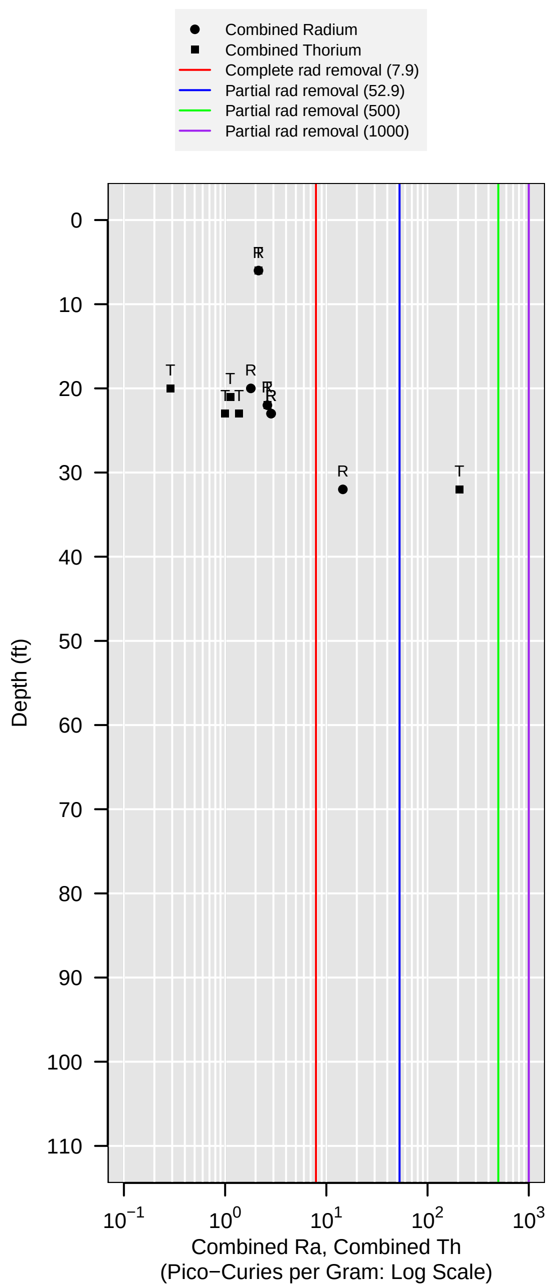

GCPT−2−2
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

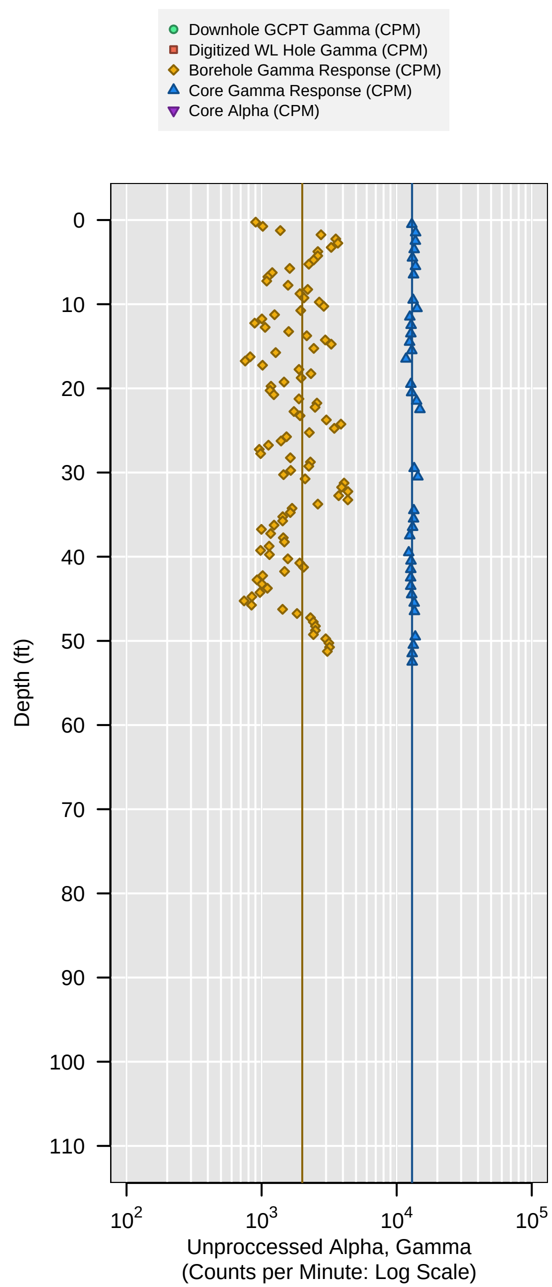
Sonic−2−2

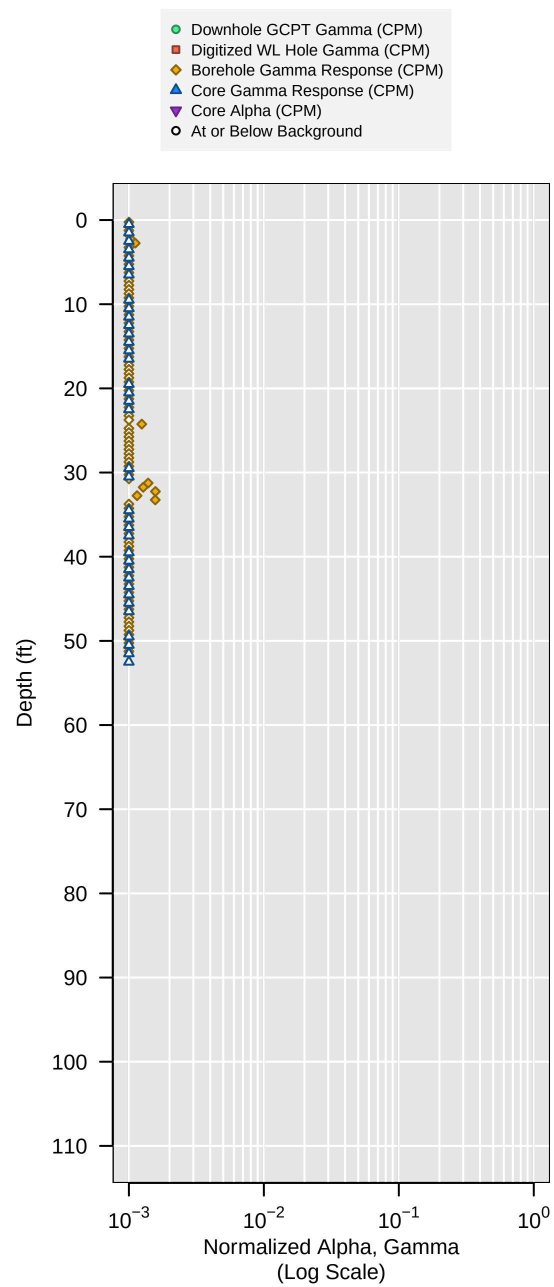


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

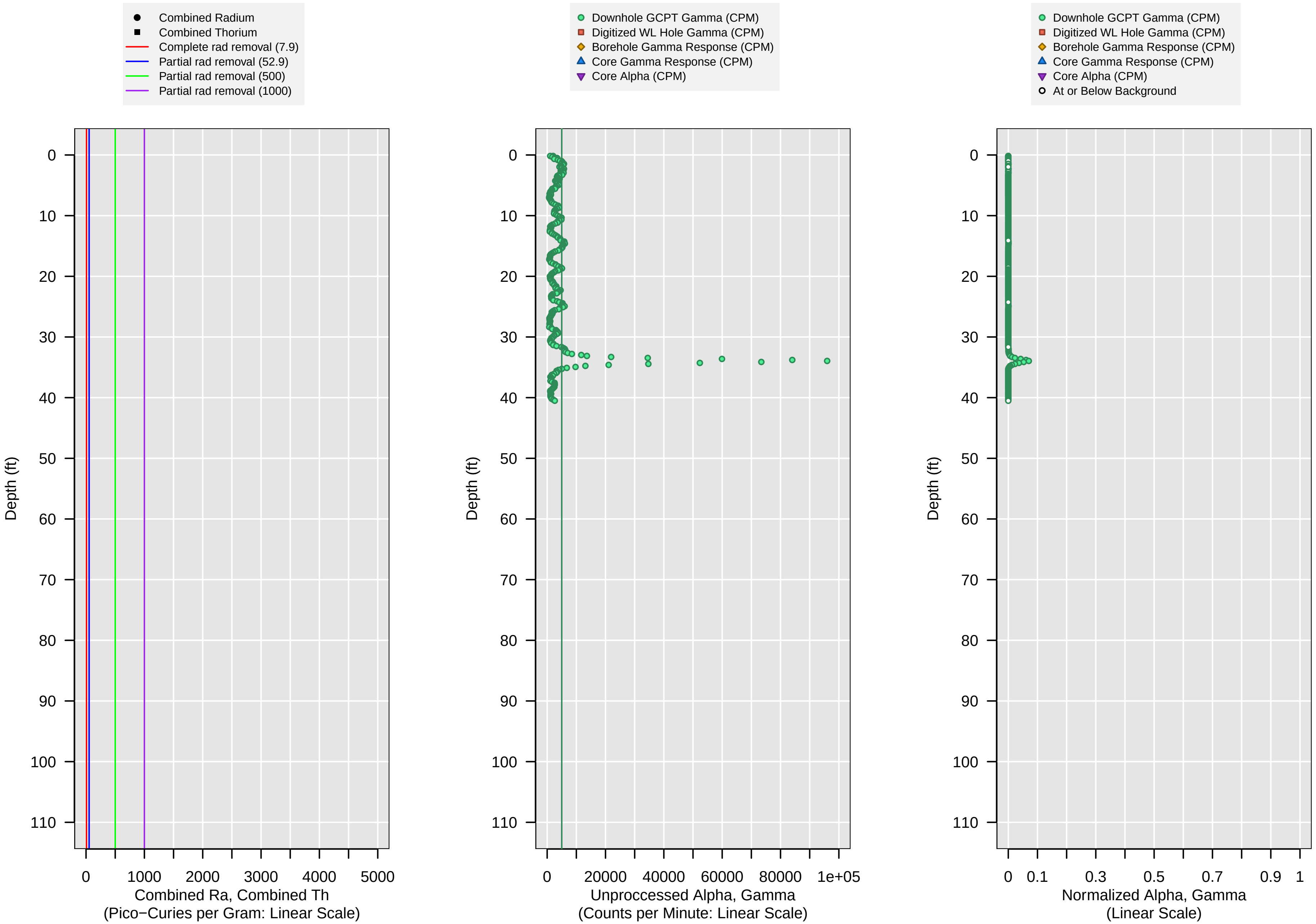
Sonic−2−2


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)

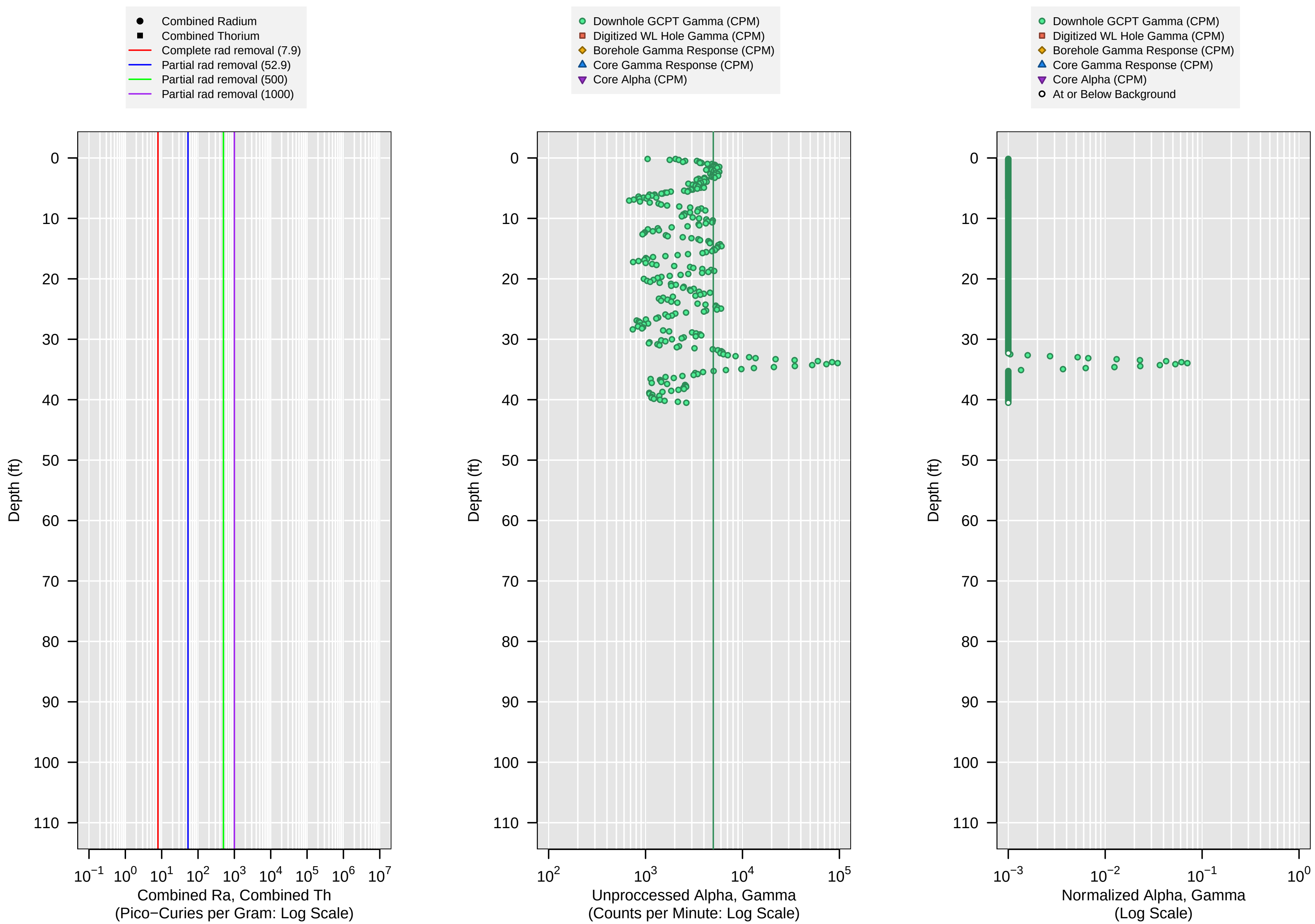

Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

GCPT−2−2A



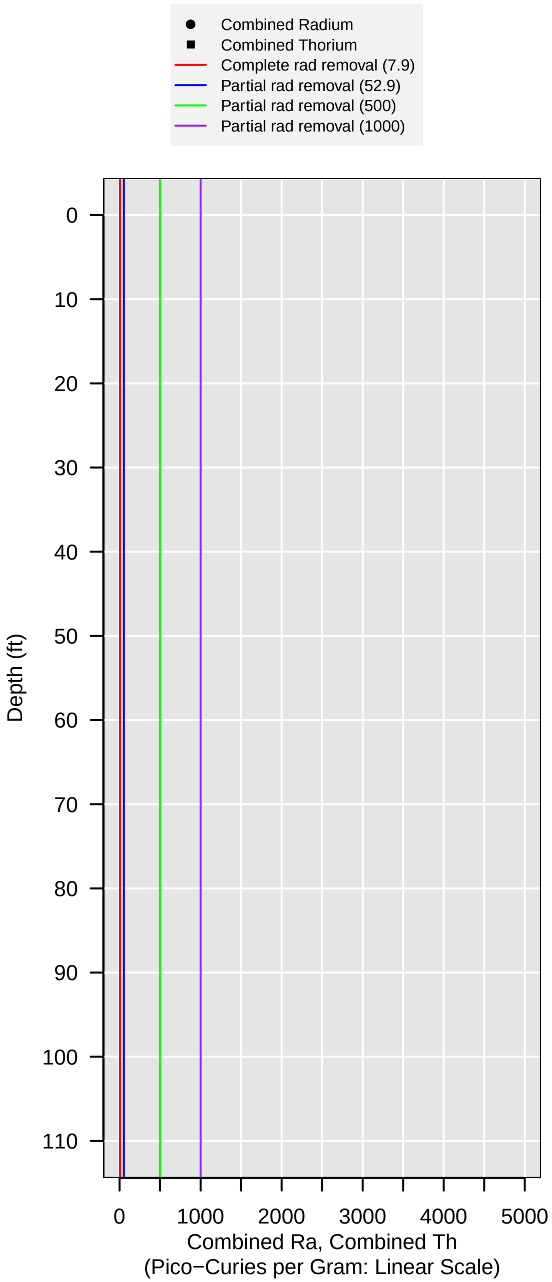
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

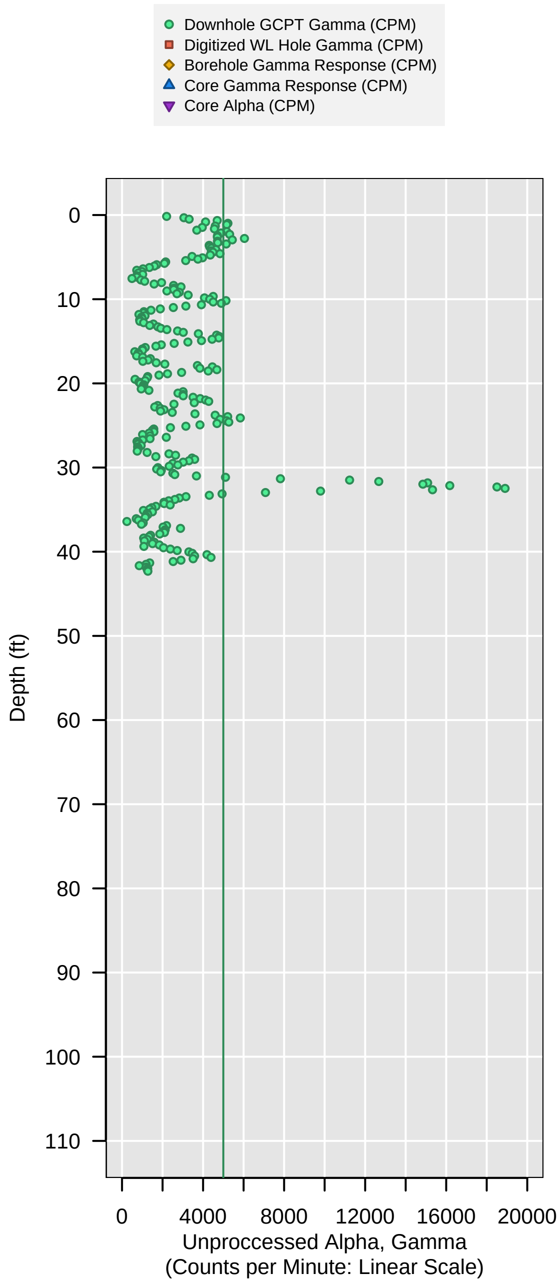
GCPT−2−2A

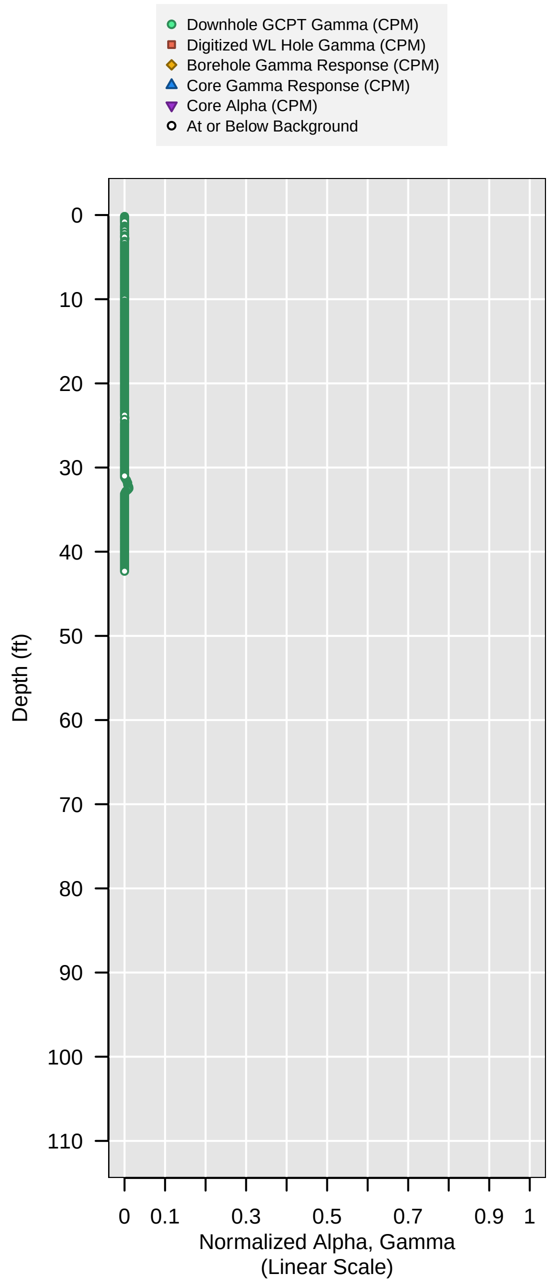


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

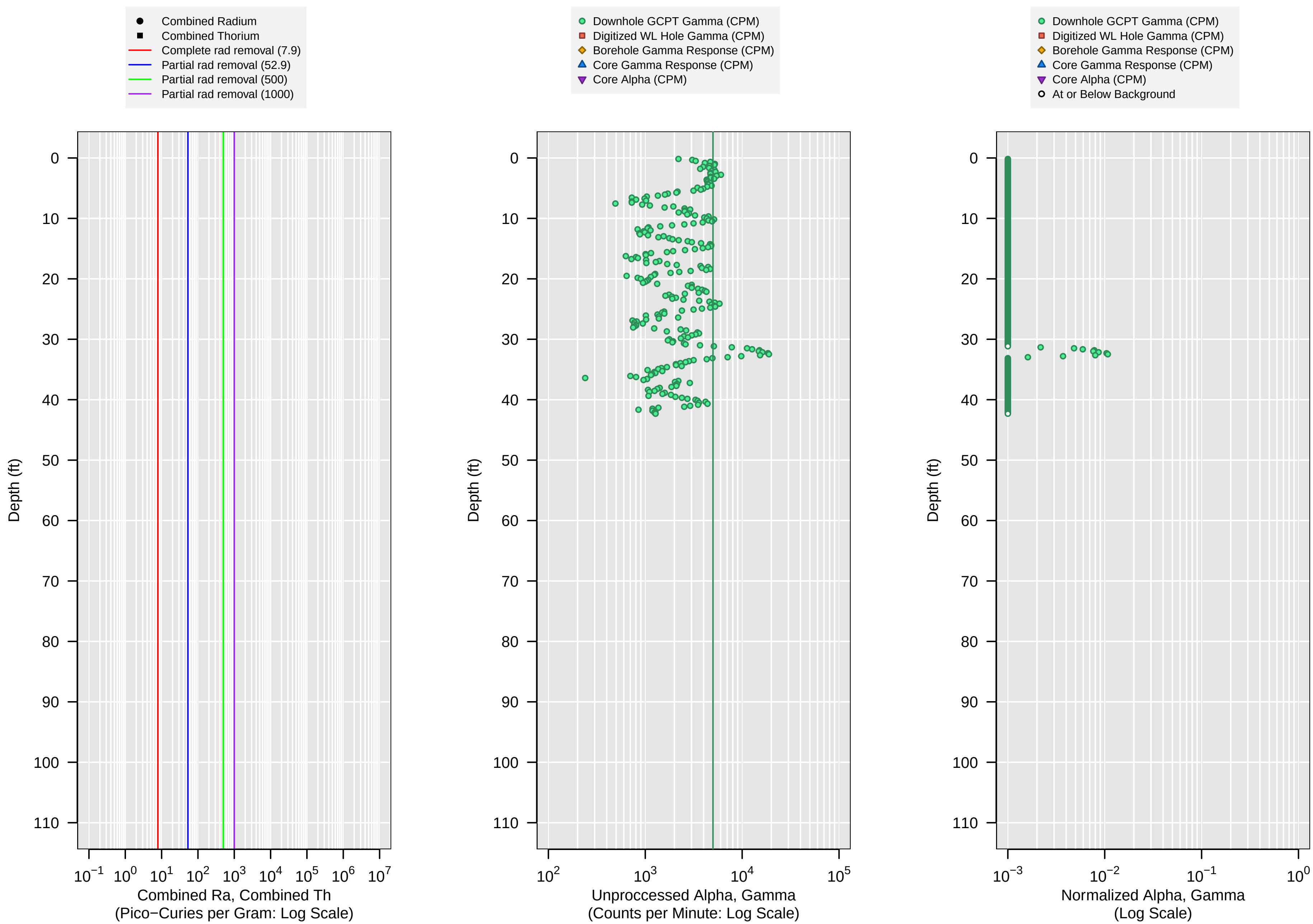
GCPT−2−2C


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
4000
8000
12000
16000
20000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)

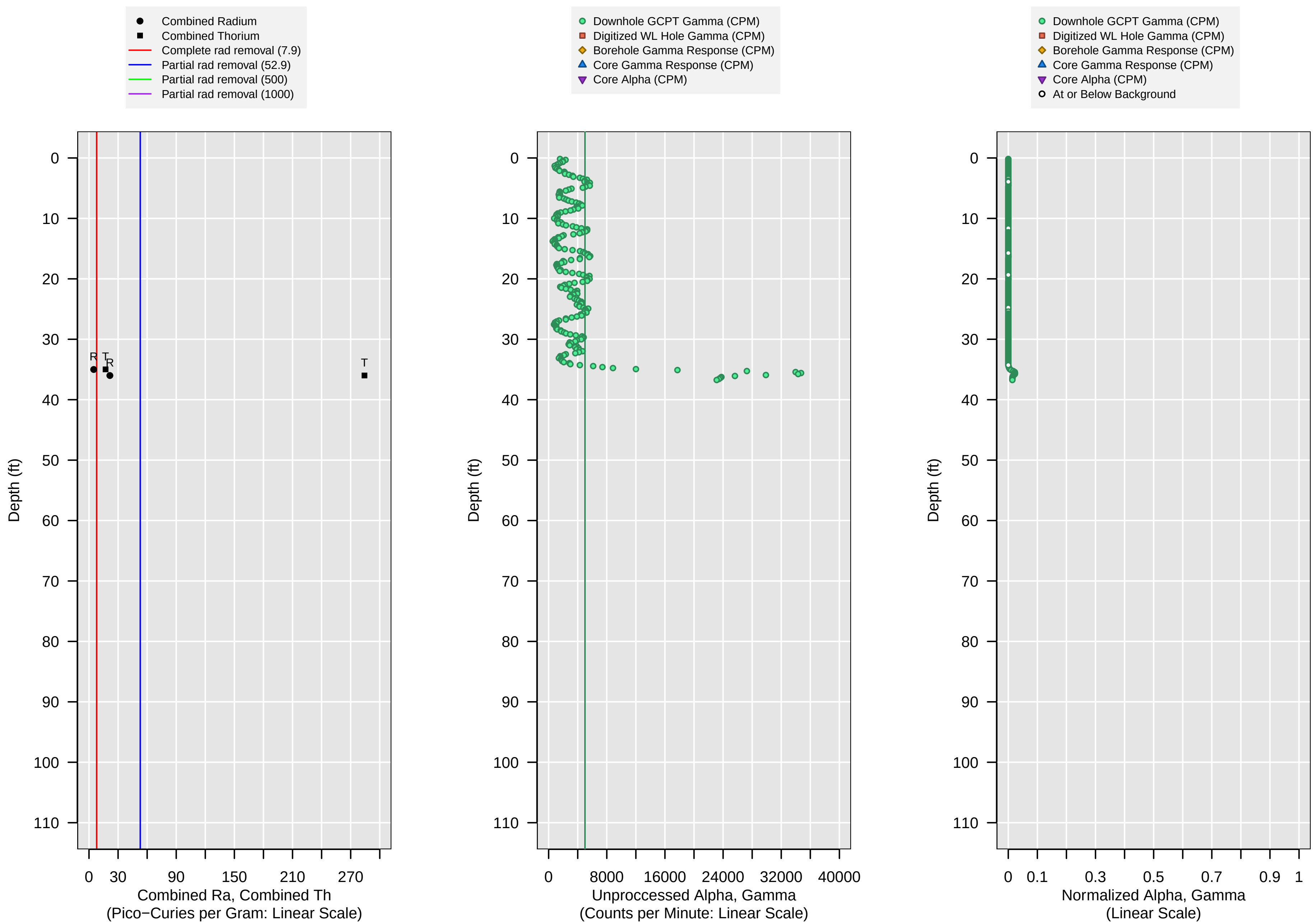

Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

GCPT−2−2C

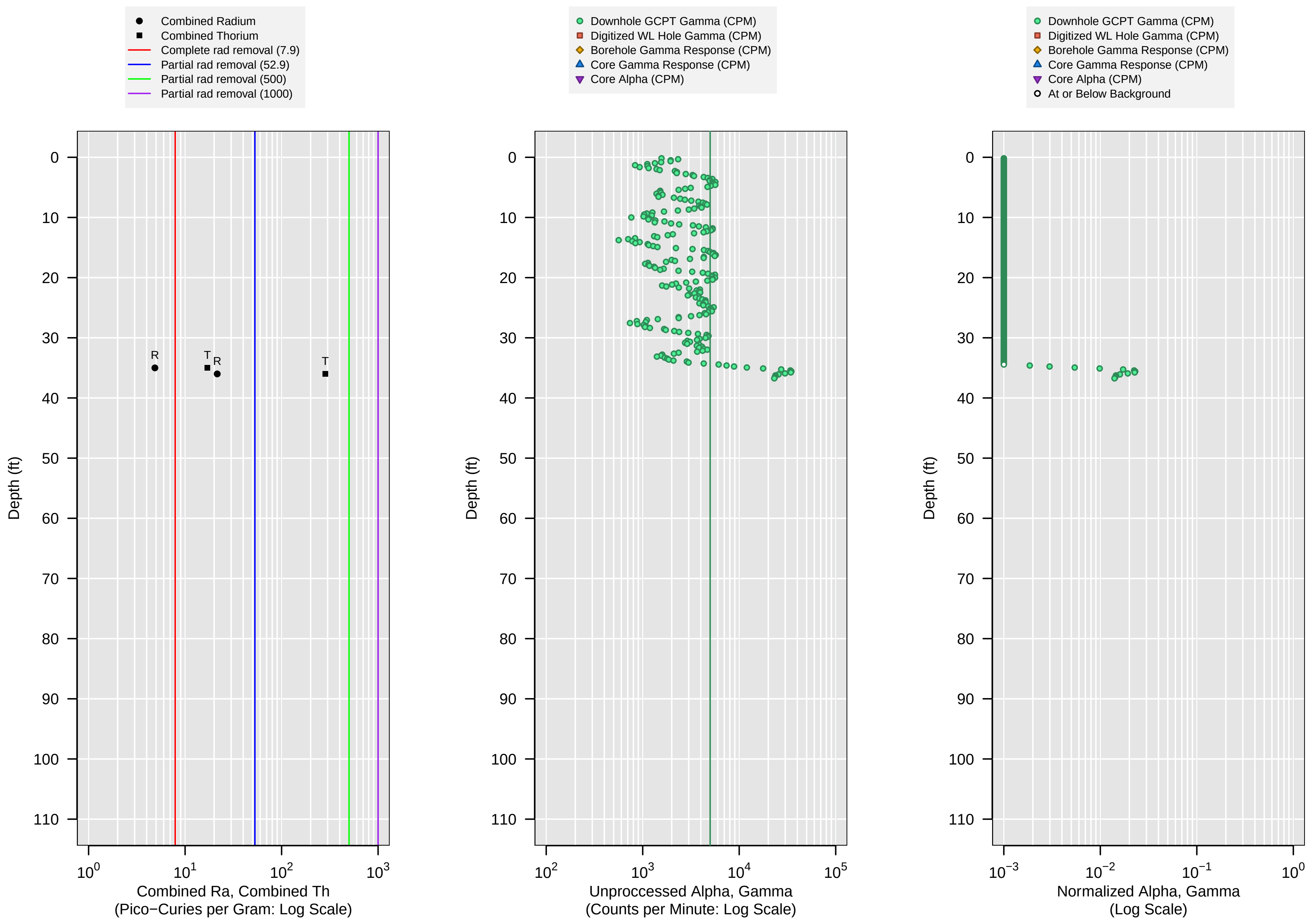


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

GCPT−2−3

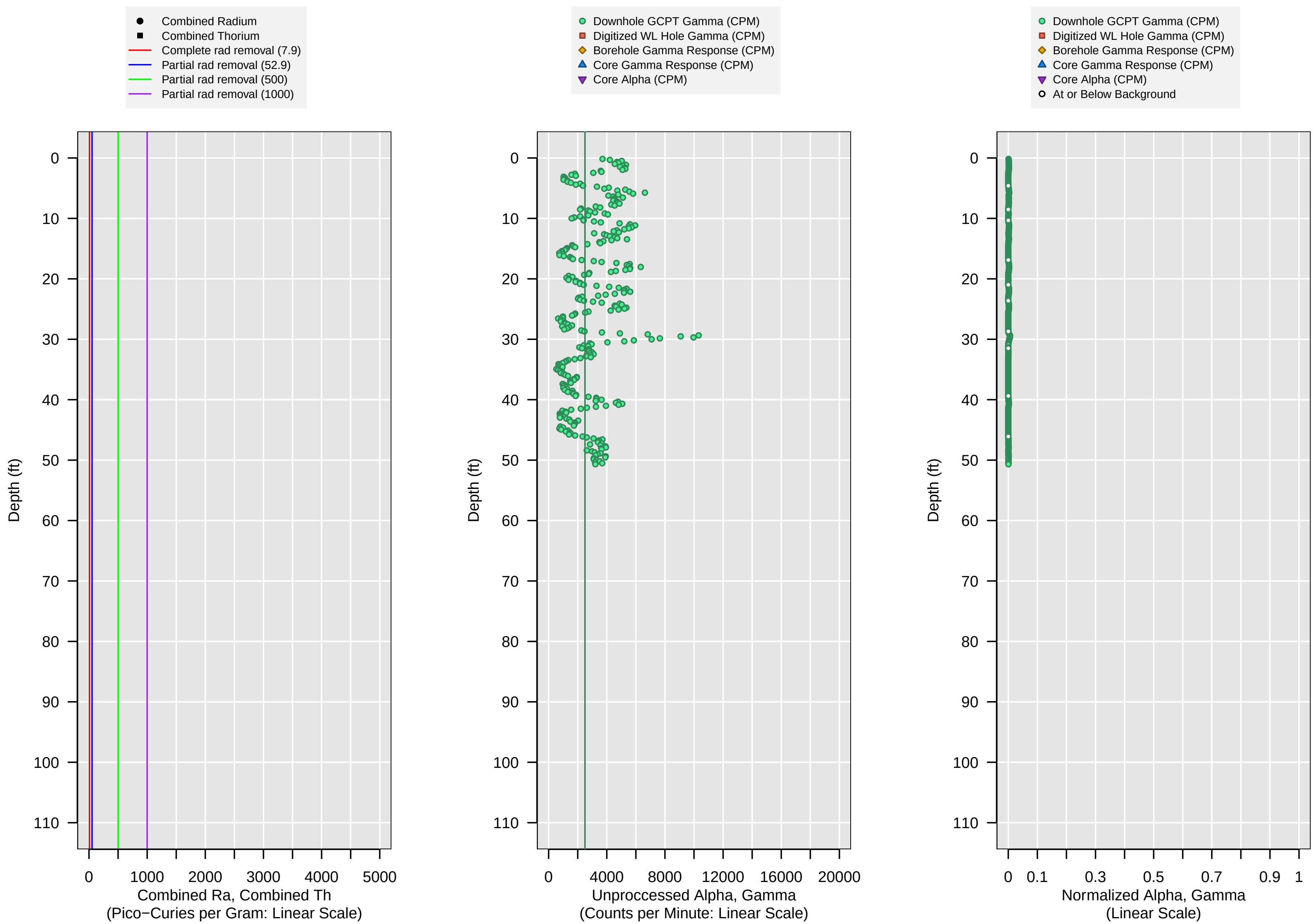

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
R
T
R
T
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−2−3



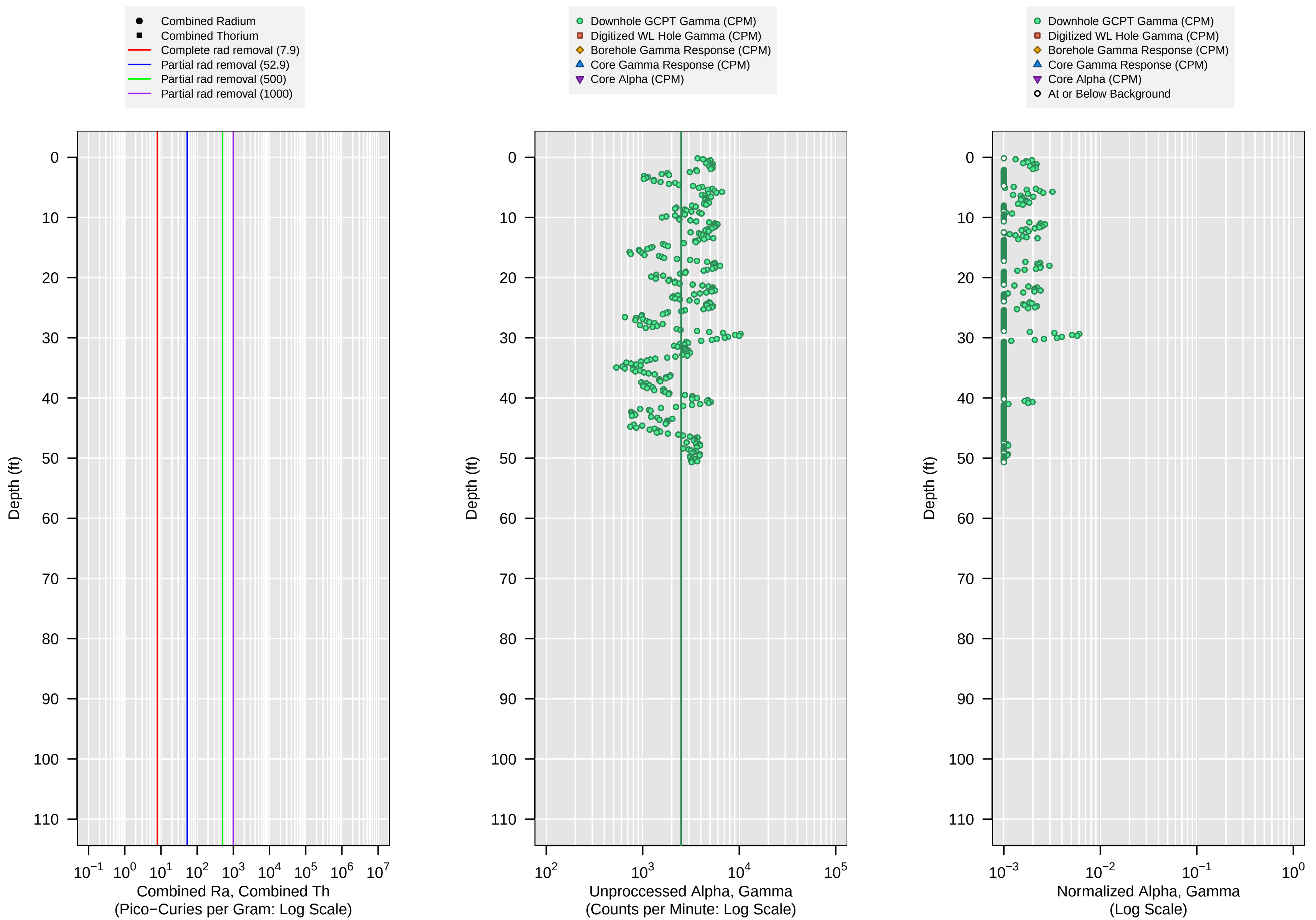
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
R
T
R
T
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−2−4



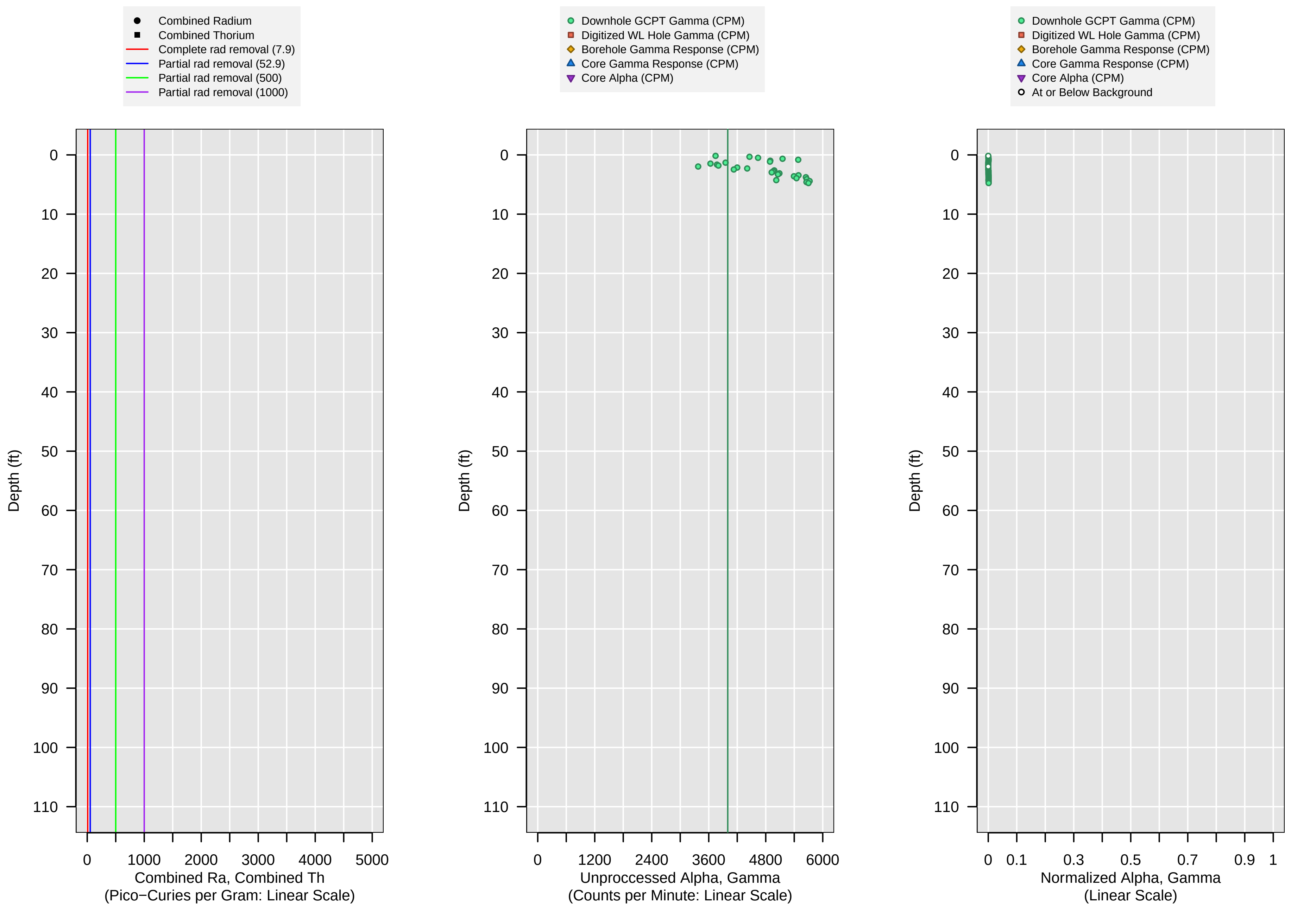
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
4000
8000
12000
16000
20000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

GCPT−2−4

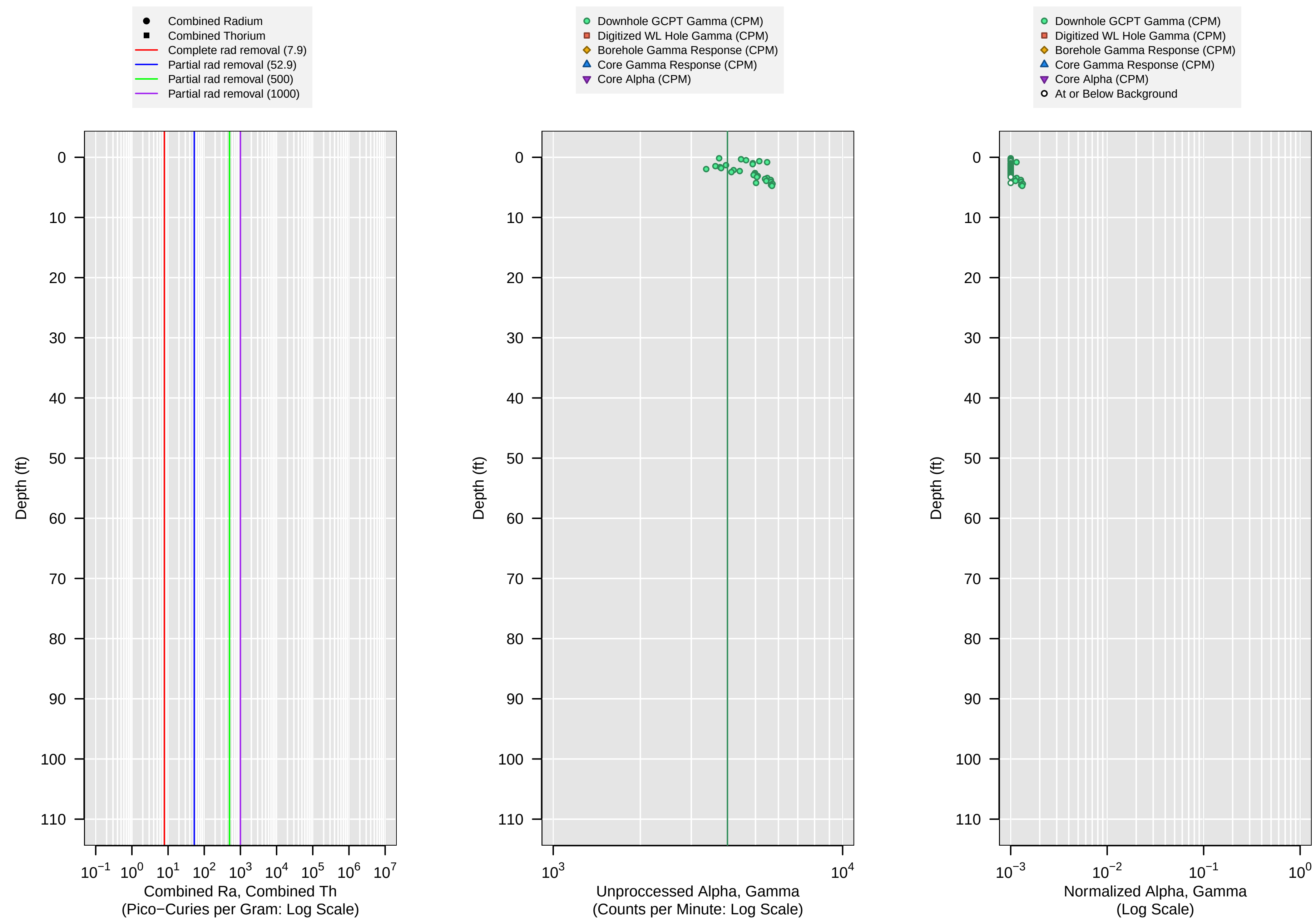


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

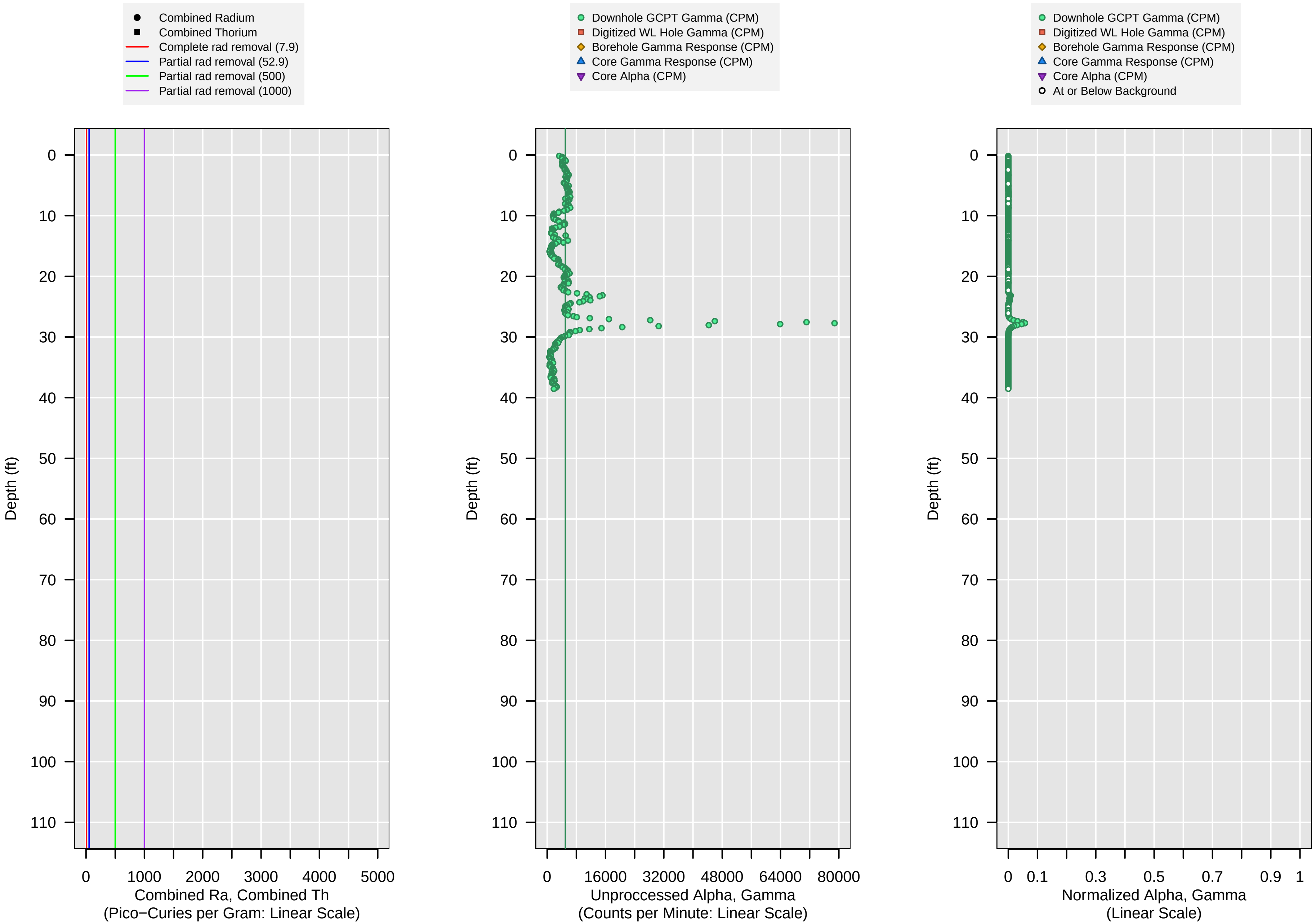
GCPT−3−1


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Linear Scale)

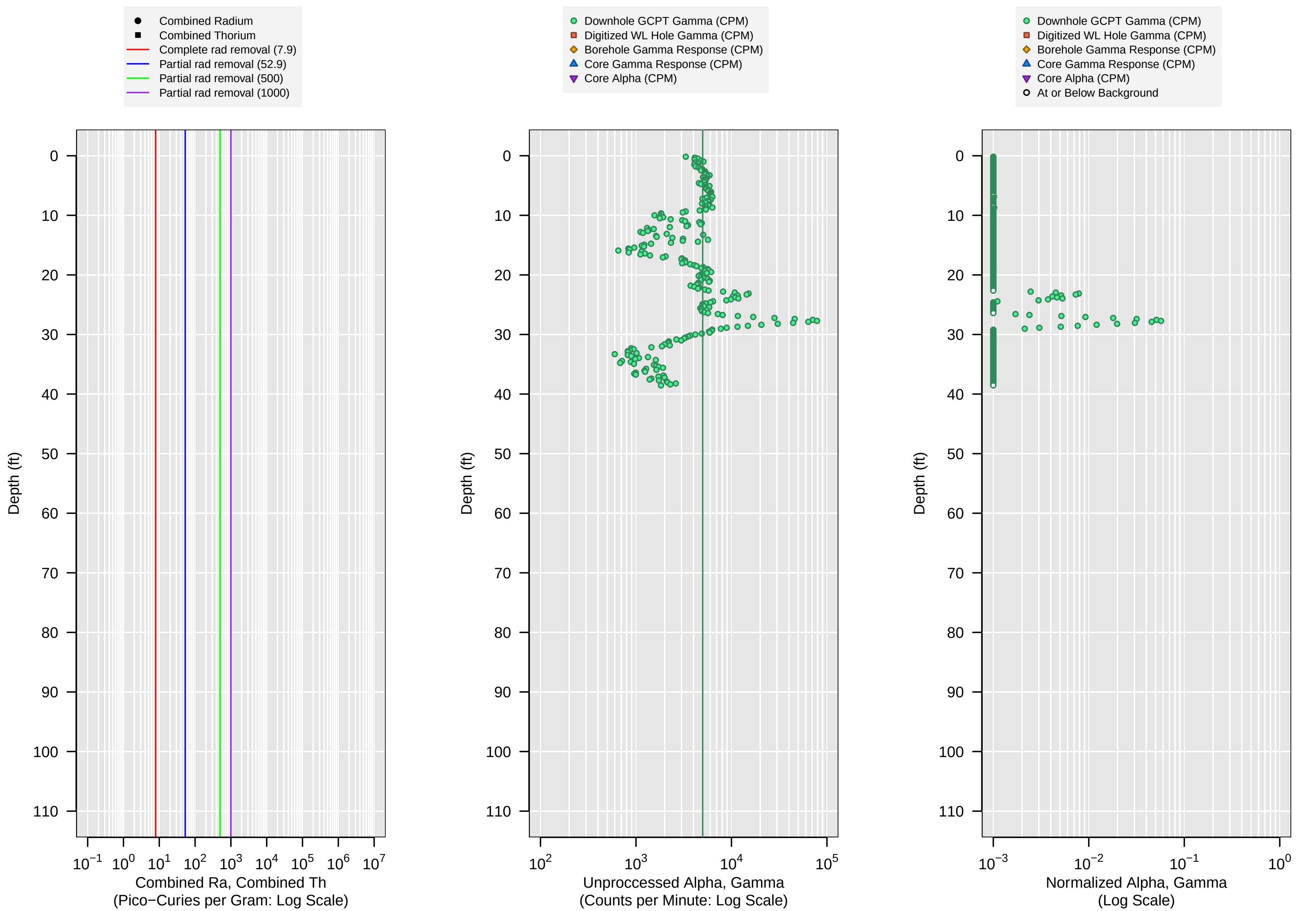
GCPT−3−1


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

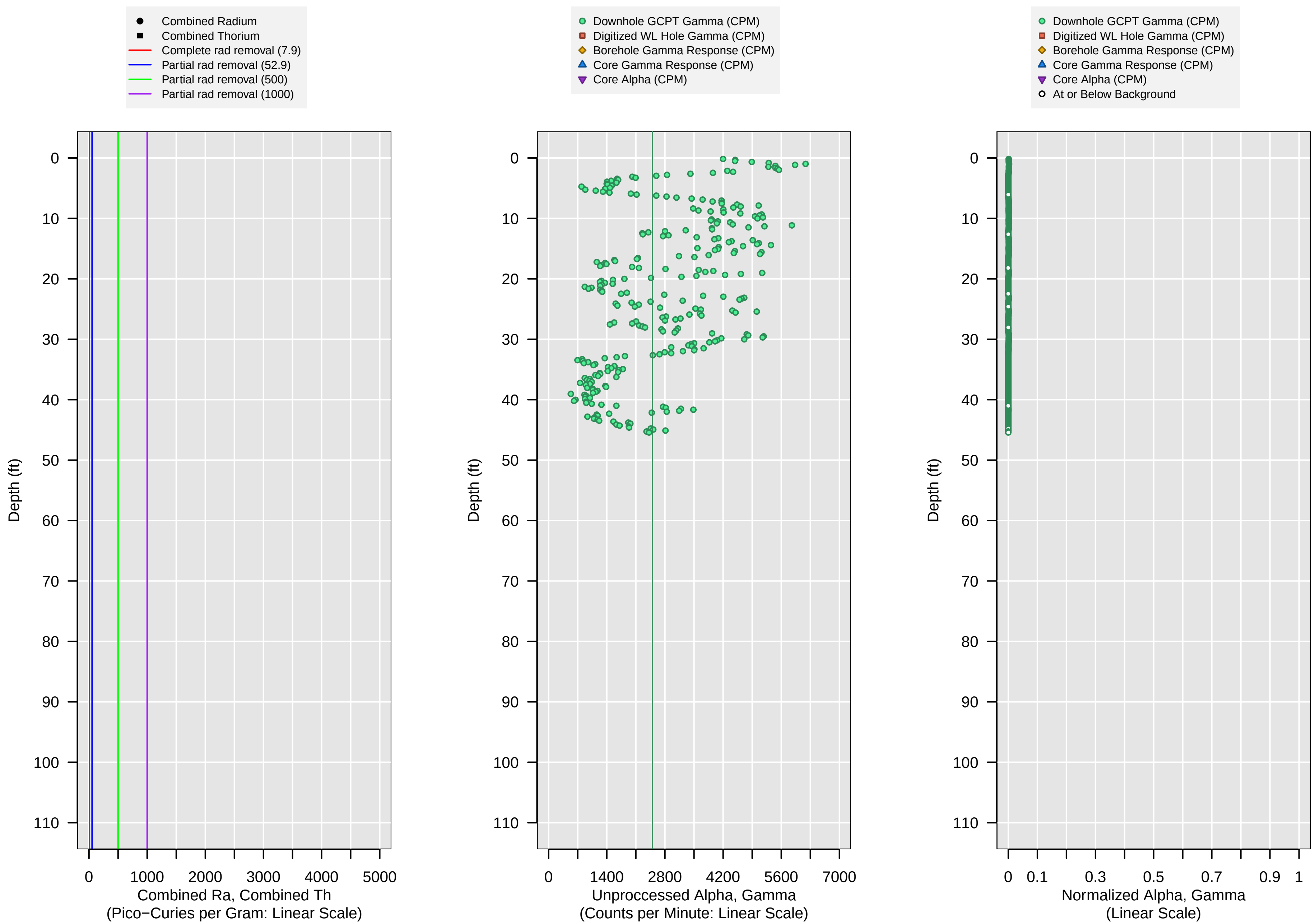
GCPT−3−1A

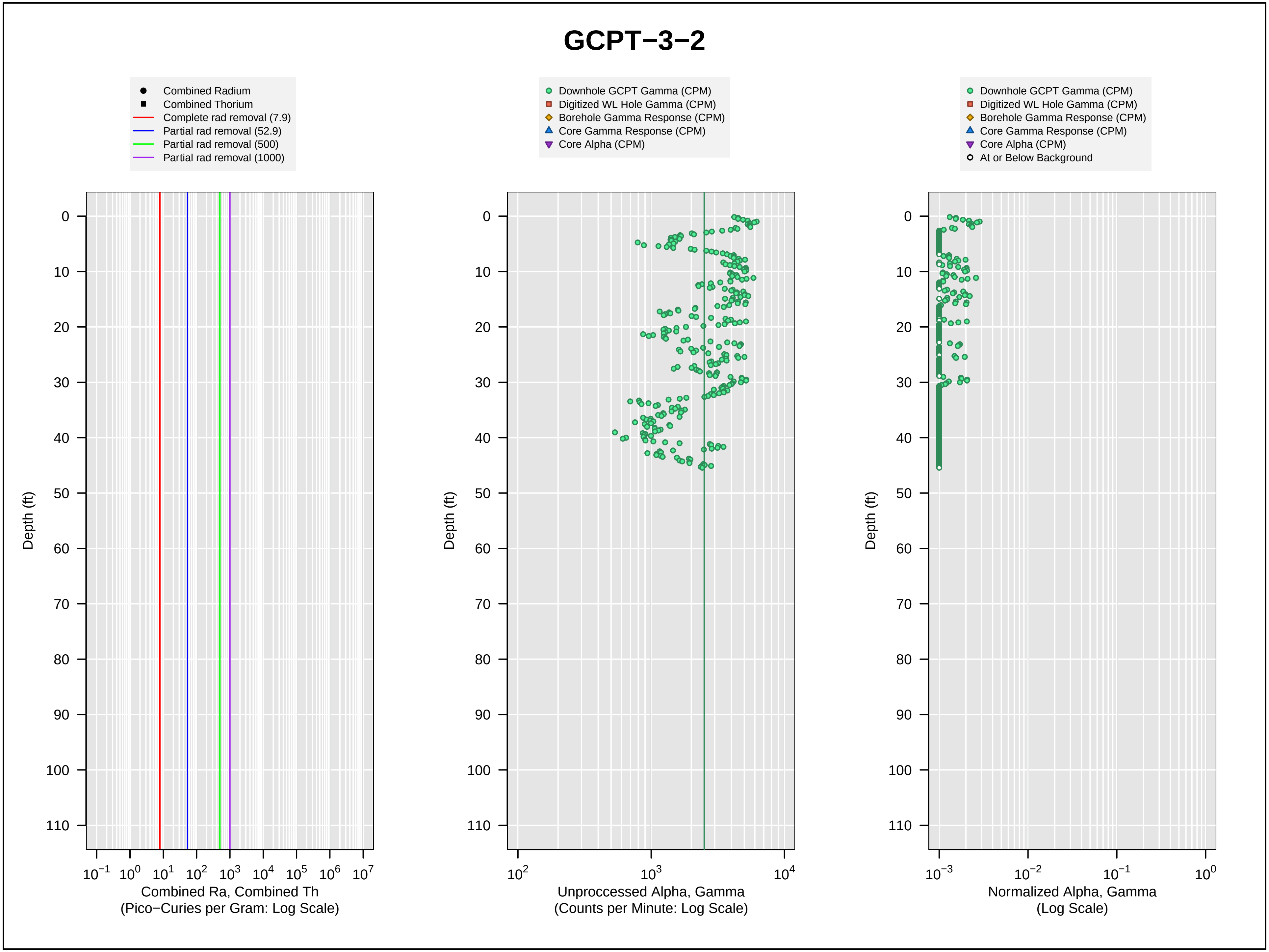

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−3−1A

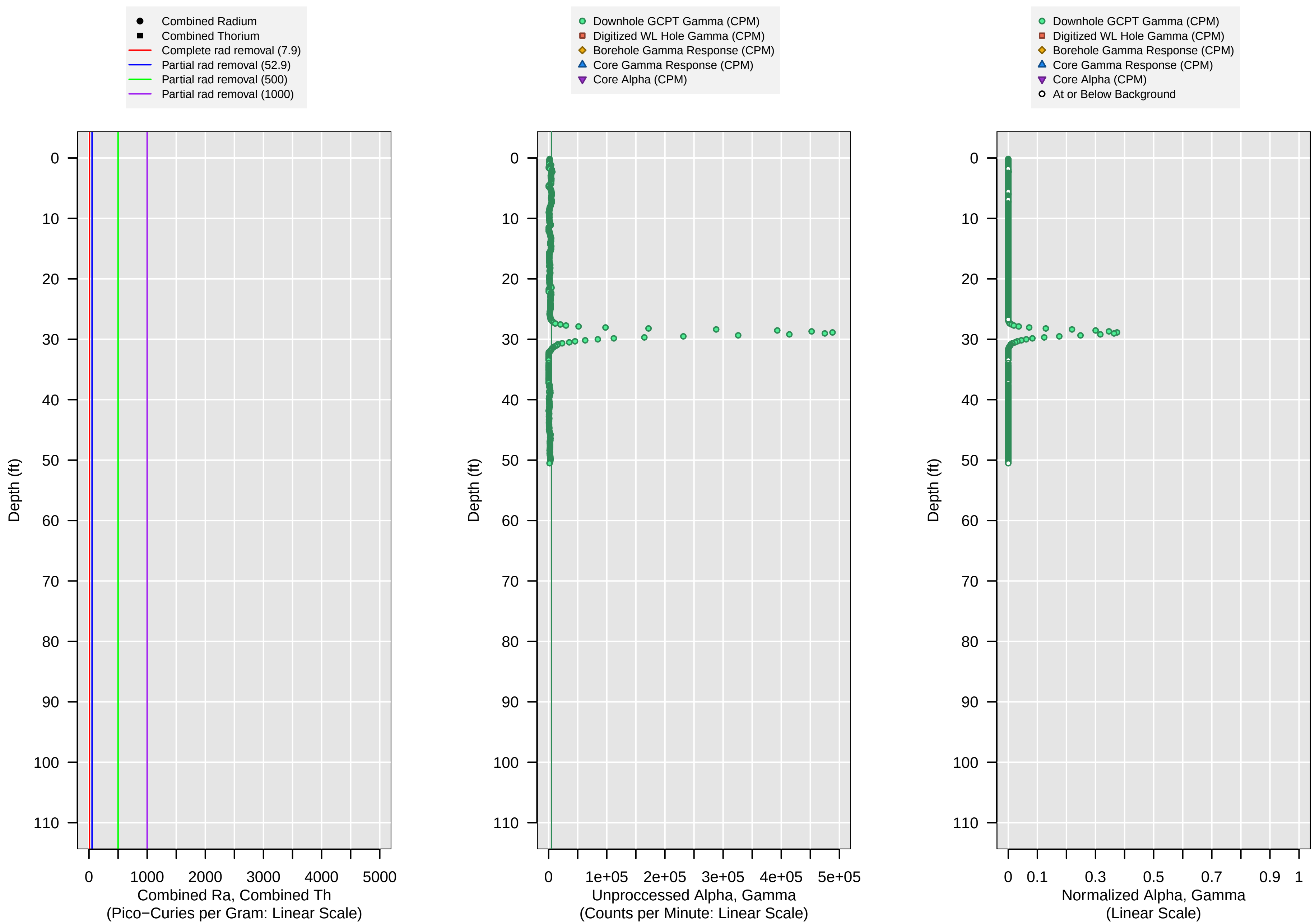

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

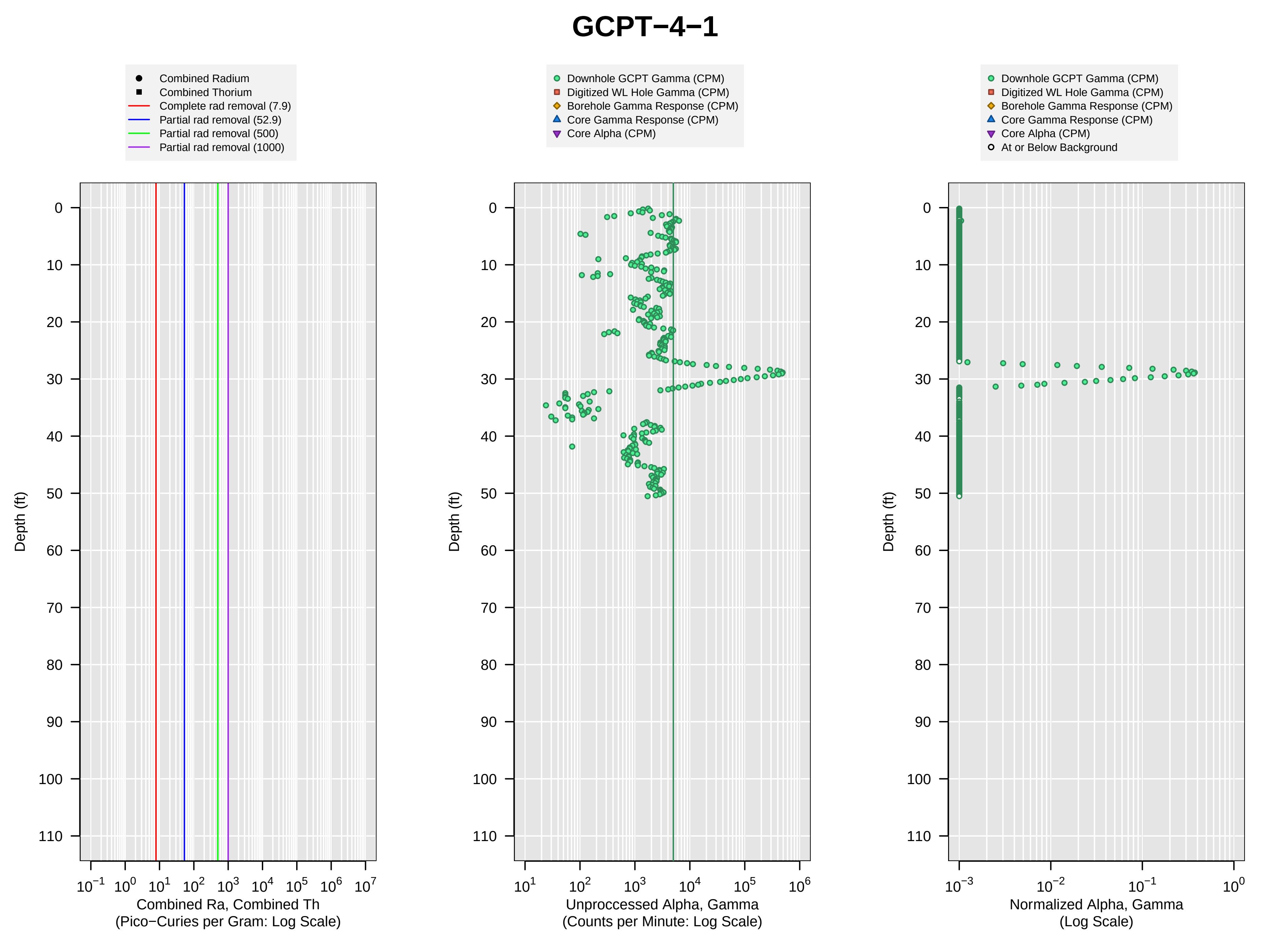
GCPT−3−2


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1400
2800
4200
5600
7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

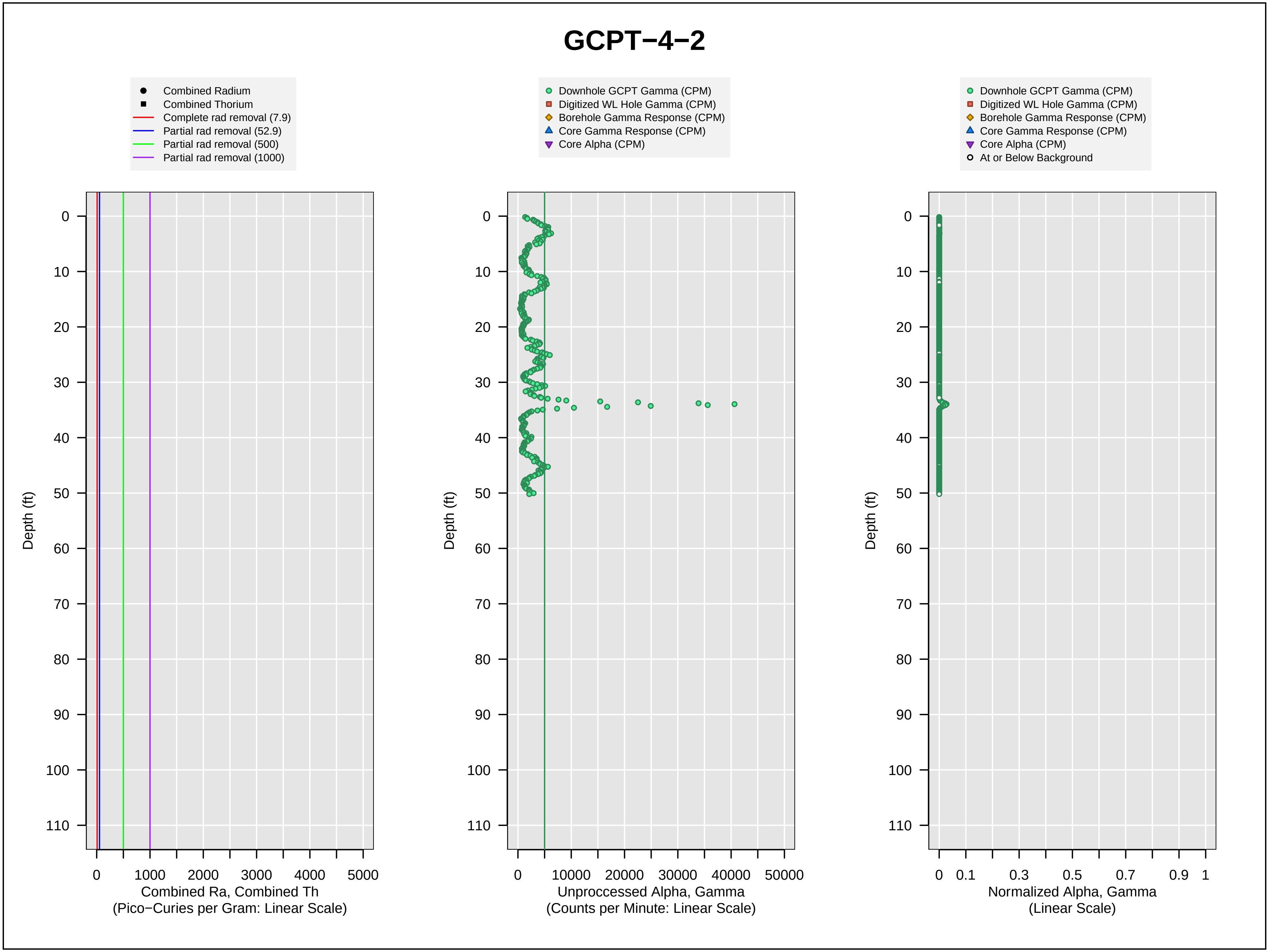

GCPT−3−2
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

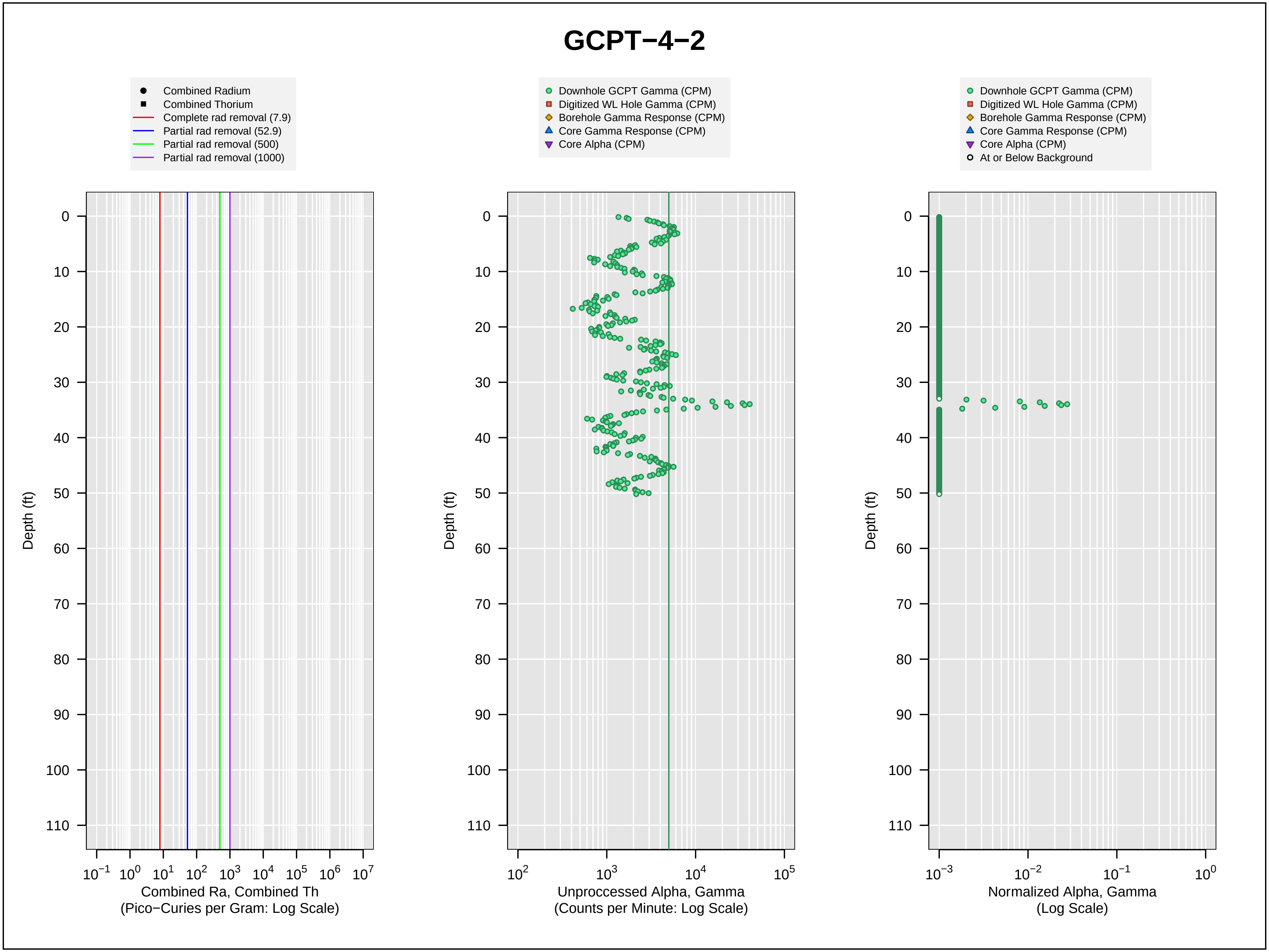
GCPT−4−1


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1e+05
2e+05
3e+05
4e+05
5e+05
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

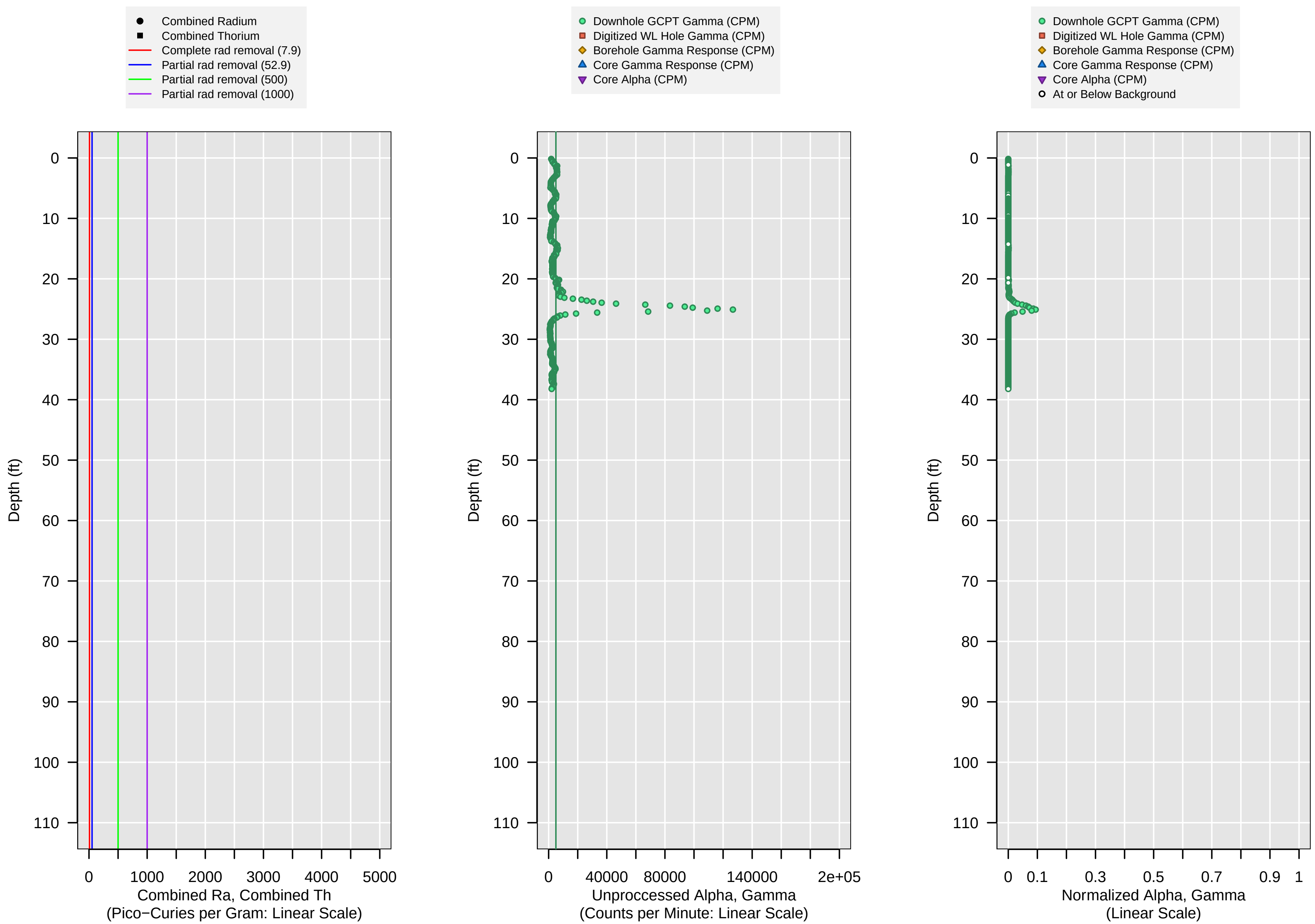

GCPT−4−1
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

S.S. Papadopulos & Associates, Inc.

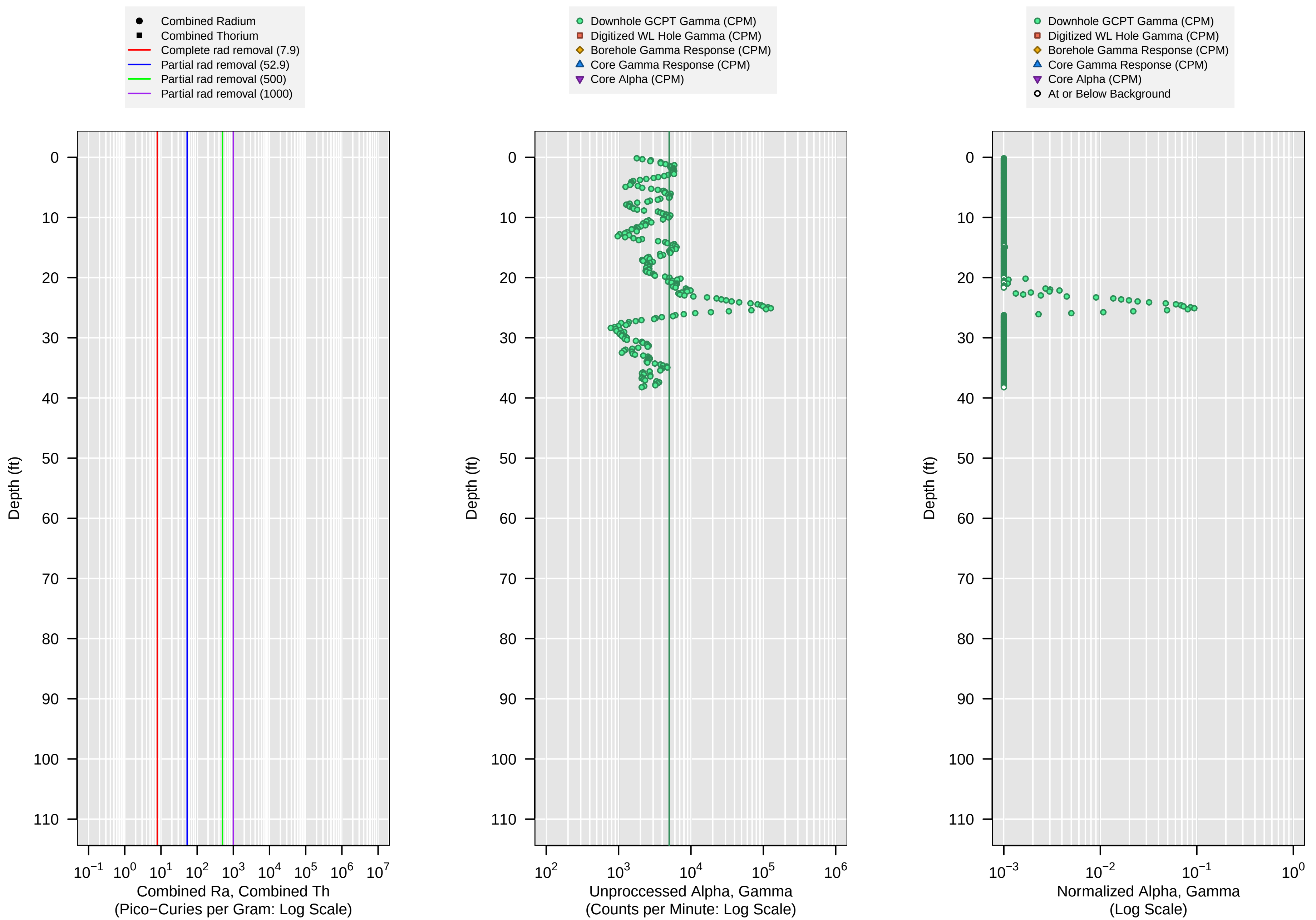



GCPT−4−2
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

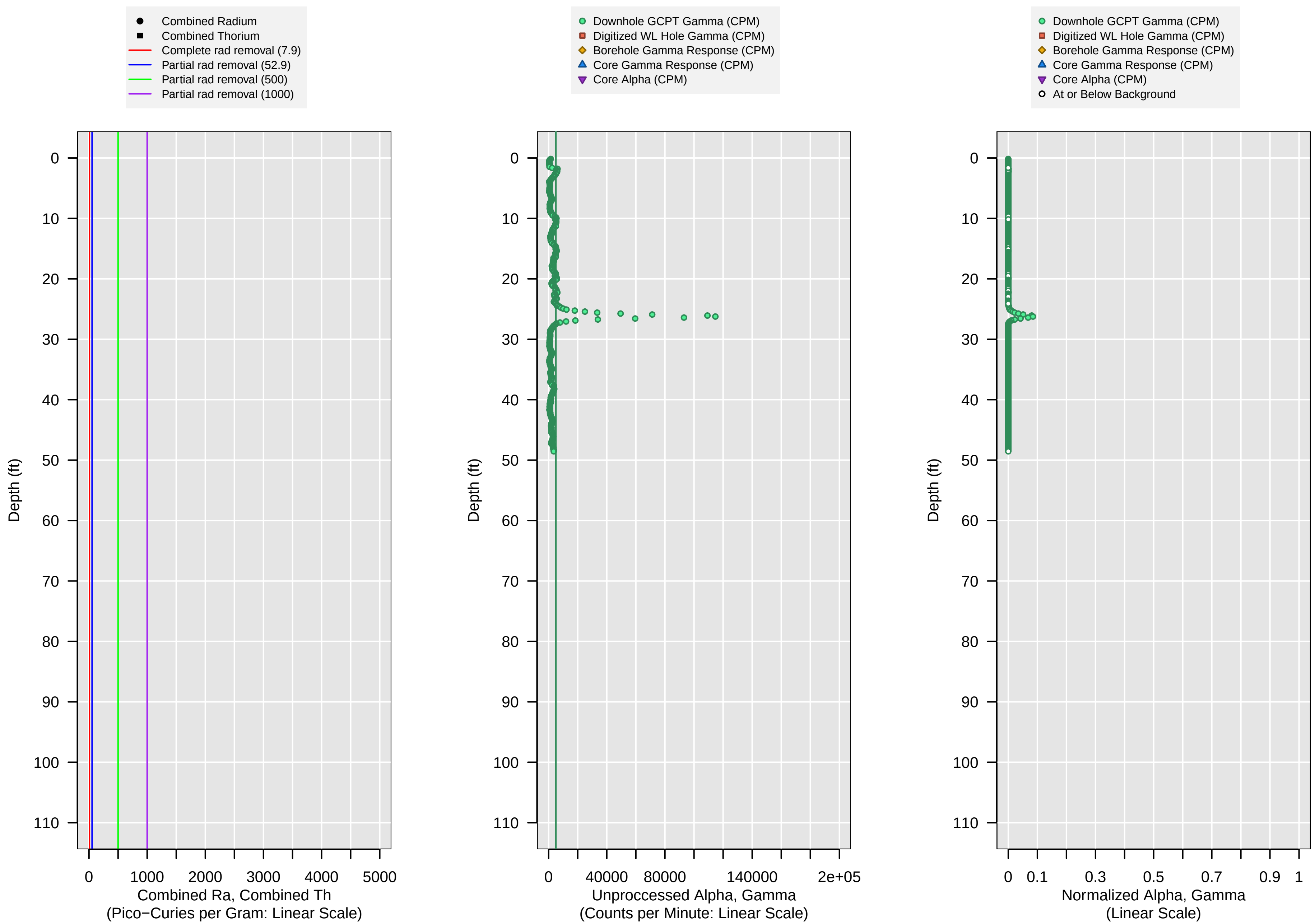
GCPT−5−1


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
40000
80000
140000
2e+05
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

GCPT−5−1

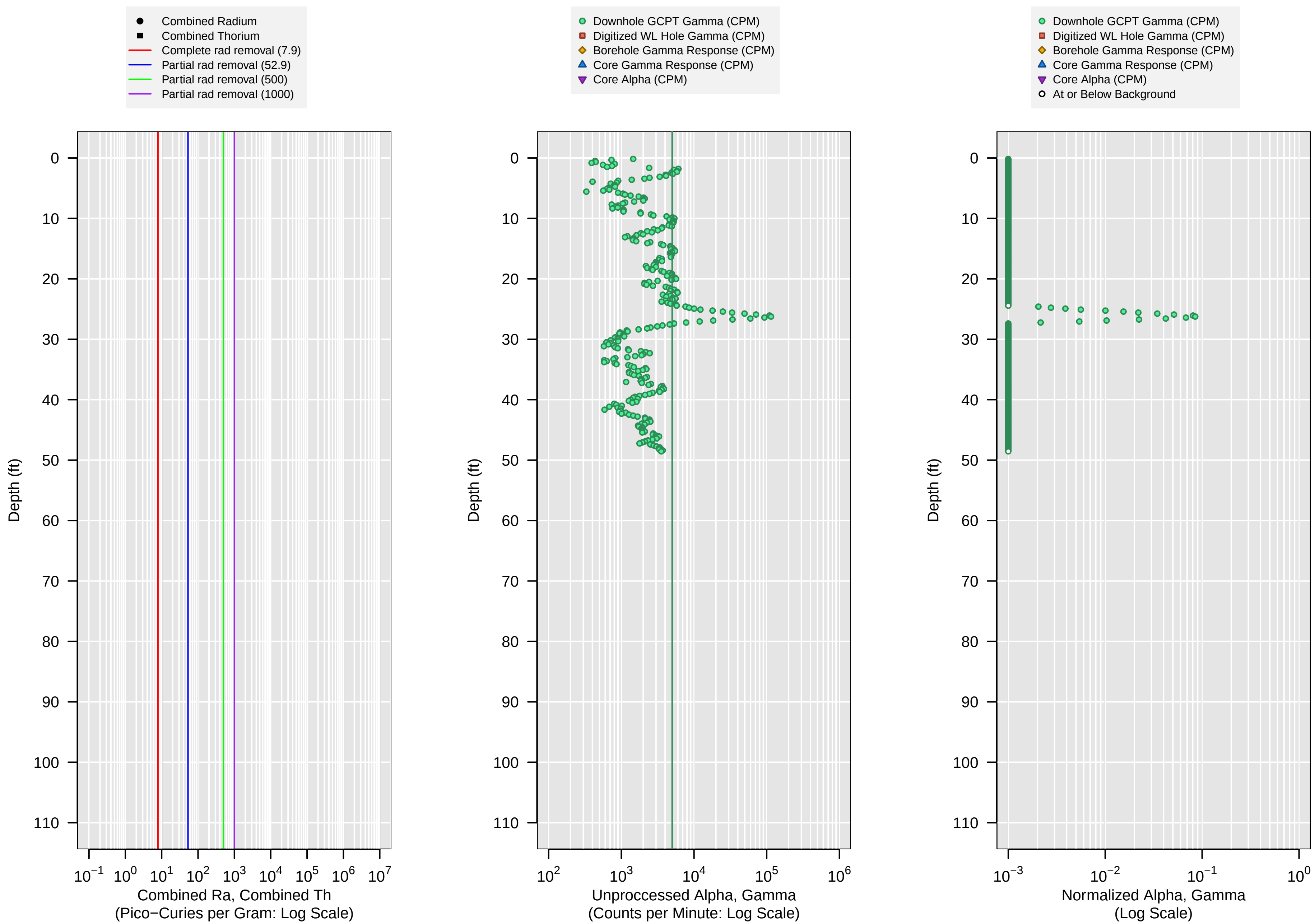

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−5−2

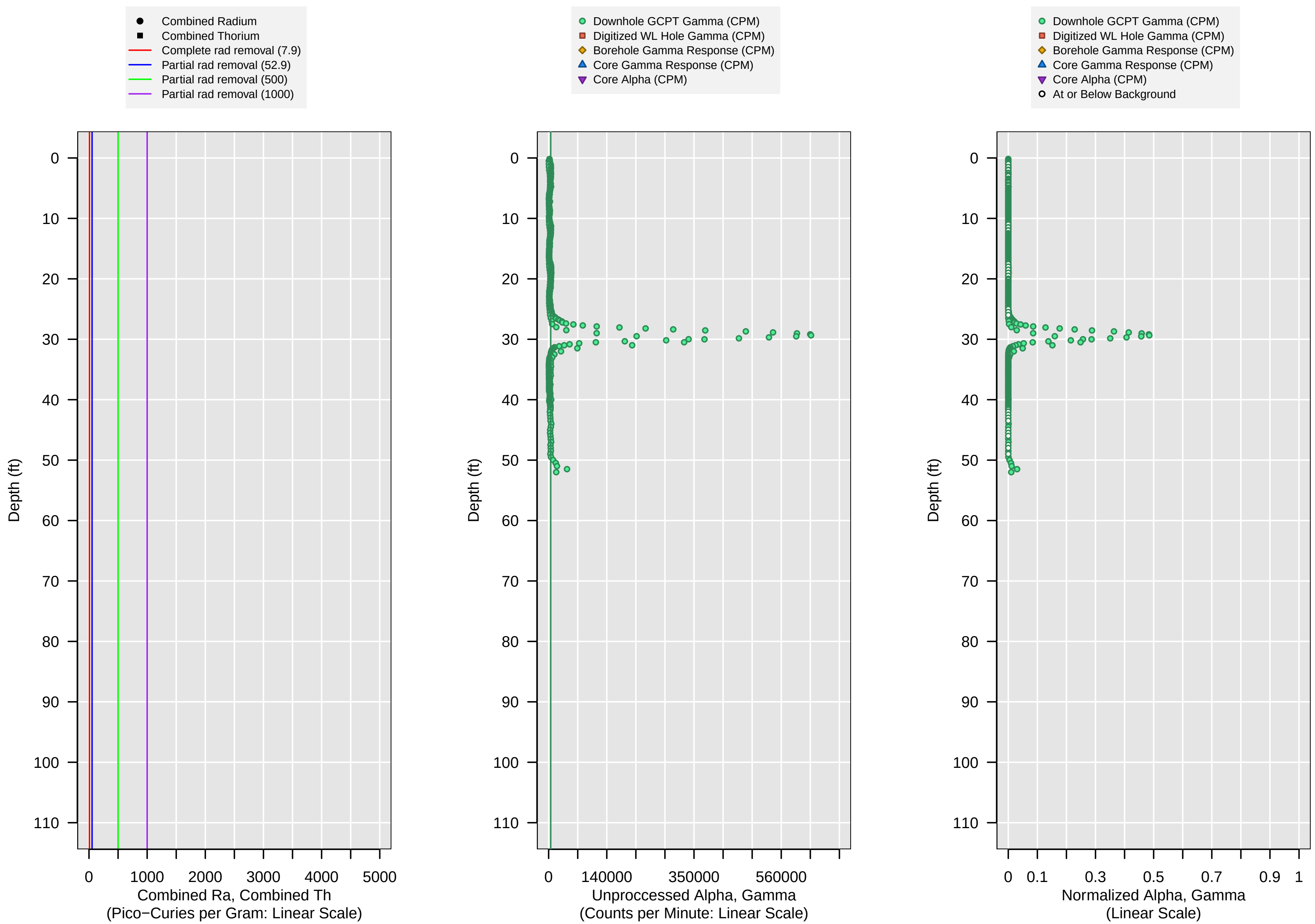


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
40000
80000
140000
2e+05
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

GCPT−5−2

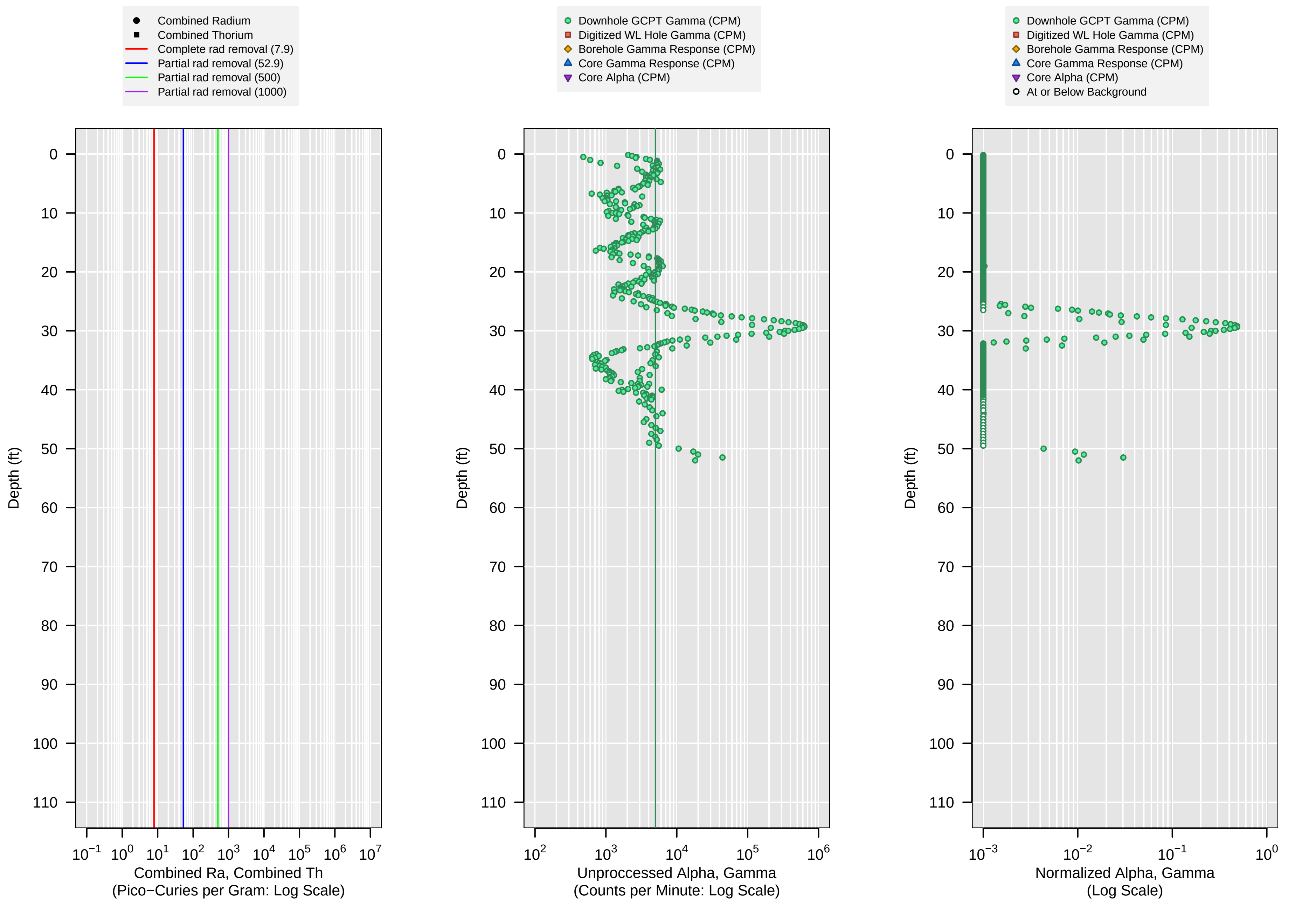

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−5−3

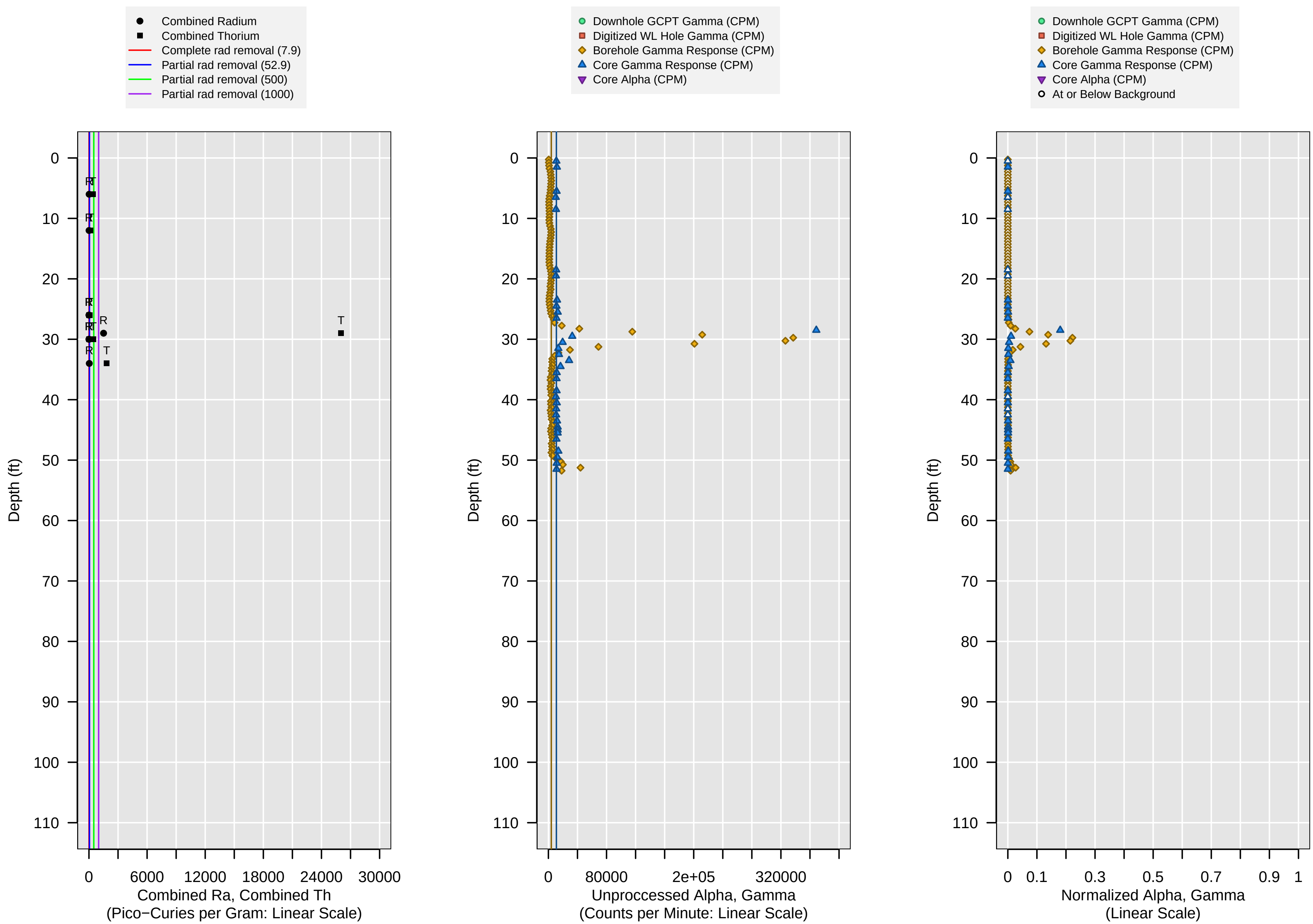


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
140000
350000
560000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

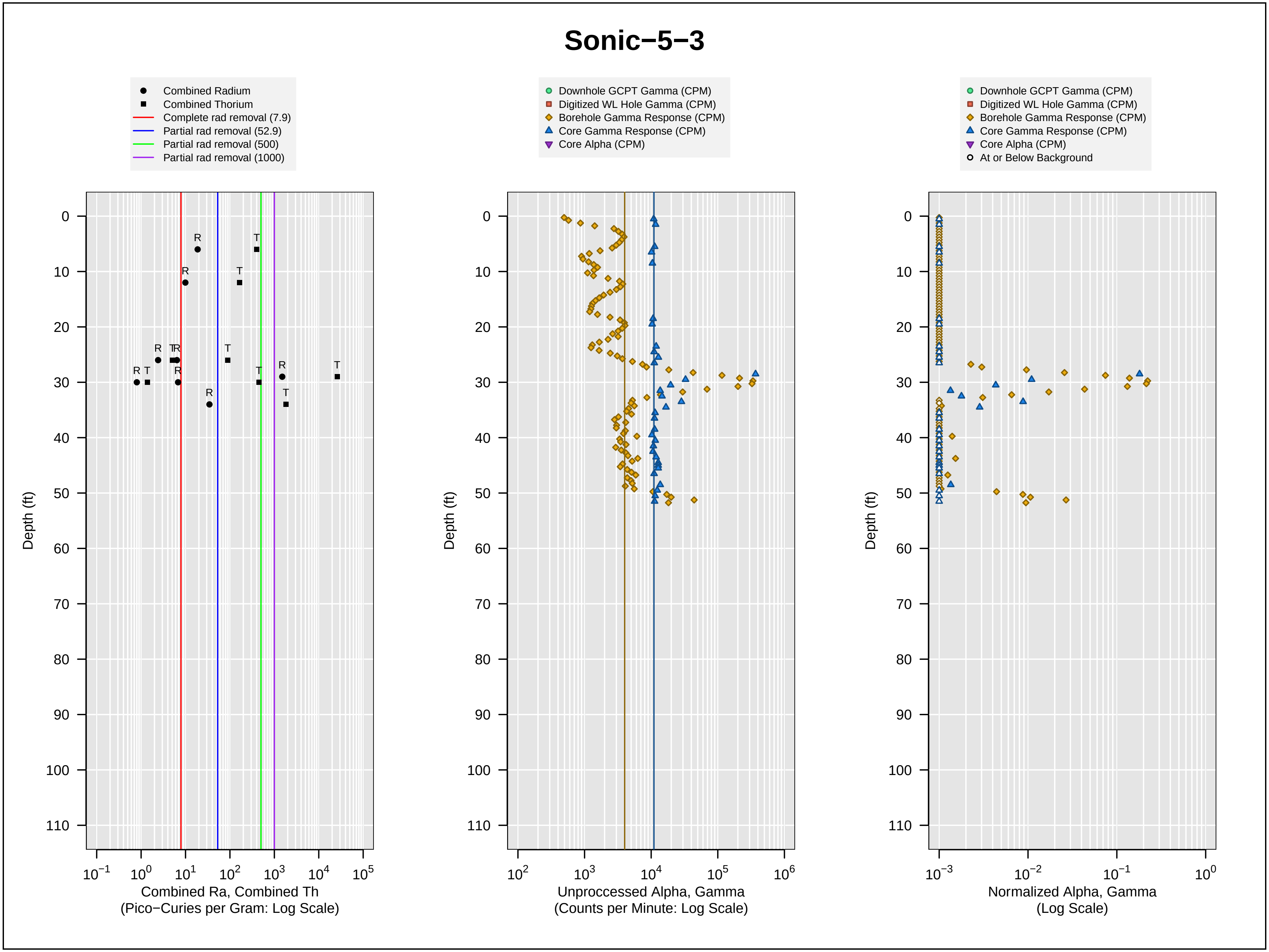
GCPT−5−3


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

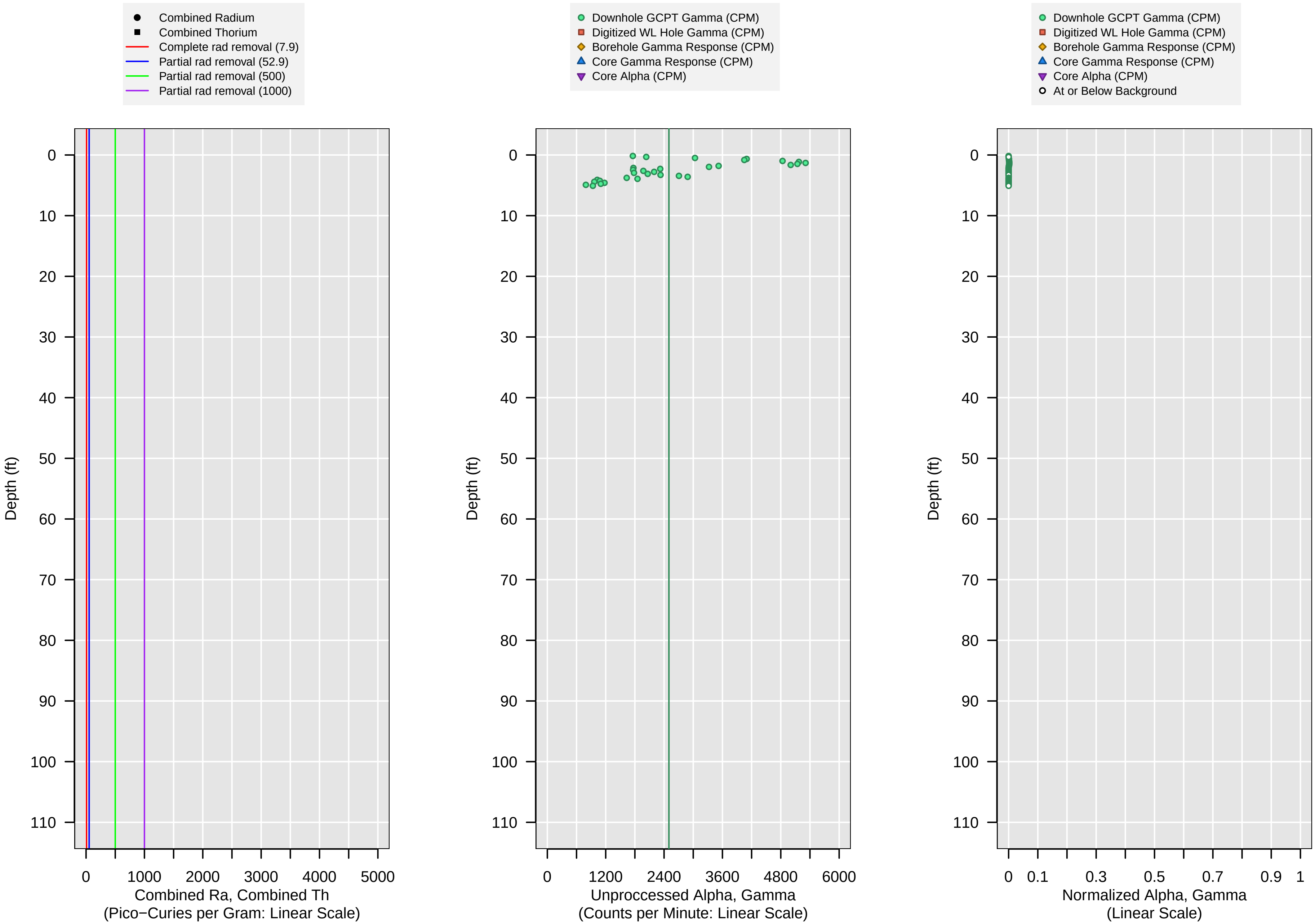
Sonic−5−3



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
R
T
0
6000
12000
18000
24000
30000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
80000
2e+05
320000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

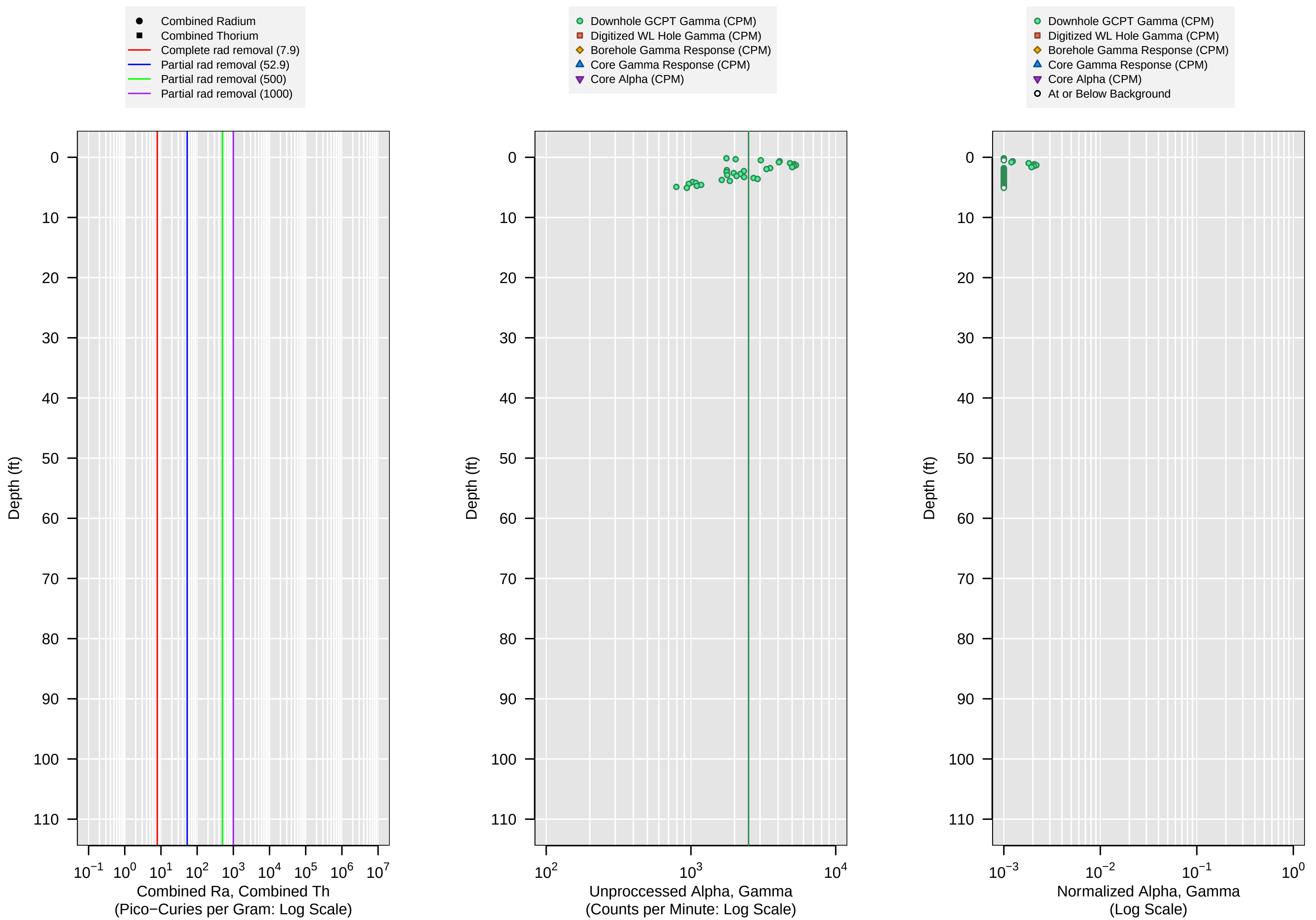

Sonic−5−3
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Normalized Alpha, Gamma
(Log Scale)

GCPT−5−4



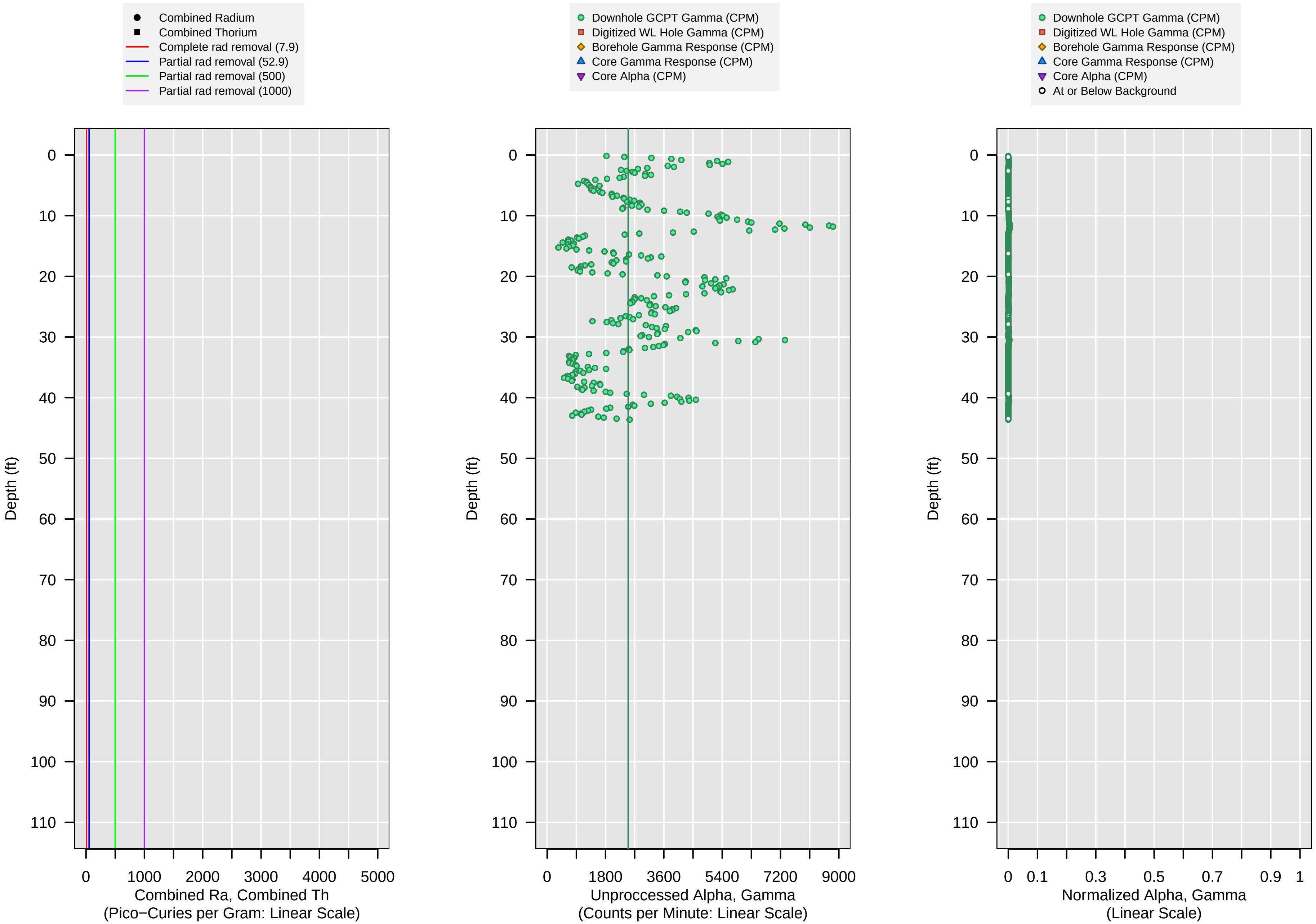
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1200
2400
3600
4800
6000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

GCPT−5−4



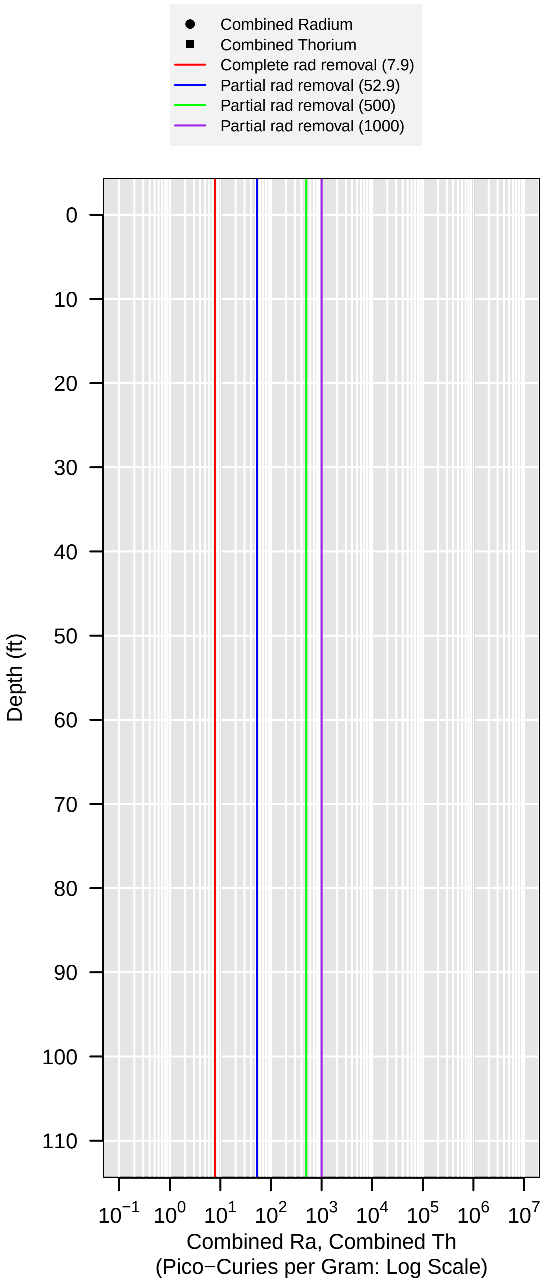
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−5−4A

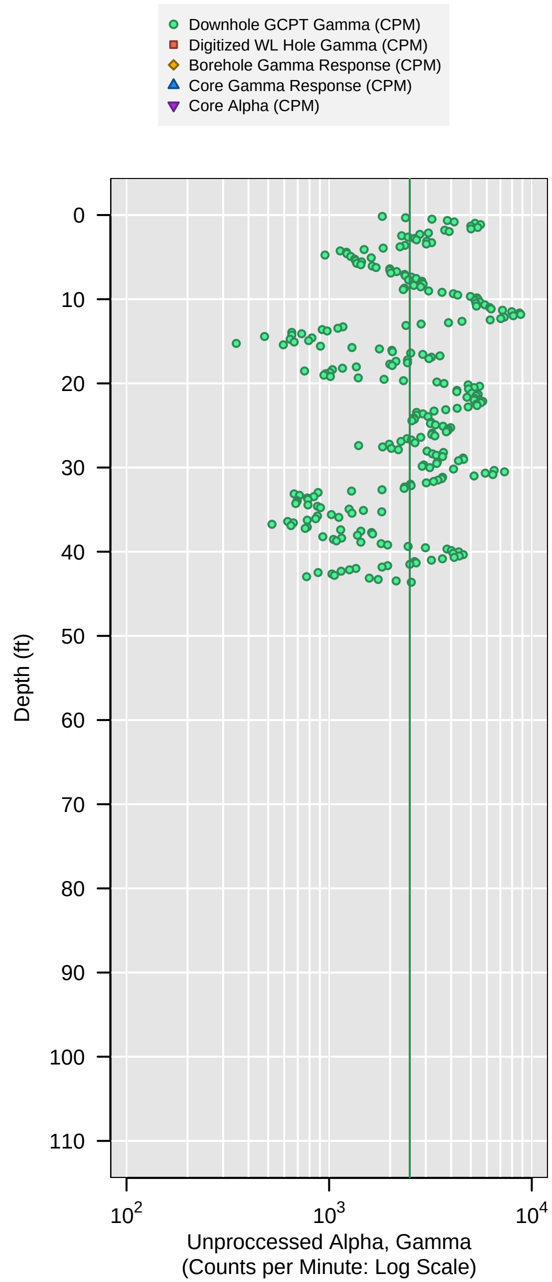


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1800
3600
5400
7200
9000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

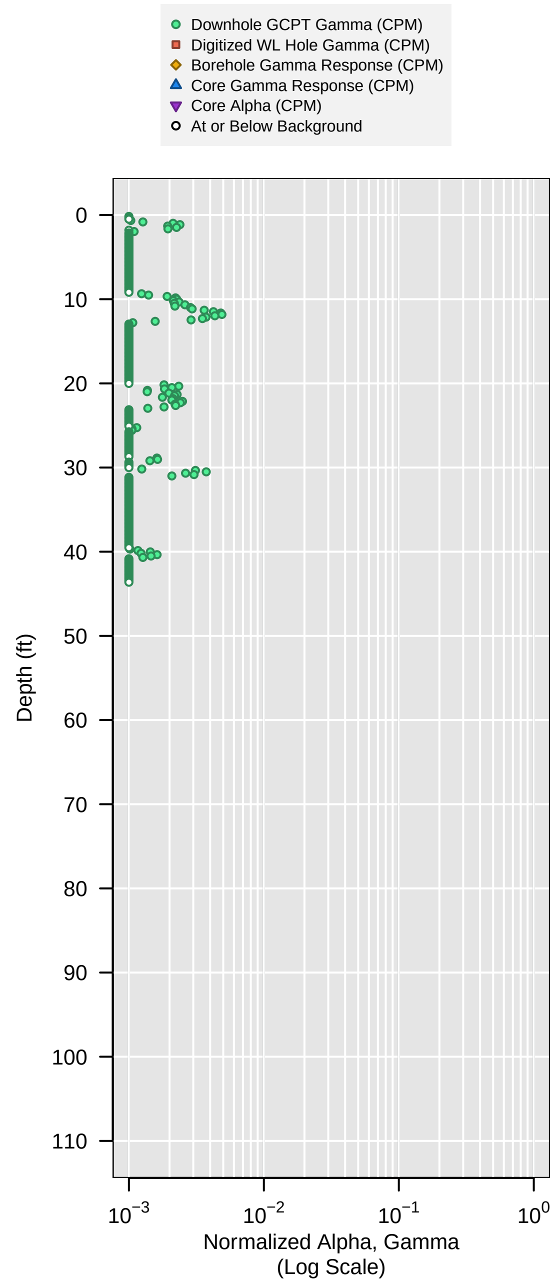
GCPT−5−4A



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{-1} 10^{0} 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6} 10^{7}
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)

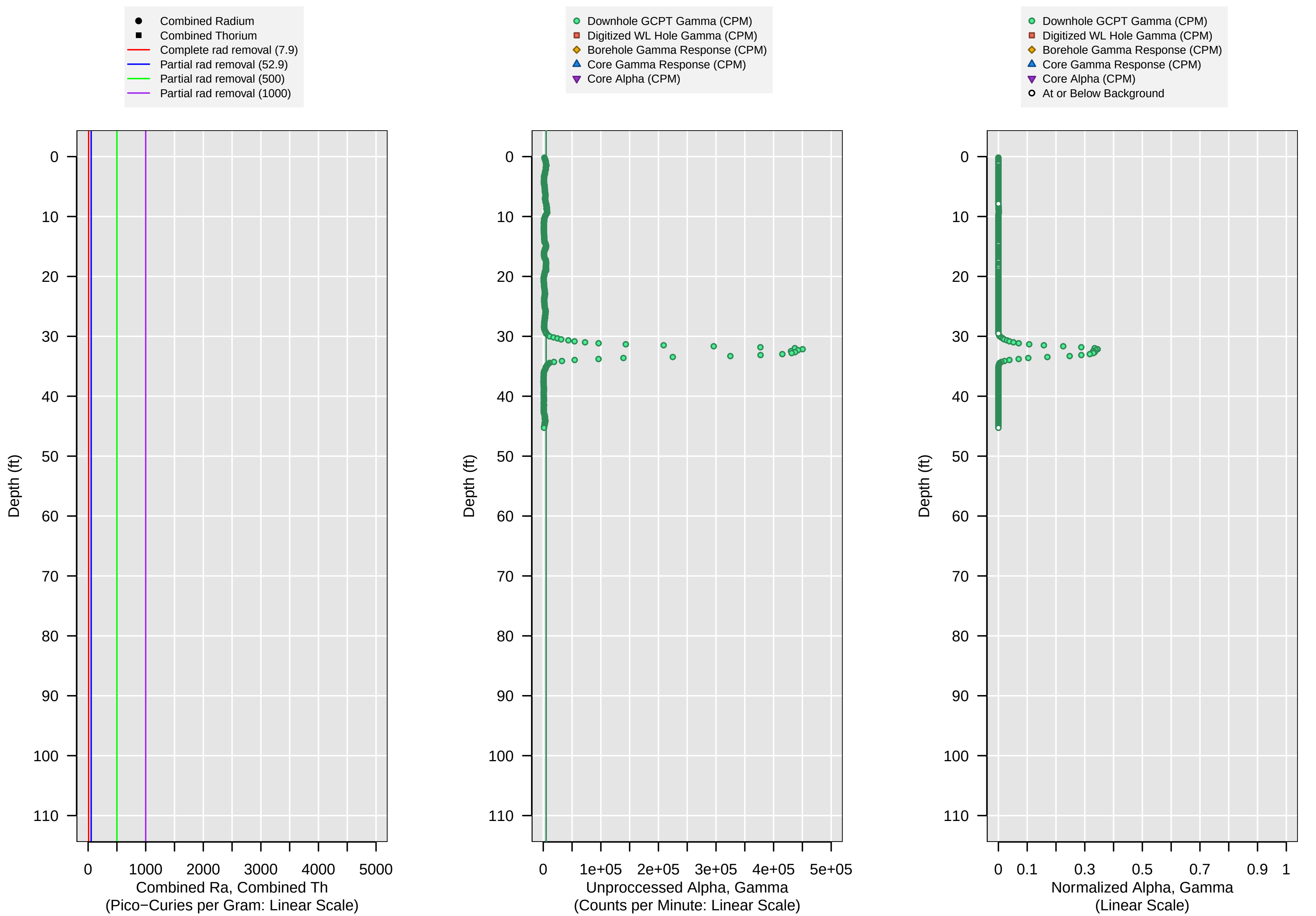


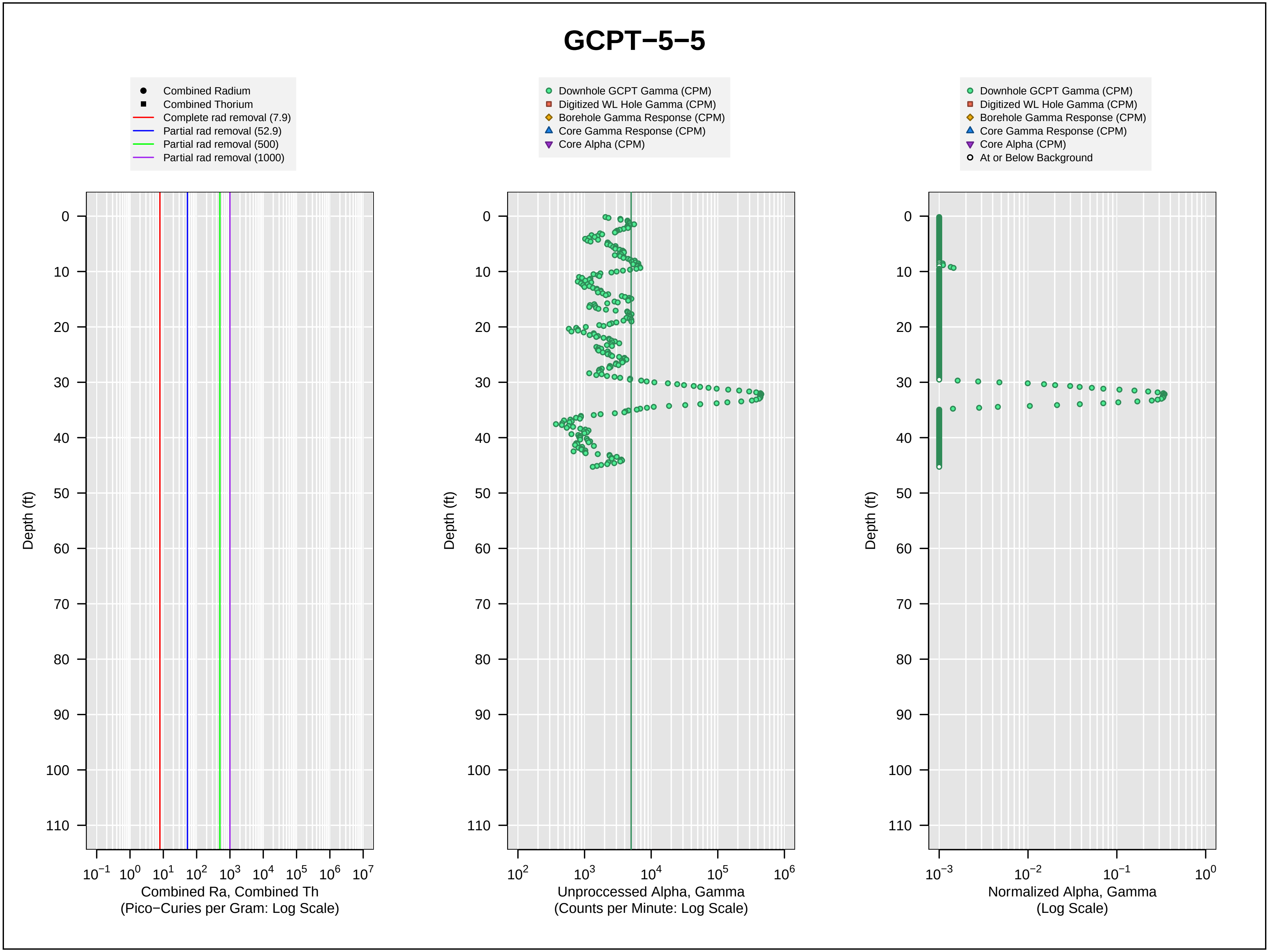
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{2} 10^{3} 10^{4}
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)

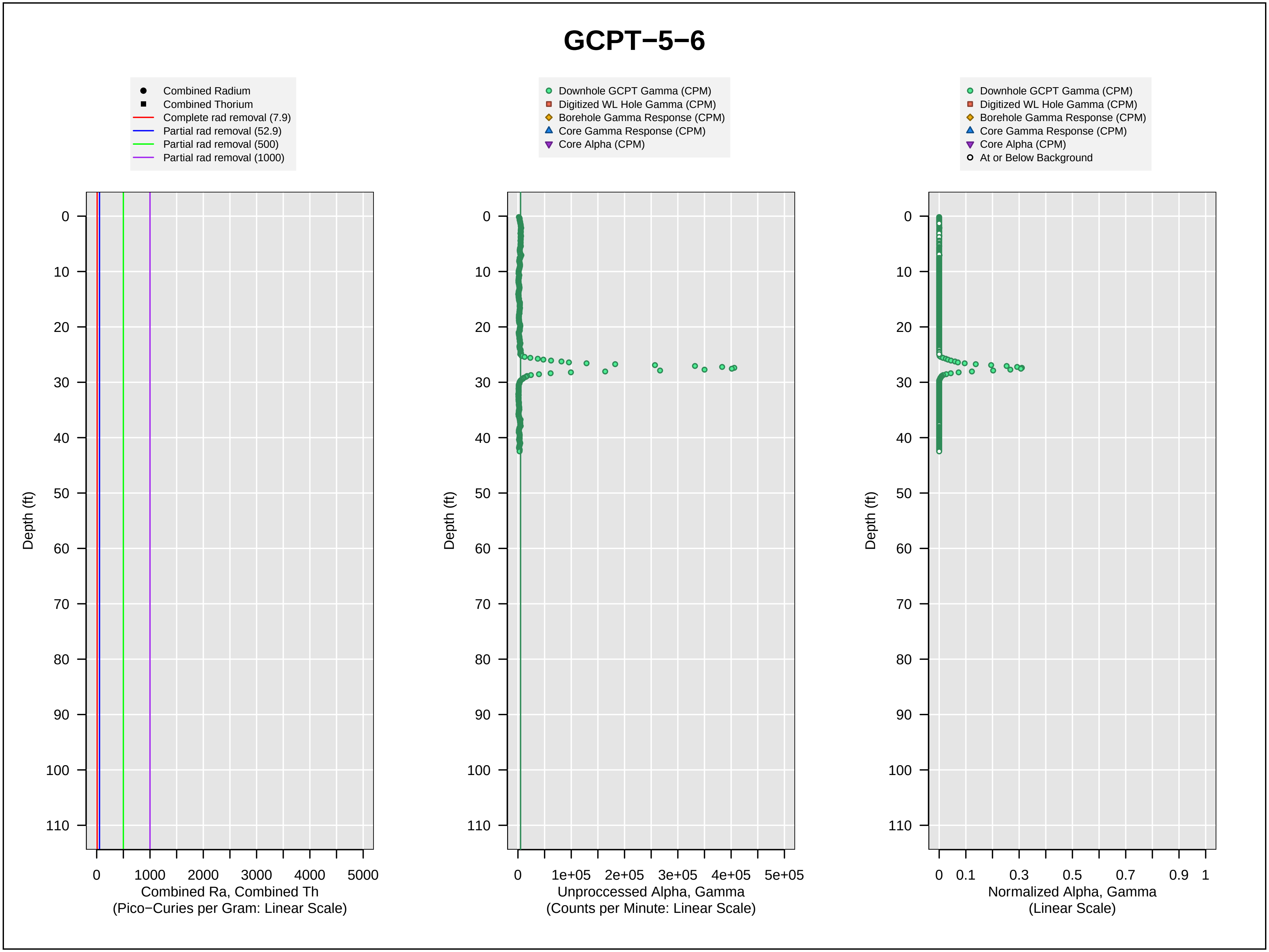


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{-3} 10^{-2} 10^{-1} 10^{0}
Normalized Alpha, Gamma
(Log Scale)

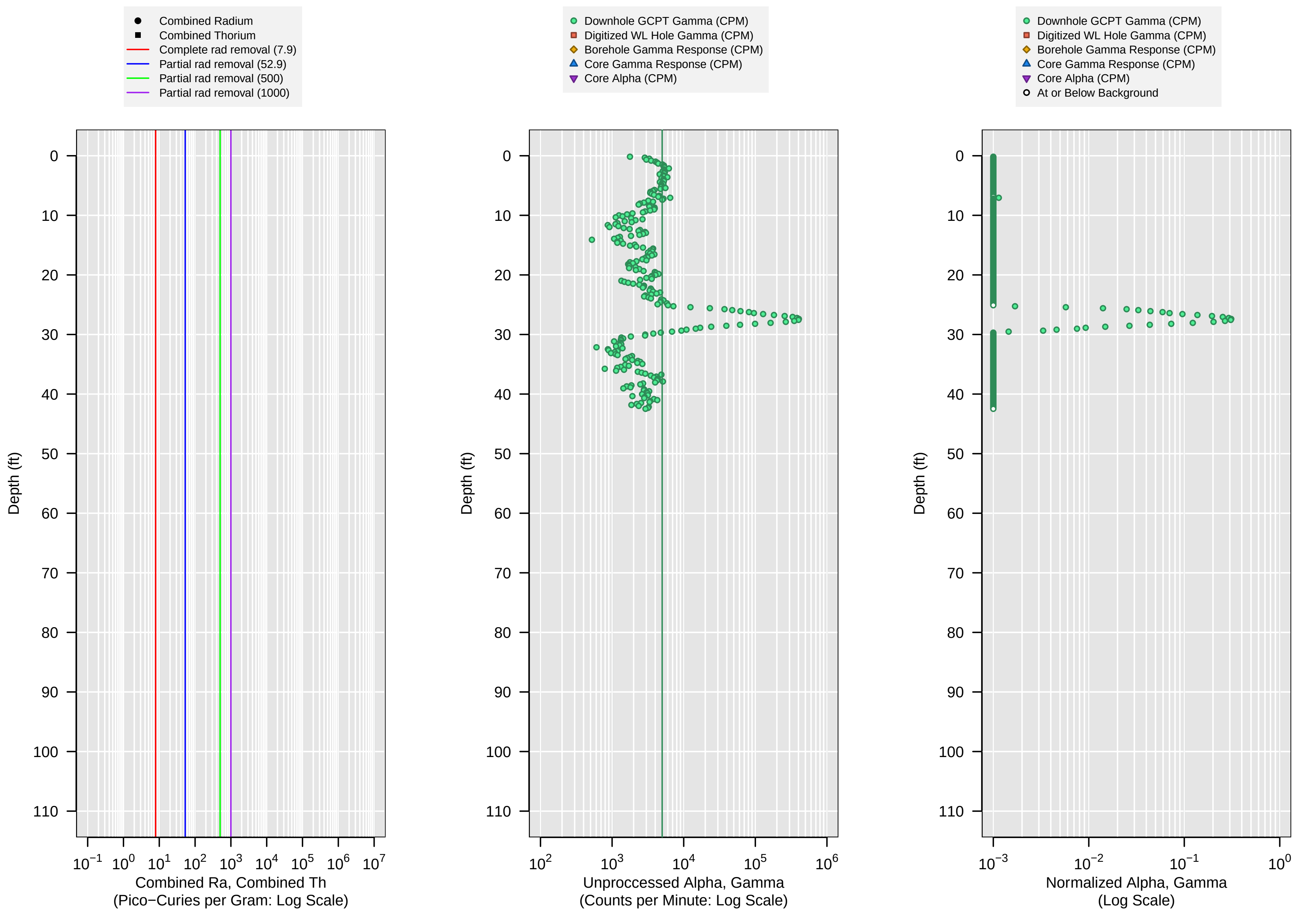
GCPT−5−5


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

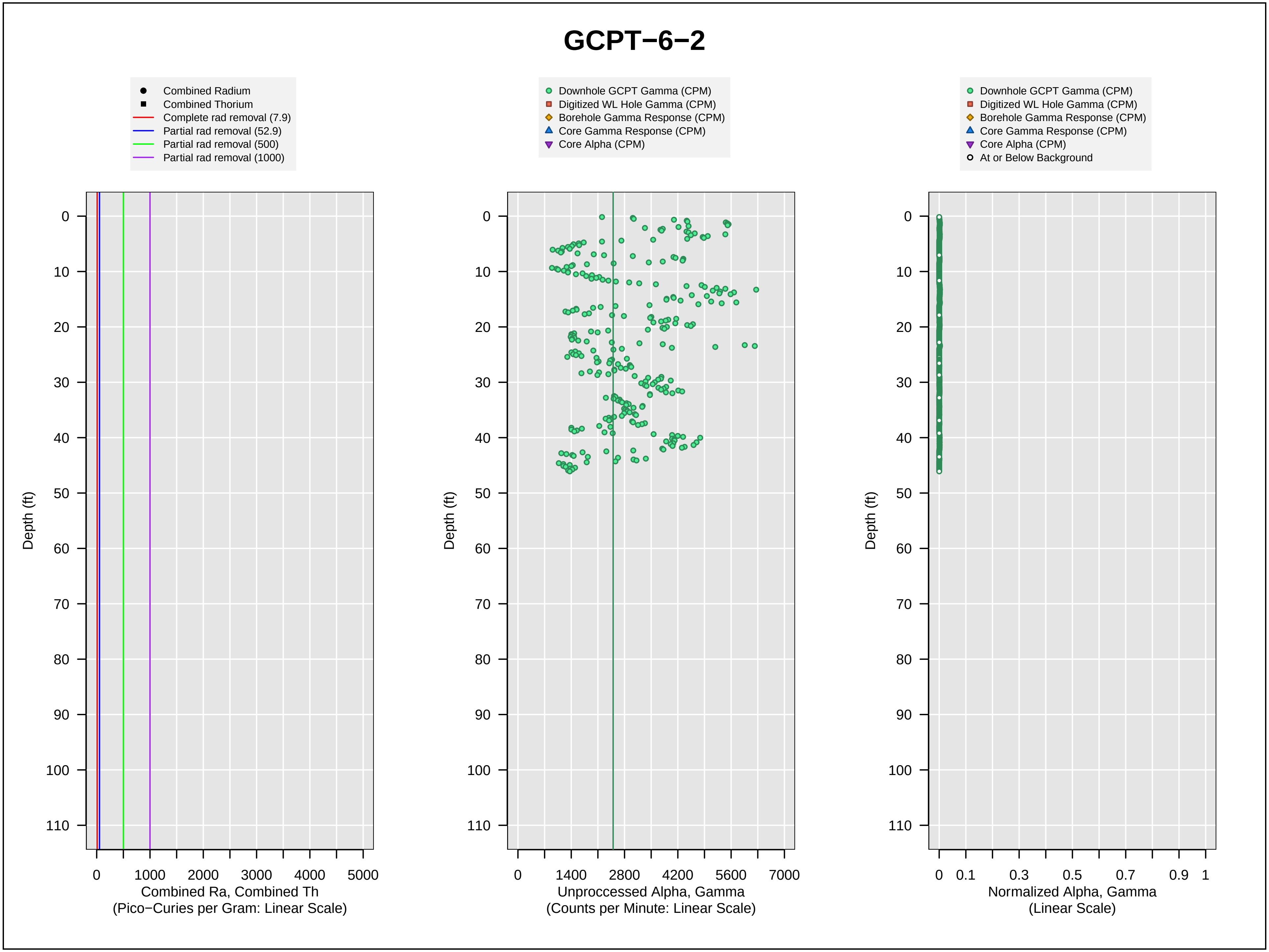

GCPT−5−5
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)


GCPT−5−6
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

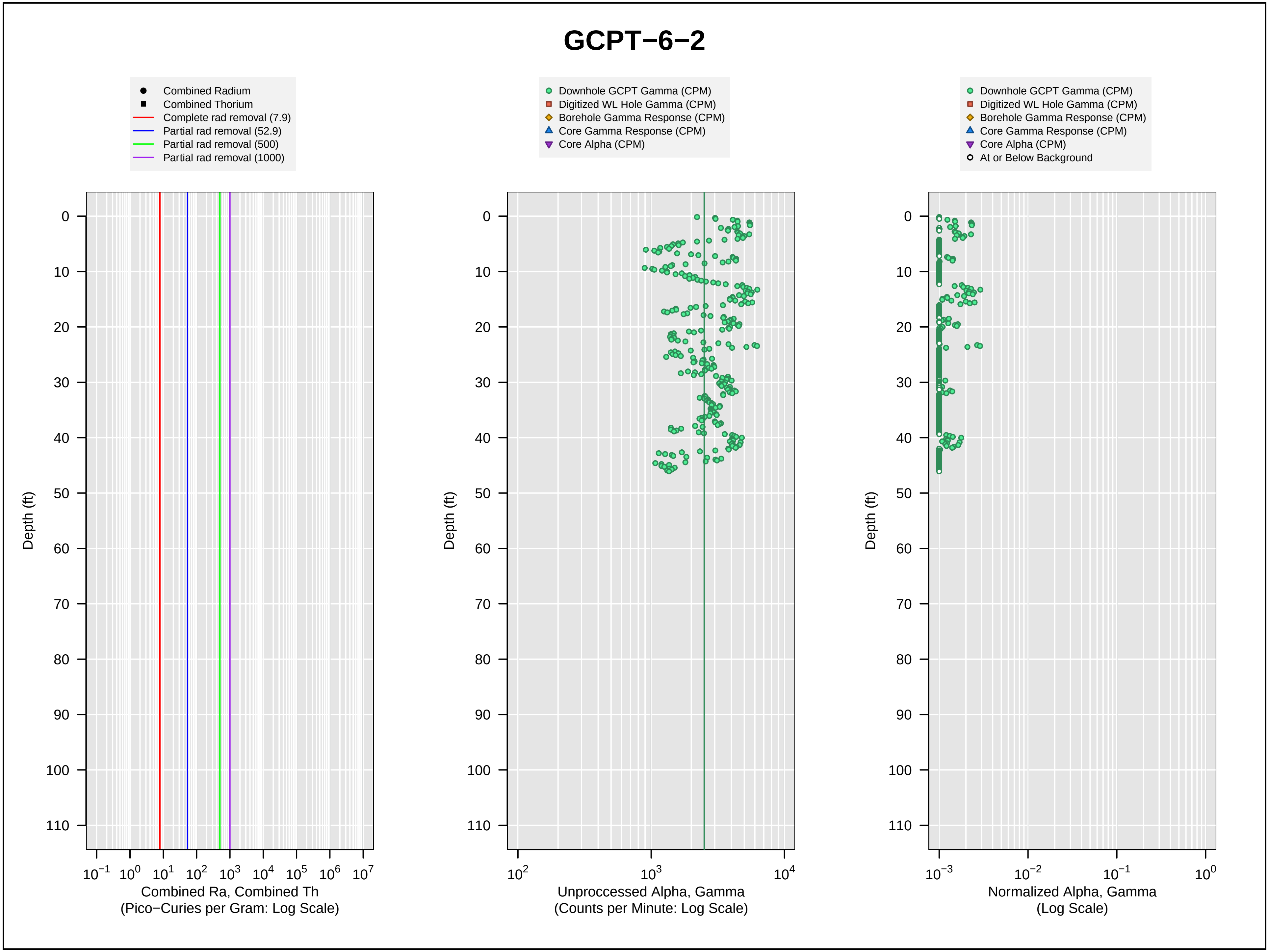
GCPT−5−6



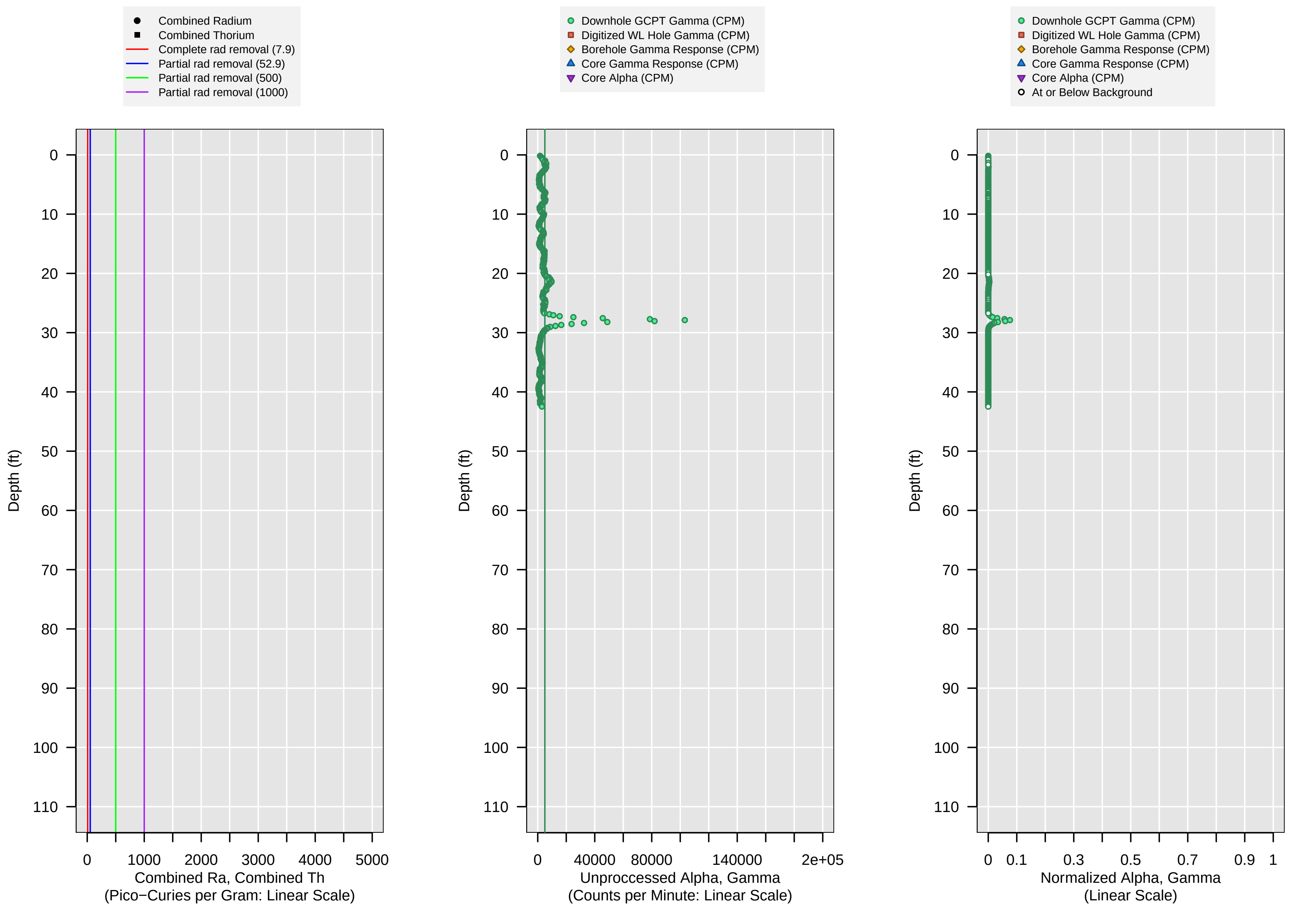
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)



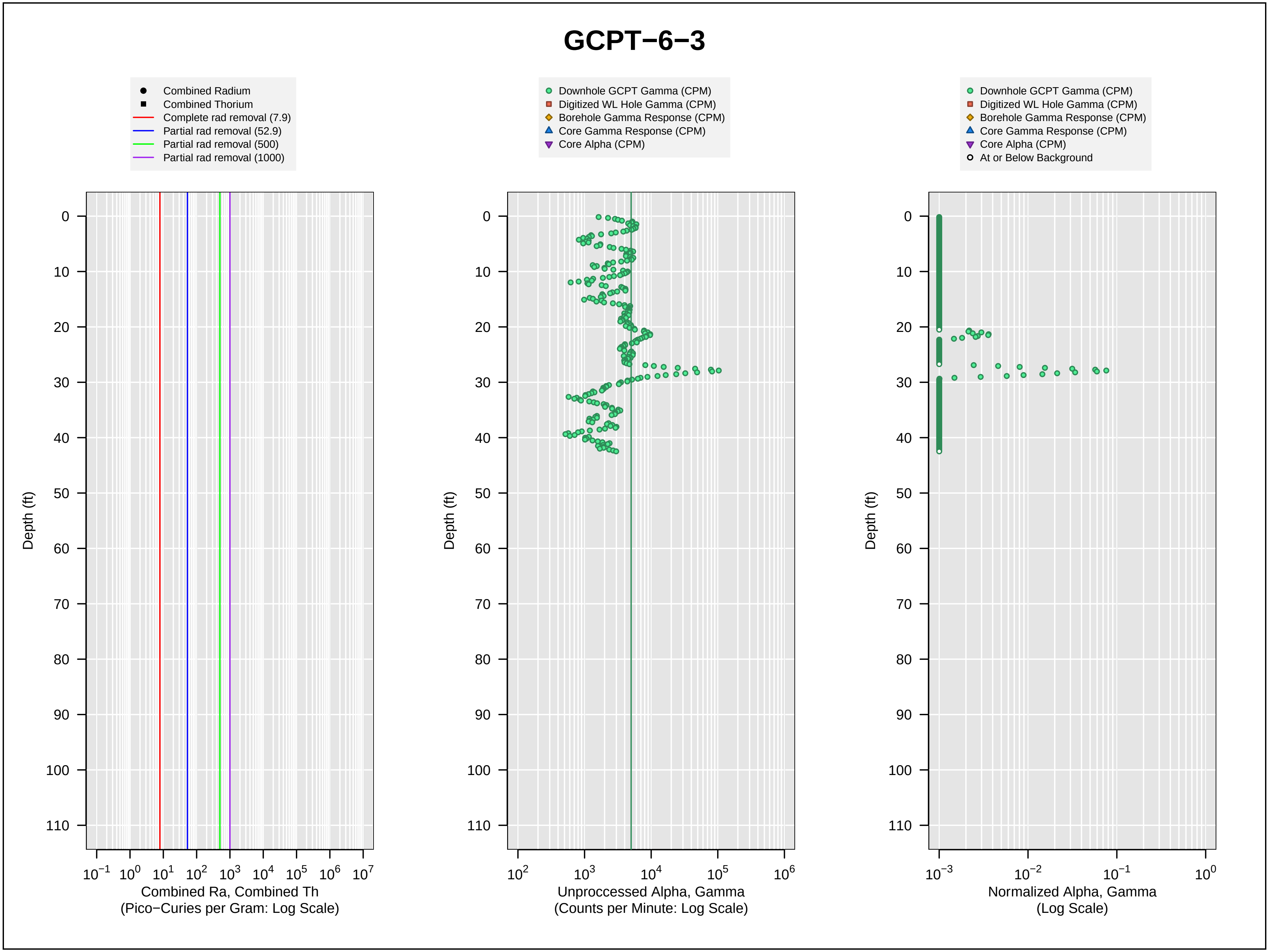
GCPT−6−2
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)


GCPT−6−2
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

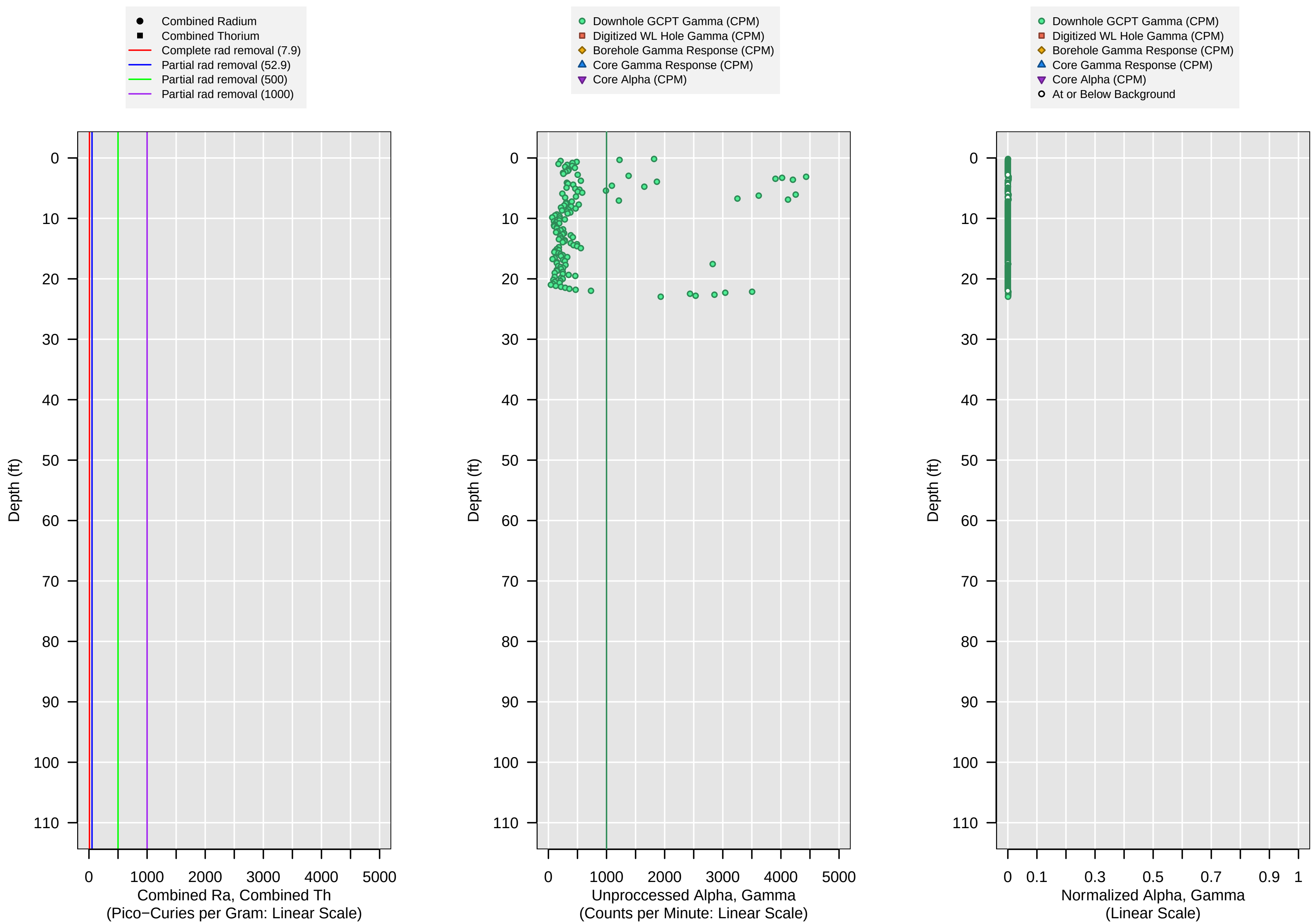
GCPT−6−3



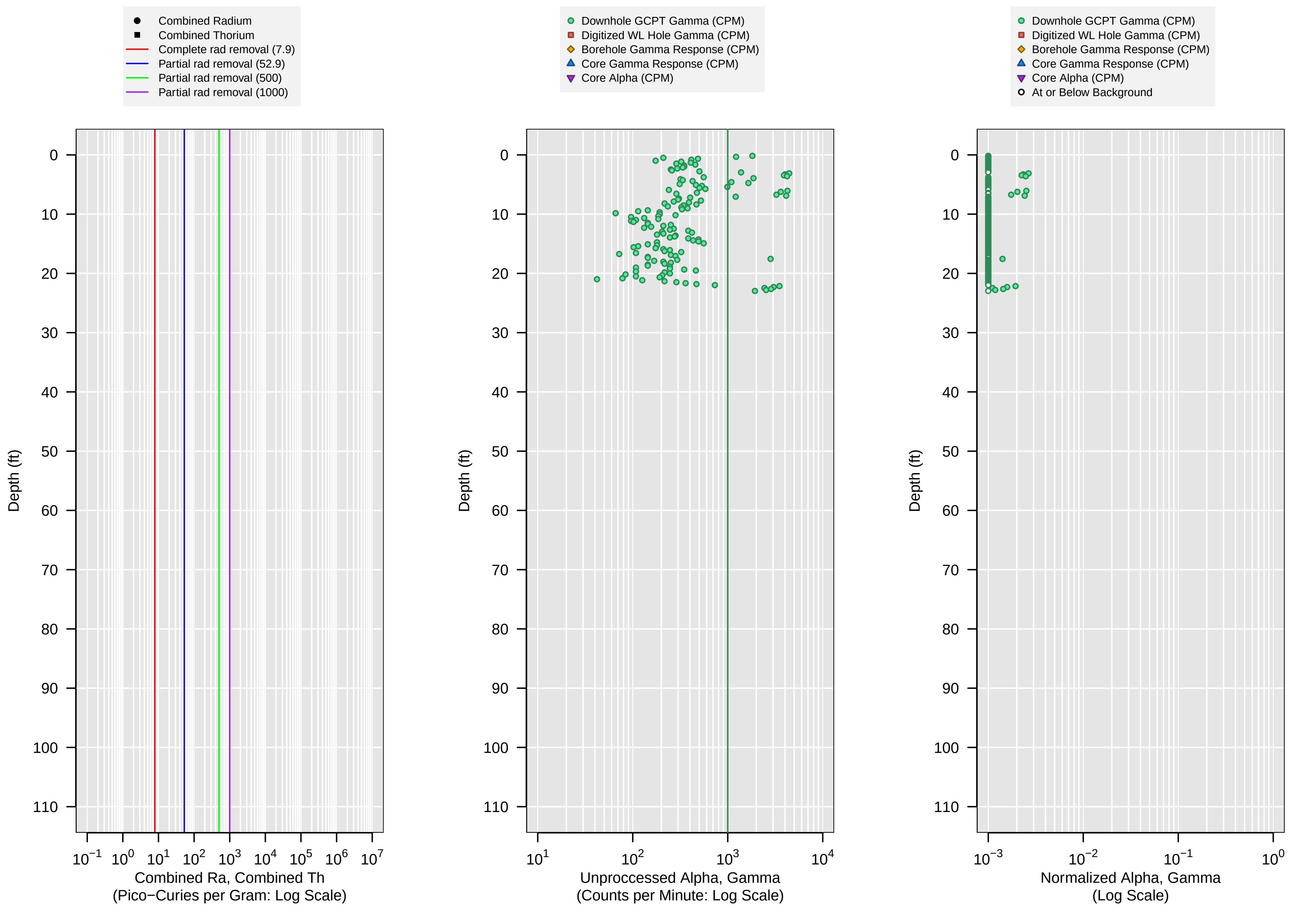
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
40000
80000
140000
2e+05
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)


GCPT−6−3
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

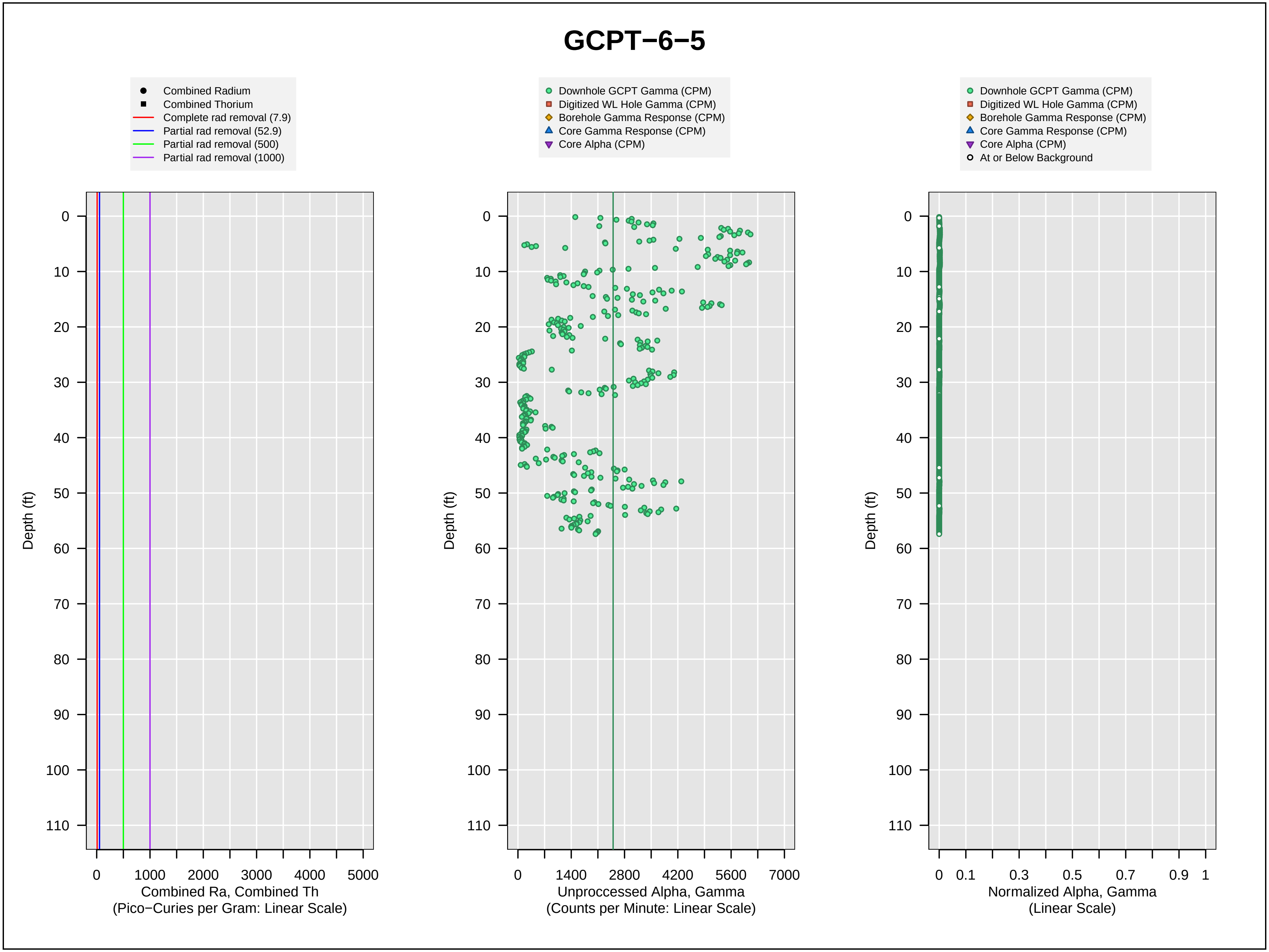
GCPT−6−4

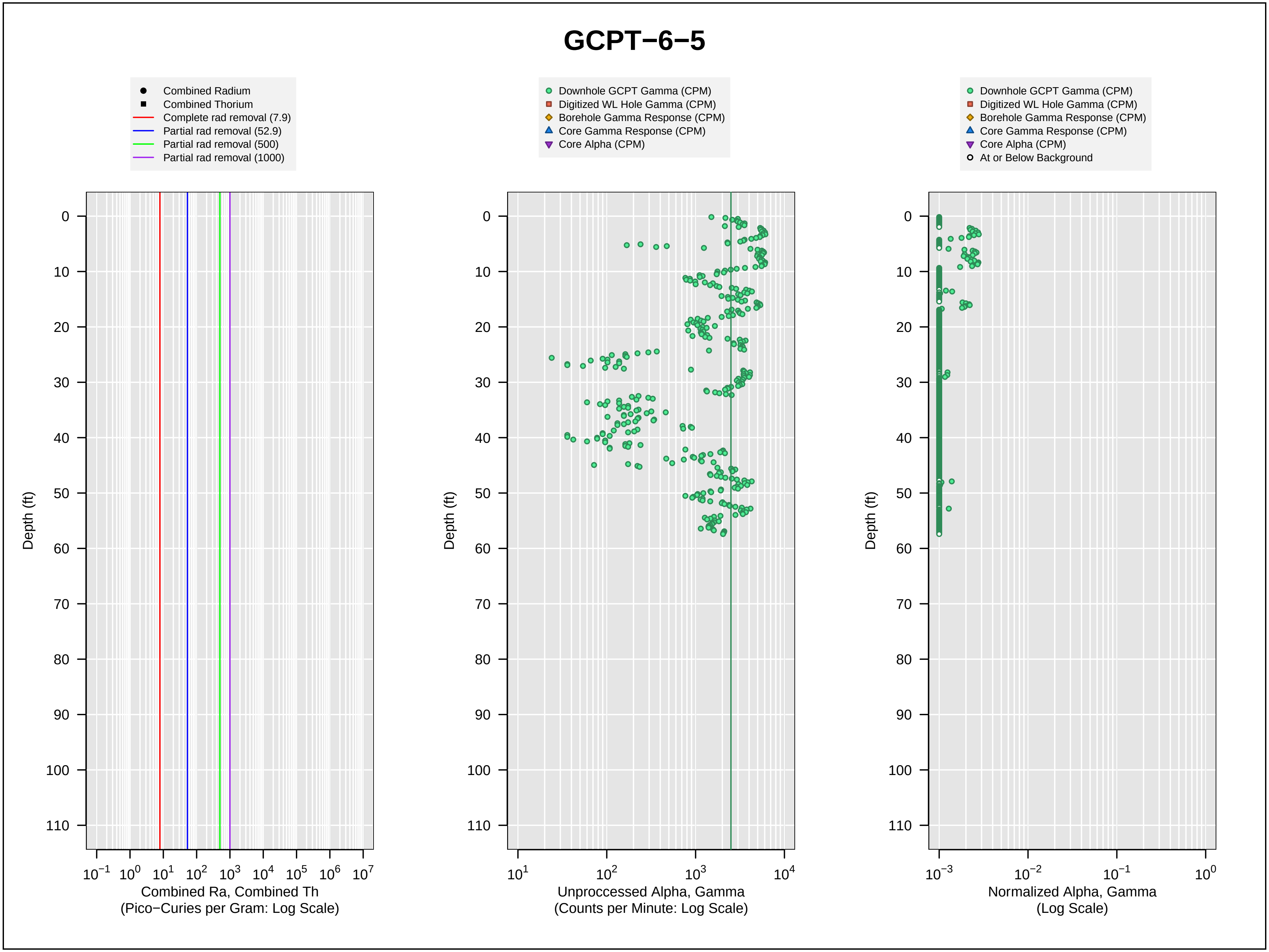

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−6−4

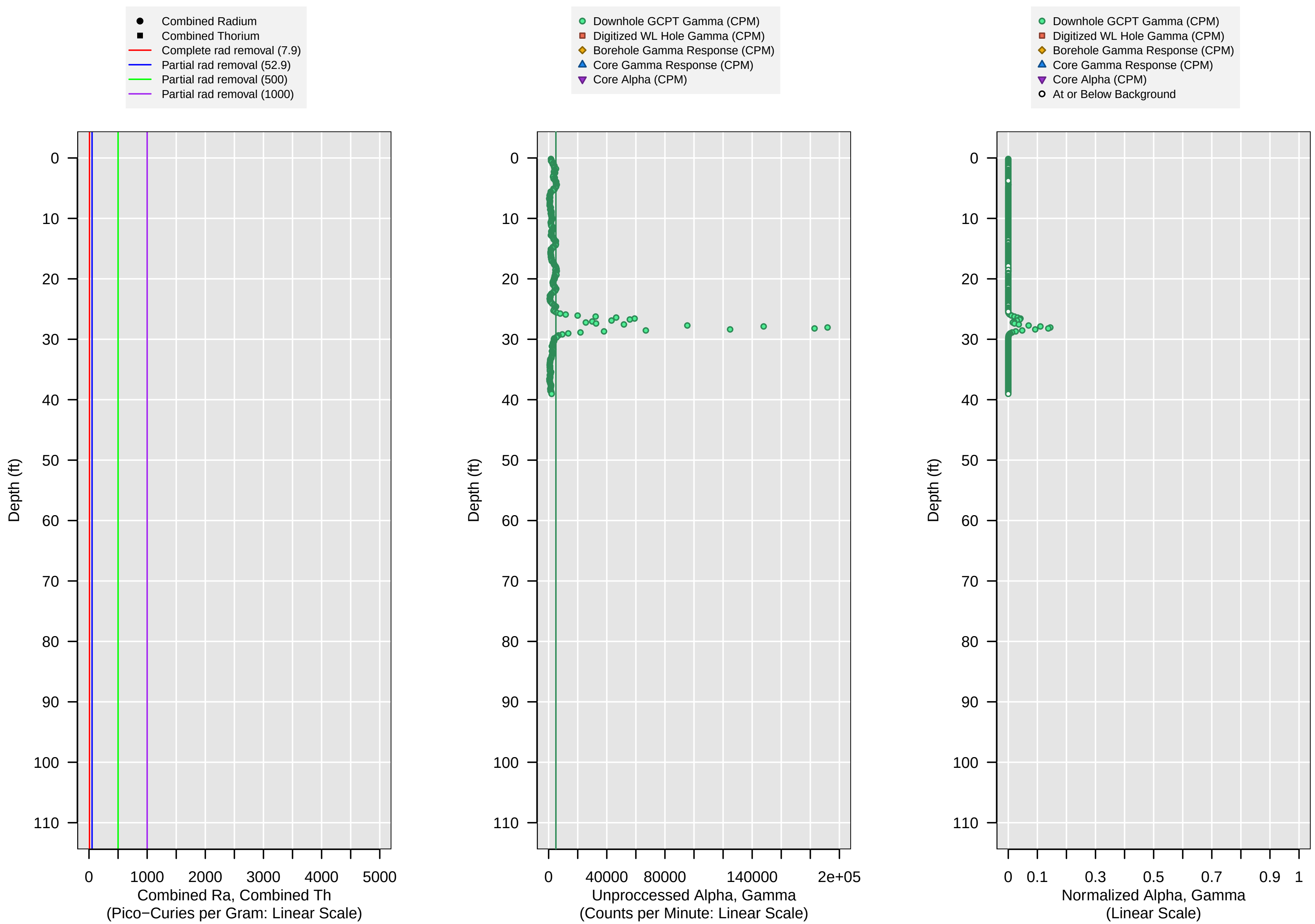


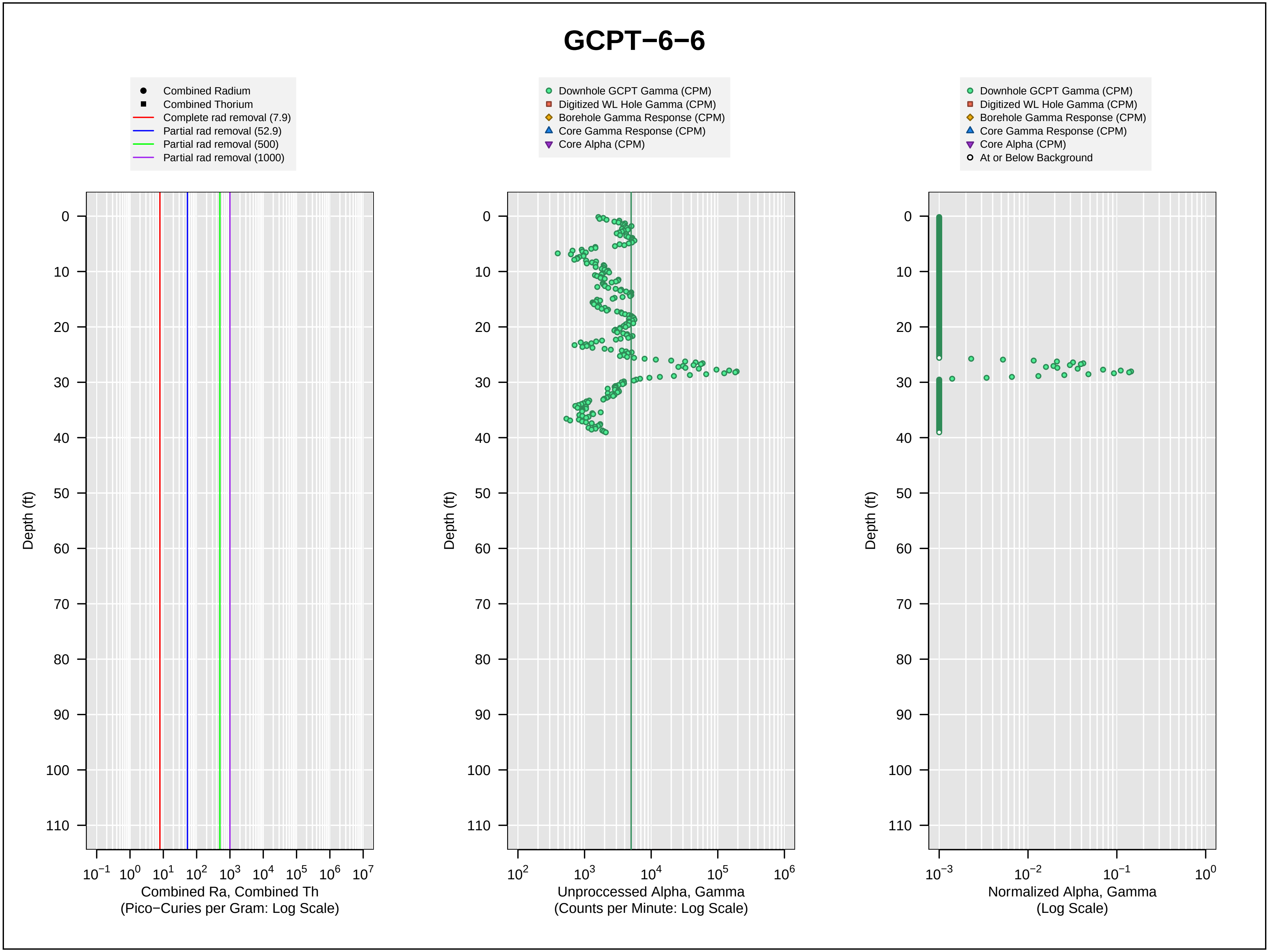
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)


GCPT−6−5
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)


GCPT−6−5
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

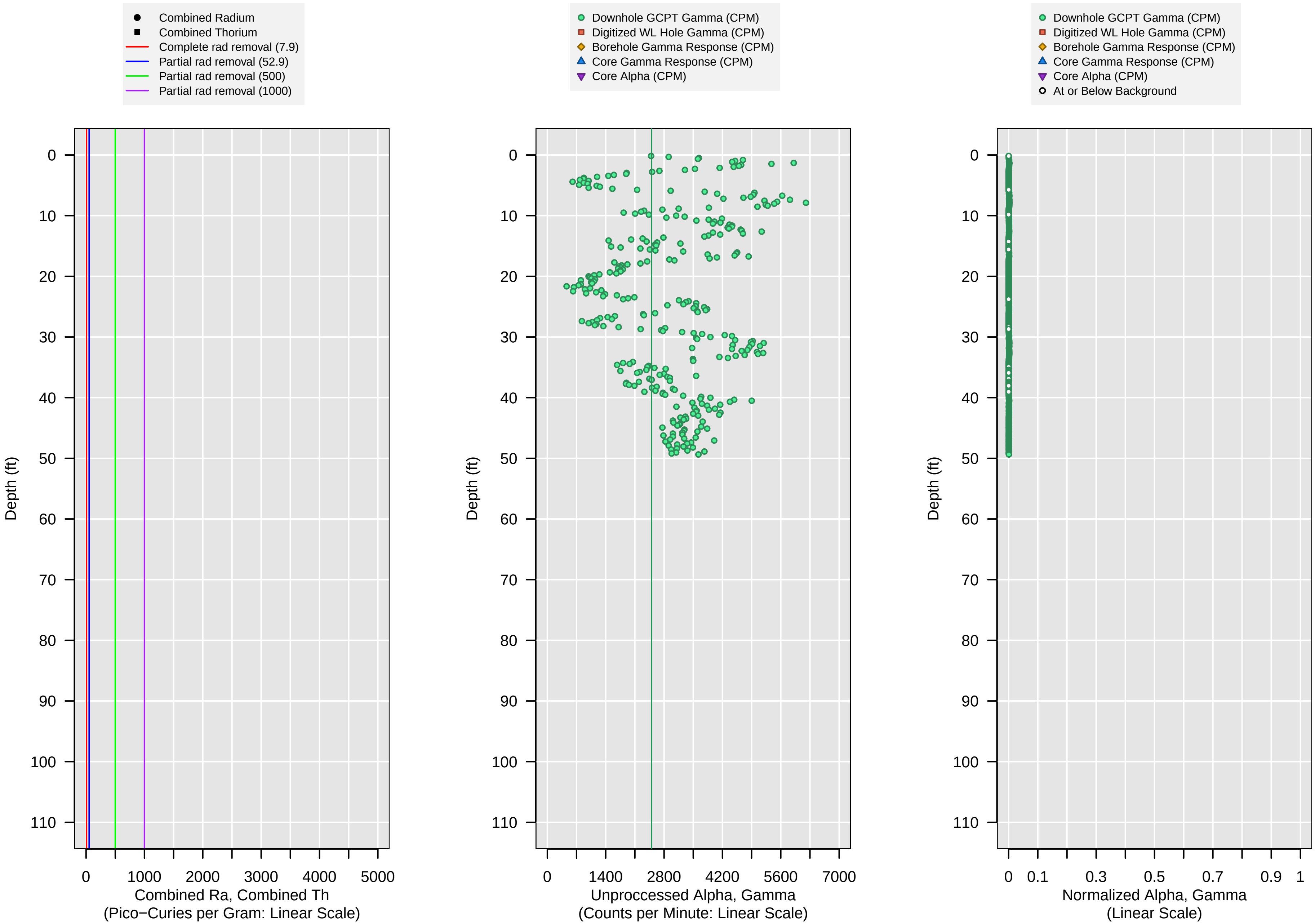
GCPT−6−6


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

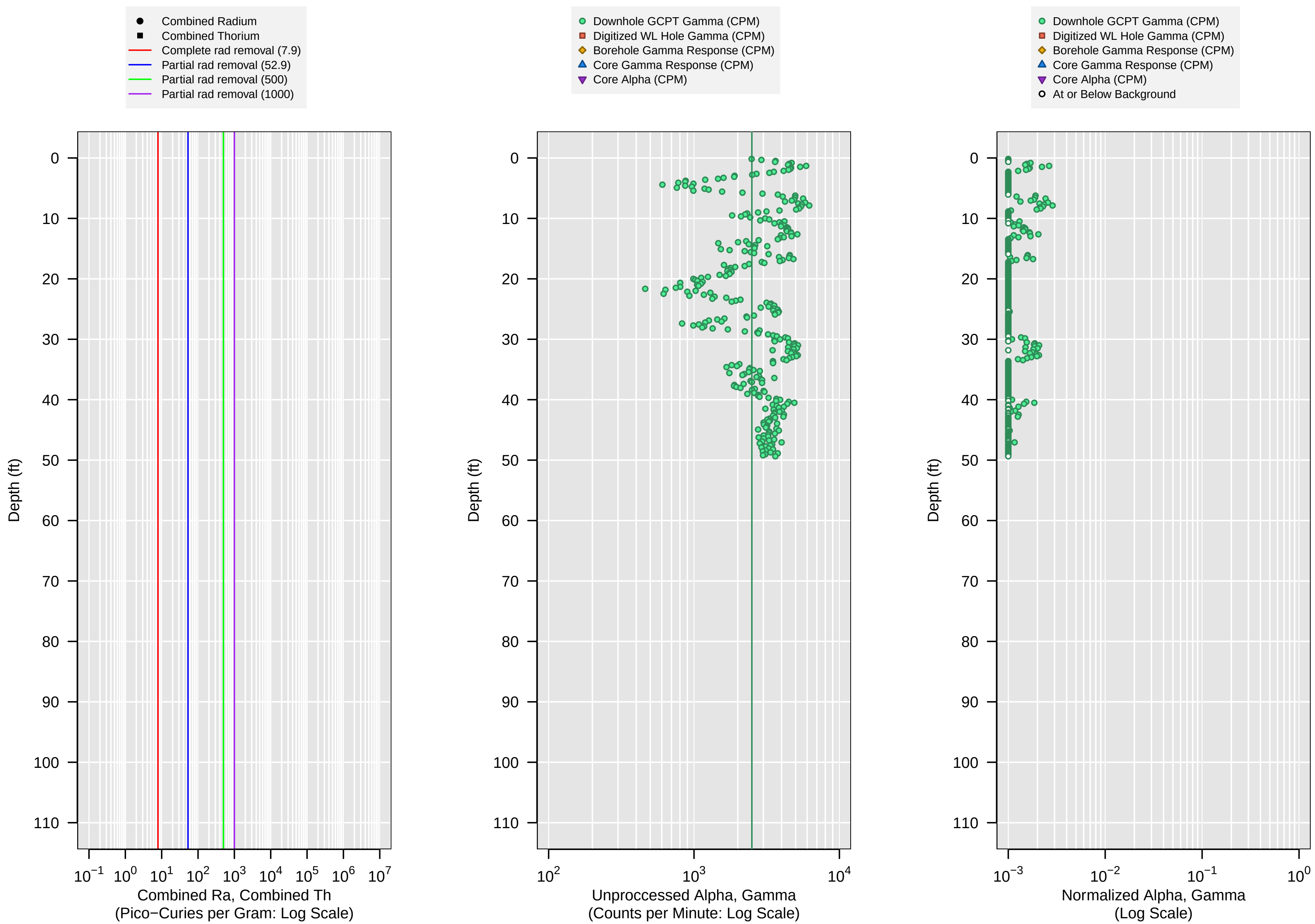


GCPT−6−6
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

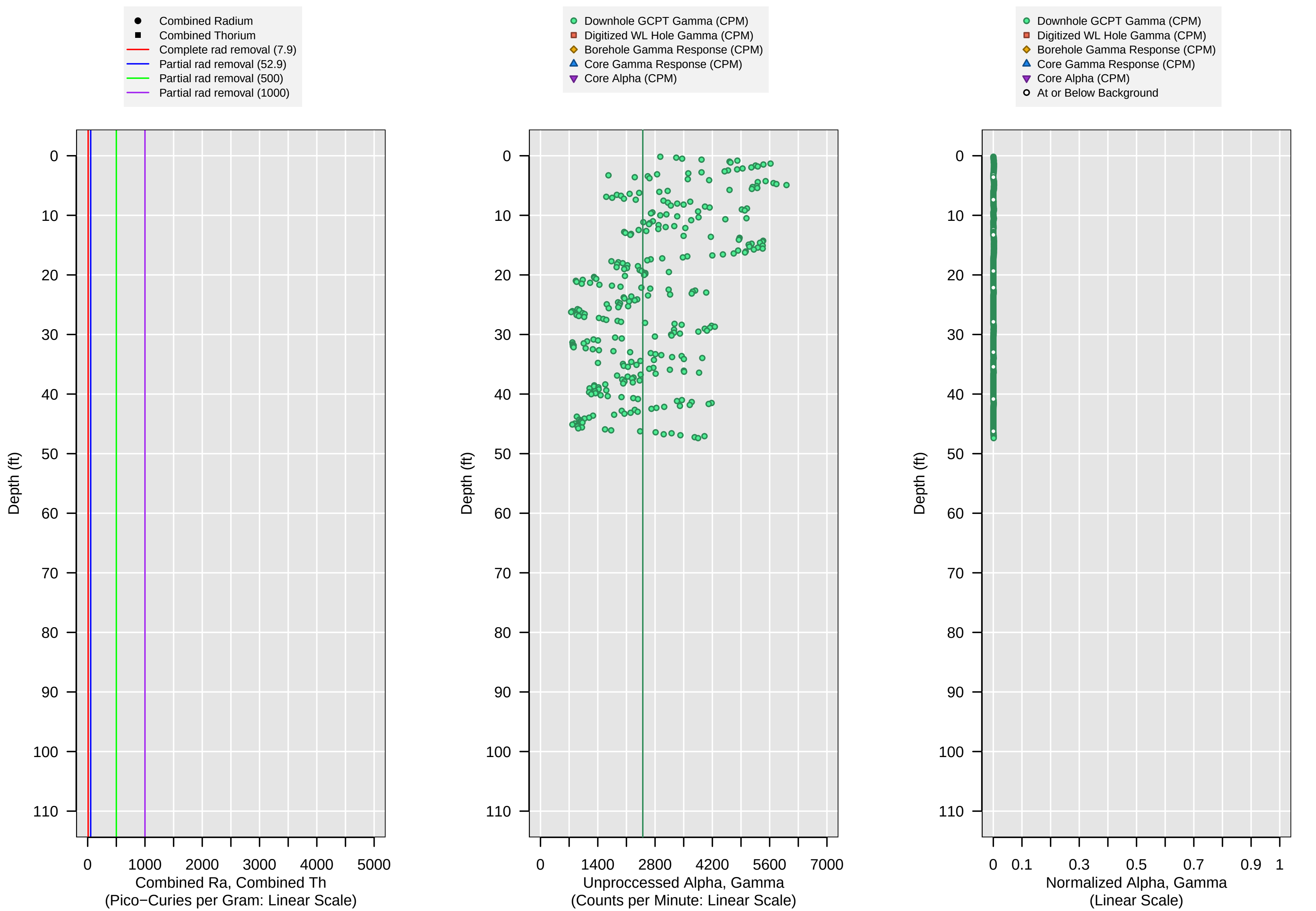
GCPT−7−1


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0 1000 2000 3000 4000 5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0 1400 2800 4200 5600 7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

GCPT−7−1

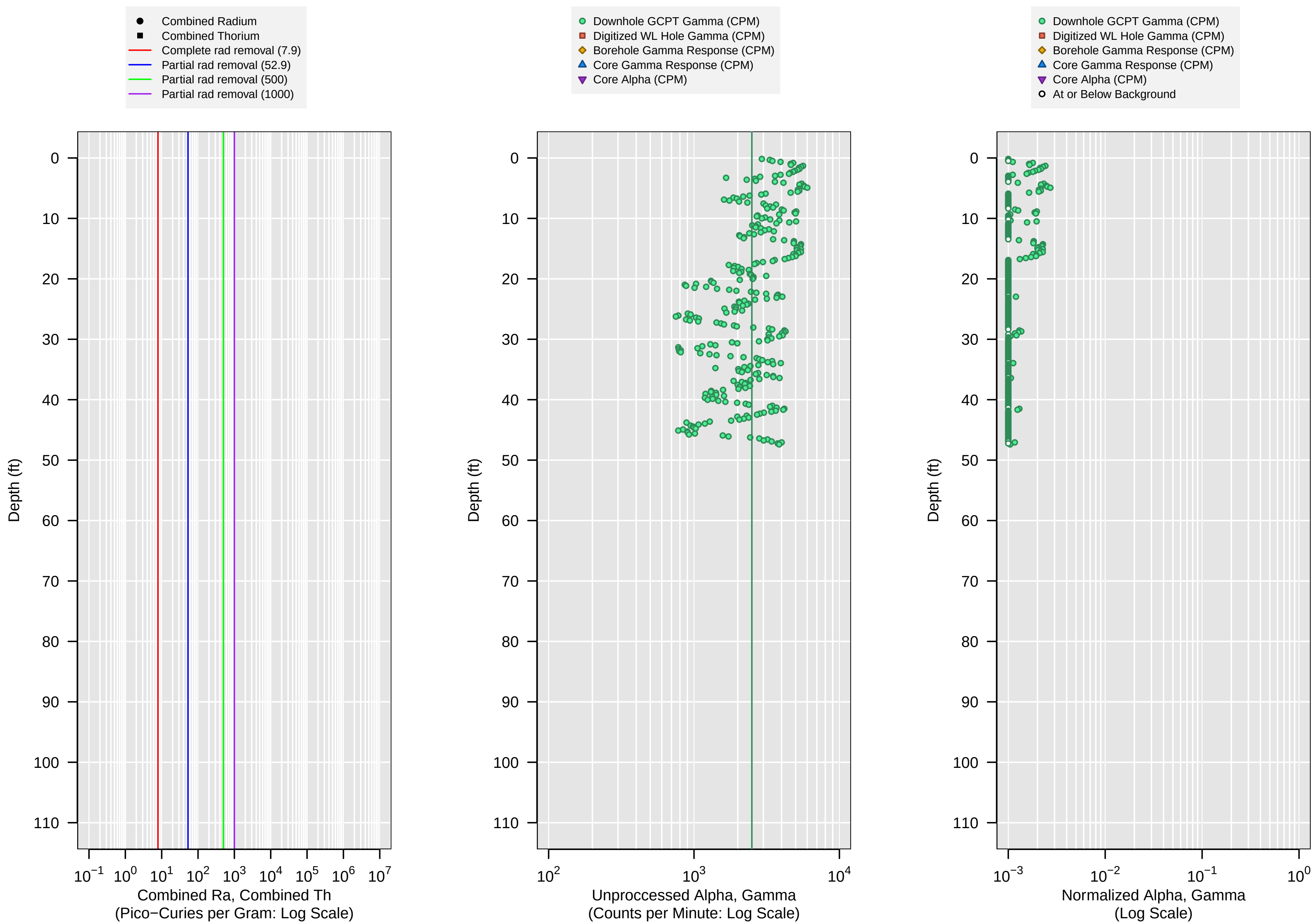

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−7−2

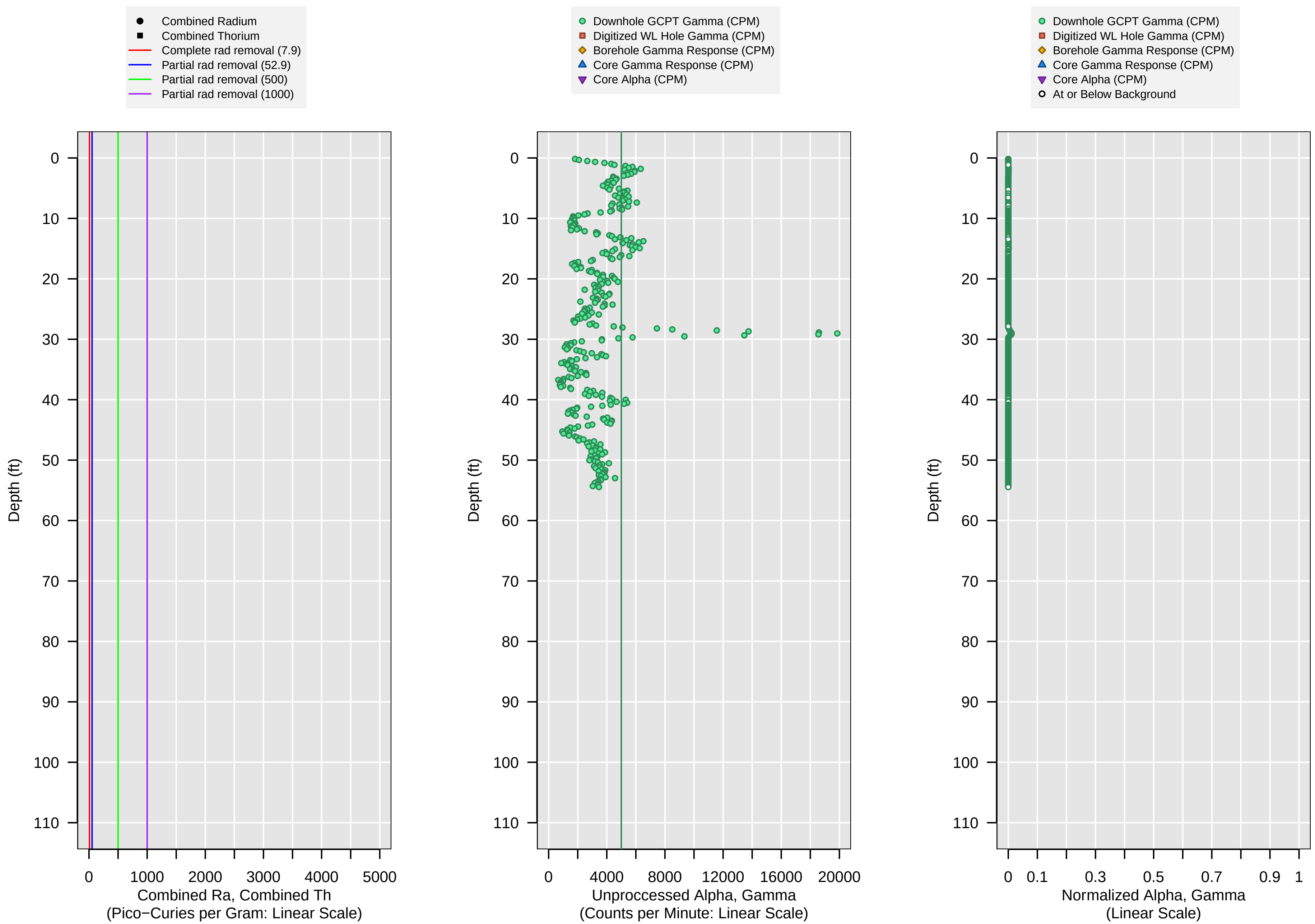


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−7−2

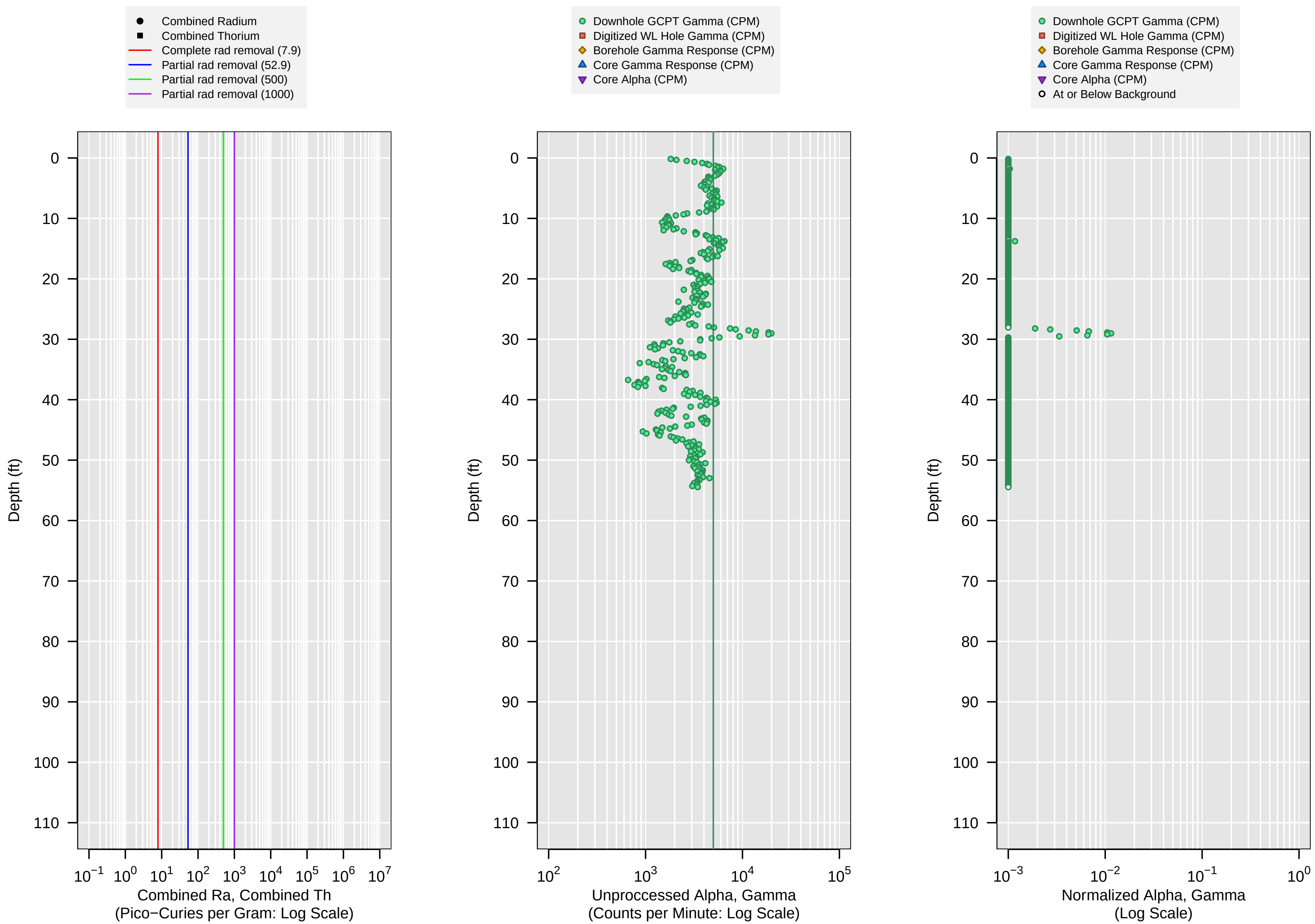

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−8−1

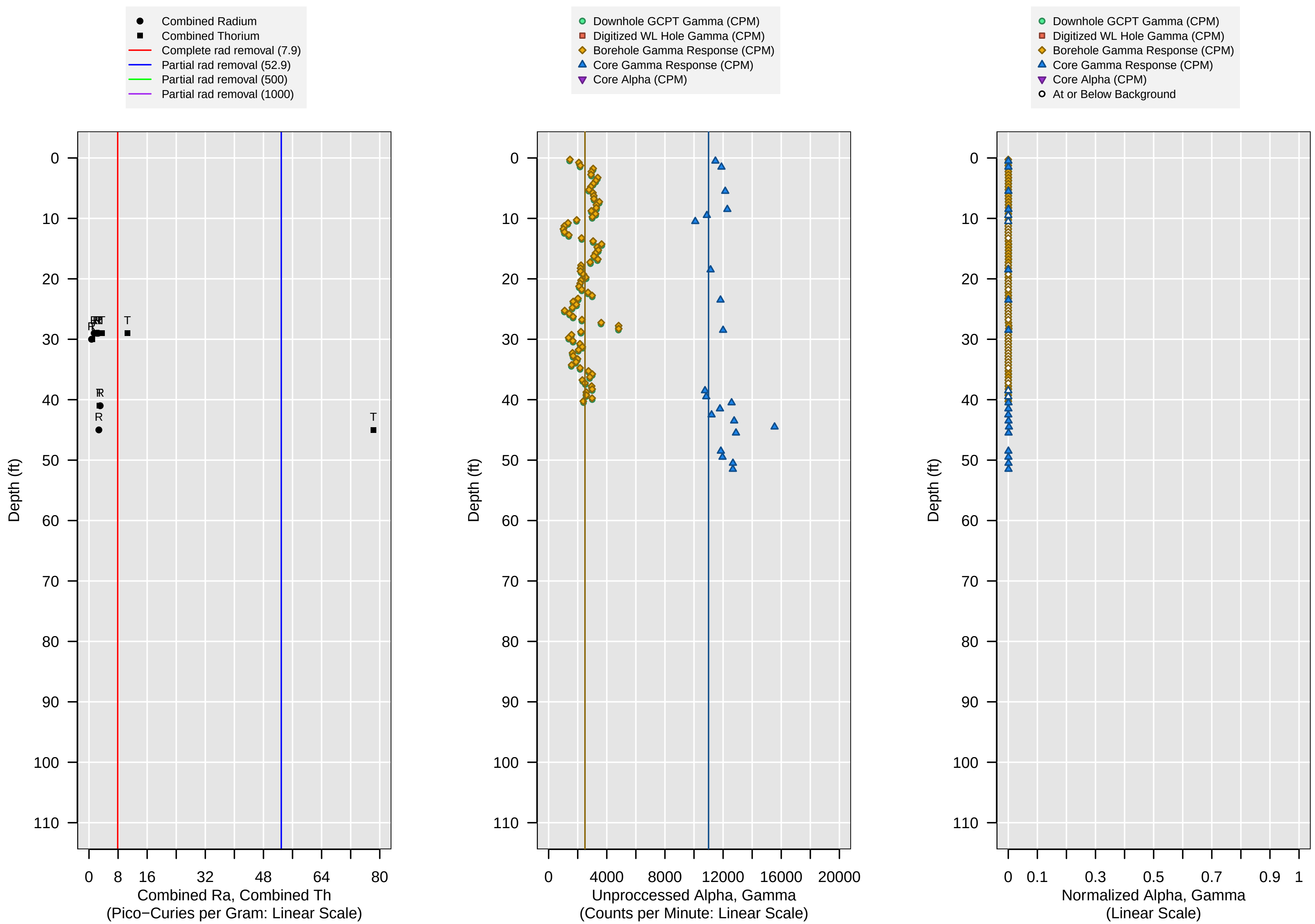


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

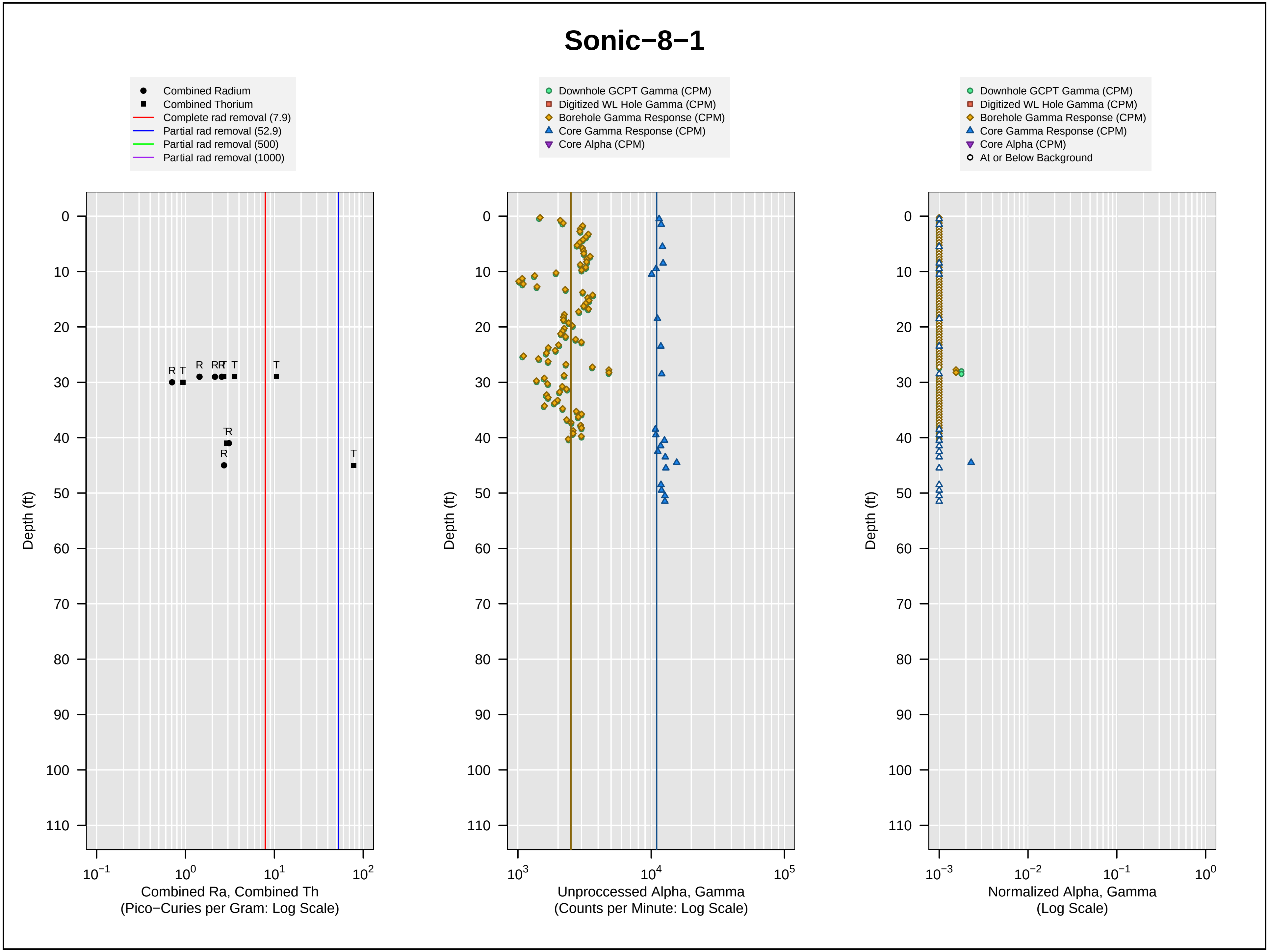
GCPT−8−1


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

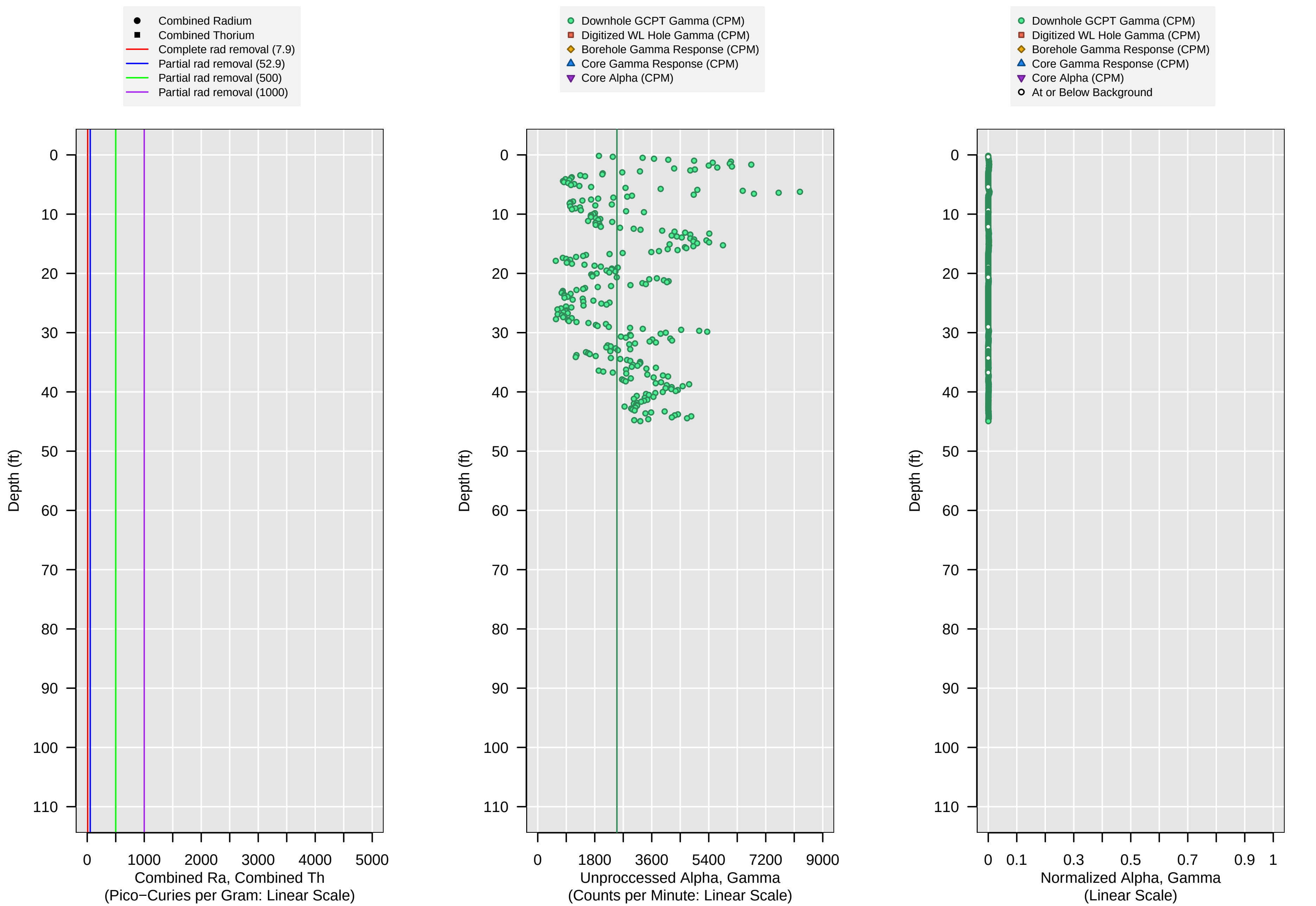
Sonic−8−1



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

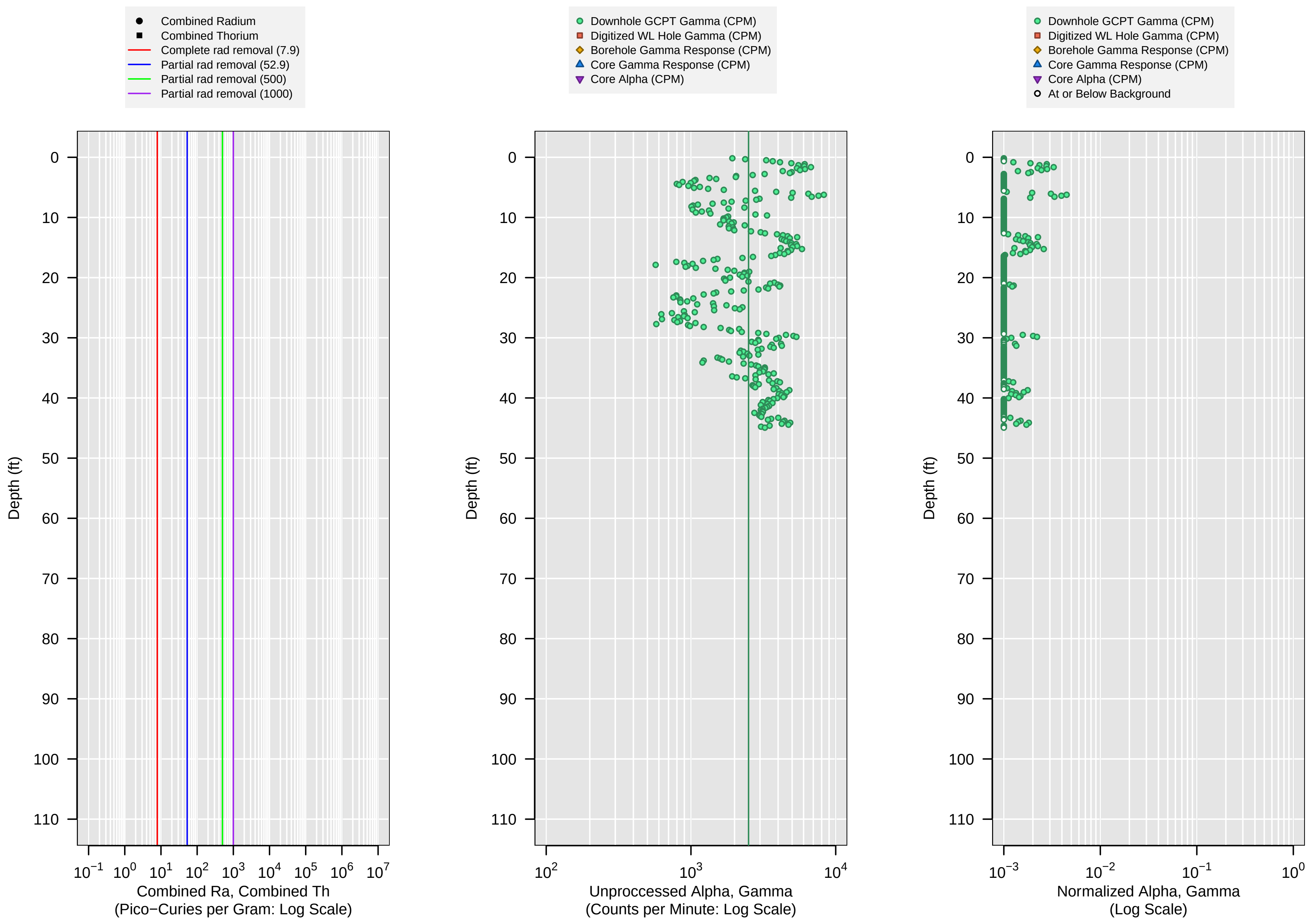

Sonic−8−1
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−9−1



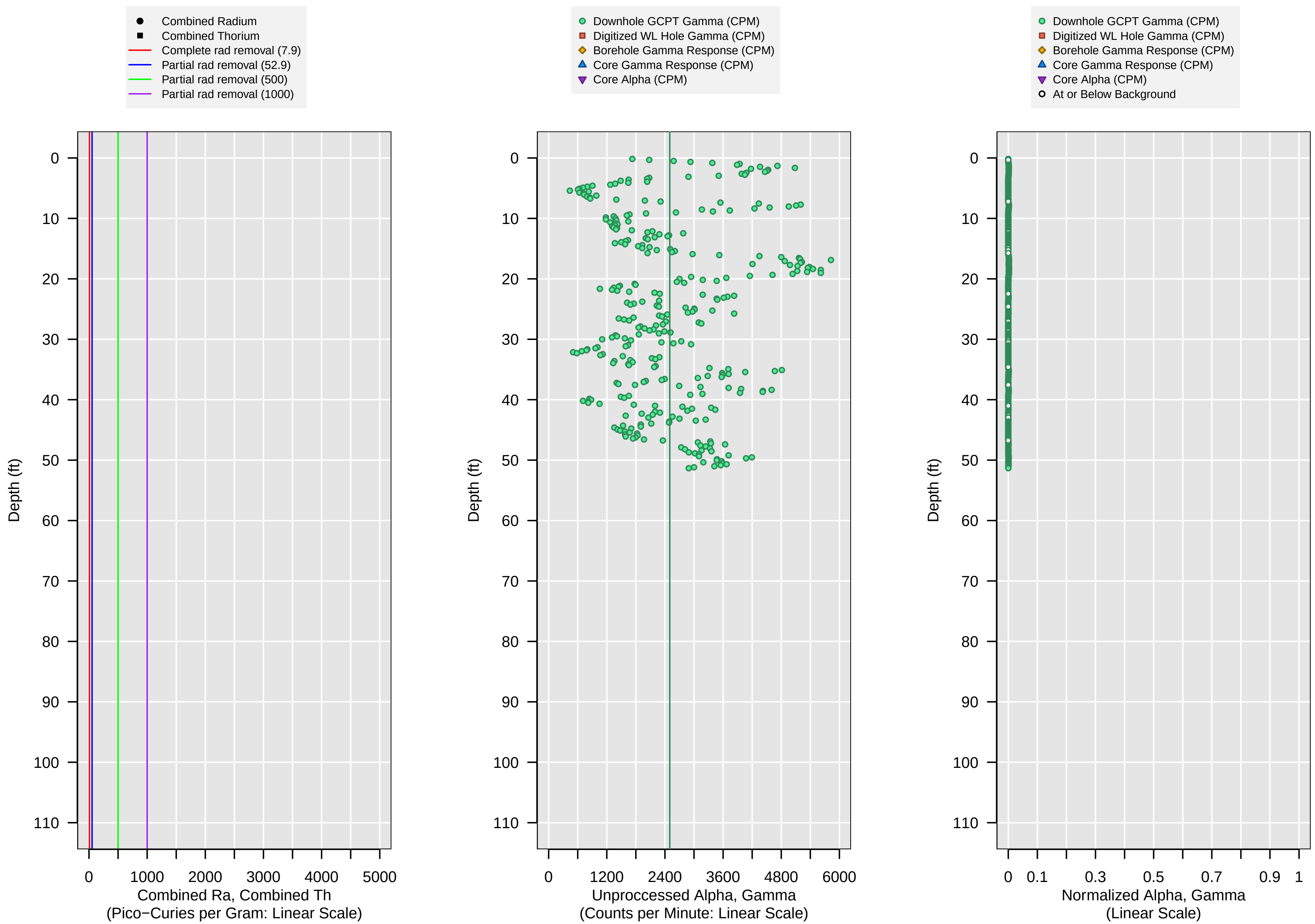
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−9−1

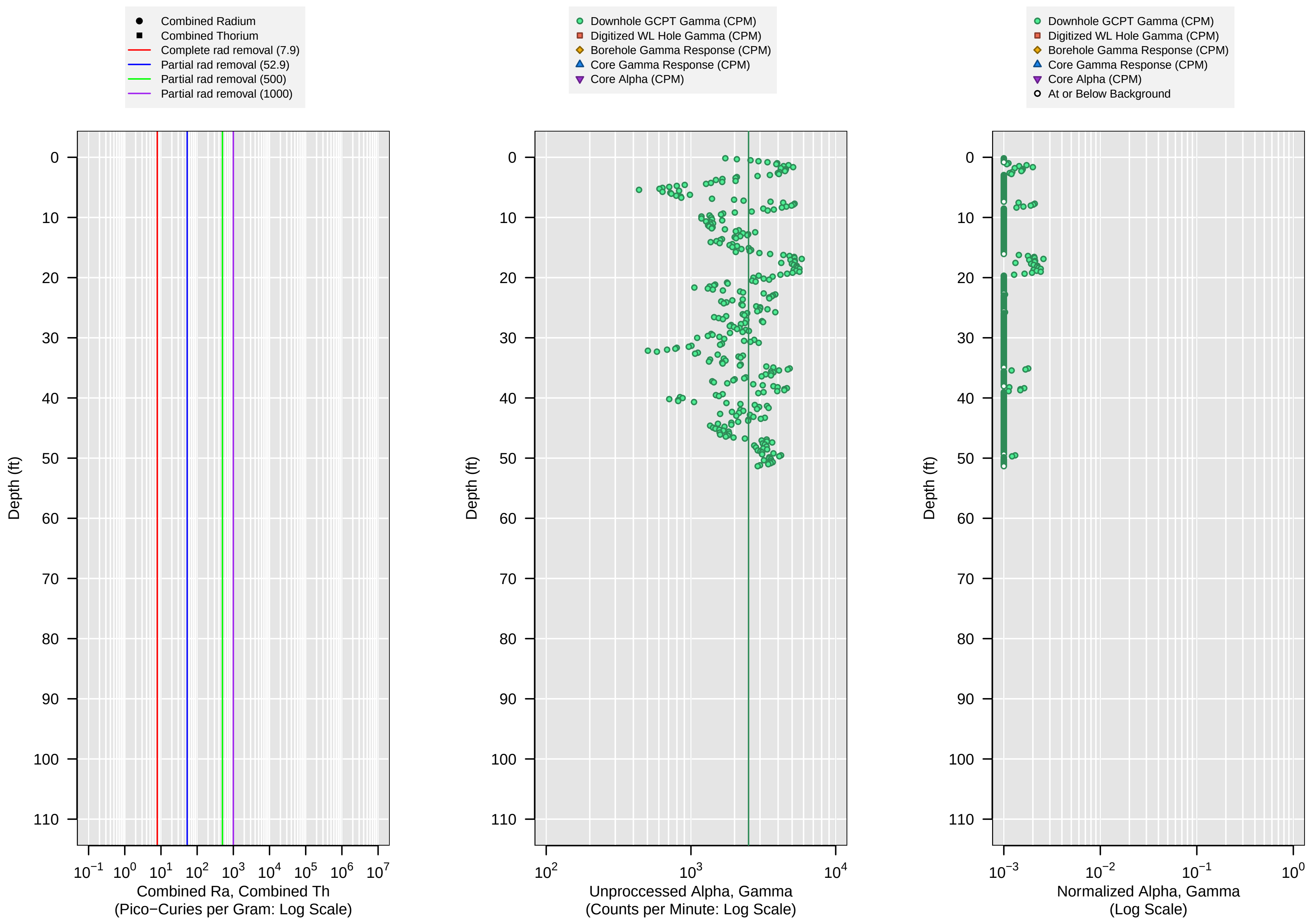


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

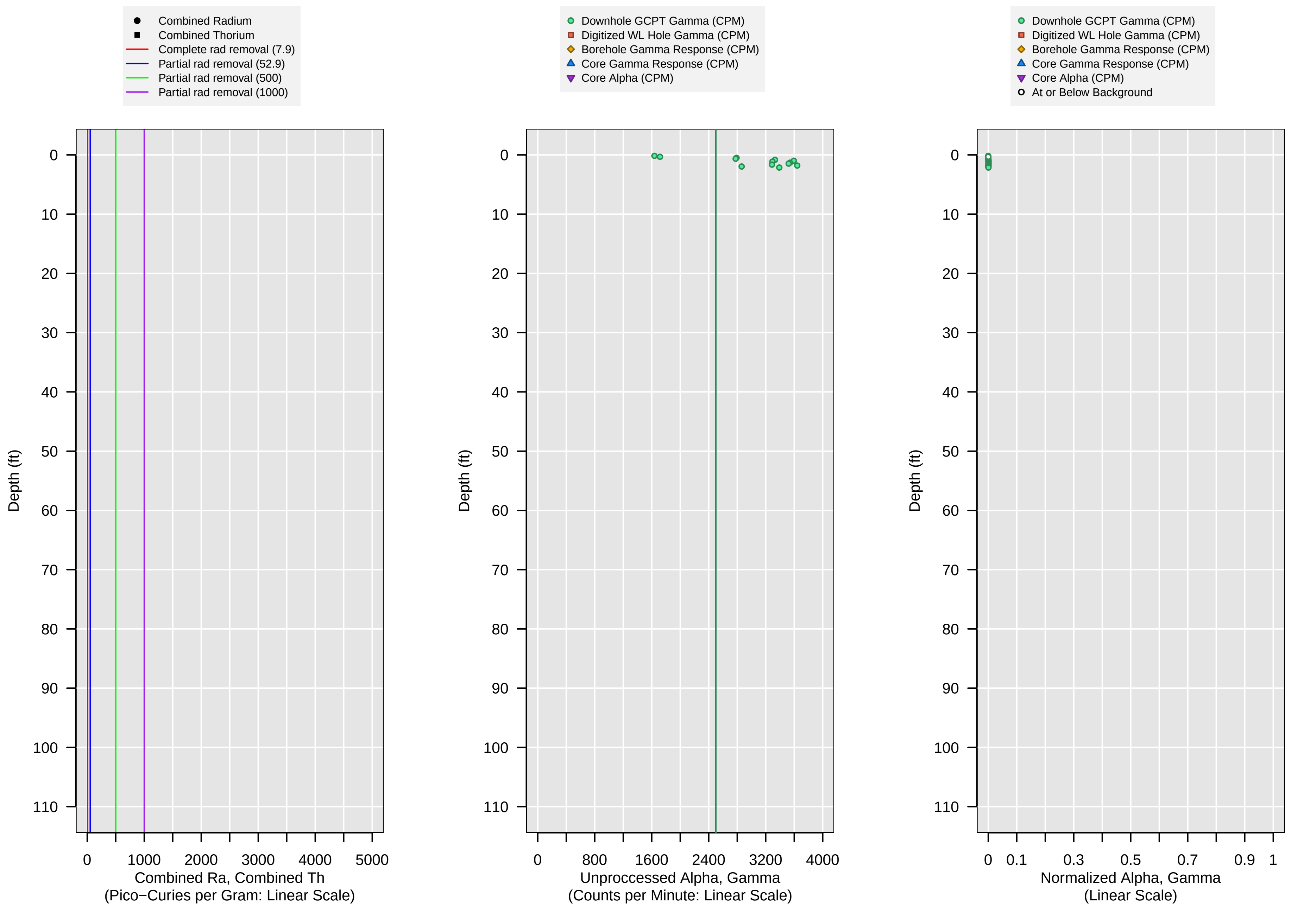
GCPT−9−2


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

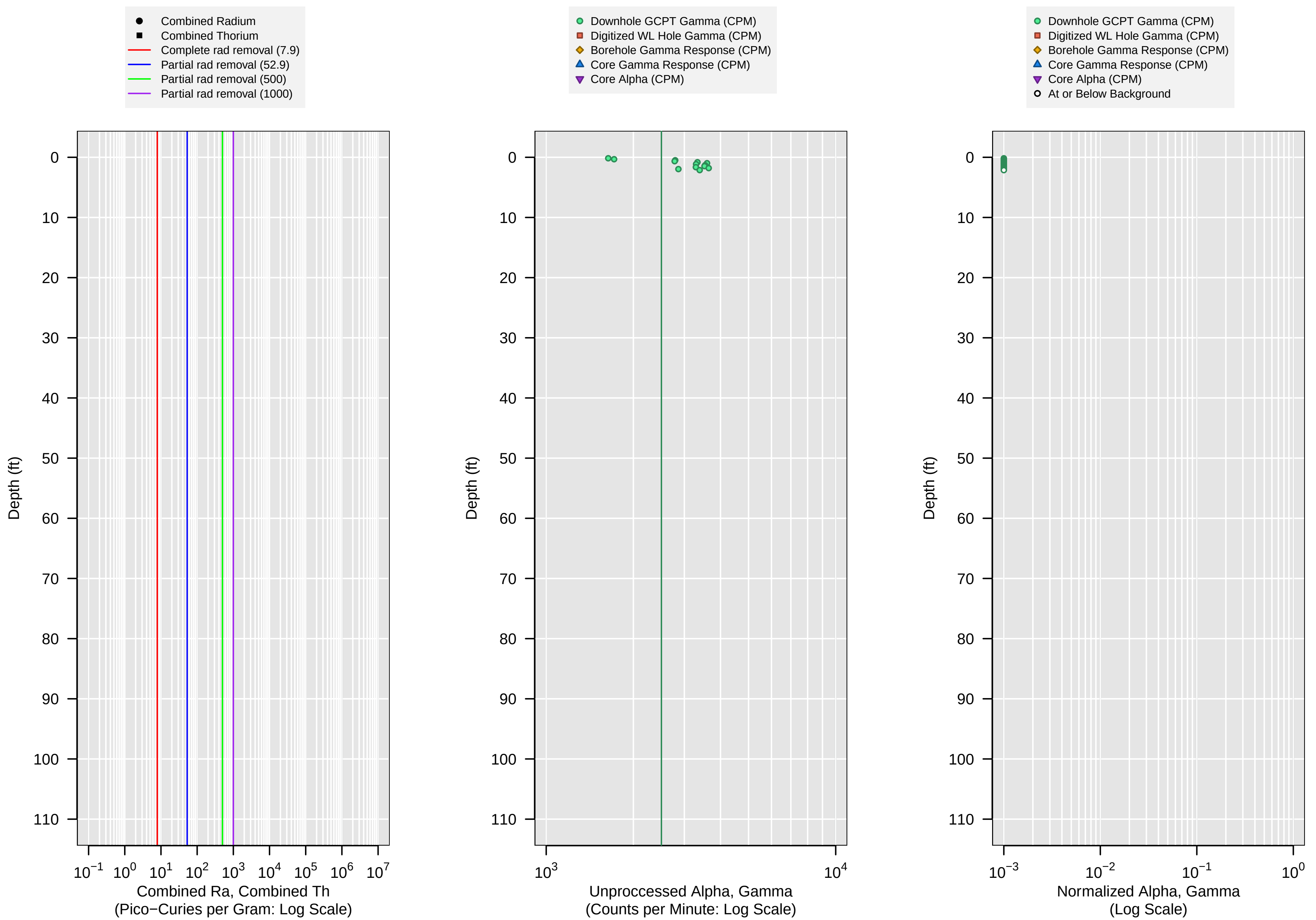
GCPT−9−2


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

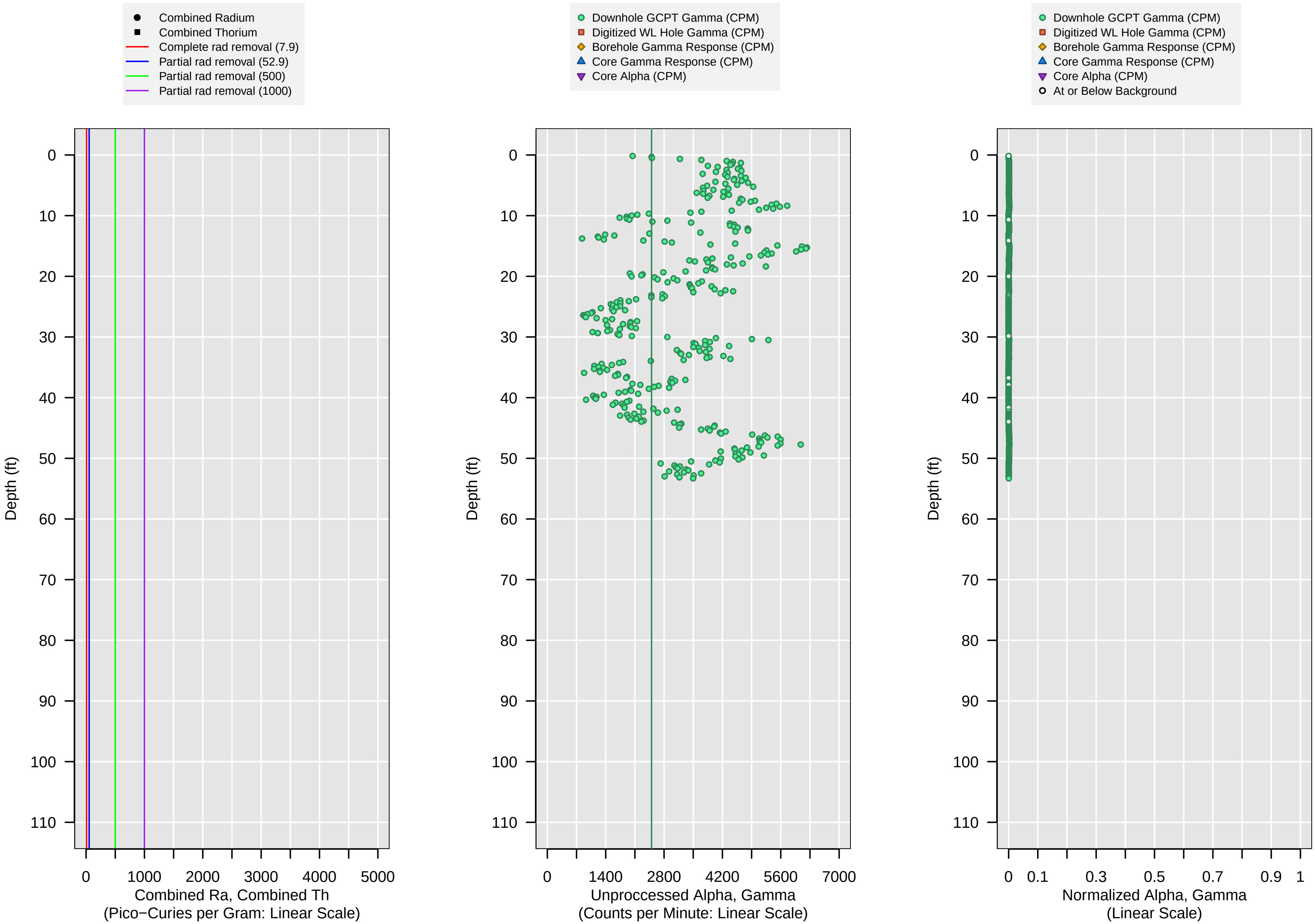
GCPT−9−3


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
800
1600
2400
3200
4000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

GCPT−9−3

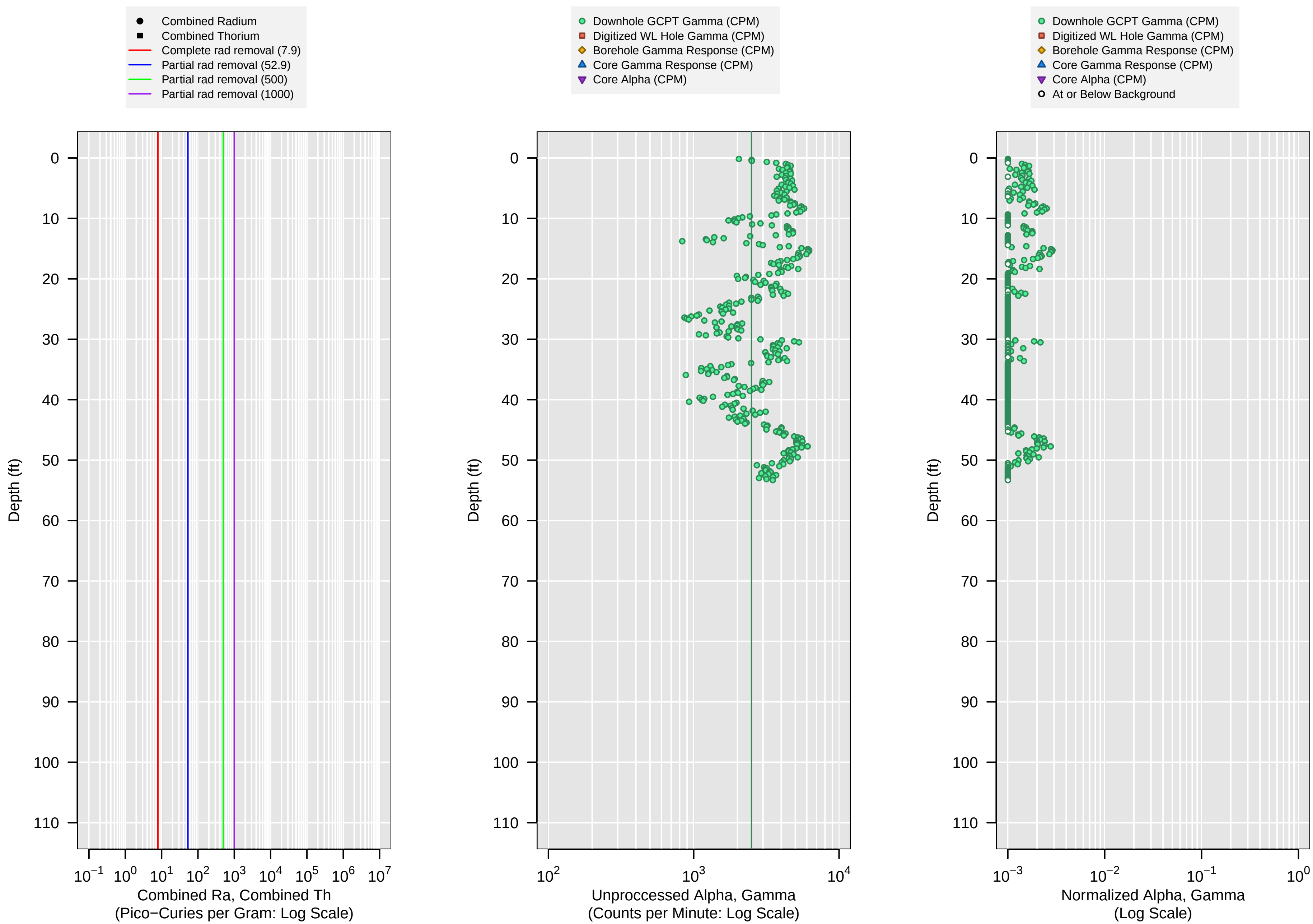

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{-1} 10^{0} 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6} 10^{7}
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
10^{3} 10^{4}
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
10^{-3} 10^{-2} 10^{-1} 10^{0}
Normalized Alpha, Gamma
(Log Scale)

GCPT−9−3A



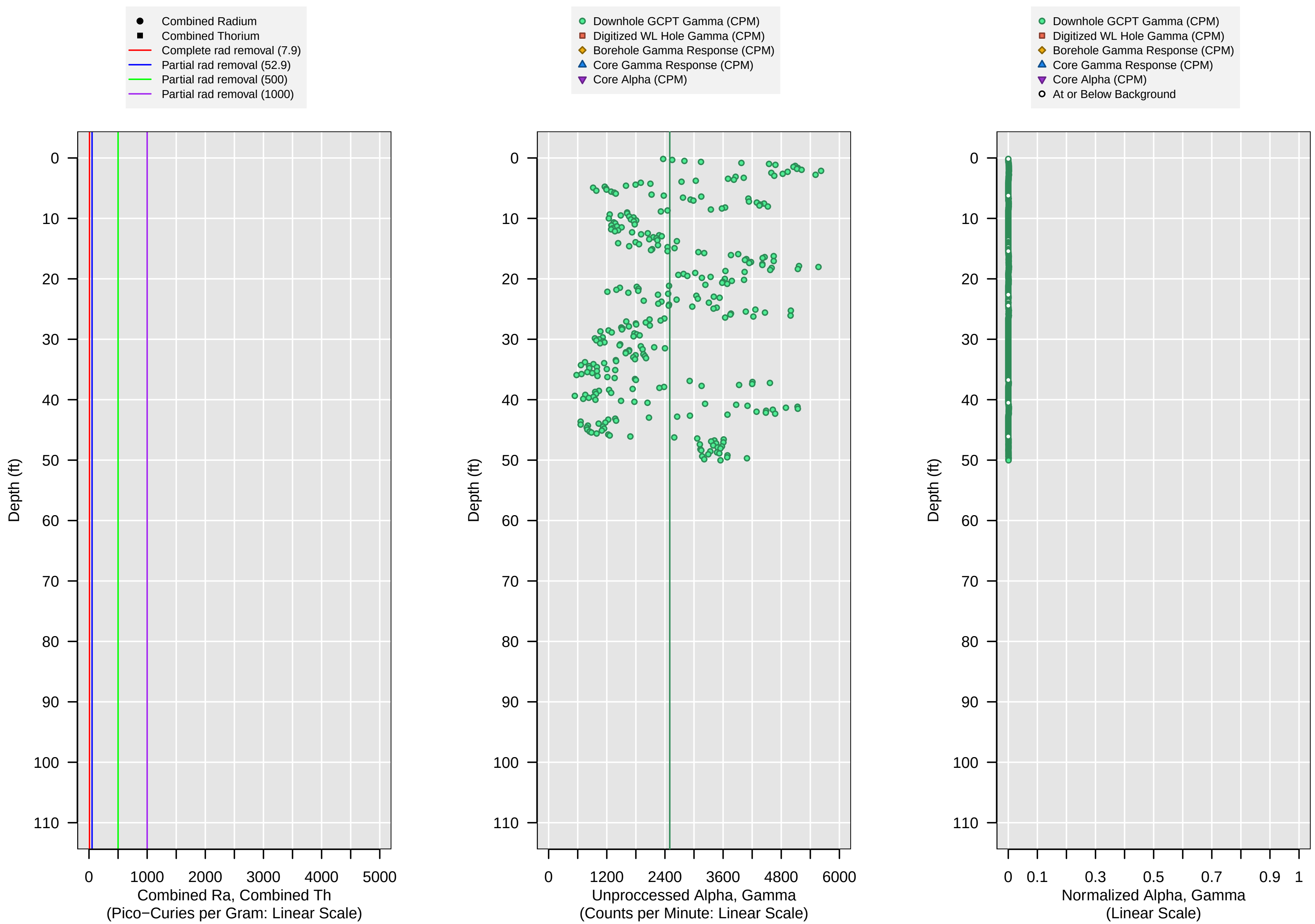
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1400
2800
4200
5600
7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

GCPT−9−3A

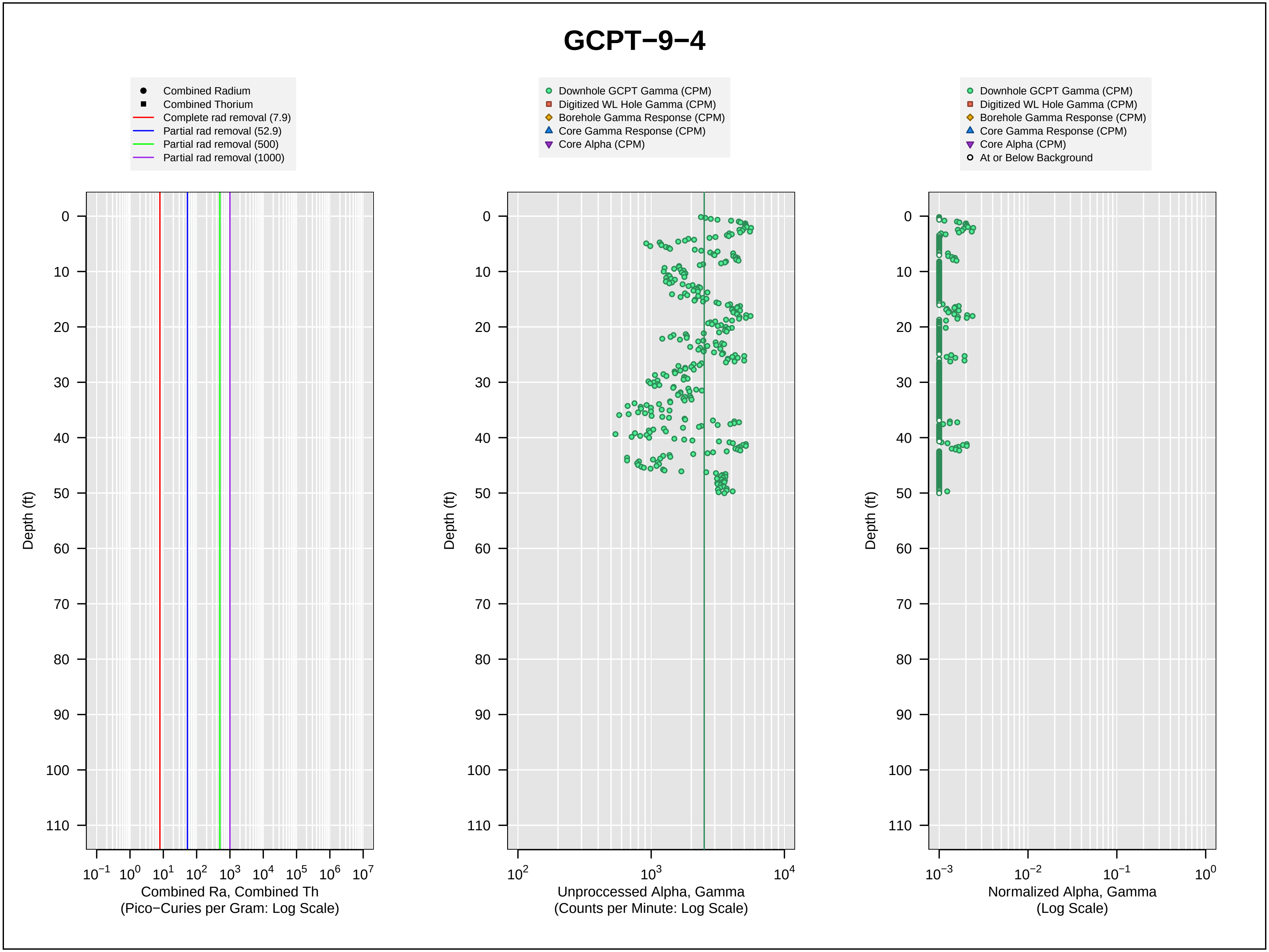


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{-1} 10^{0} 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6} 10^{7}
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
10^{2} 10^{3} 10^{4}
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
10^{-3} 10^{-2} 10^{-1} 10^{0}
Normalized Alpha, Gamma
(Log Scale)

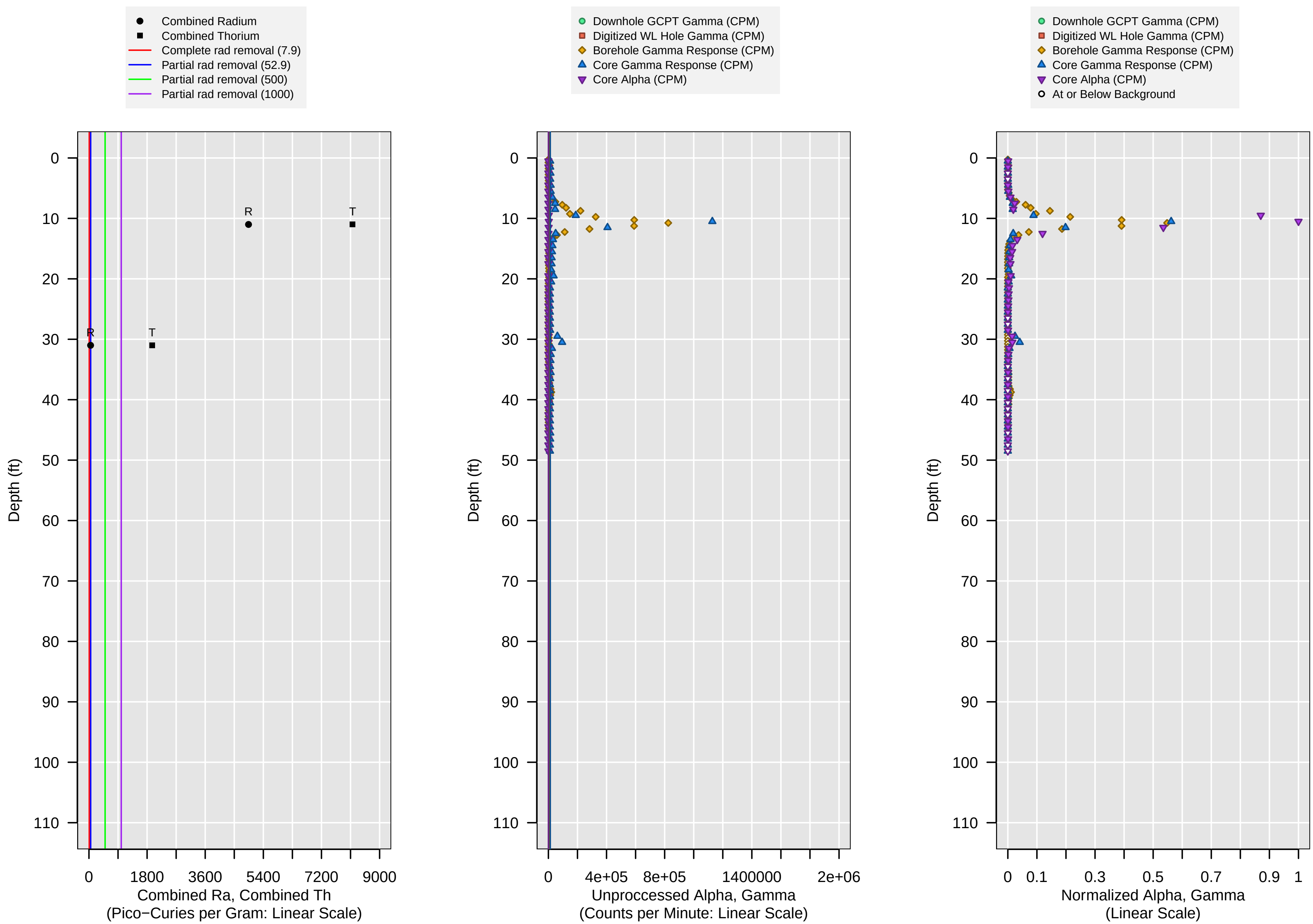
GCPT−9−4



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Linear Scale)

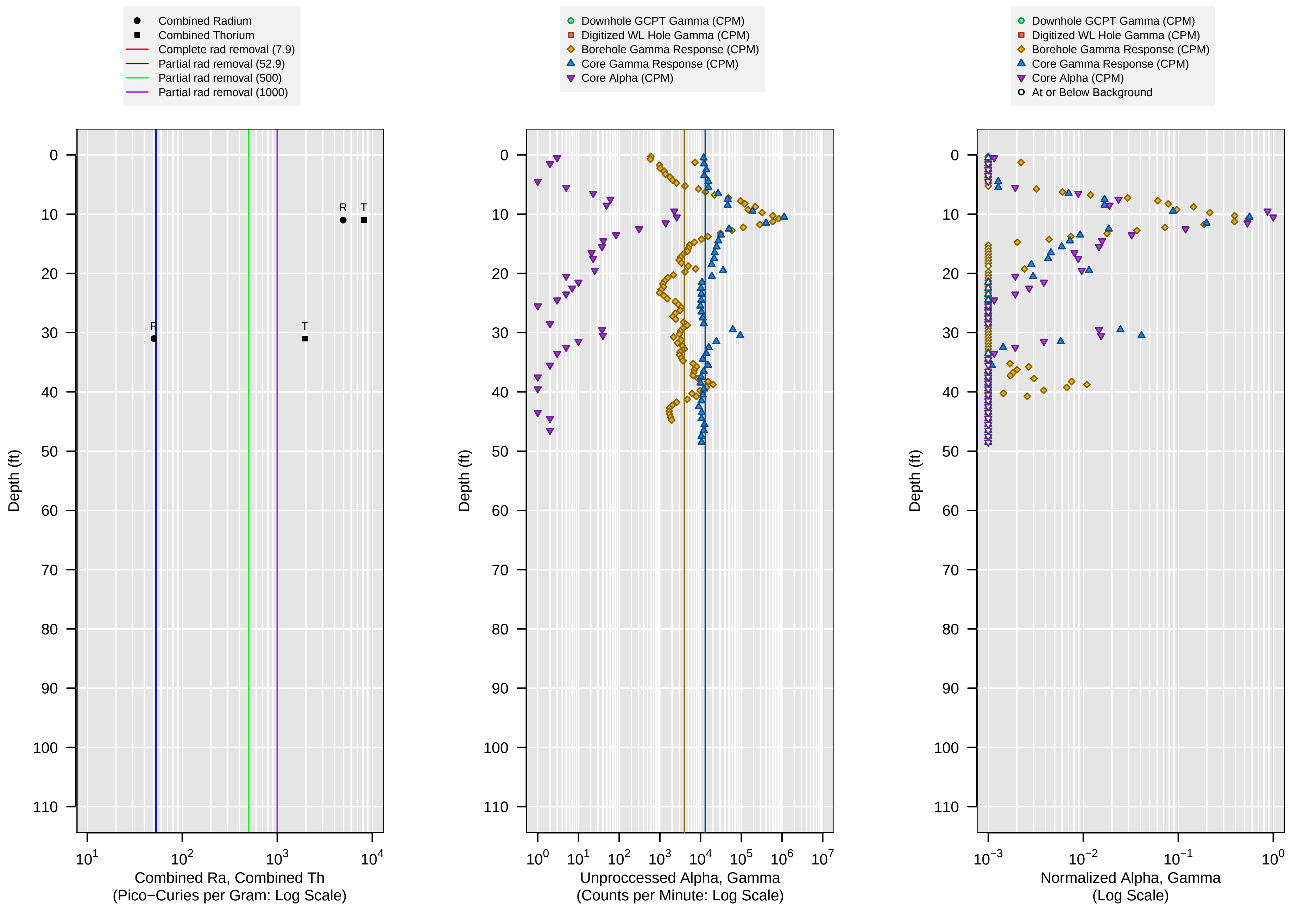

GCPT−9−4
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

AC−01

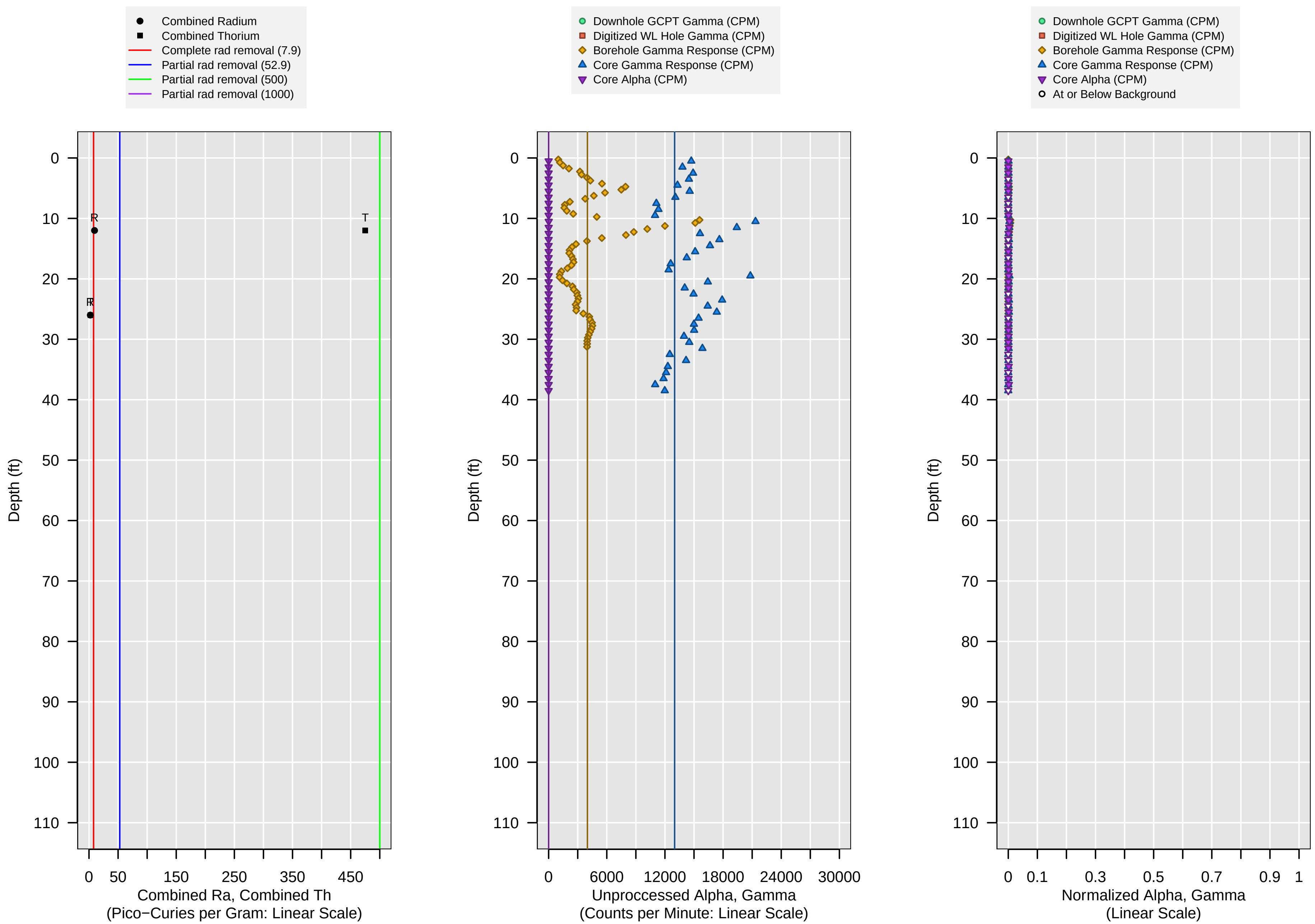


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

AC−01

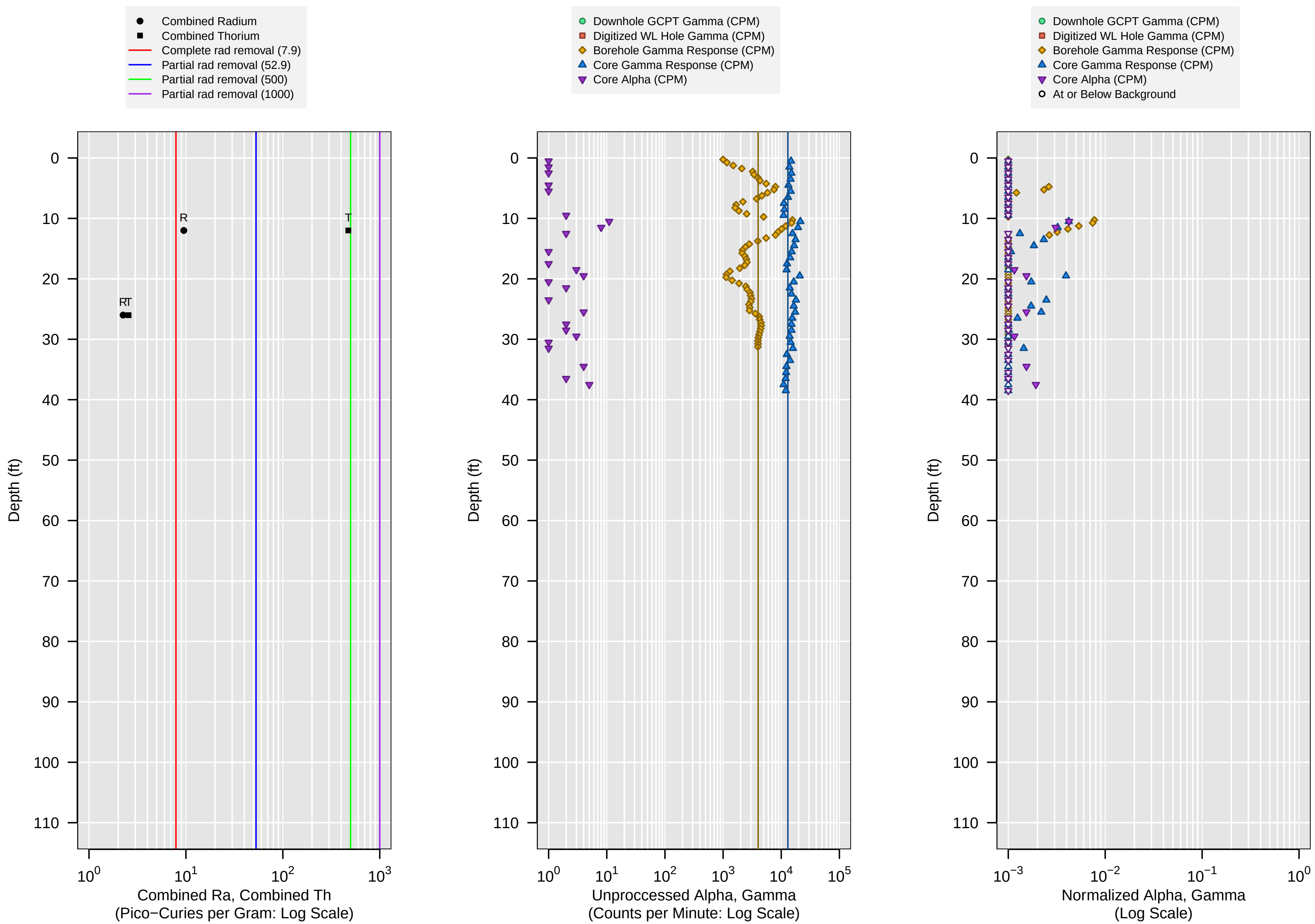

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

AC−02B



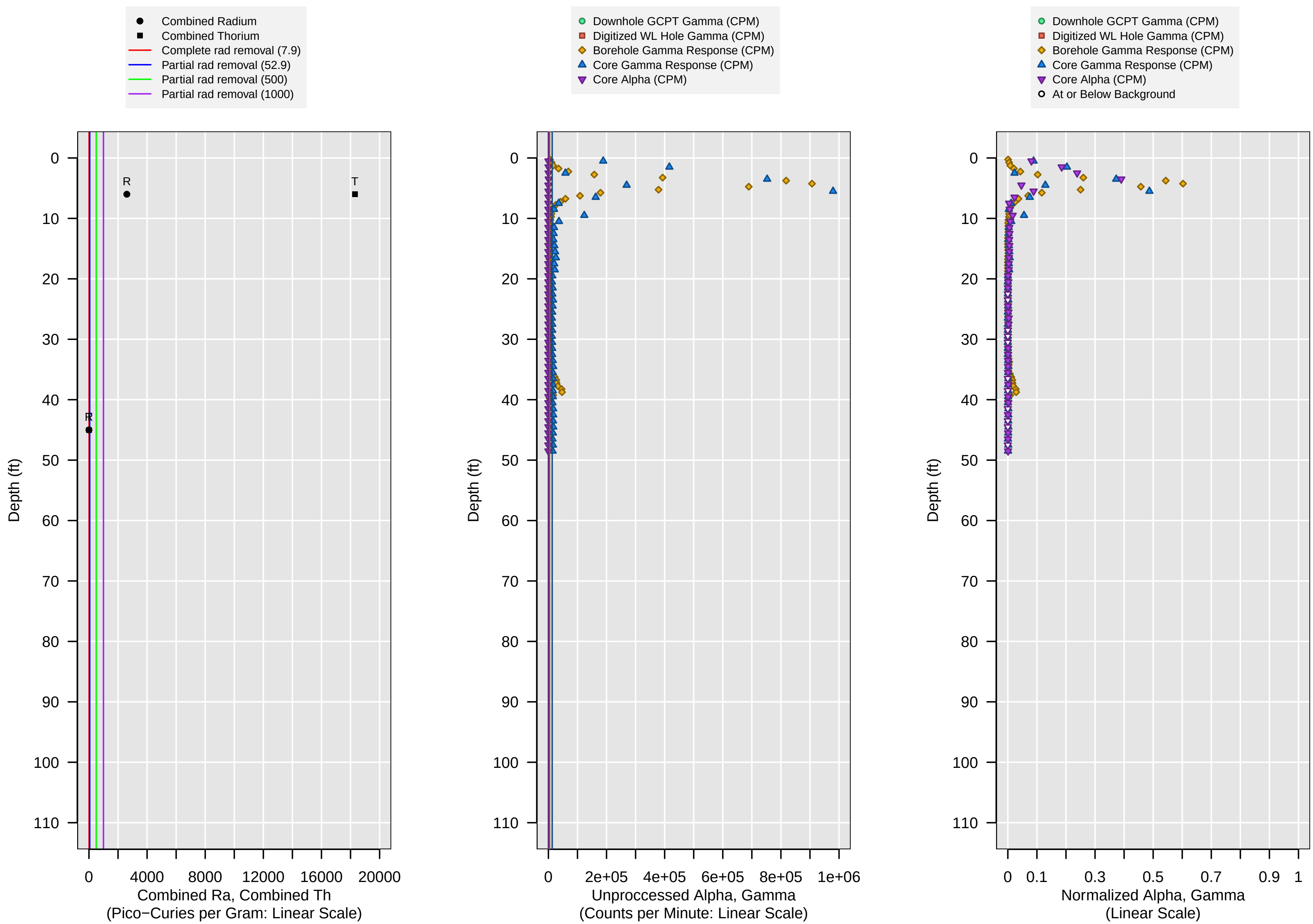
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
R
T
R
0 50 150 250 350 450
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0 6000 12000 18000 24000 30000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

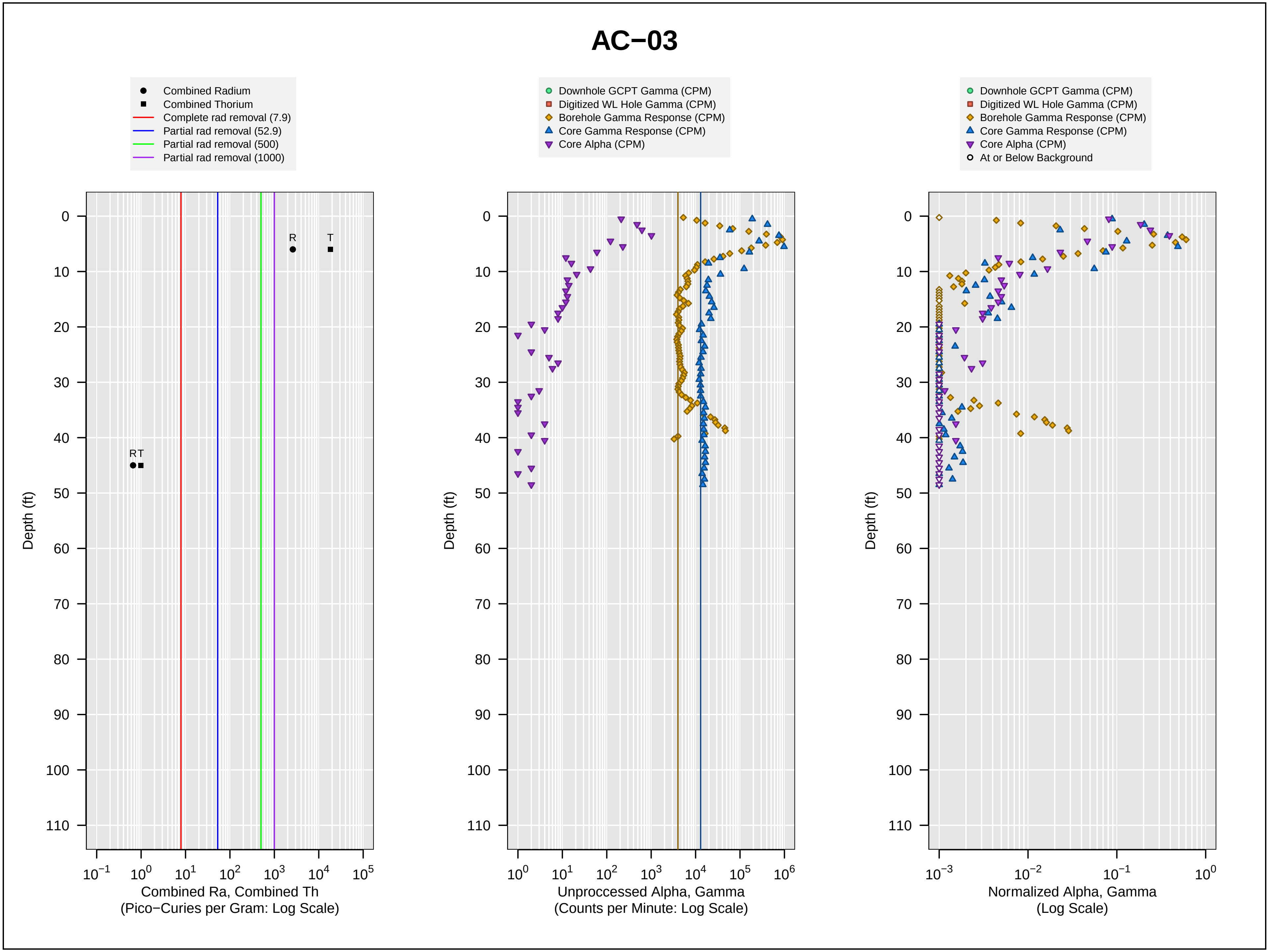
AC−02B

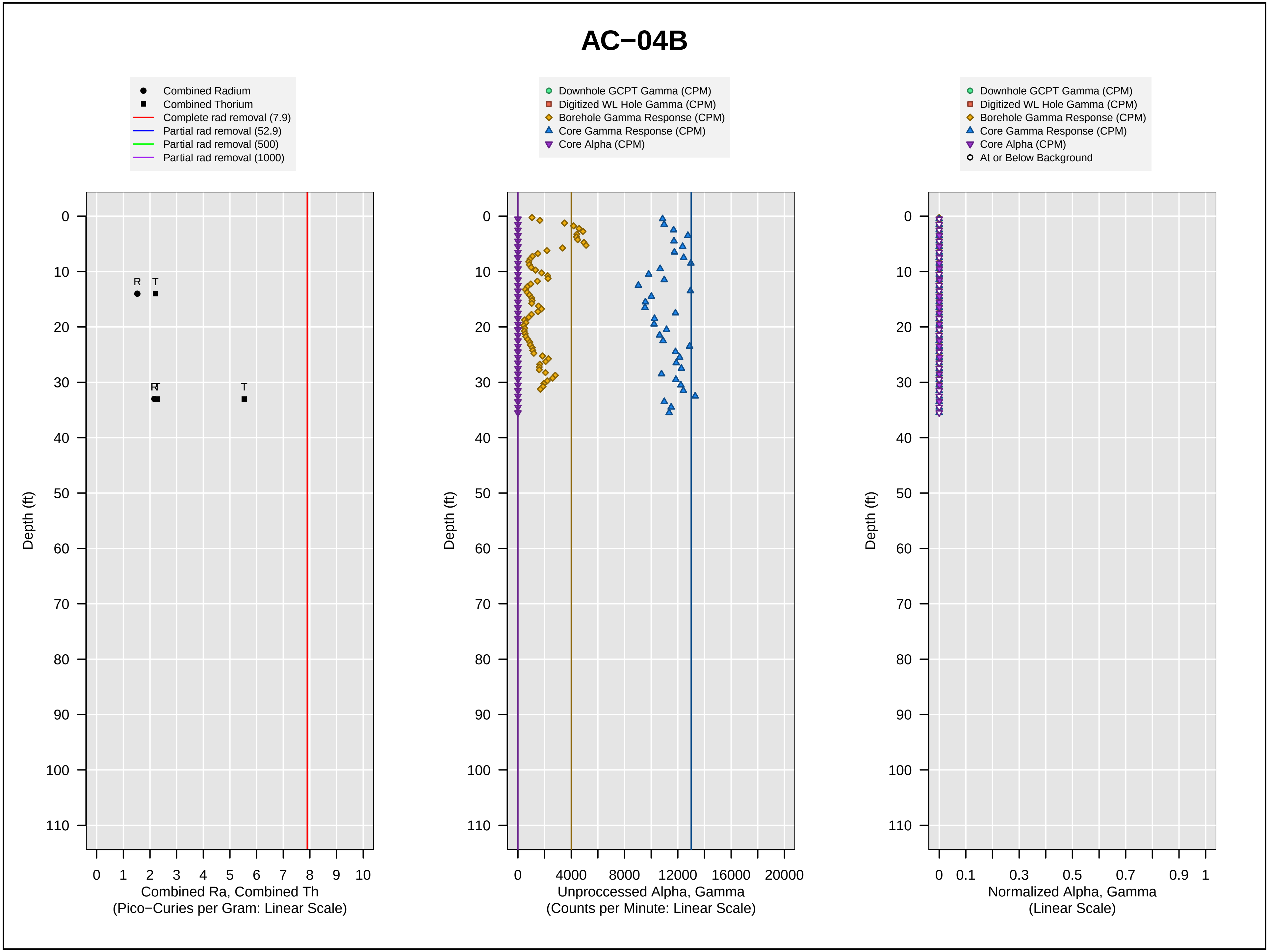


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
R
T
RT
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

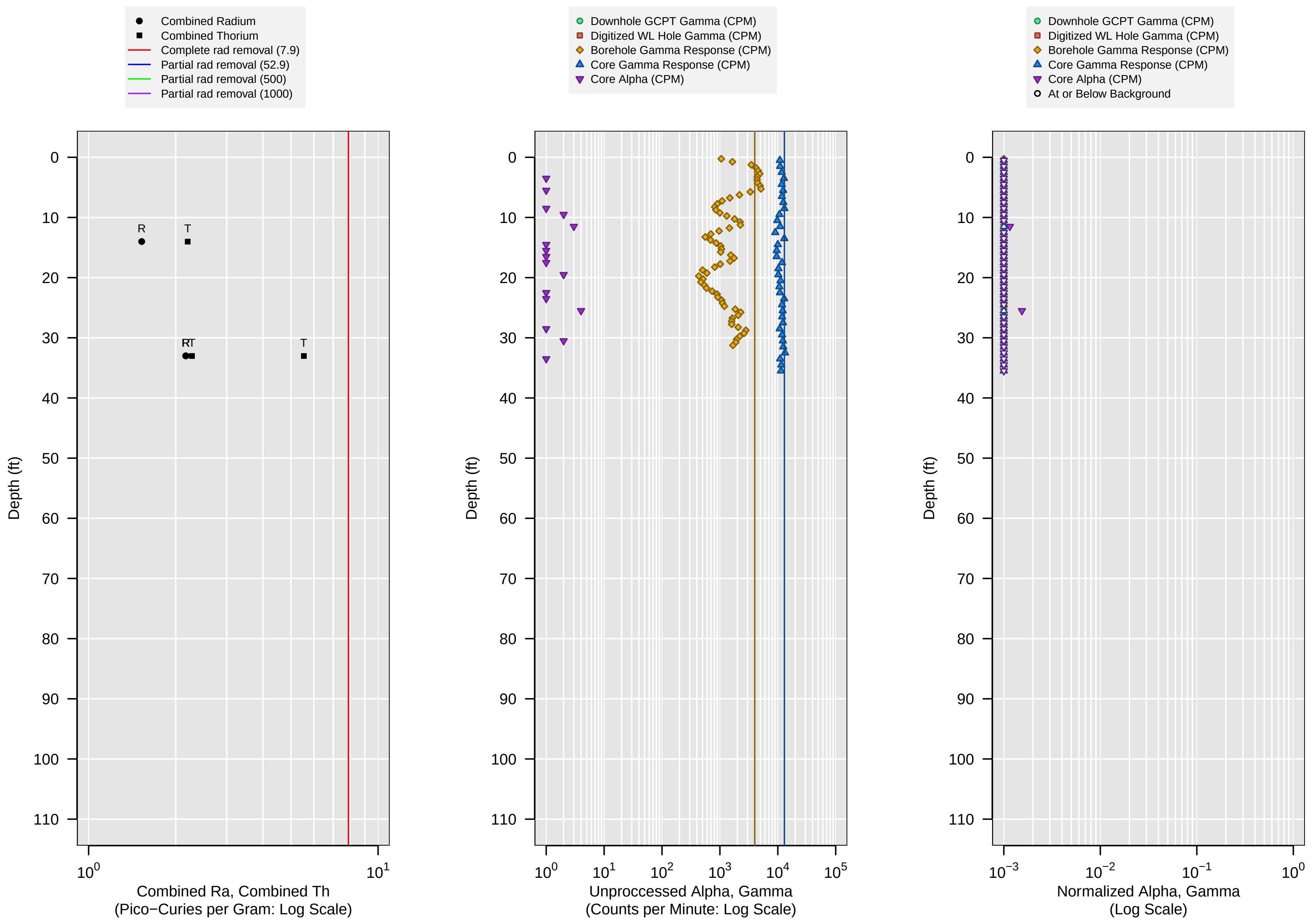
AC−03


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
0 4000 8000 12000 16000 20000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0 2e+05 4e+05 6e+05 8e+05 1e+06
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

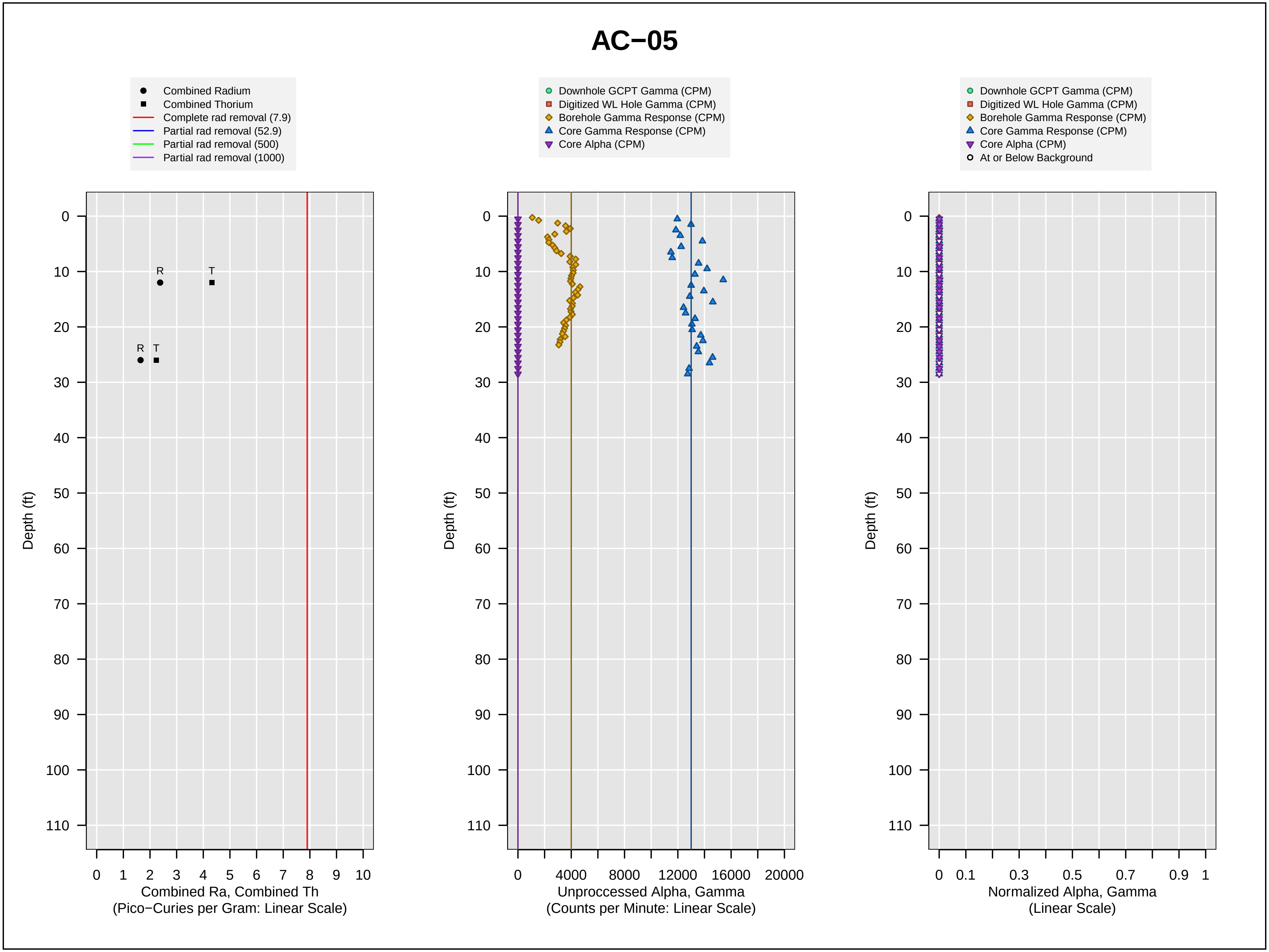

AC−03
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
R
T
RT
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)


AC−04B
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

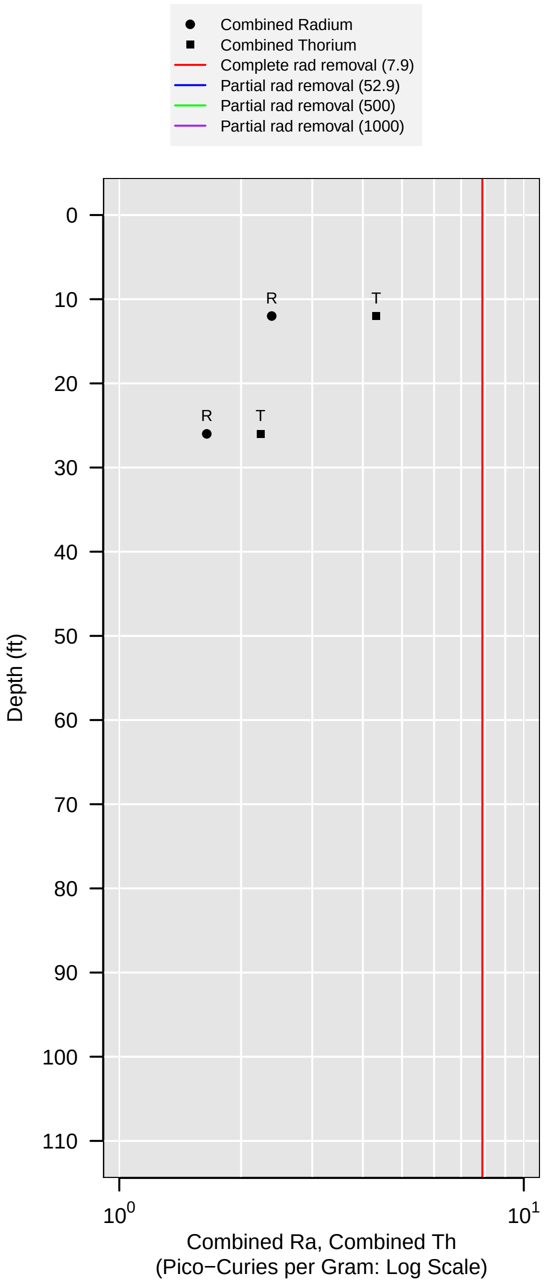
AC−04B



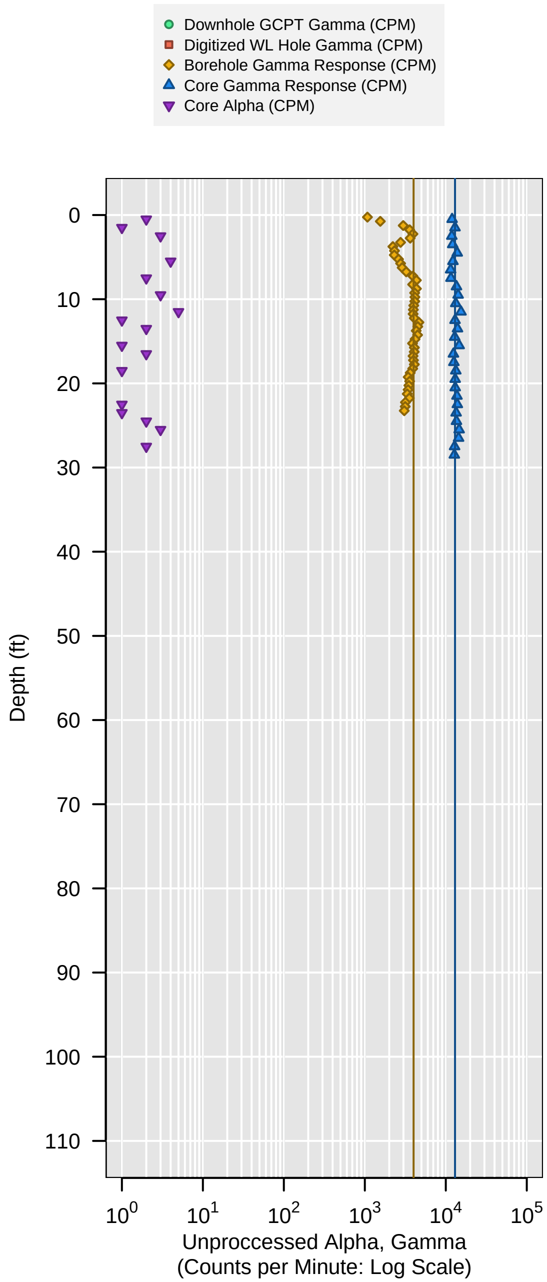
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)


AC−05
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

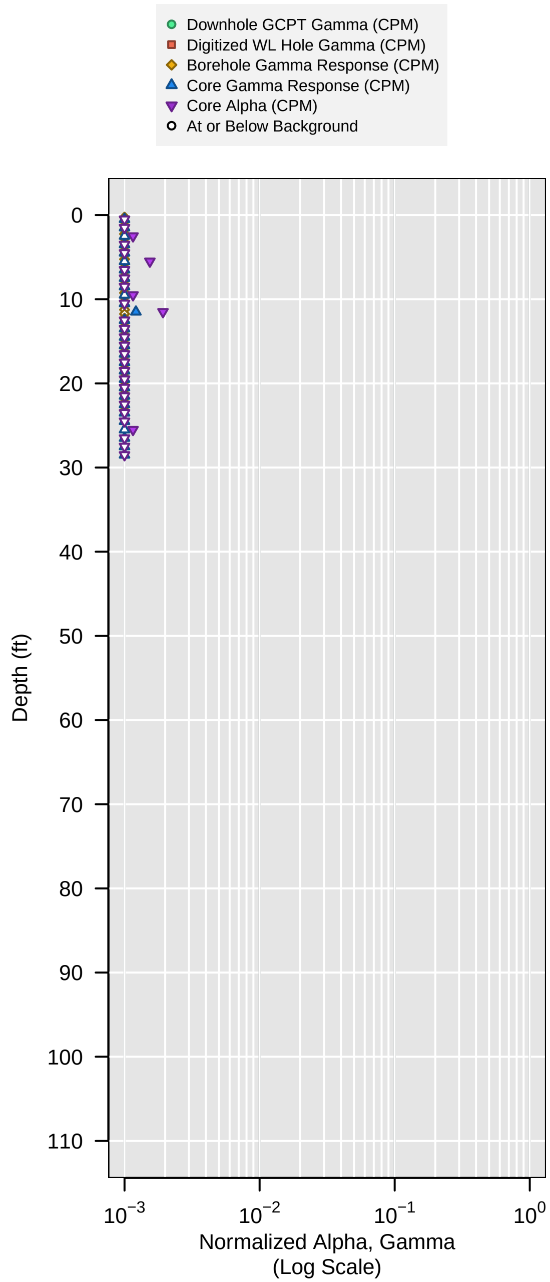
AC−05



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^0
10^1
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)

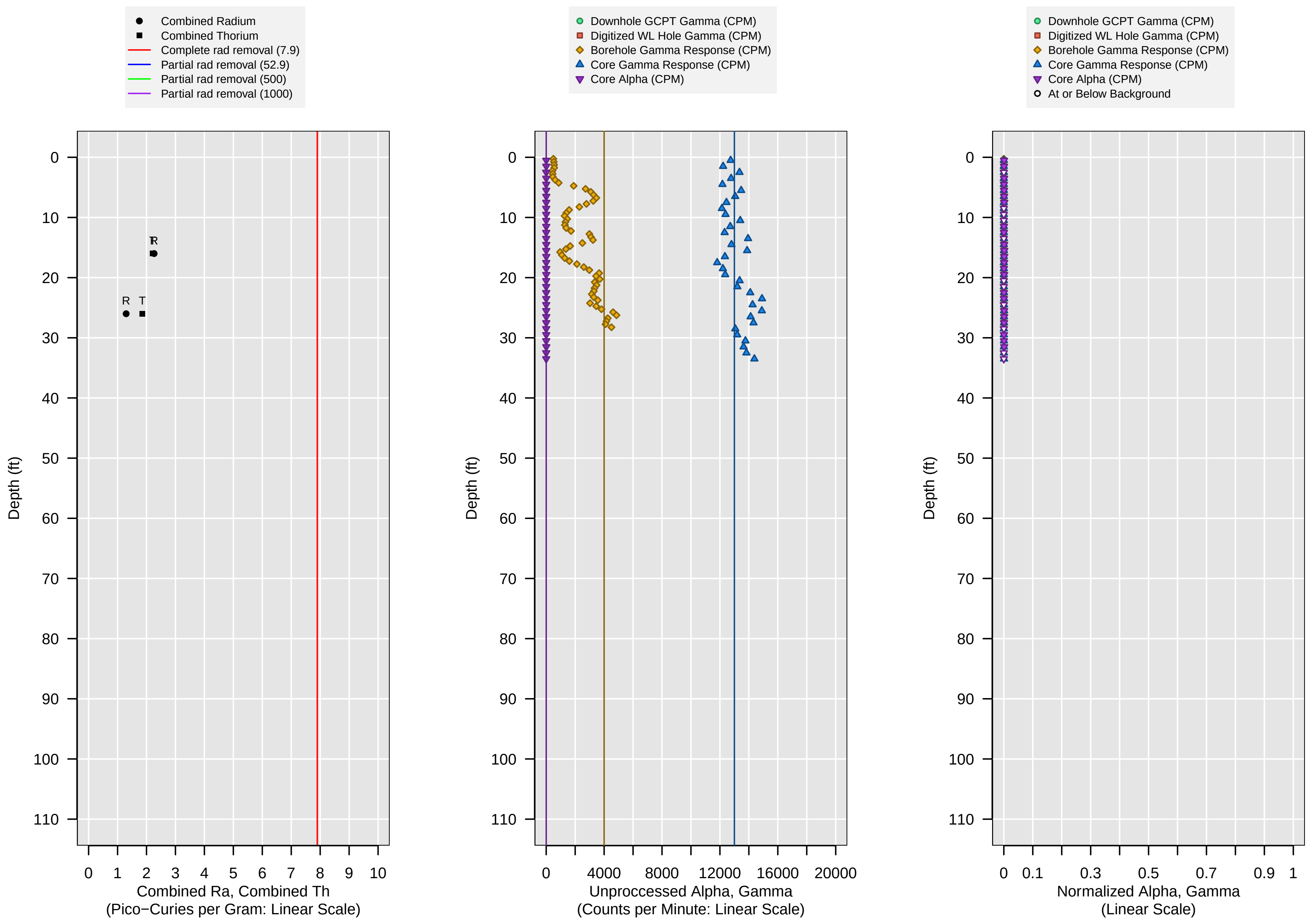


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
10^0
10^1
10^2
10^3
10^4
10^5
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)



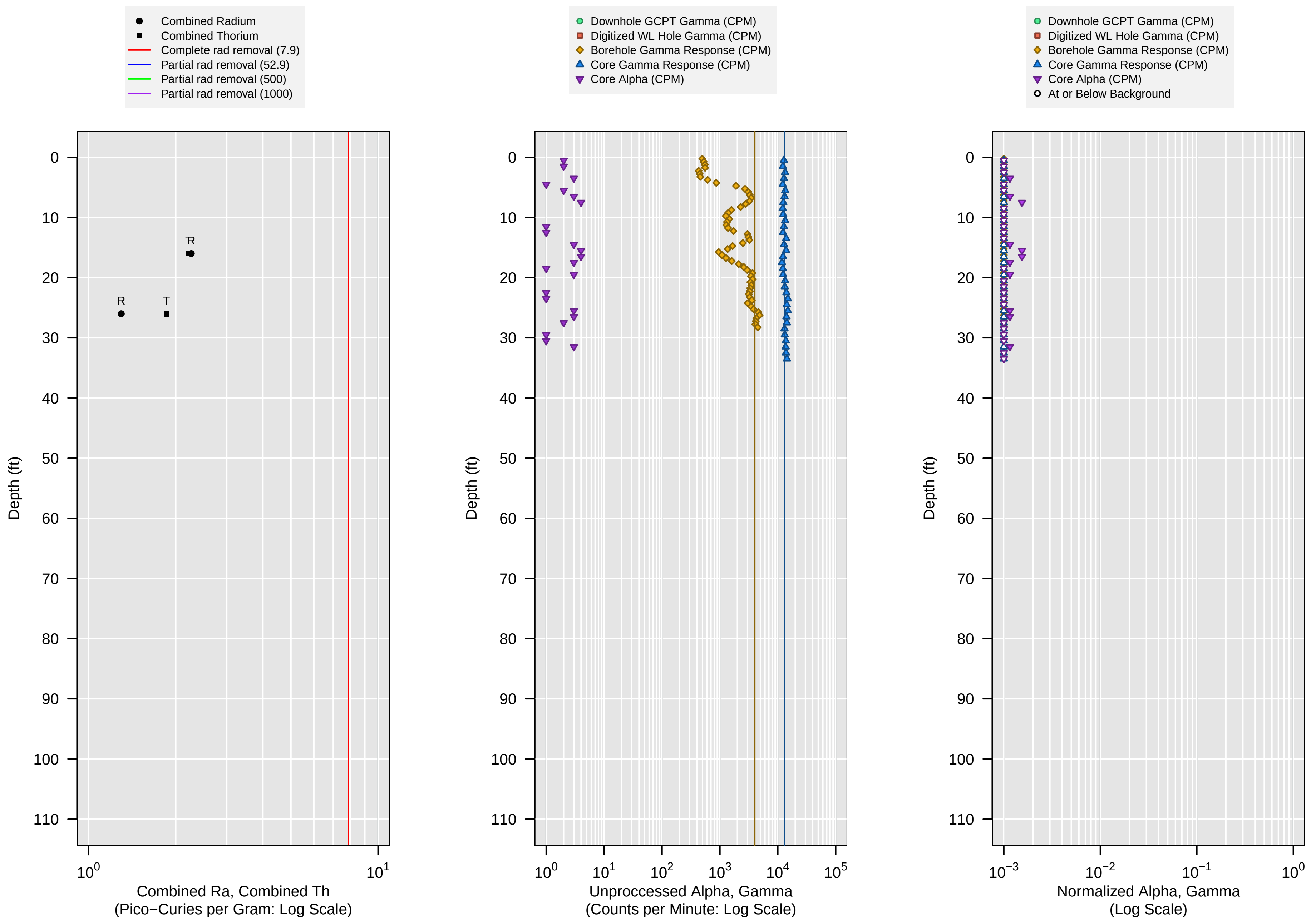
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
10^{-3}
10^{-2}
10^{-1}
10^0
Normalized Alpha, Gamma
(Log Scale)

AC−06



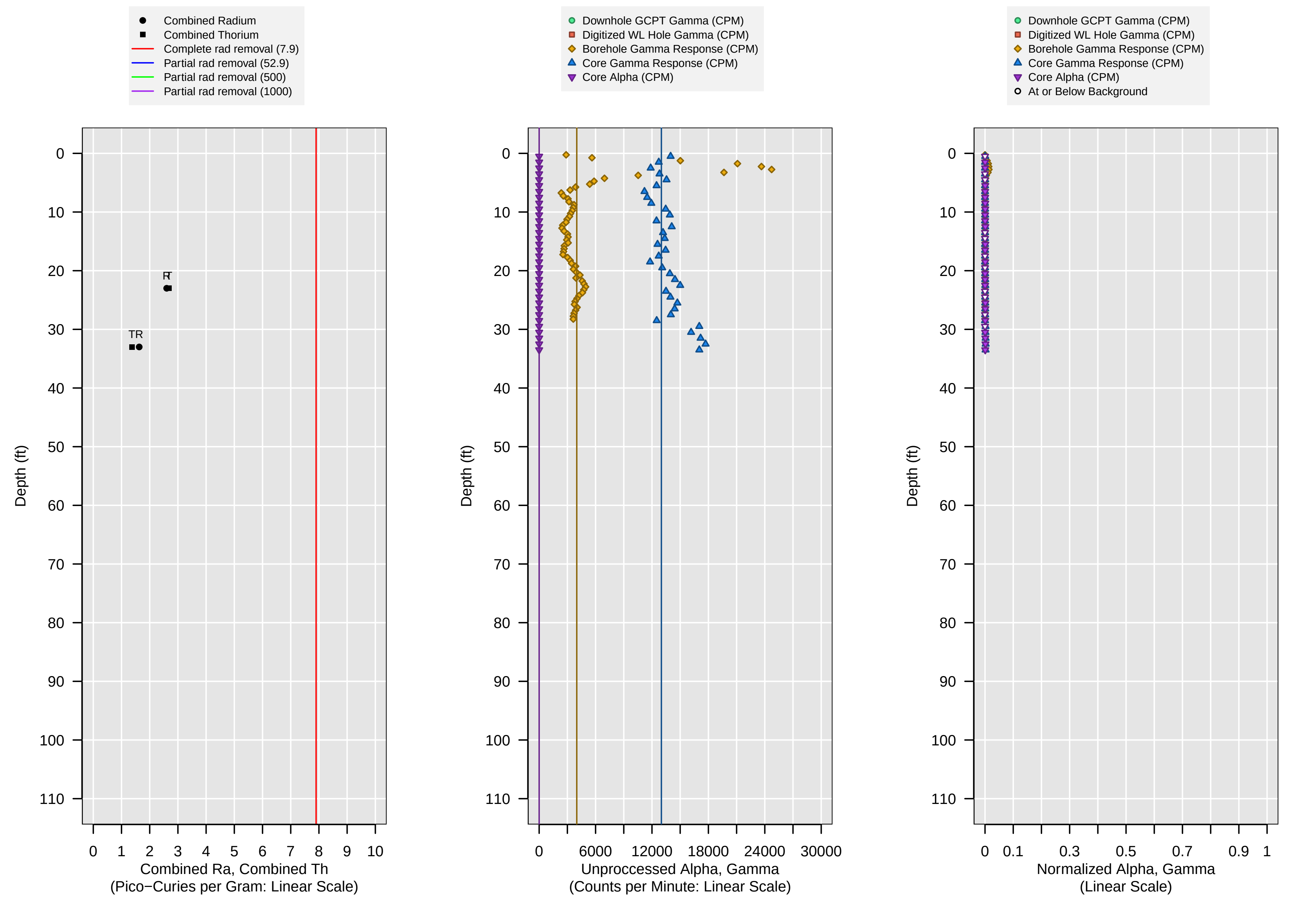
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

AC−06



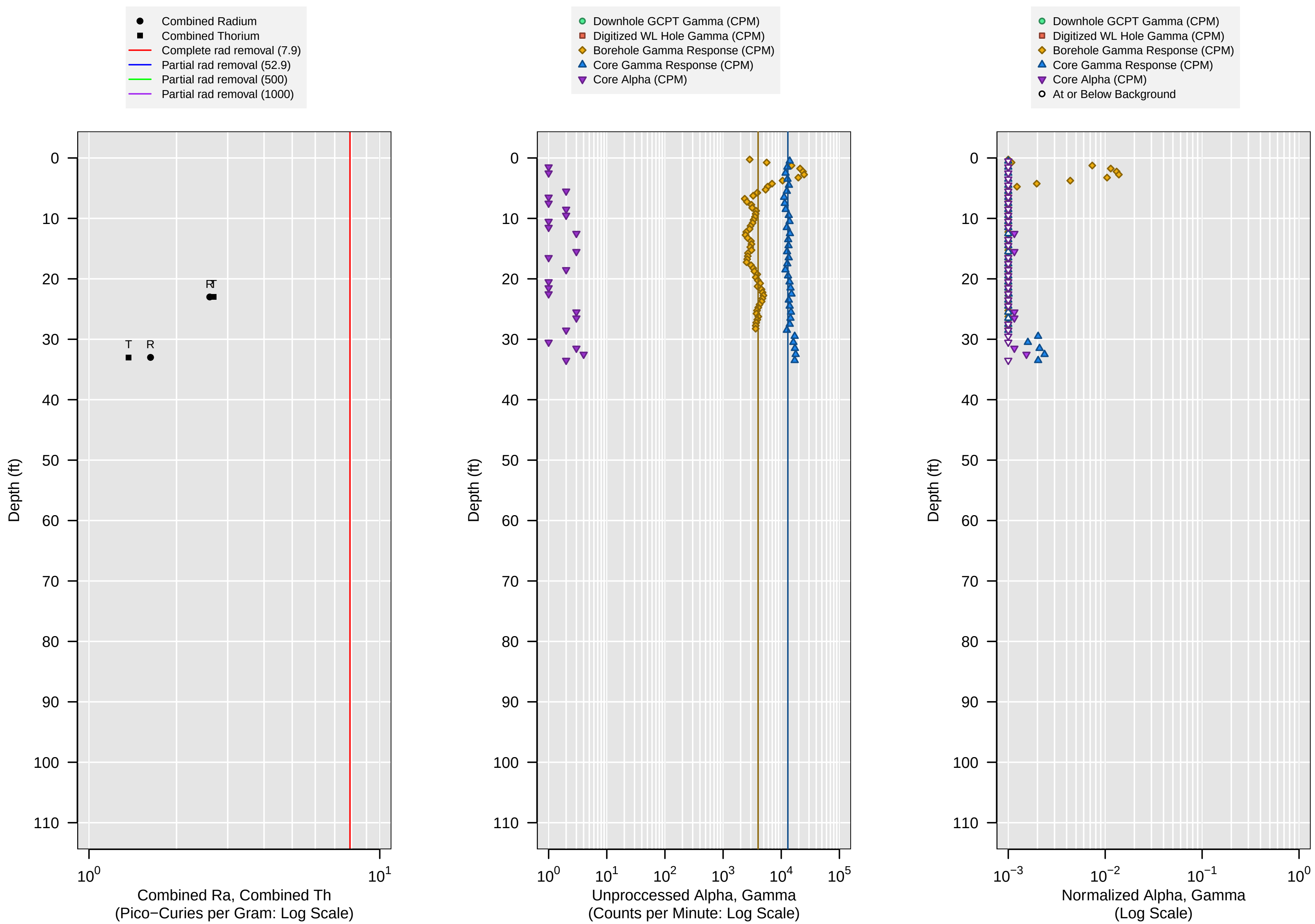
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

AC−07

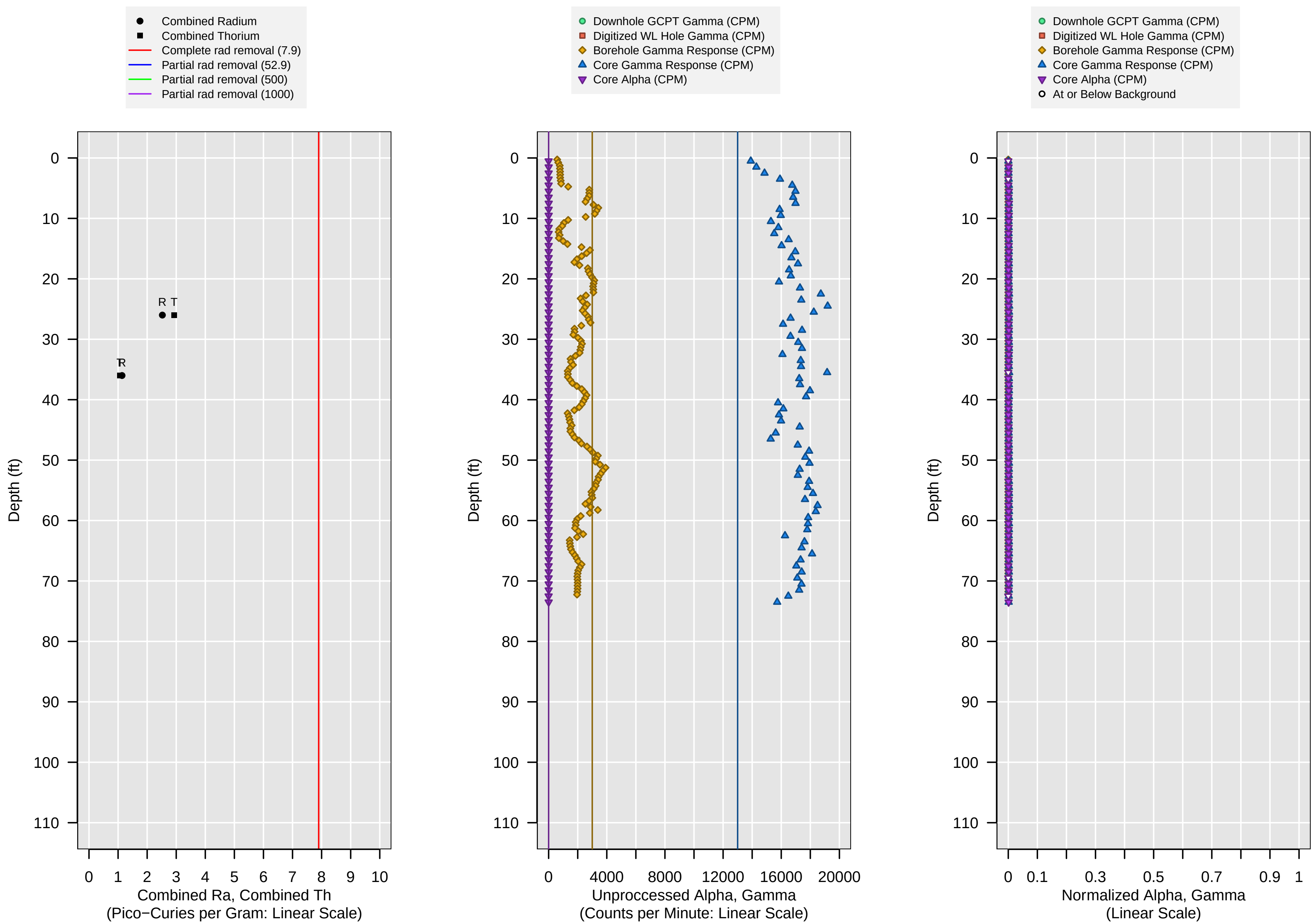


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

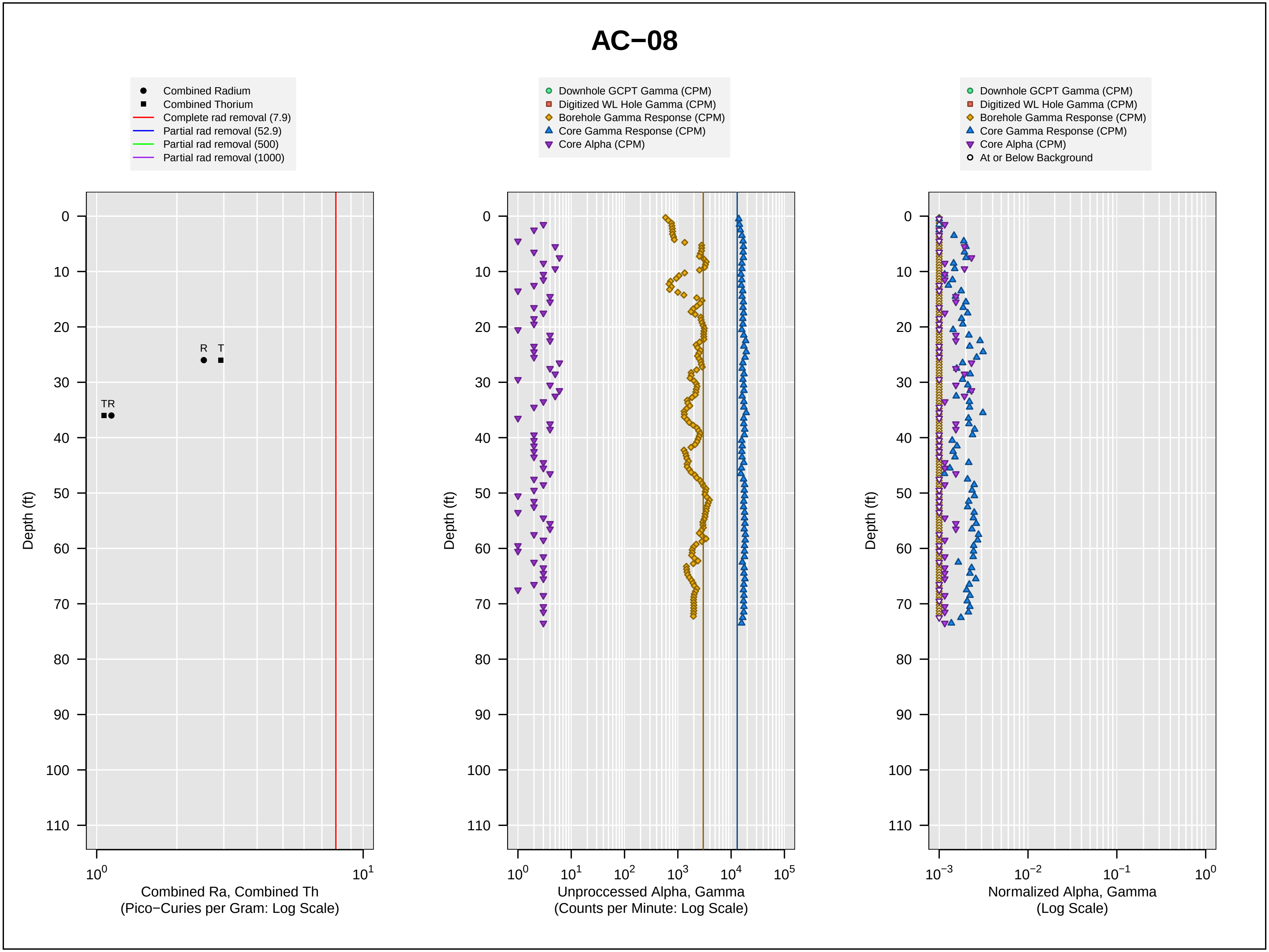
AC−07


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
T
R
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

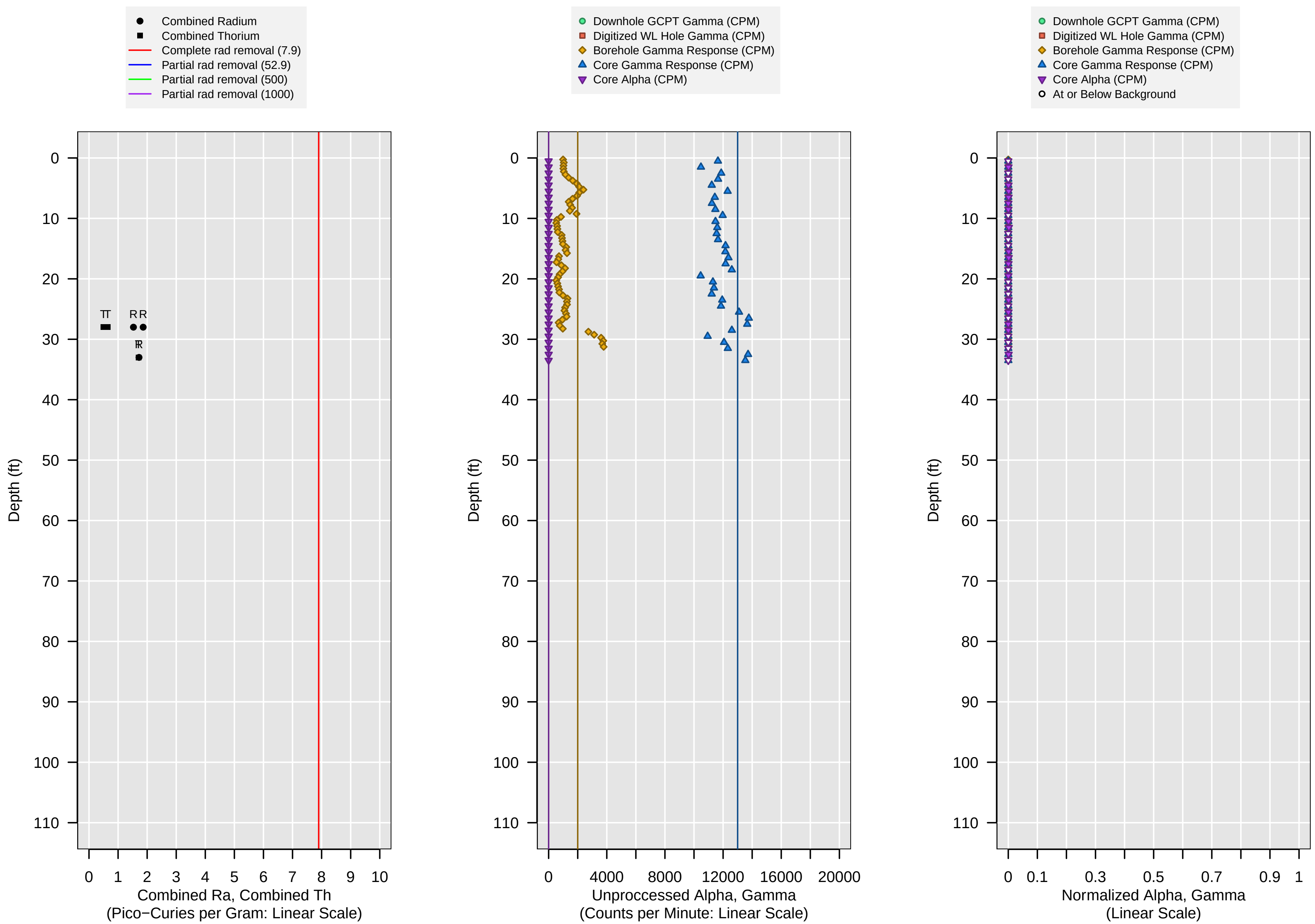
AC−08



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

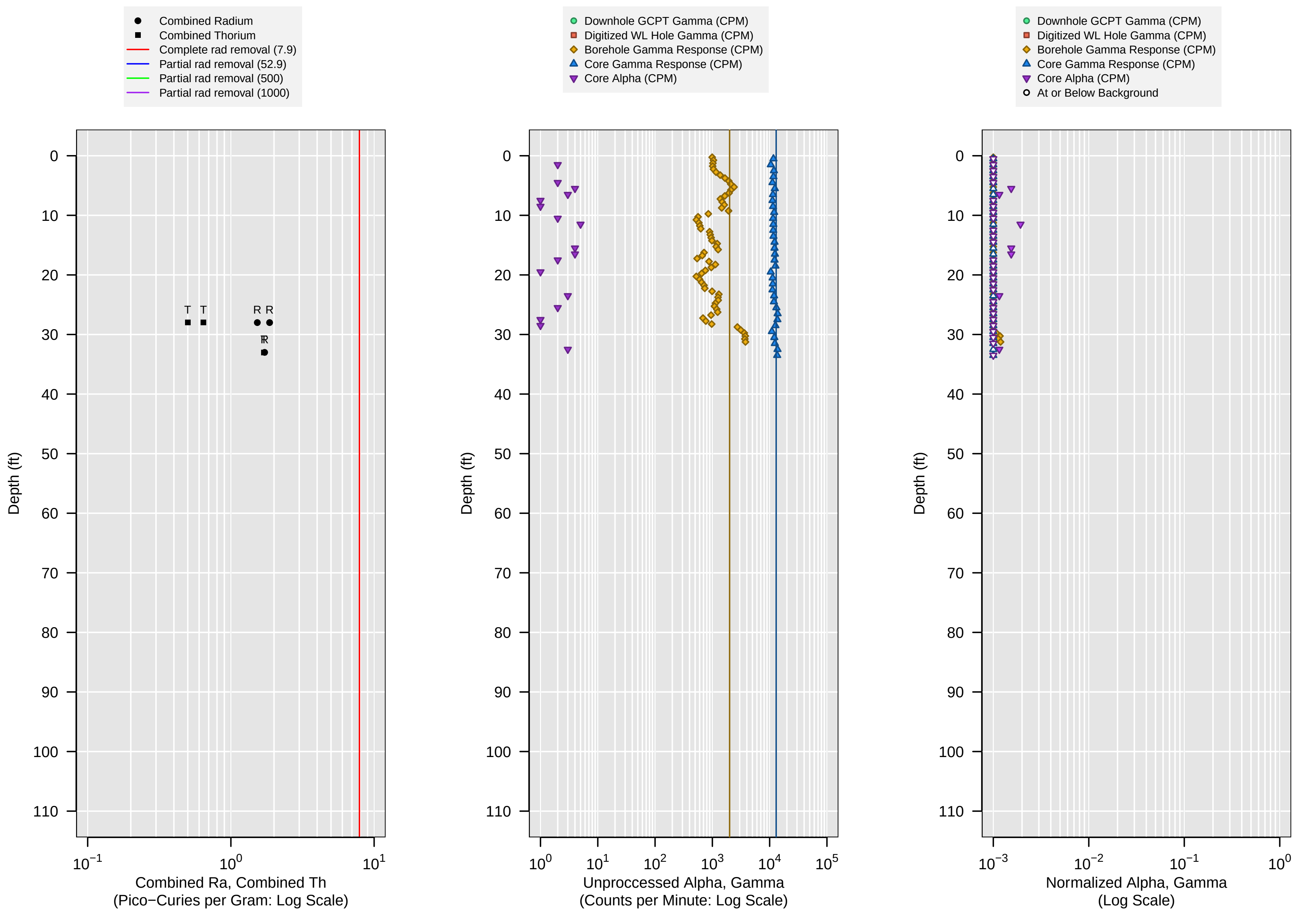

AC−08
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R T
TR
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

AC−09



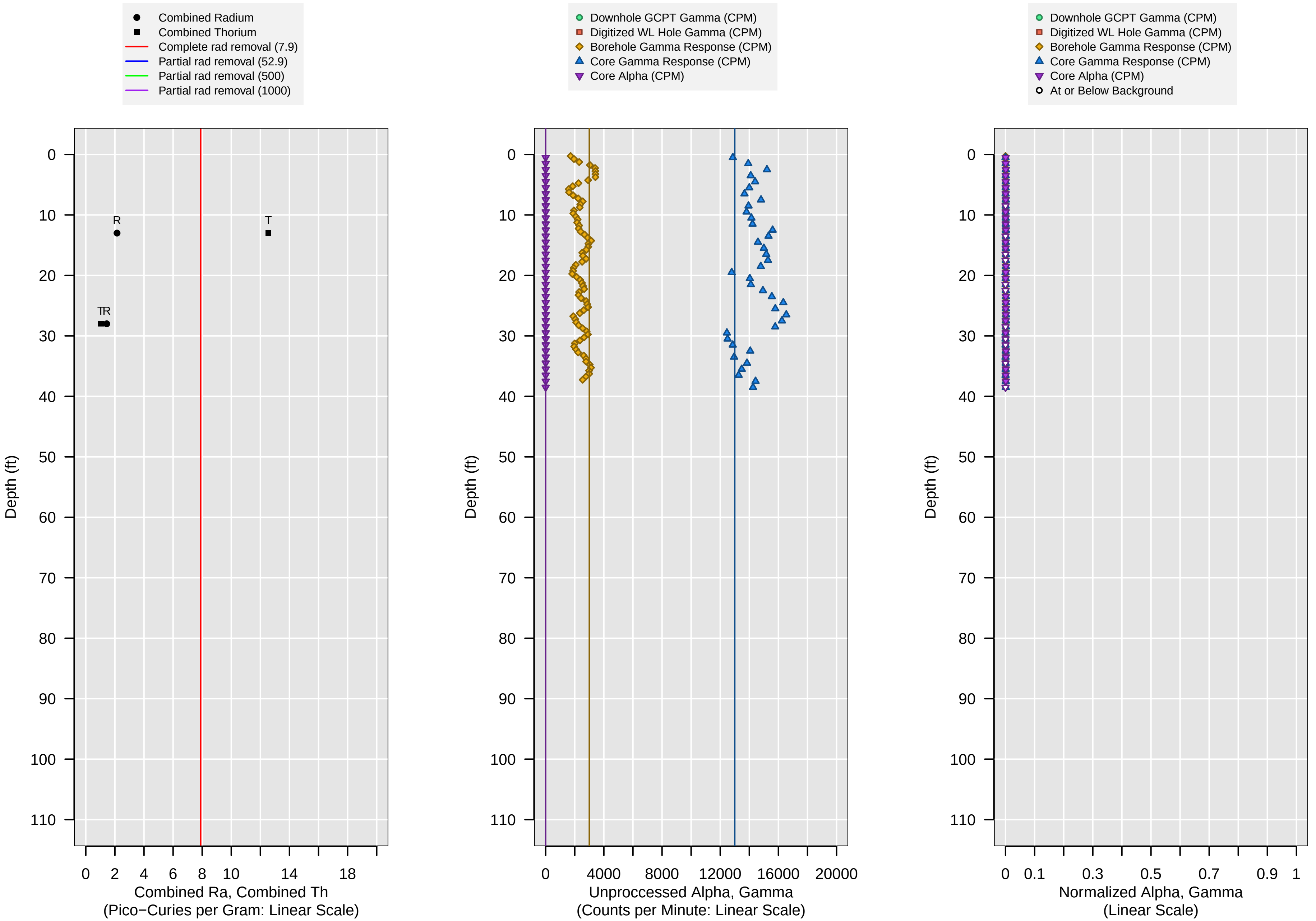
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

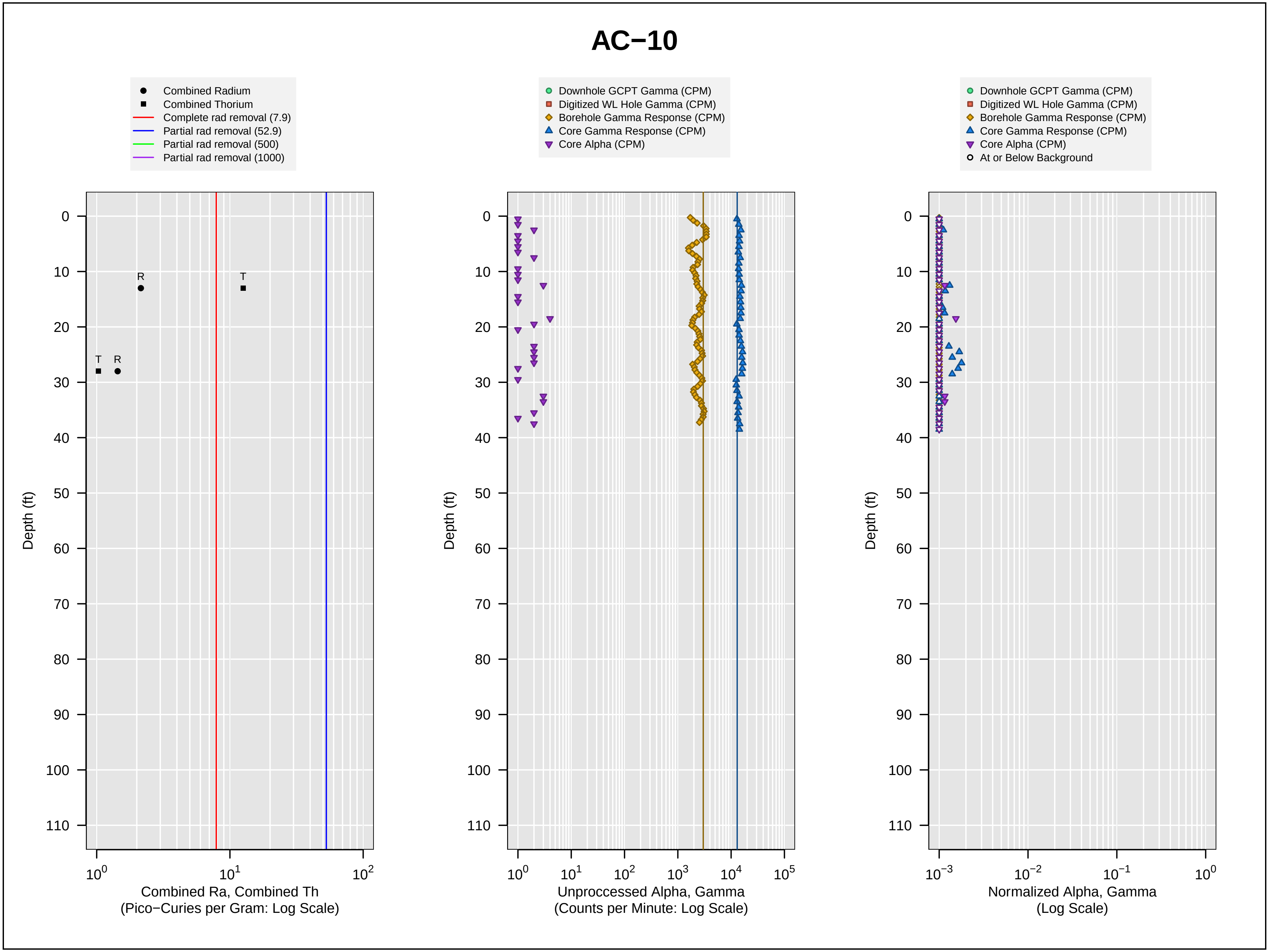
AC−09



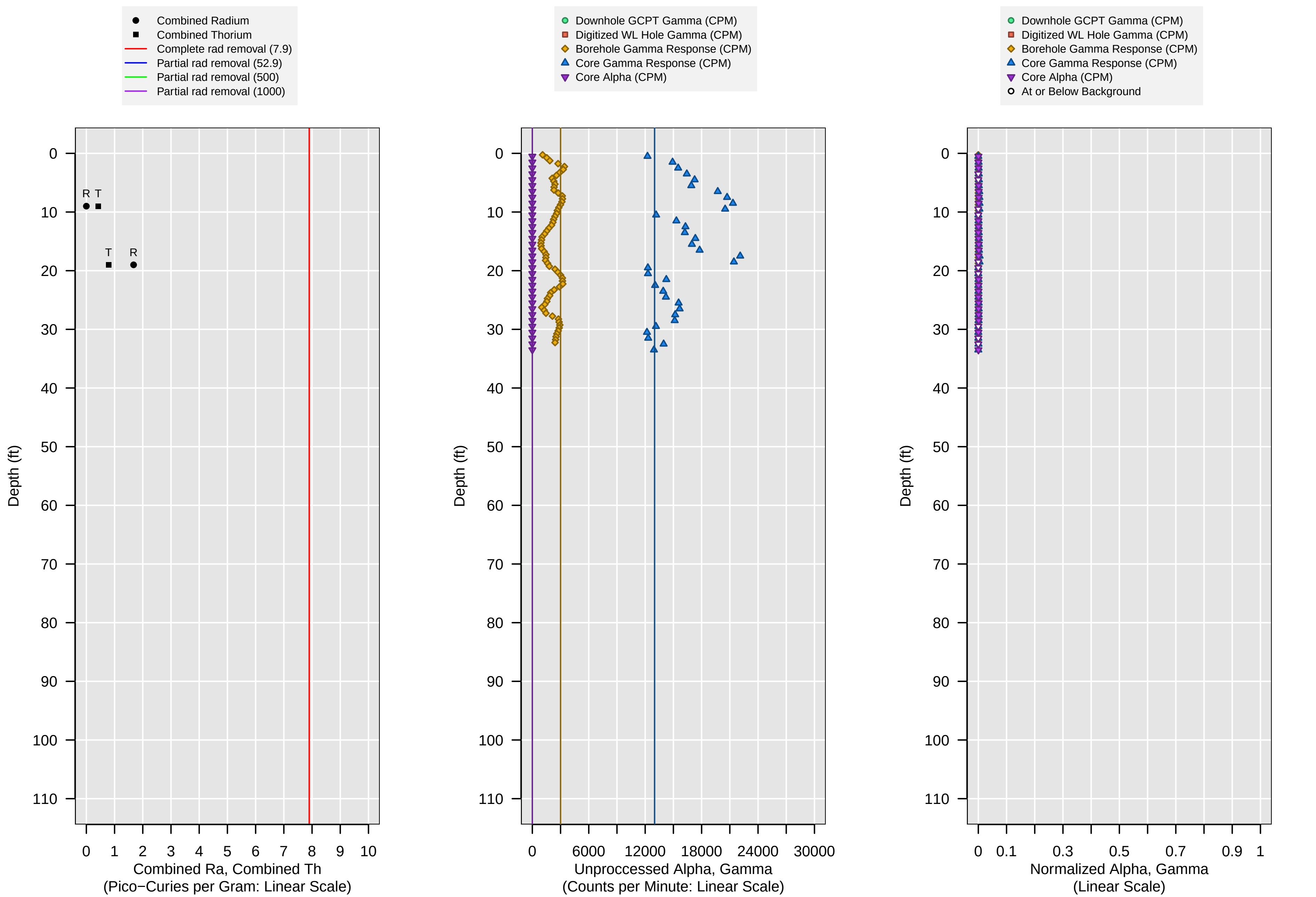
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

AC−10


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
TR
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Linear Scale)

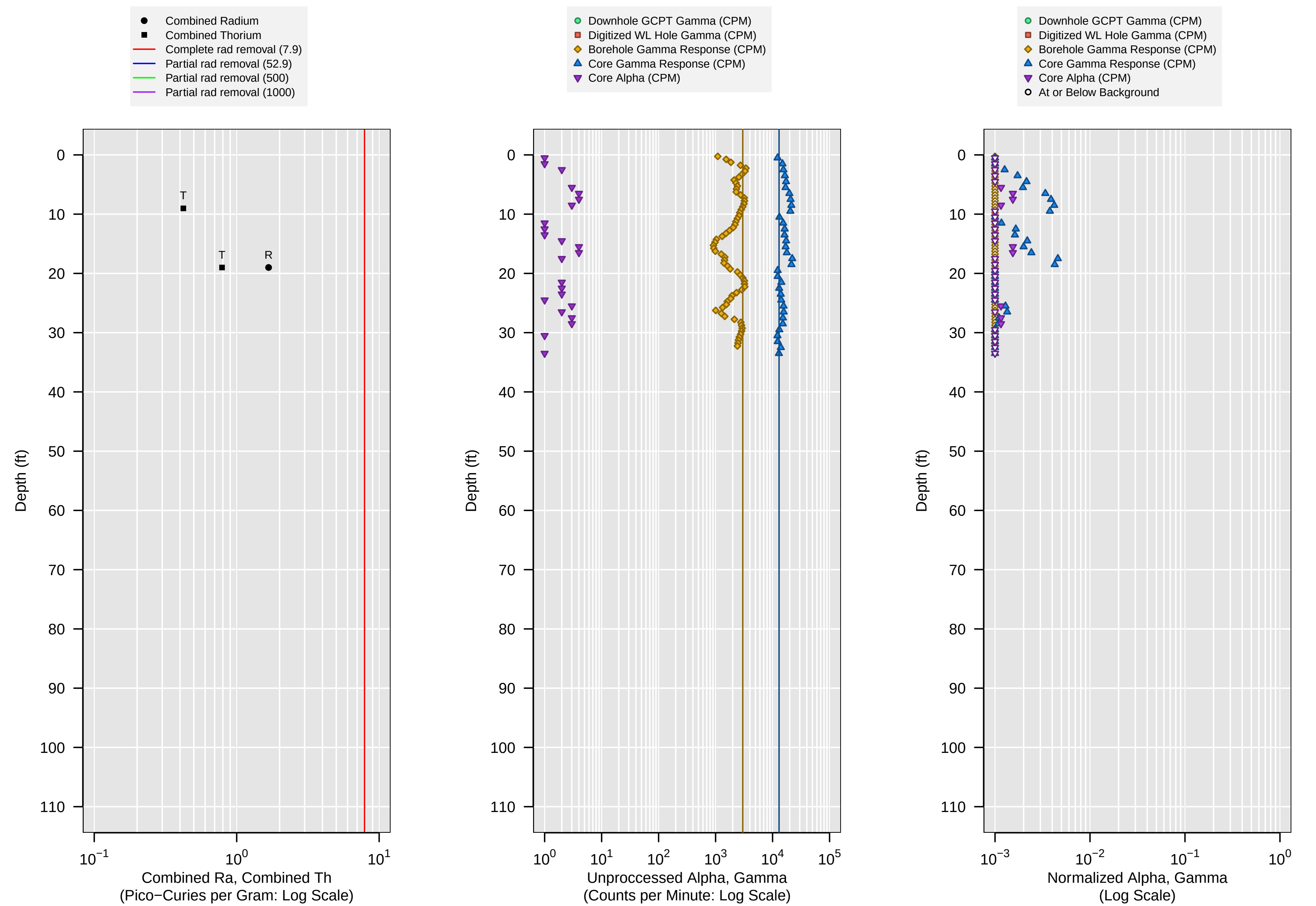

AC−10
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Normalized Alpha, Gamma
(Log Scale)

AC−11



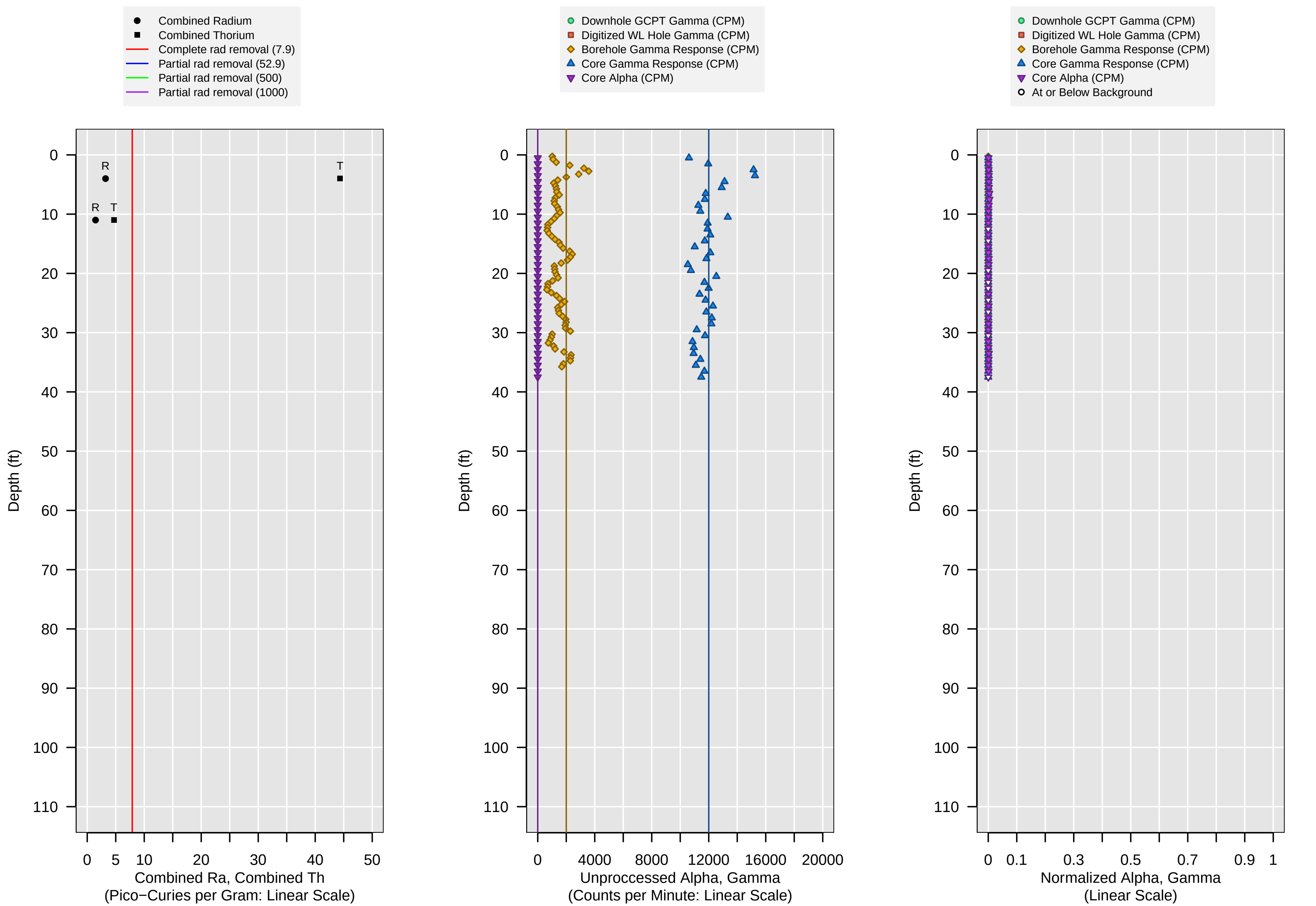
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
R T
T R
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

AC−11

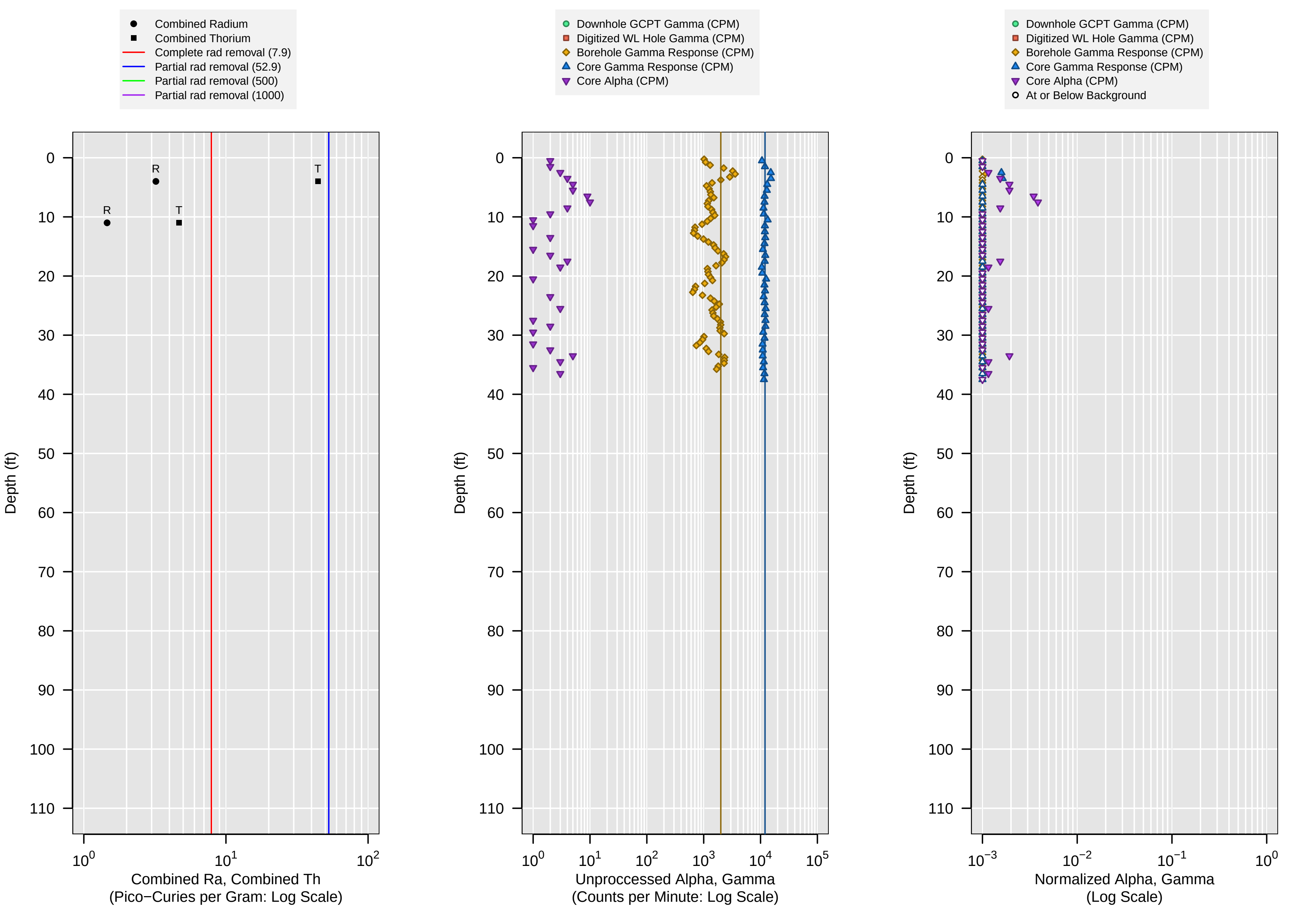


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

AC−12

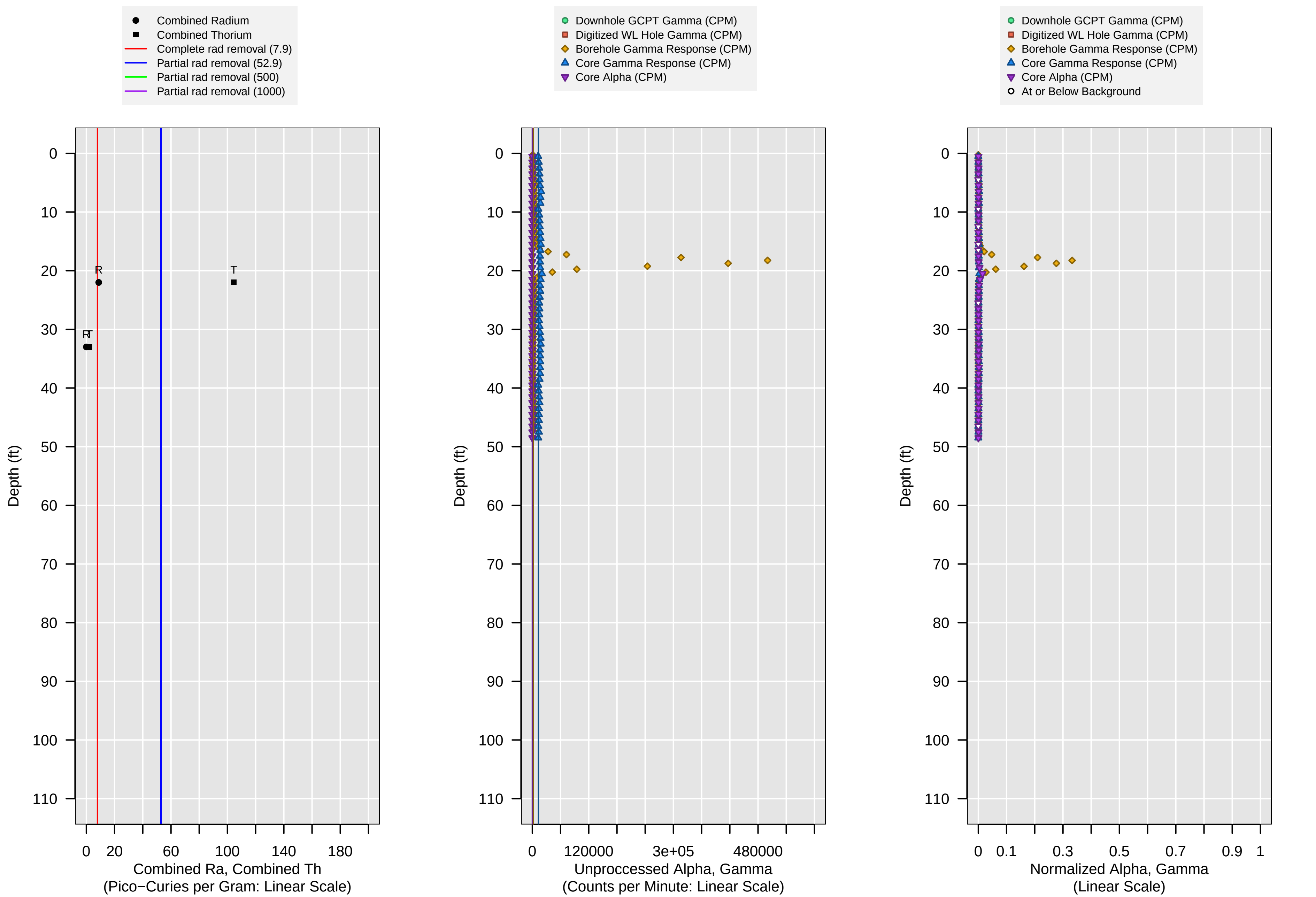

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Linear Scale)

AC−12



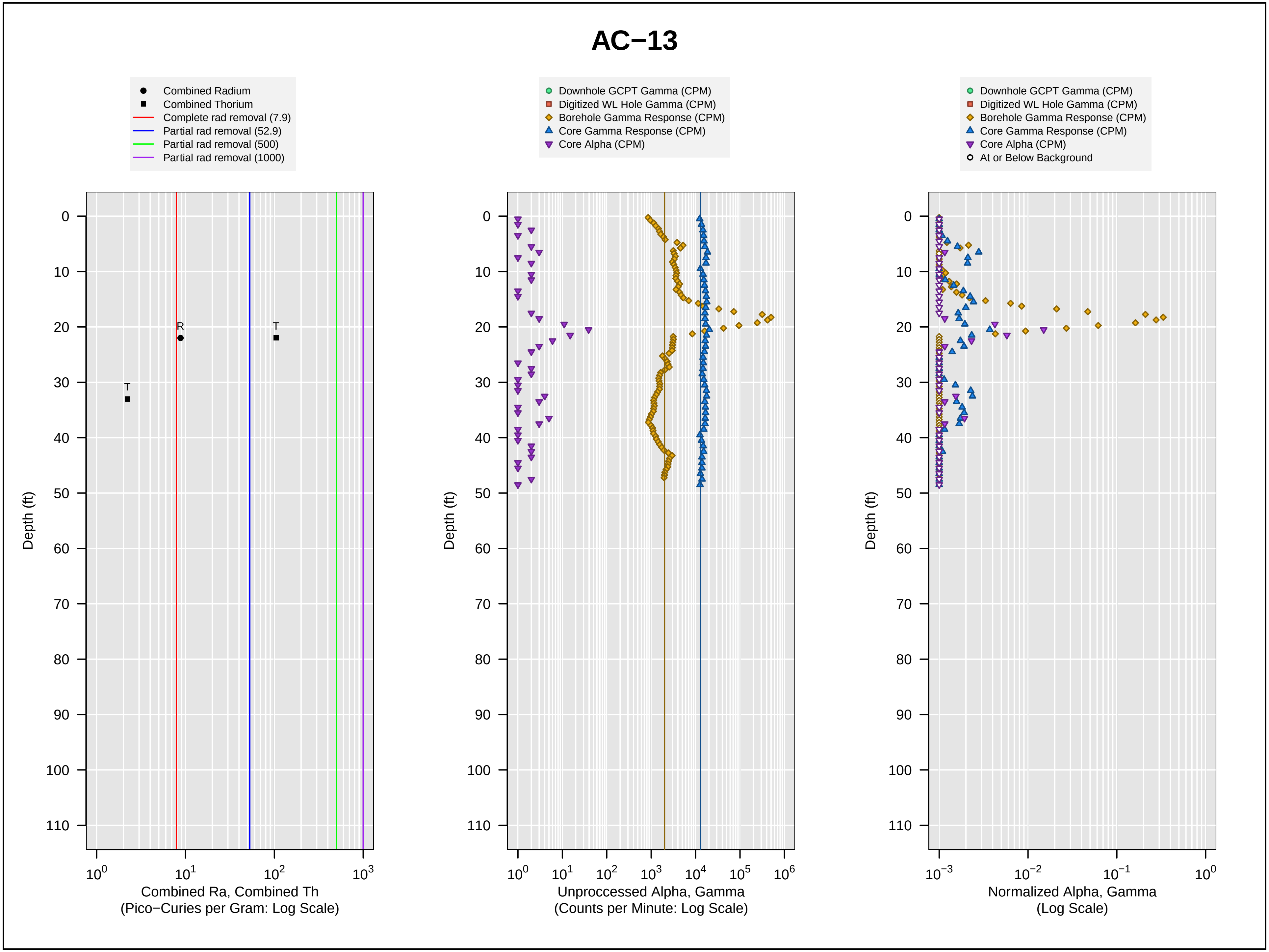
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

AC−13



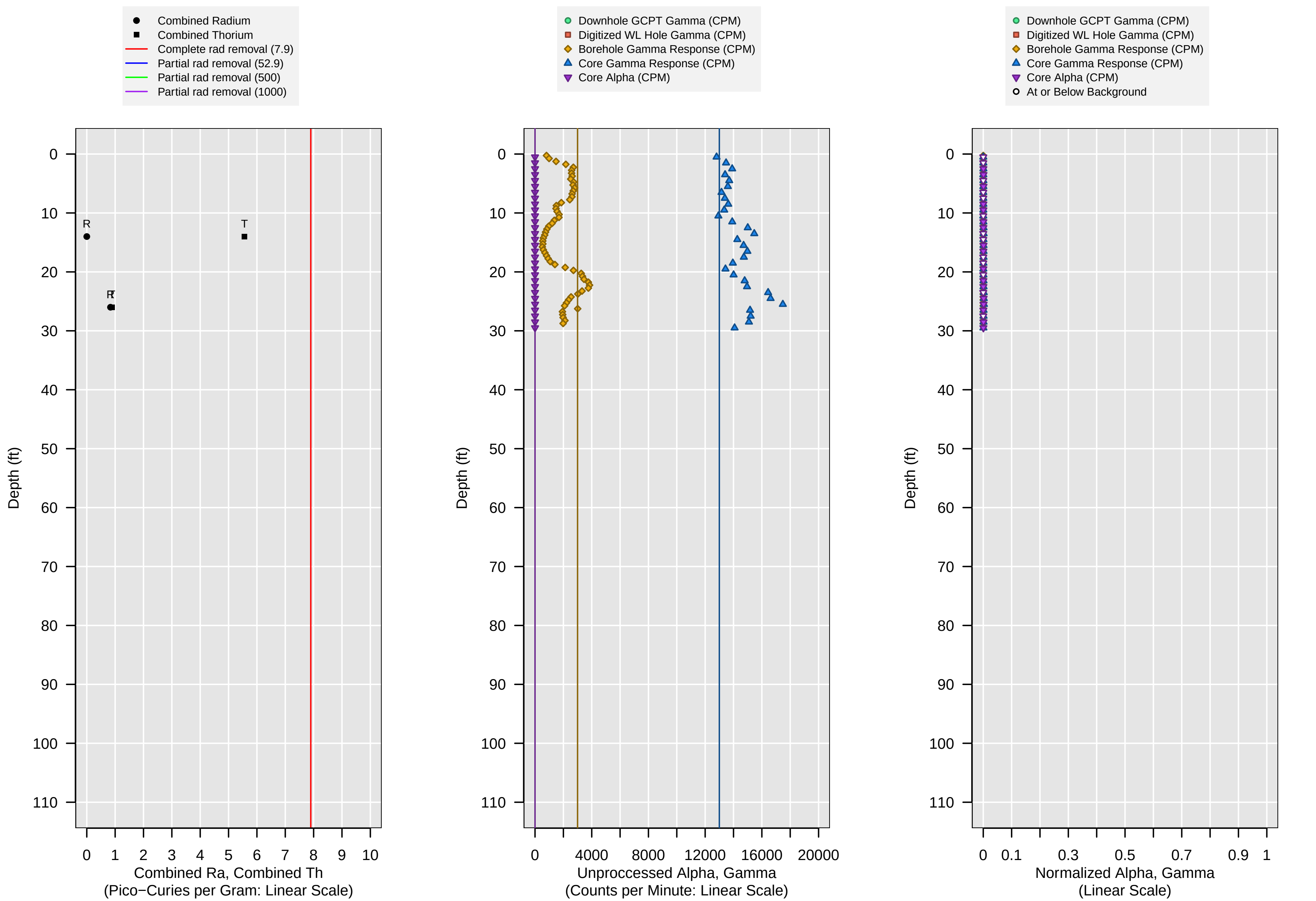
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
20
60
100
140
180
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
120000
3e+05
480000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

AC−13



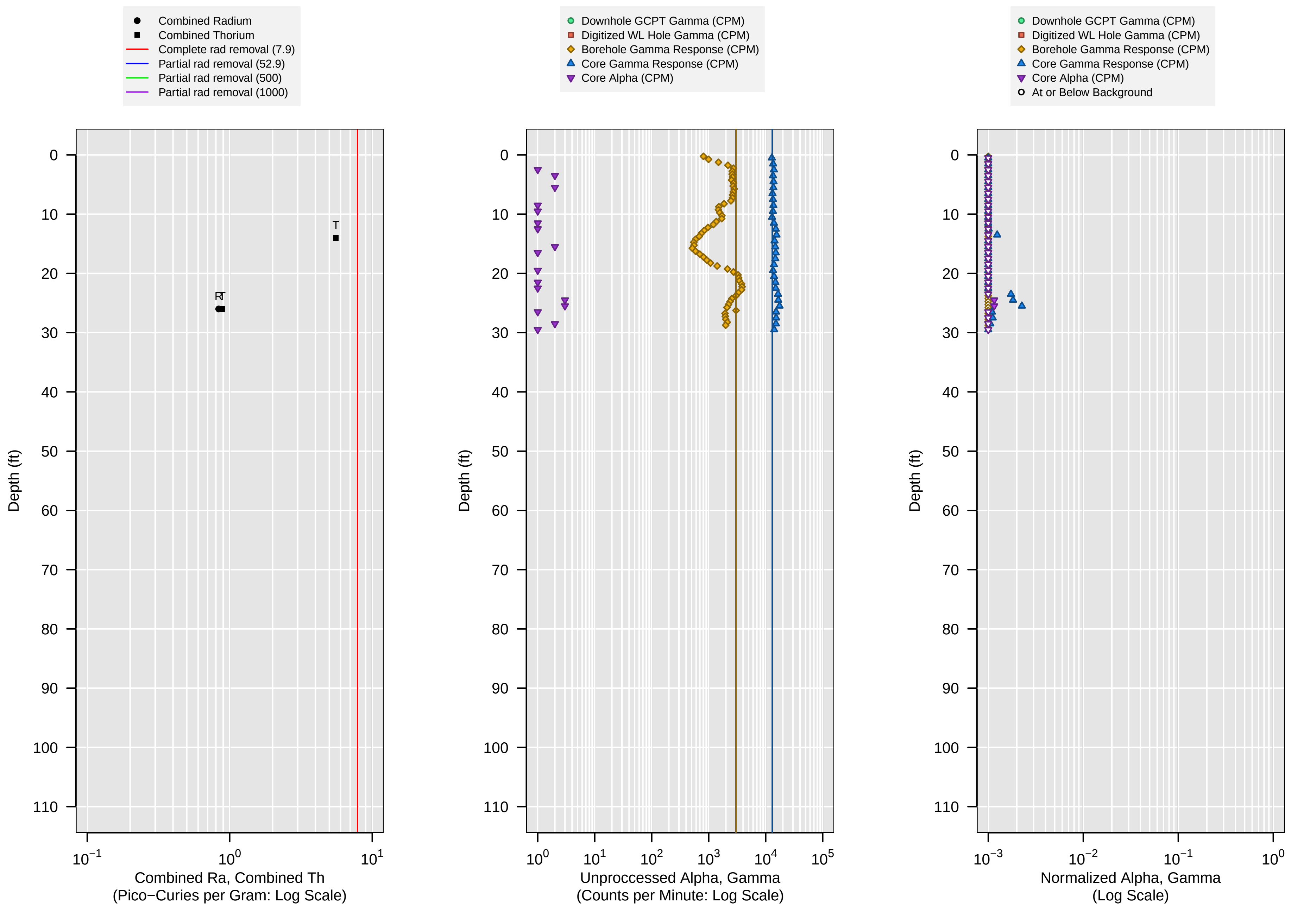
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
R
T
T
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

AC−14

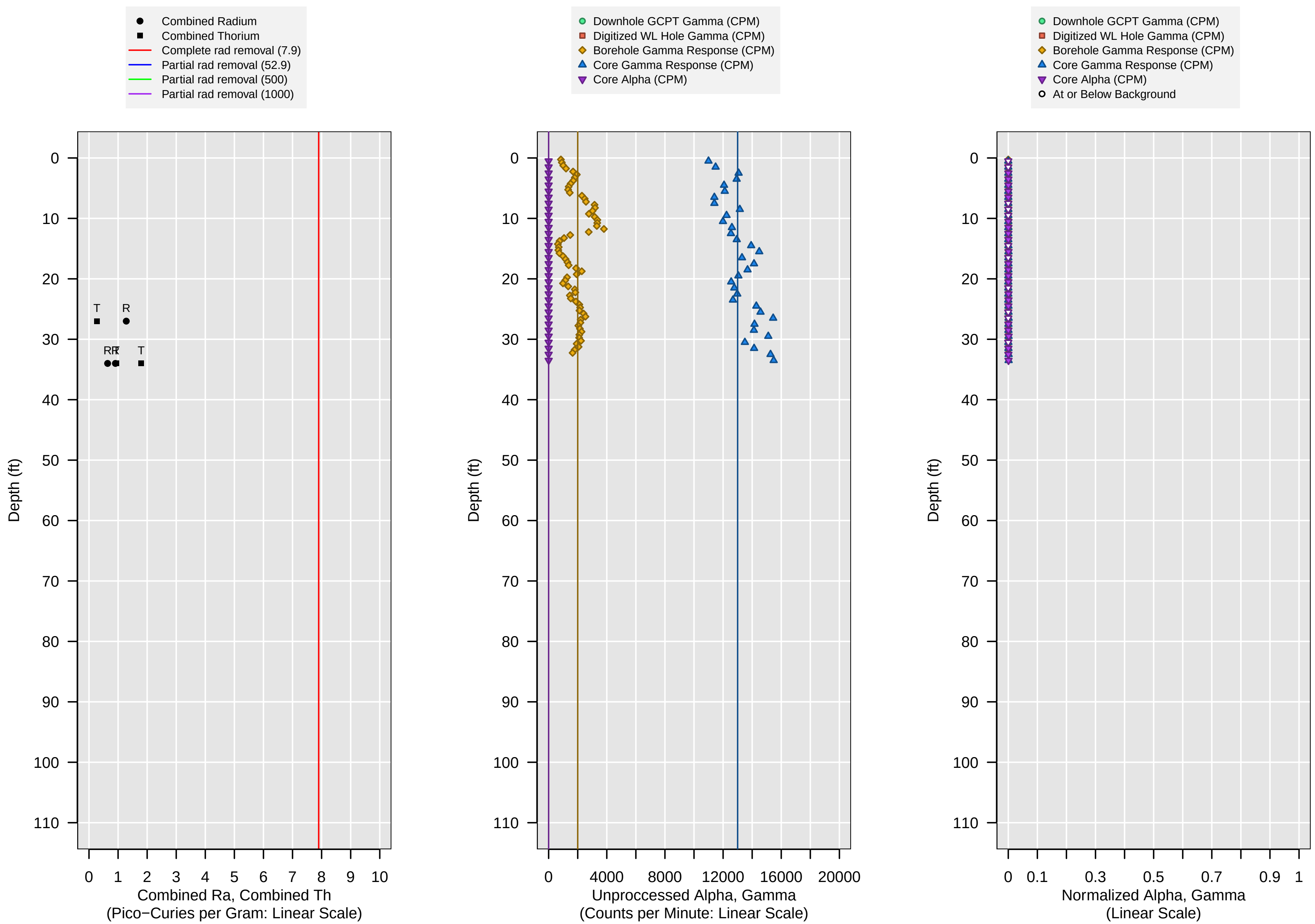


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
0 1 2 3 4 5 6 7 8 9 10
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0 4000 8000 12000 16000 20000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)
0 10 20 30 40 50 60 70 80 90 100 110

AC−14

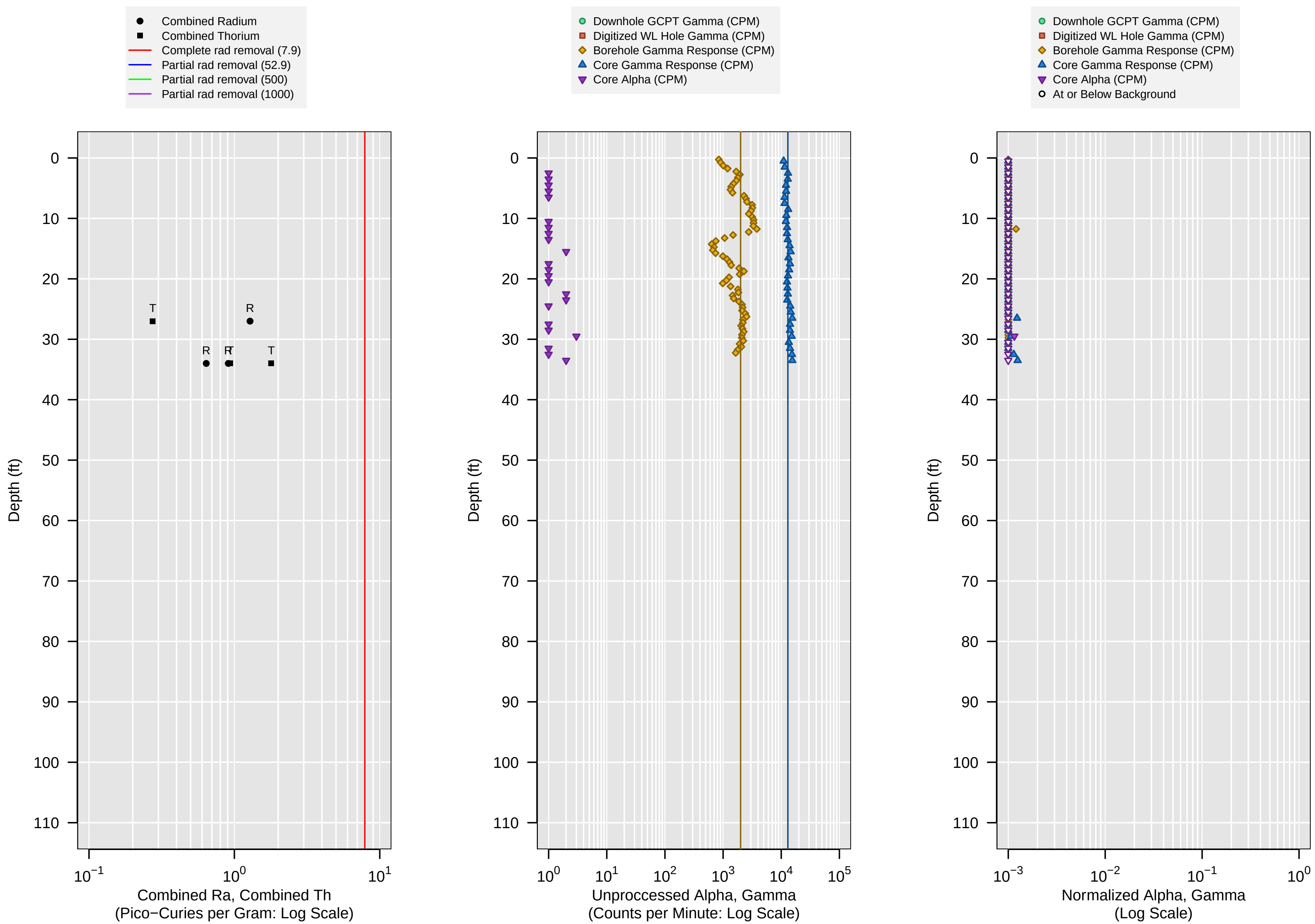

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

AC−15

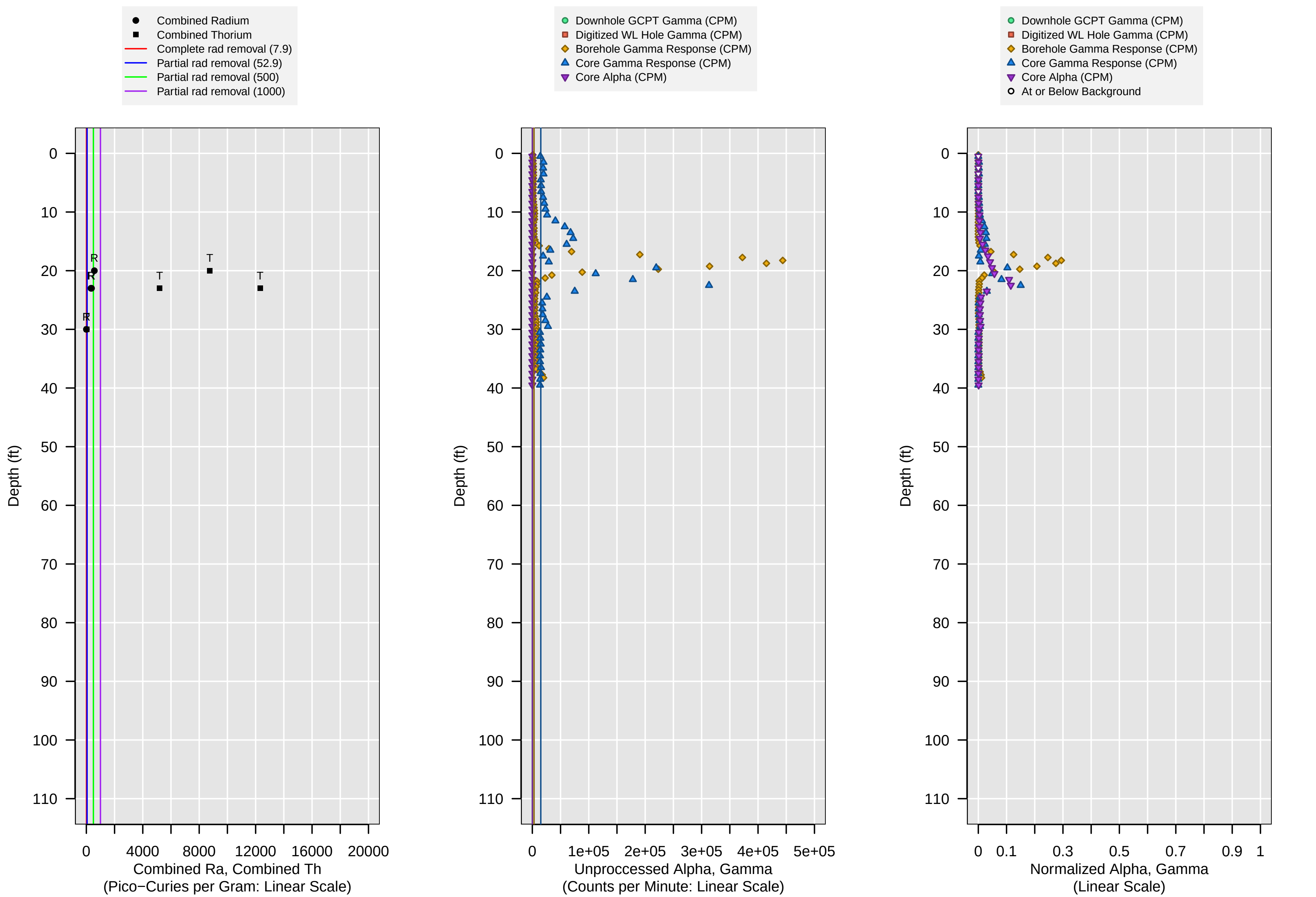


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
T
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

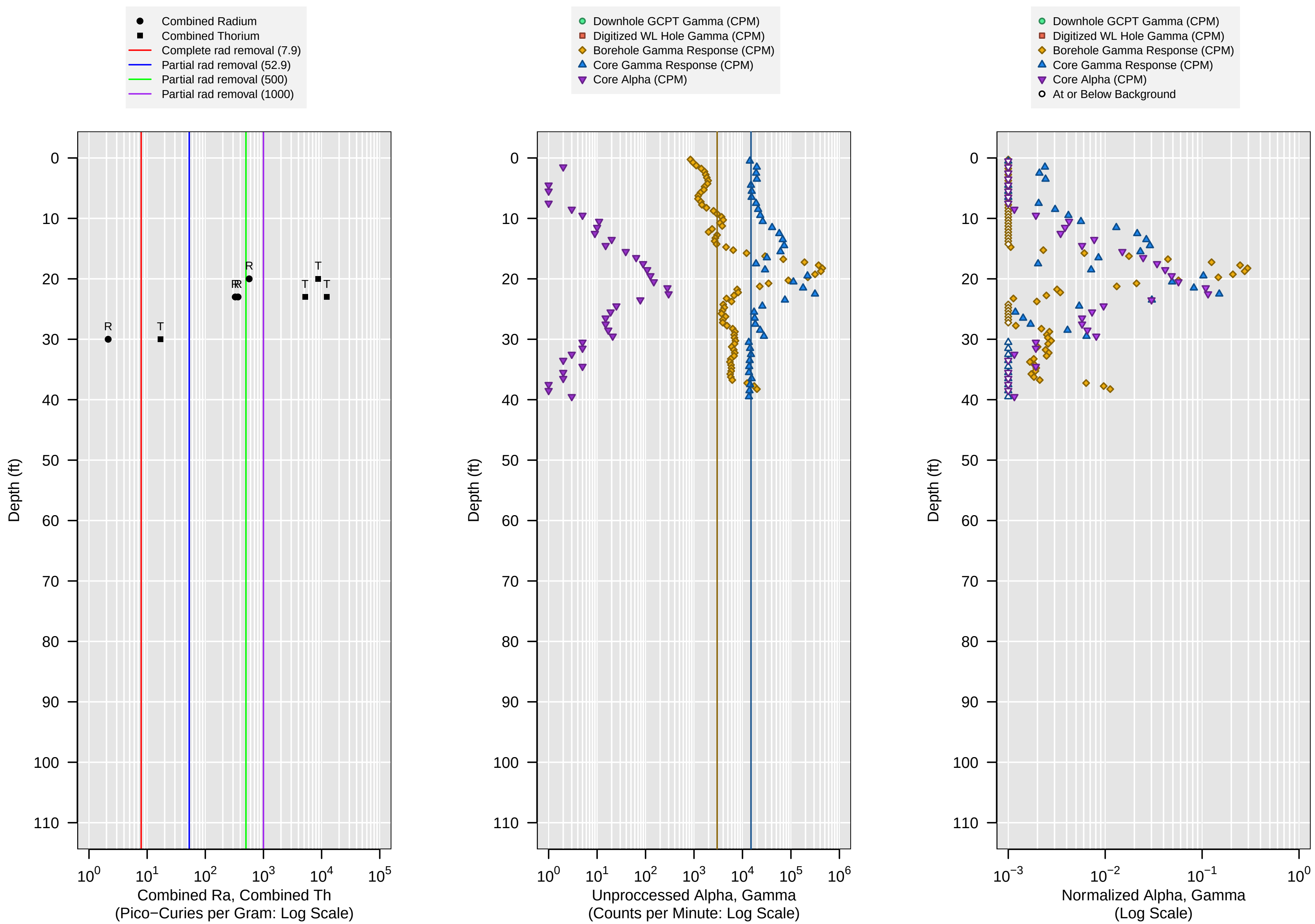
AC−15


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

AC−16

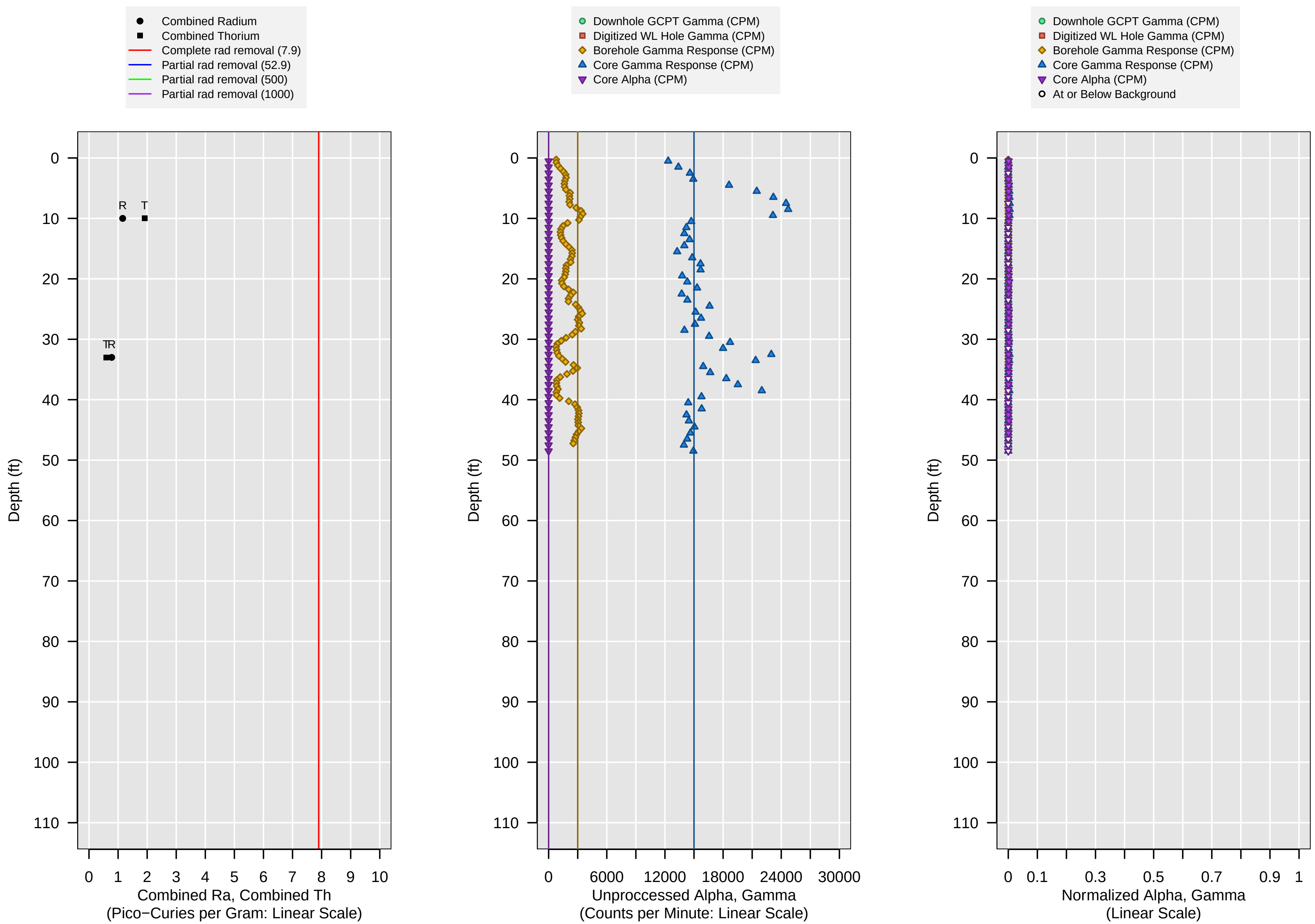

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

AC−16



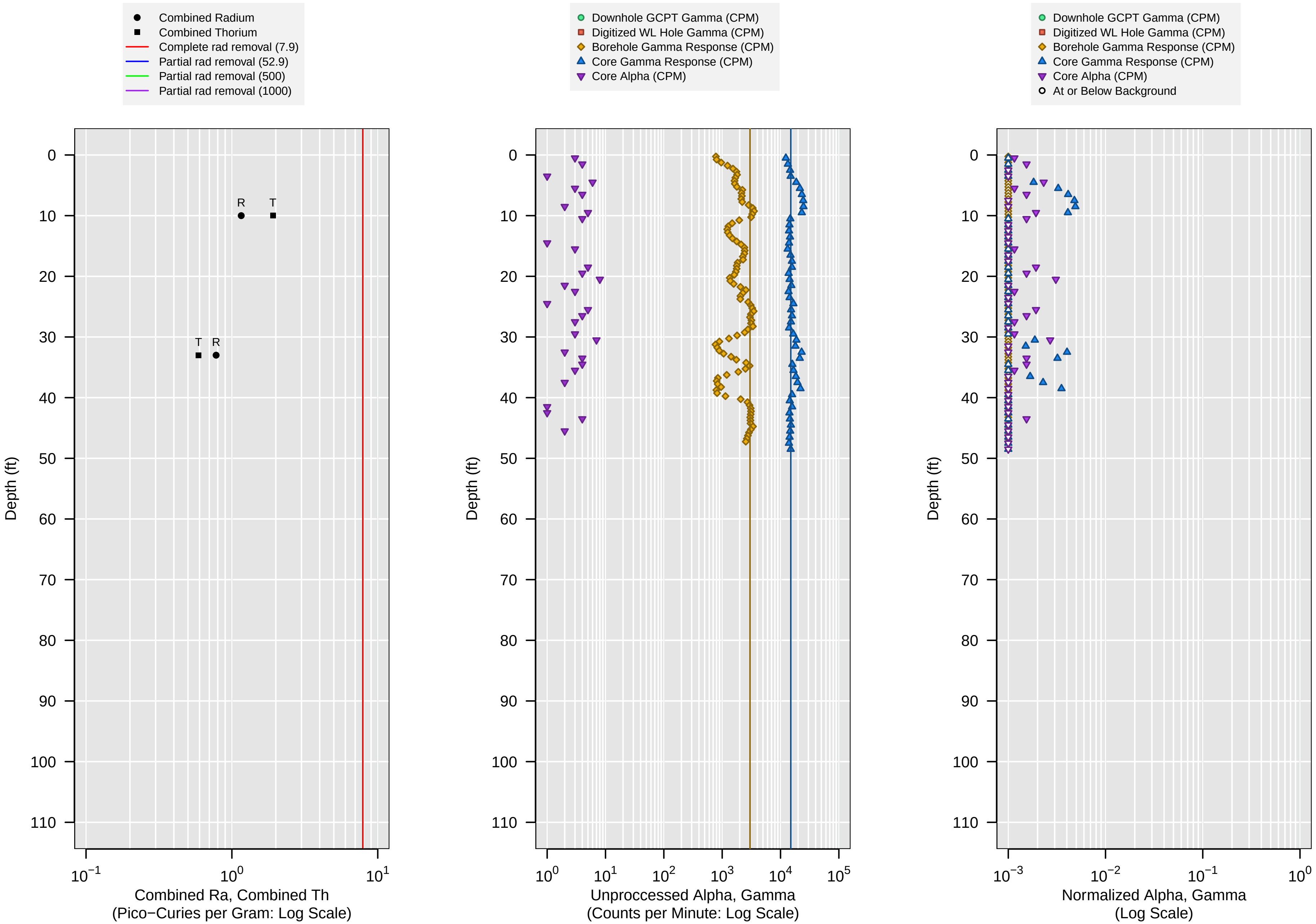
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

AC−17

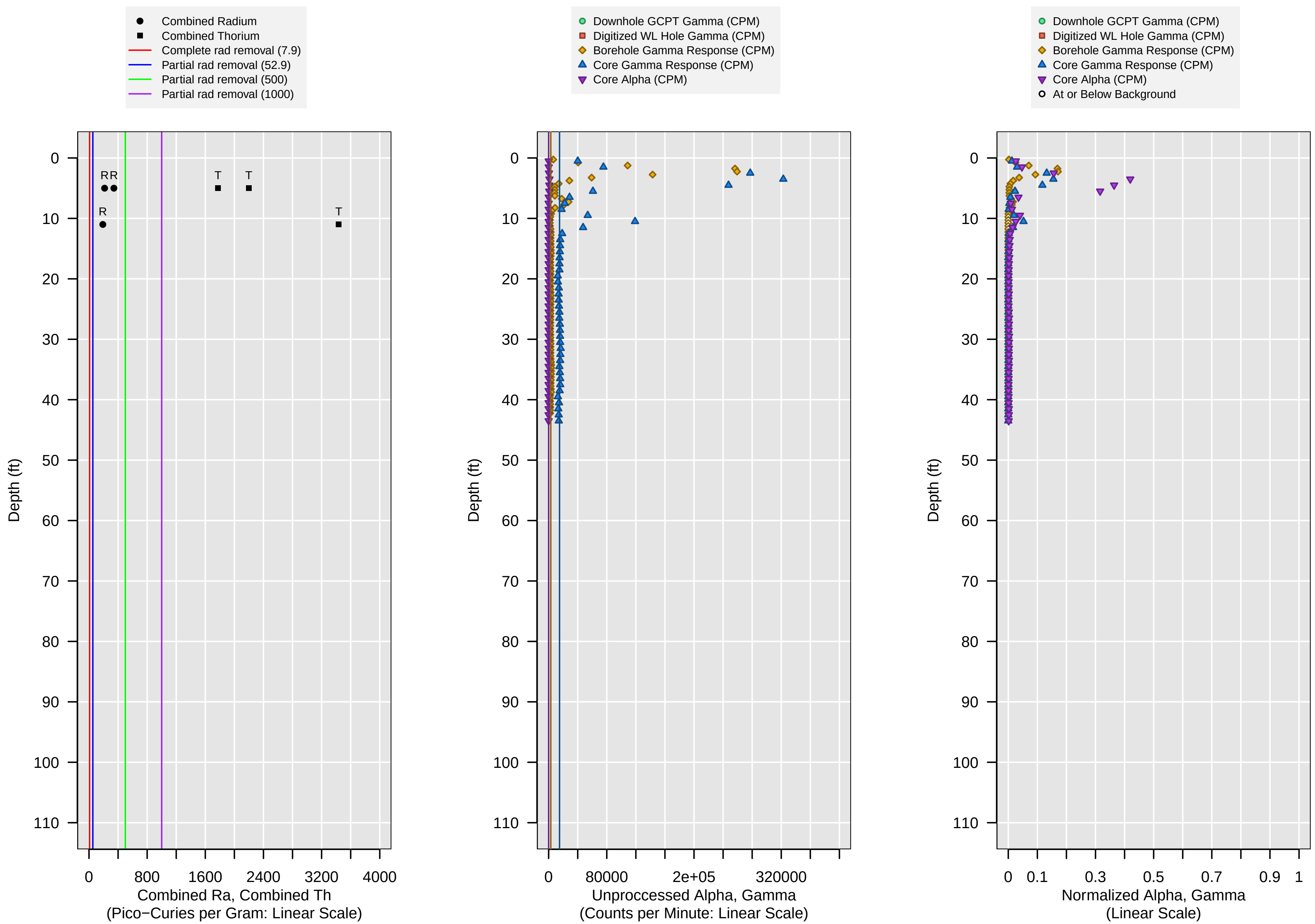


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
TR
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

AC−17

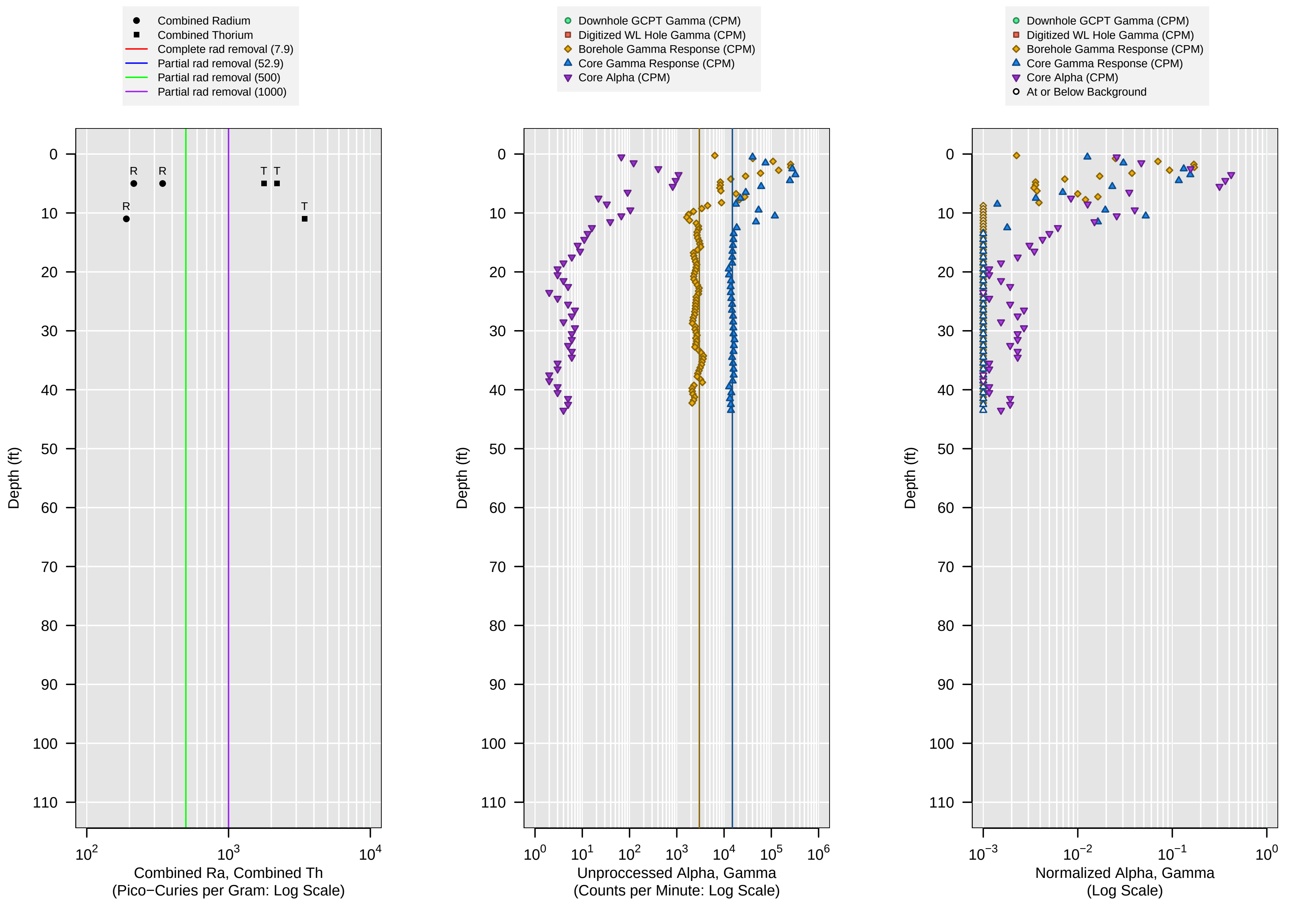

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

AC−18

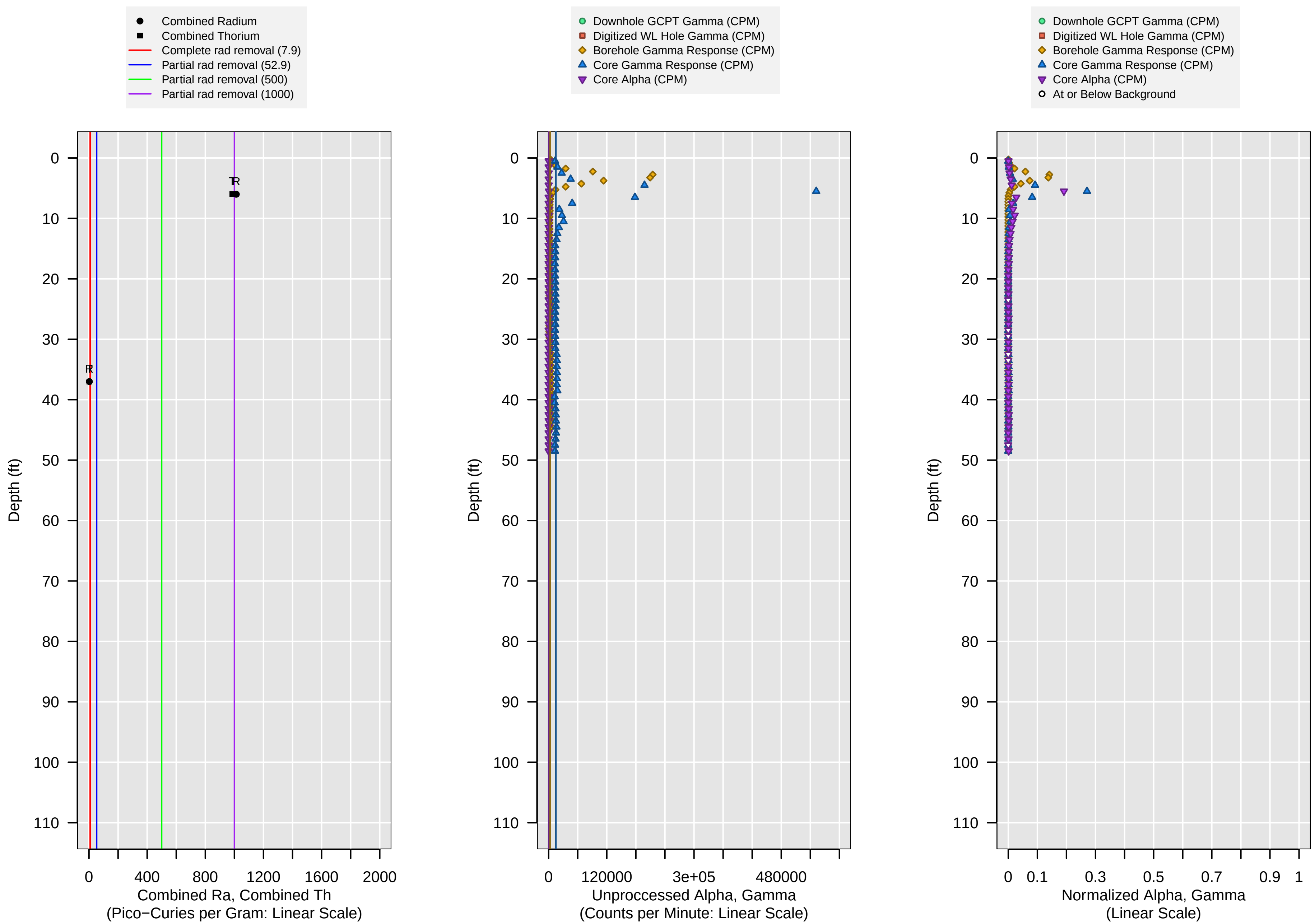


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

AC−18

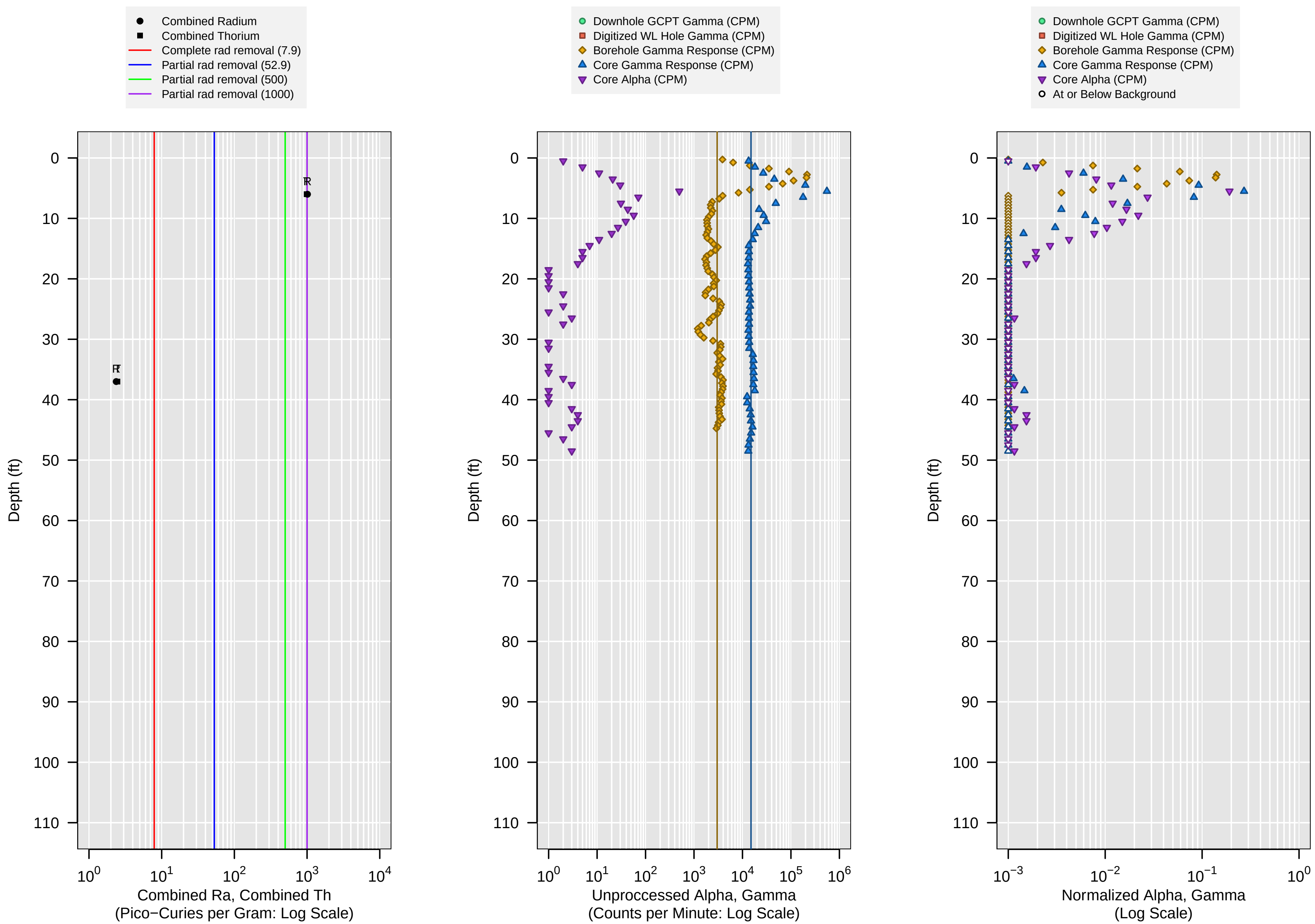

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

AC−19

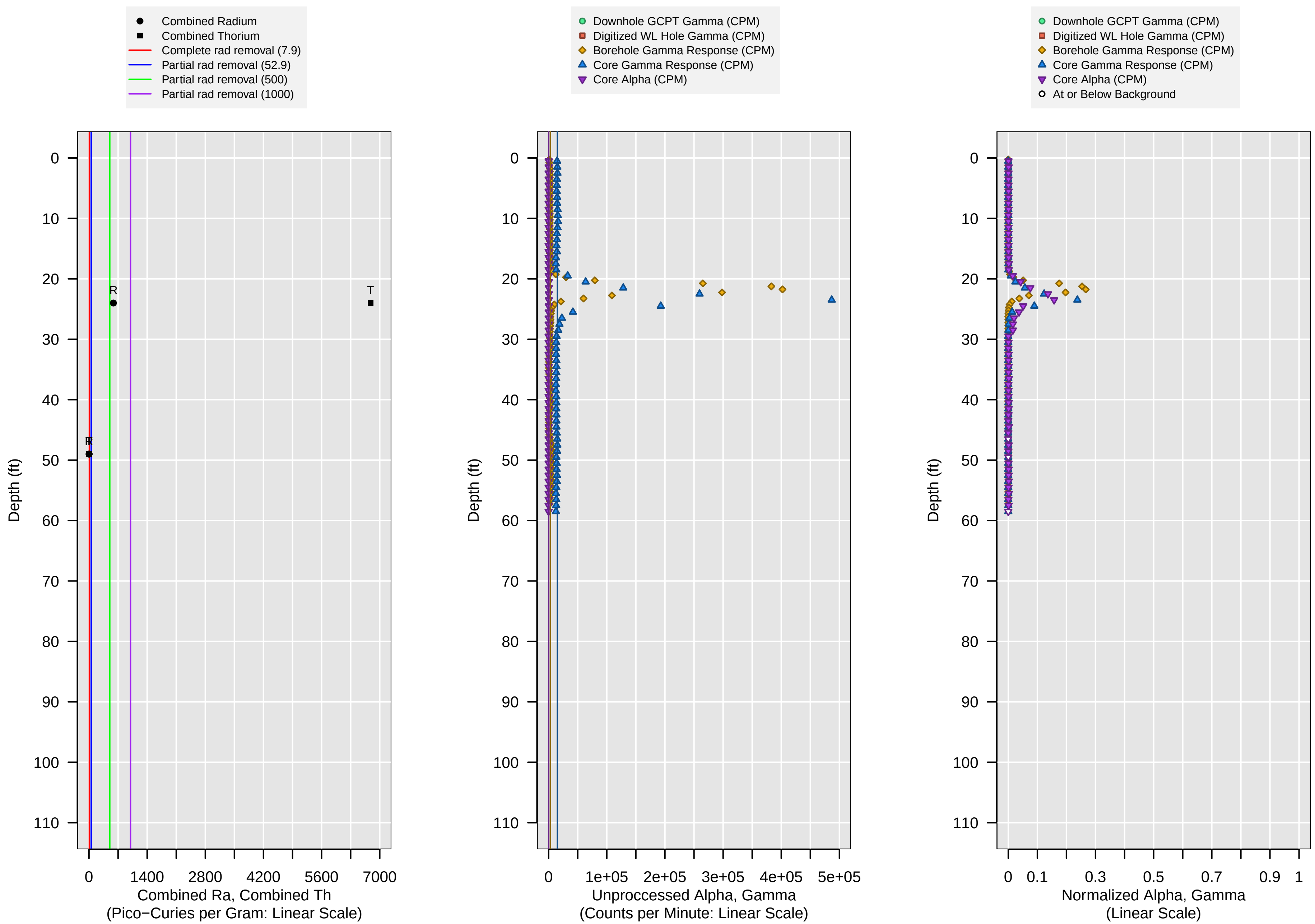


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
0 400 800 1200 1600 2000
0 10 20 30 40 50 60 70 80 90 100 110
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
0 120000 3e+05 480000
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Linear Scale)
0 0.1 0.3 0.5 0.7 0.9 1

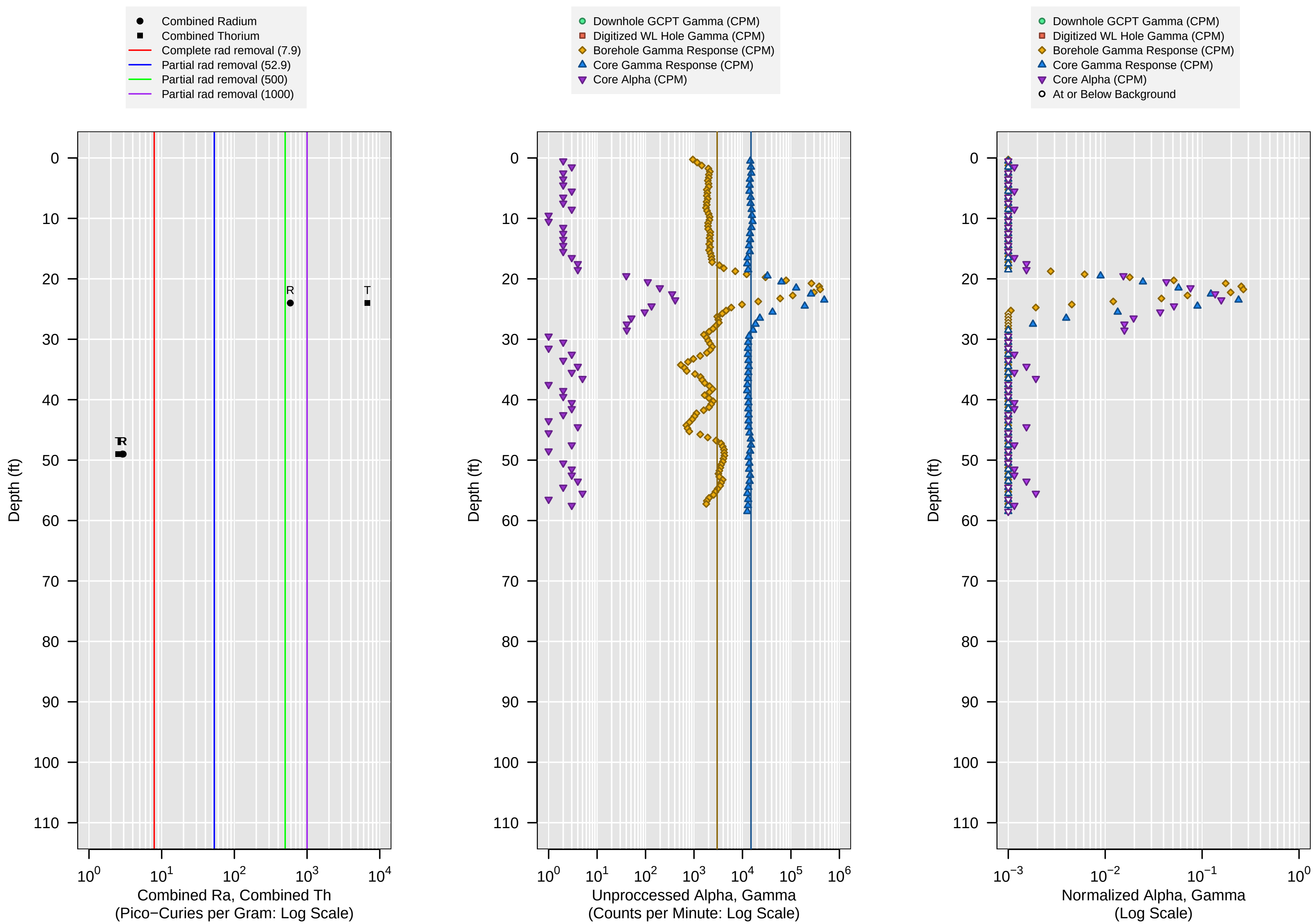
AC−19


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

AC−20

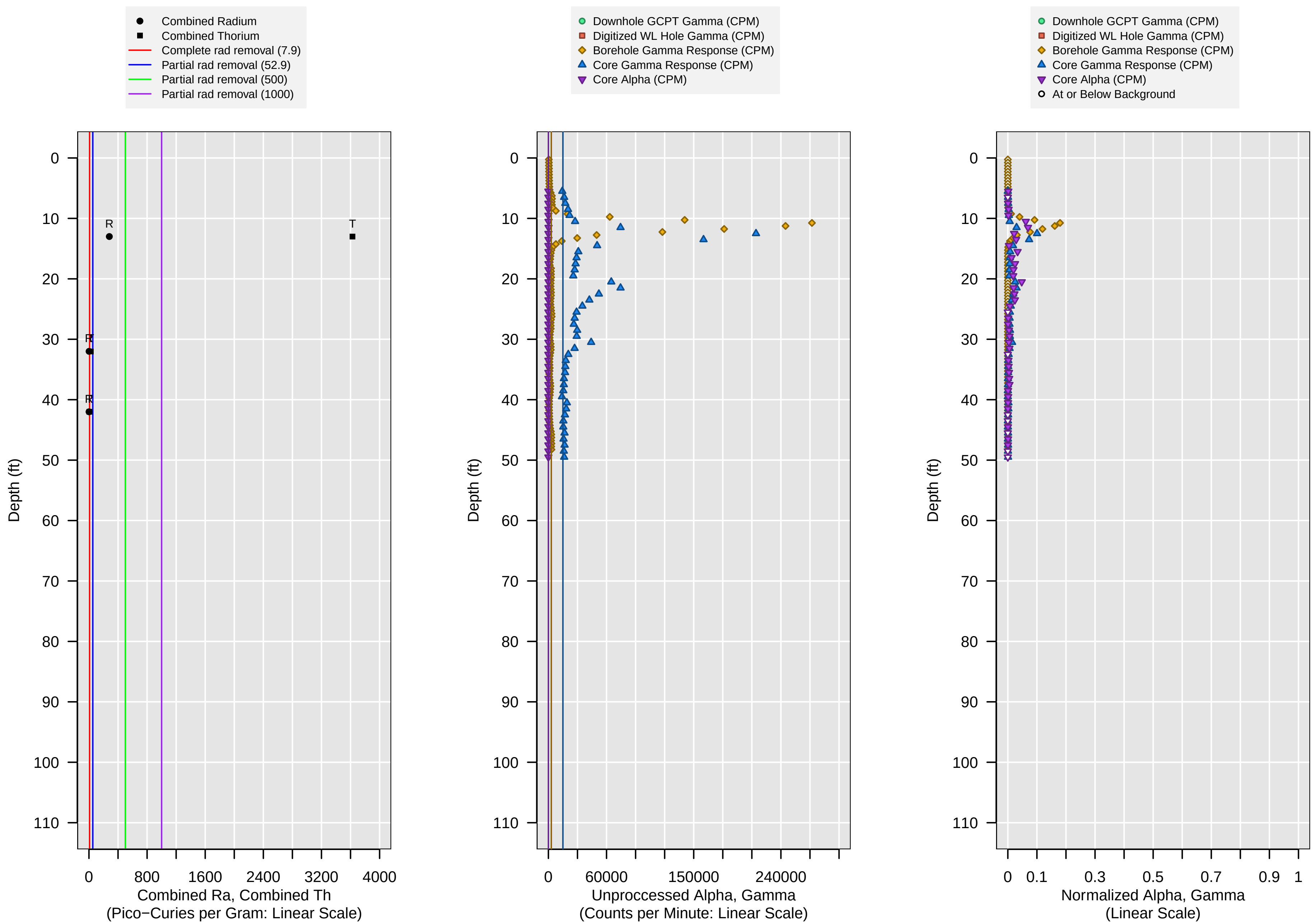

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
R
T
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

AC−20

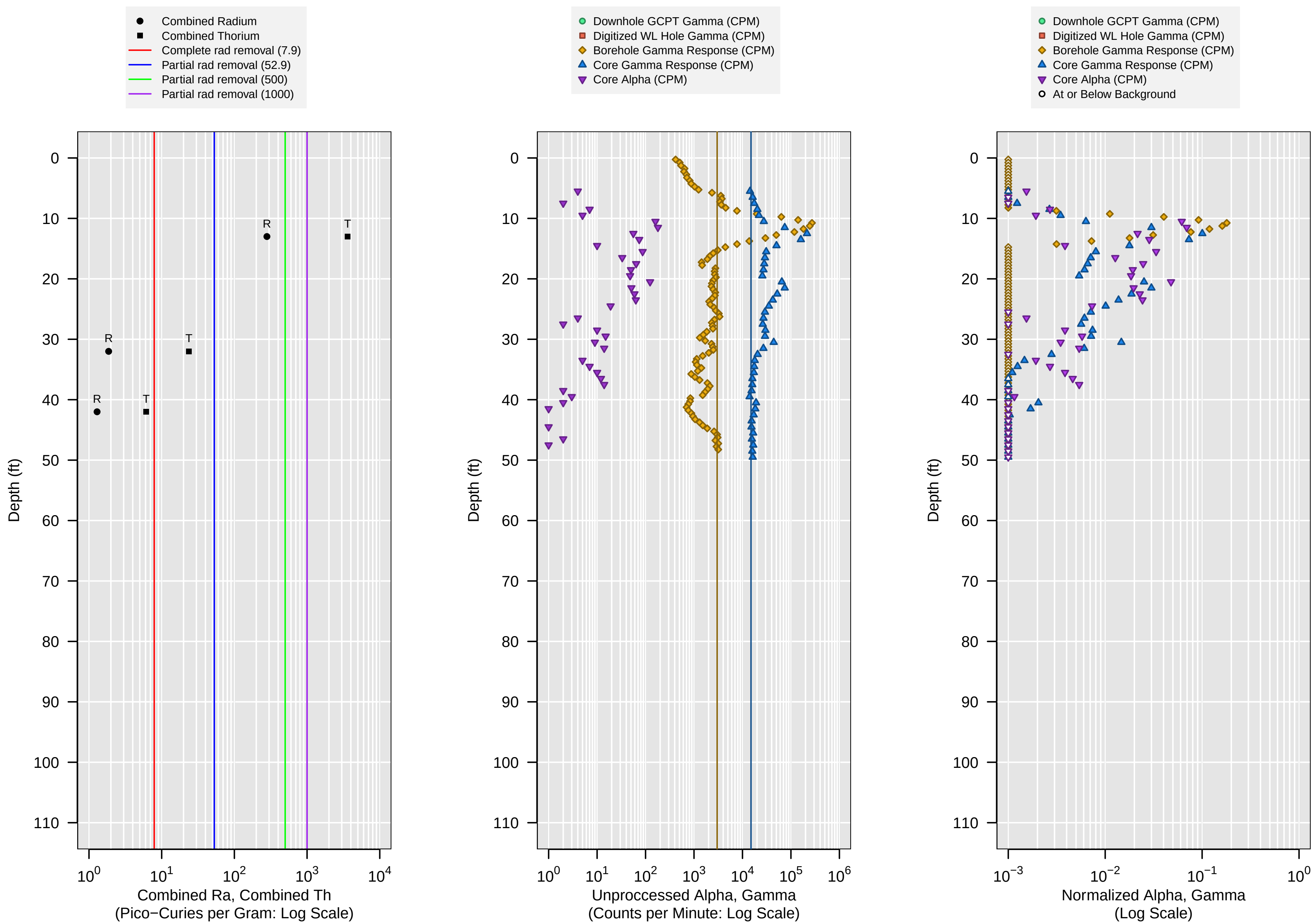


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

AC−21

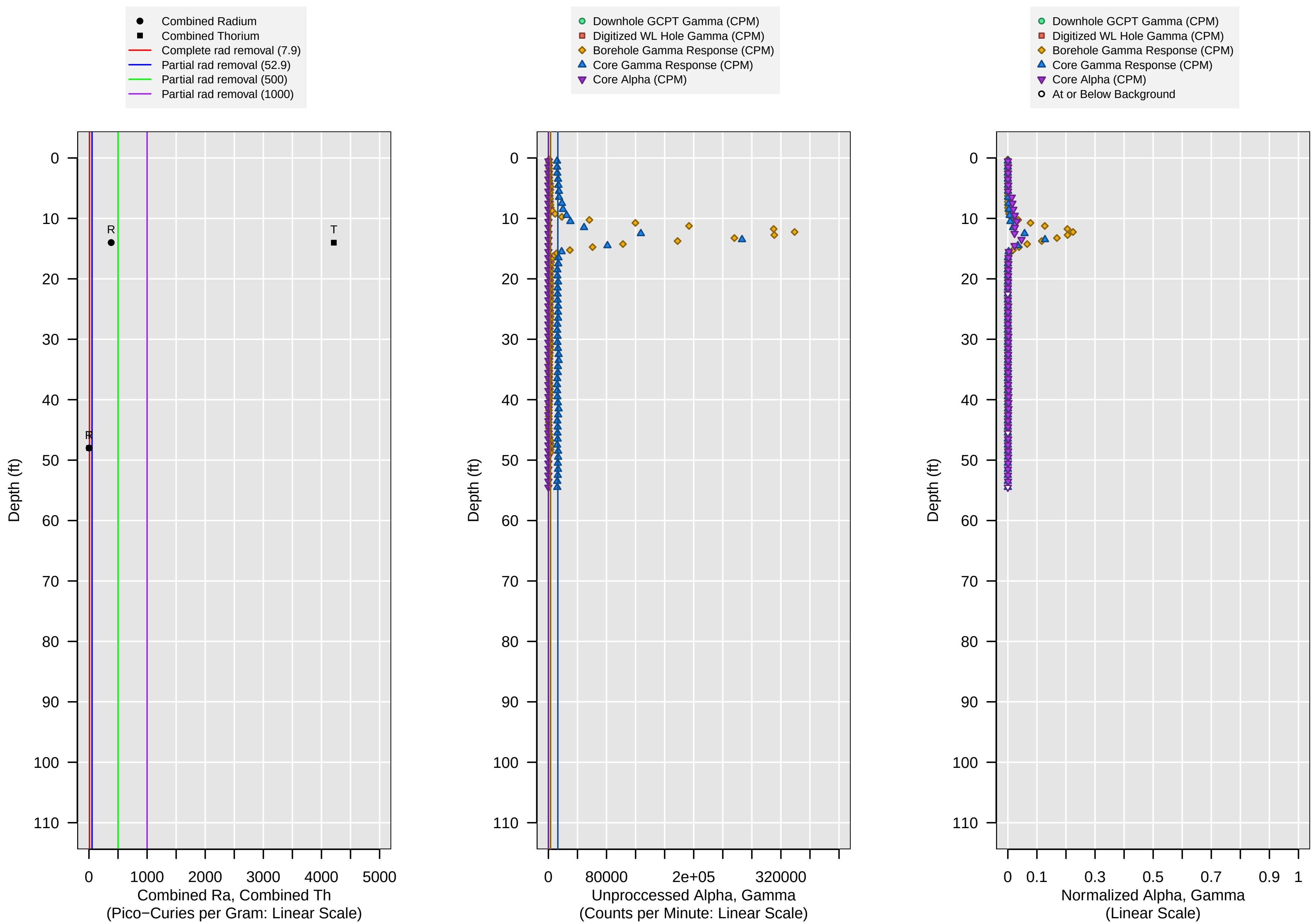

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

AC−21

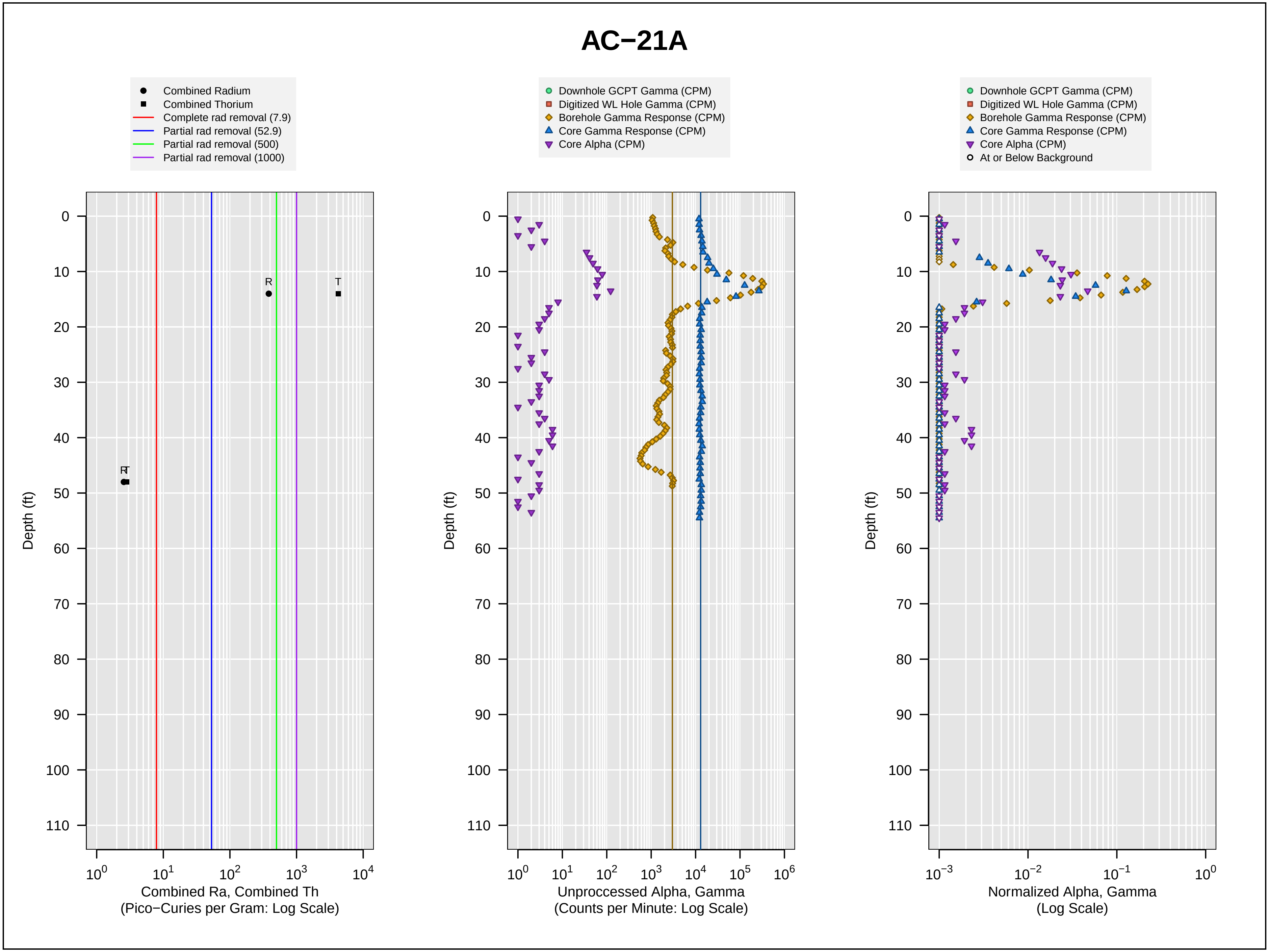


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
R
T
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

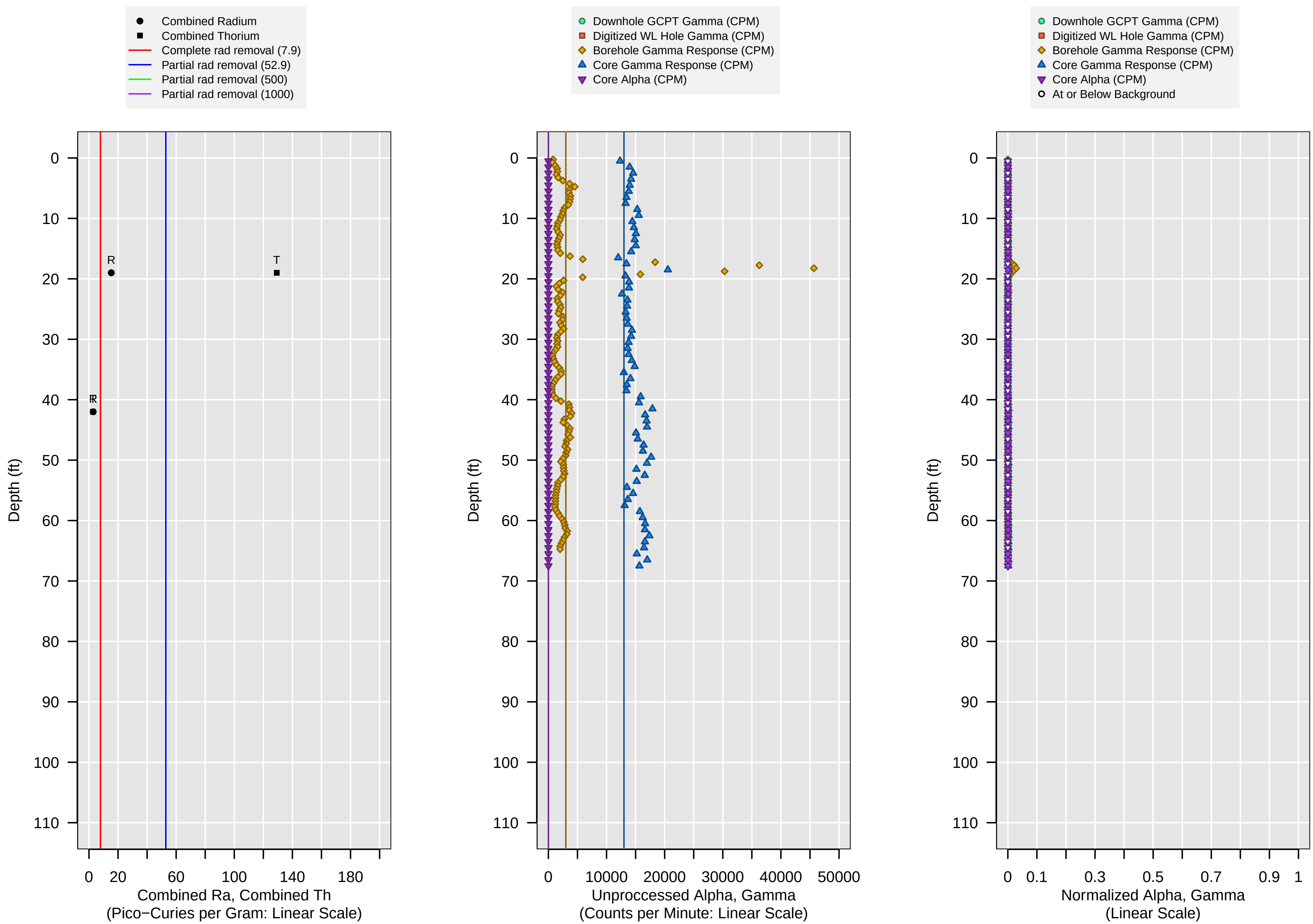
AC−21A



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
R
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
80000
2e+05
320000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

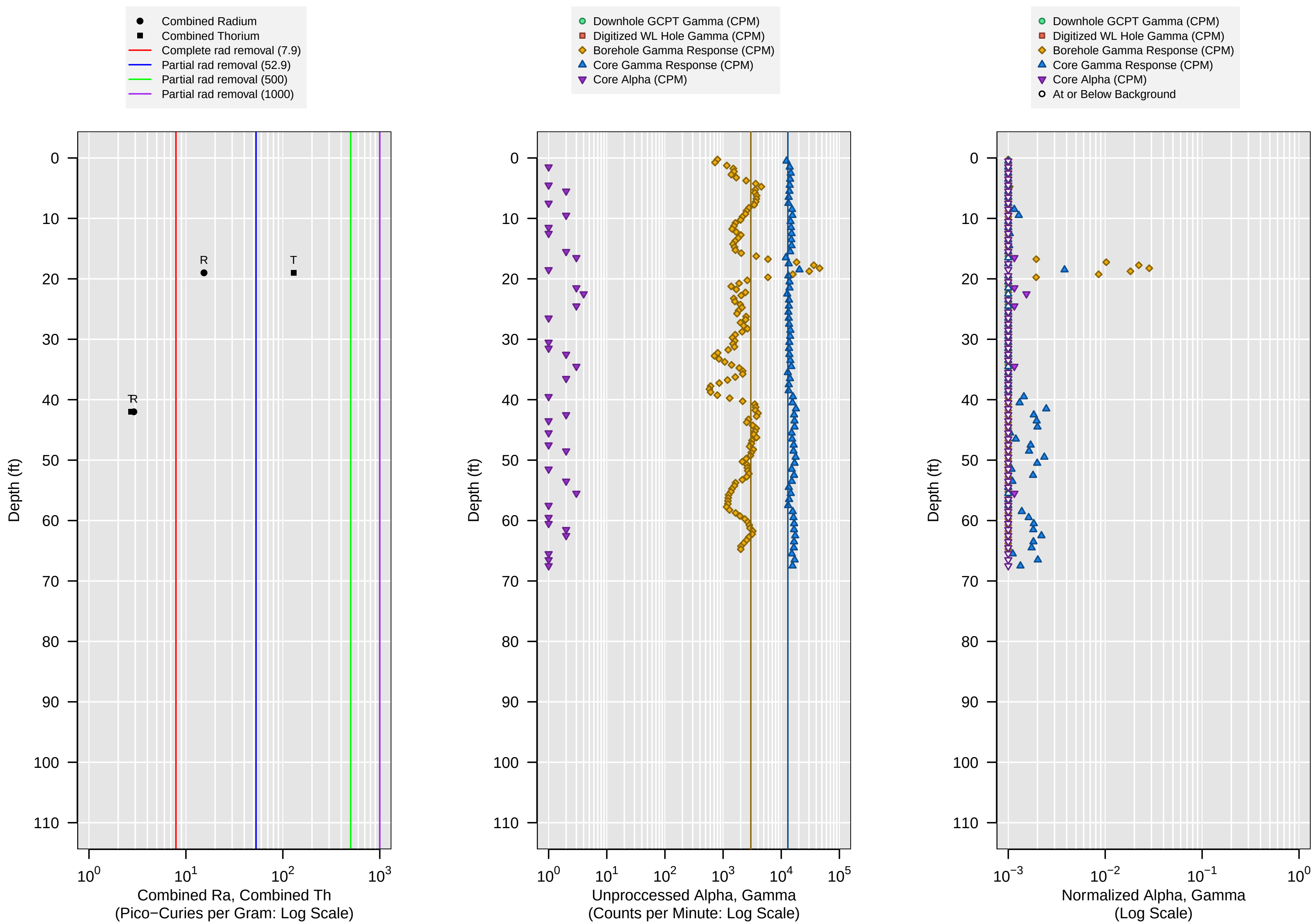

AC−21A
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

AC−22



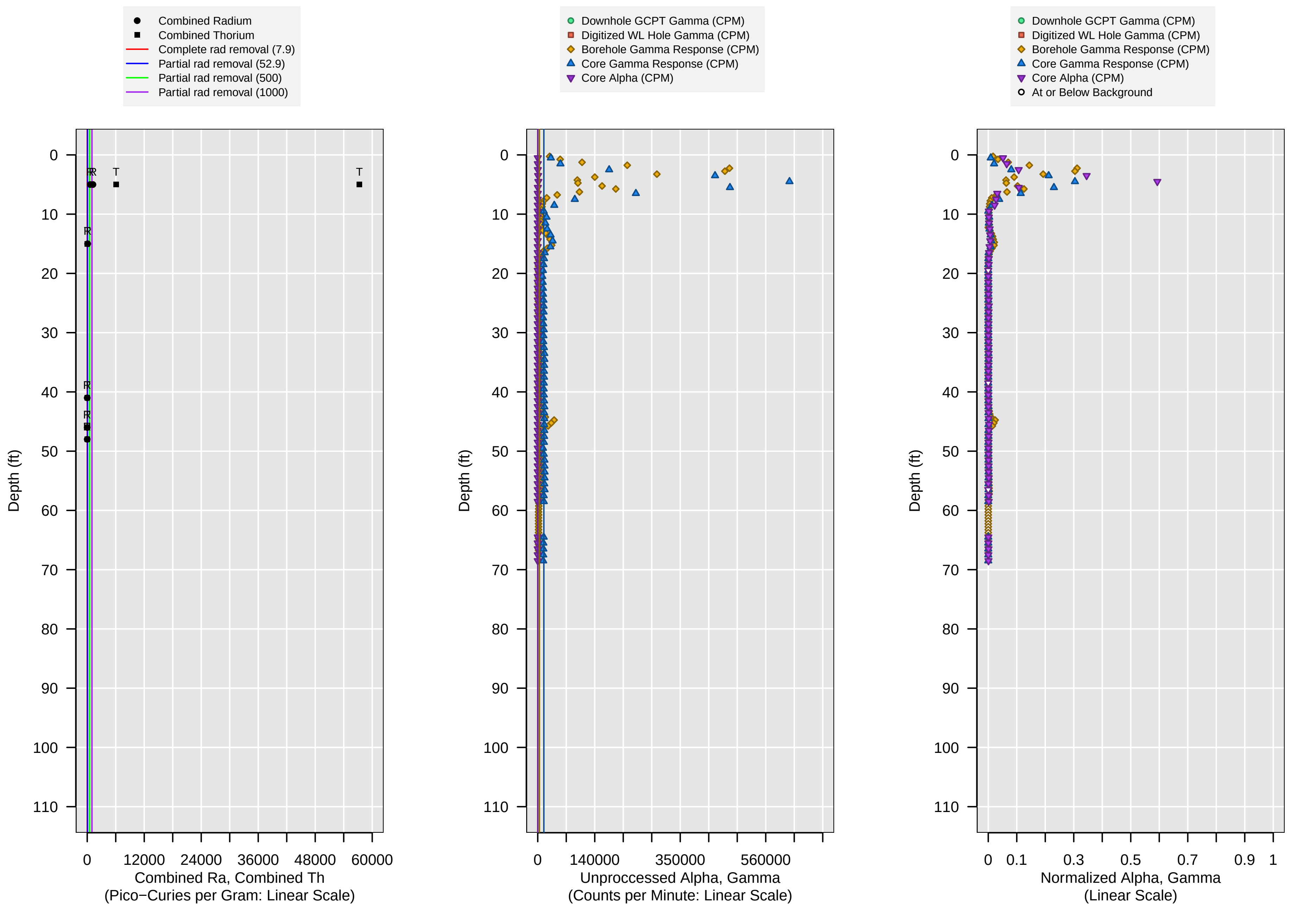
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

AC−22

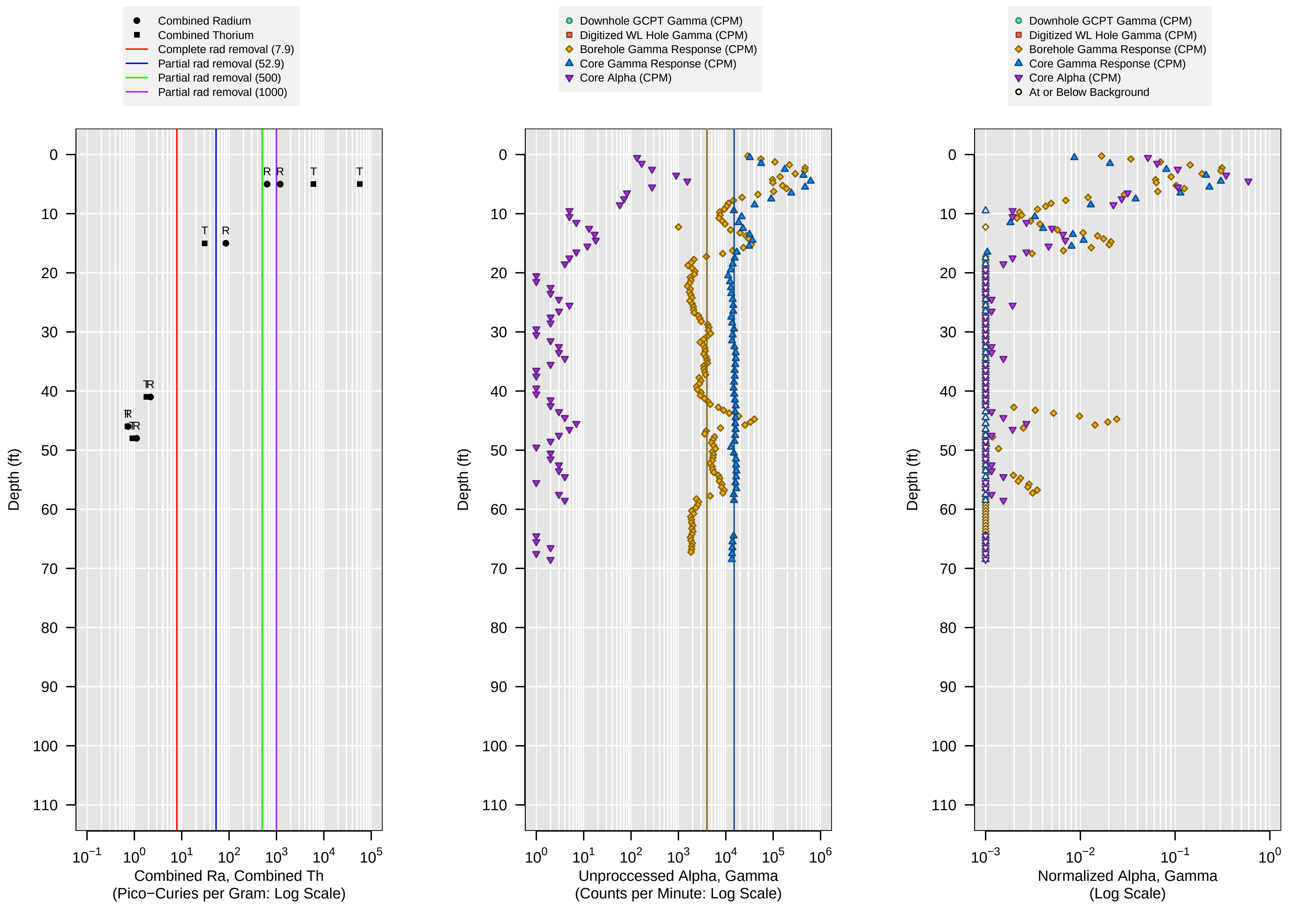


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
R
T
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

AC−24


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

AC−24



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

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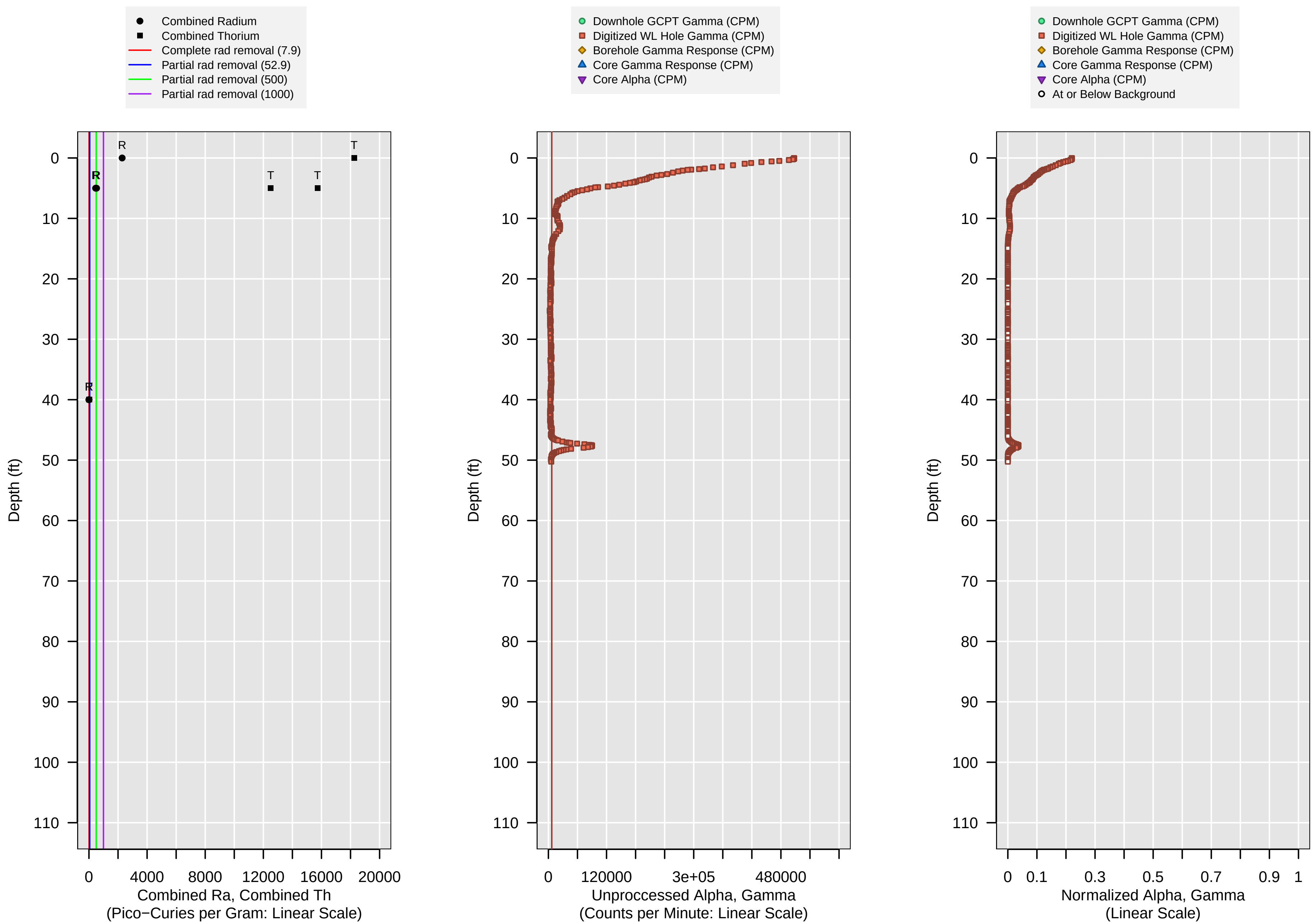
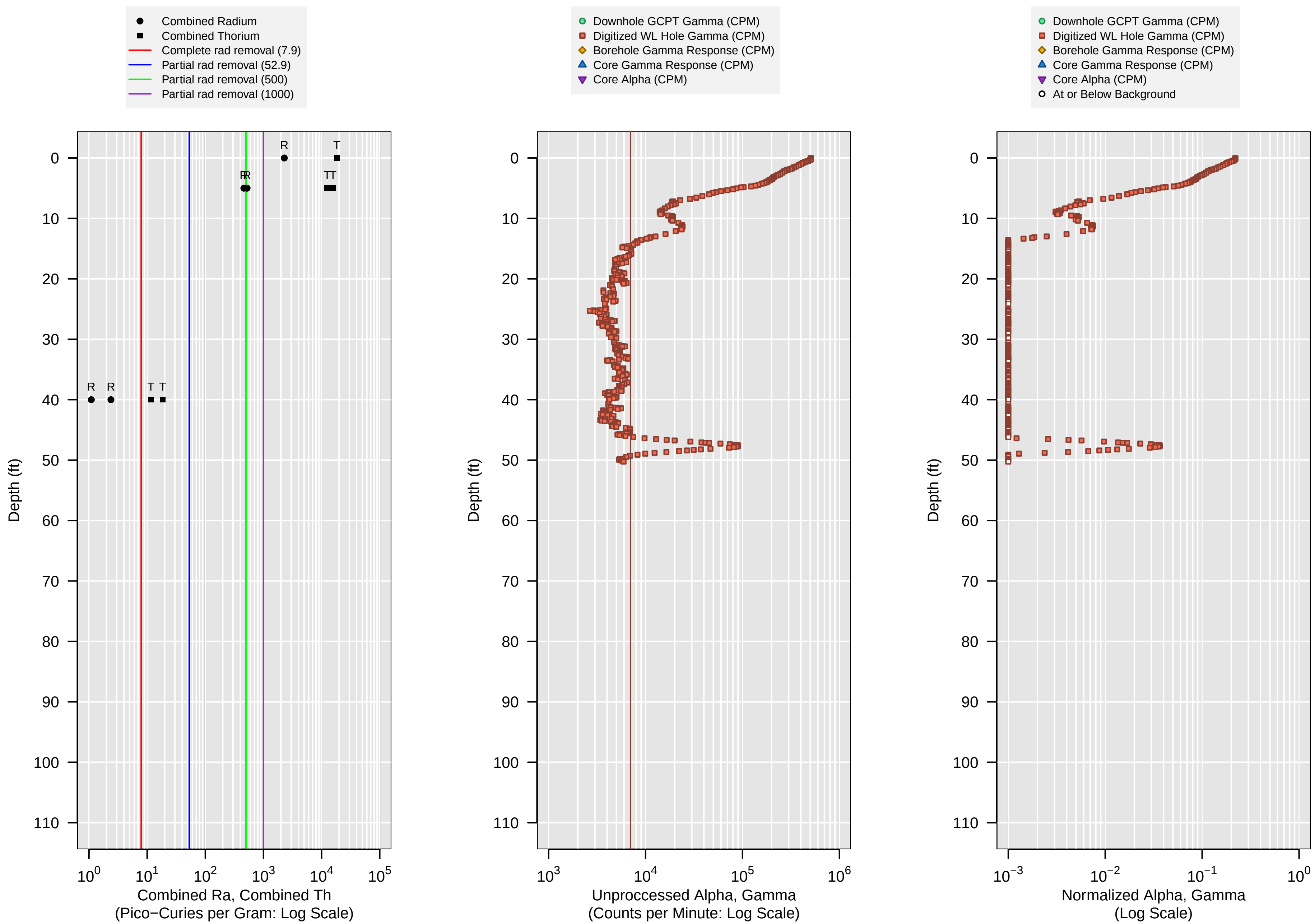
WL−210−MH

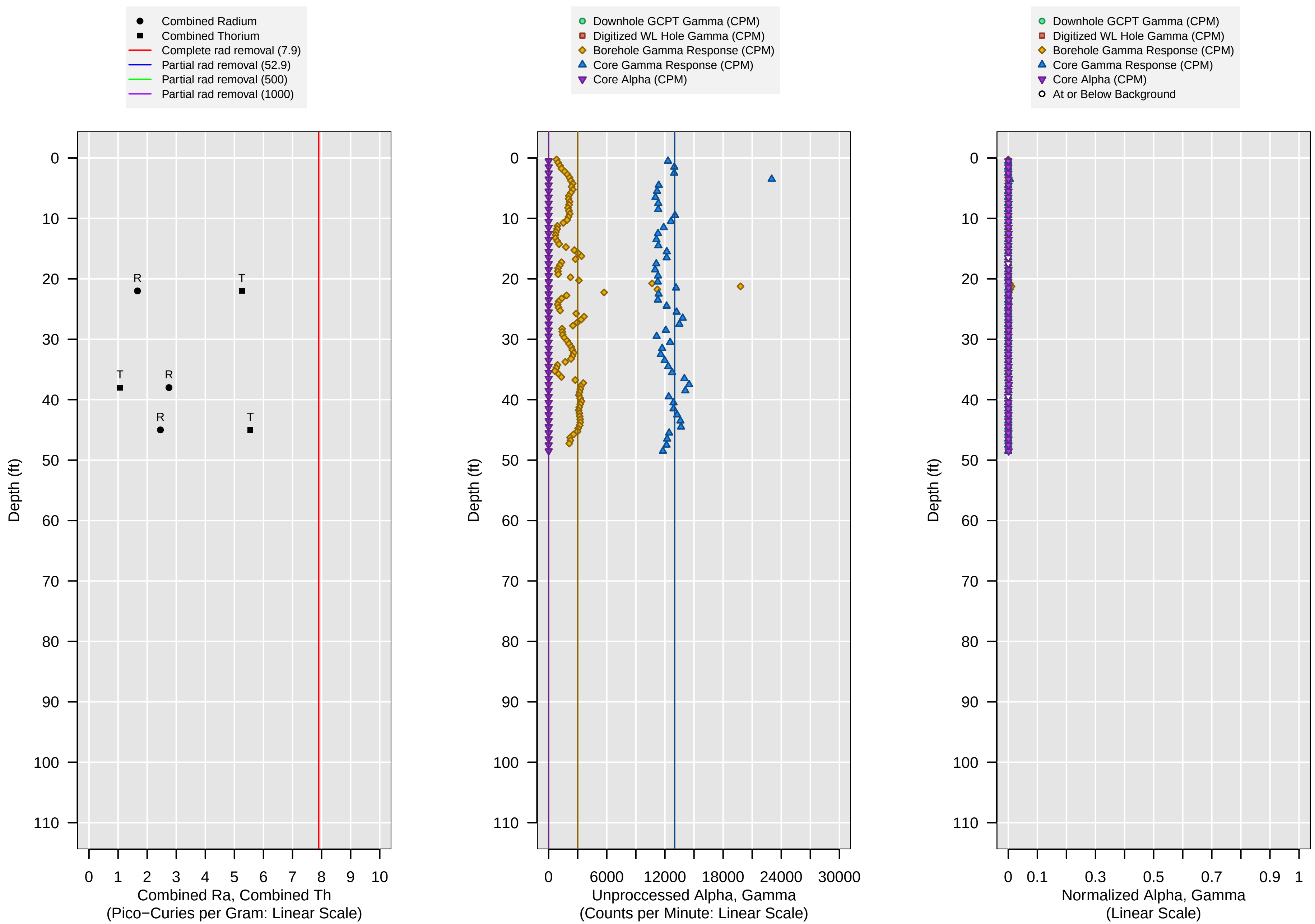


WL−210−MH



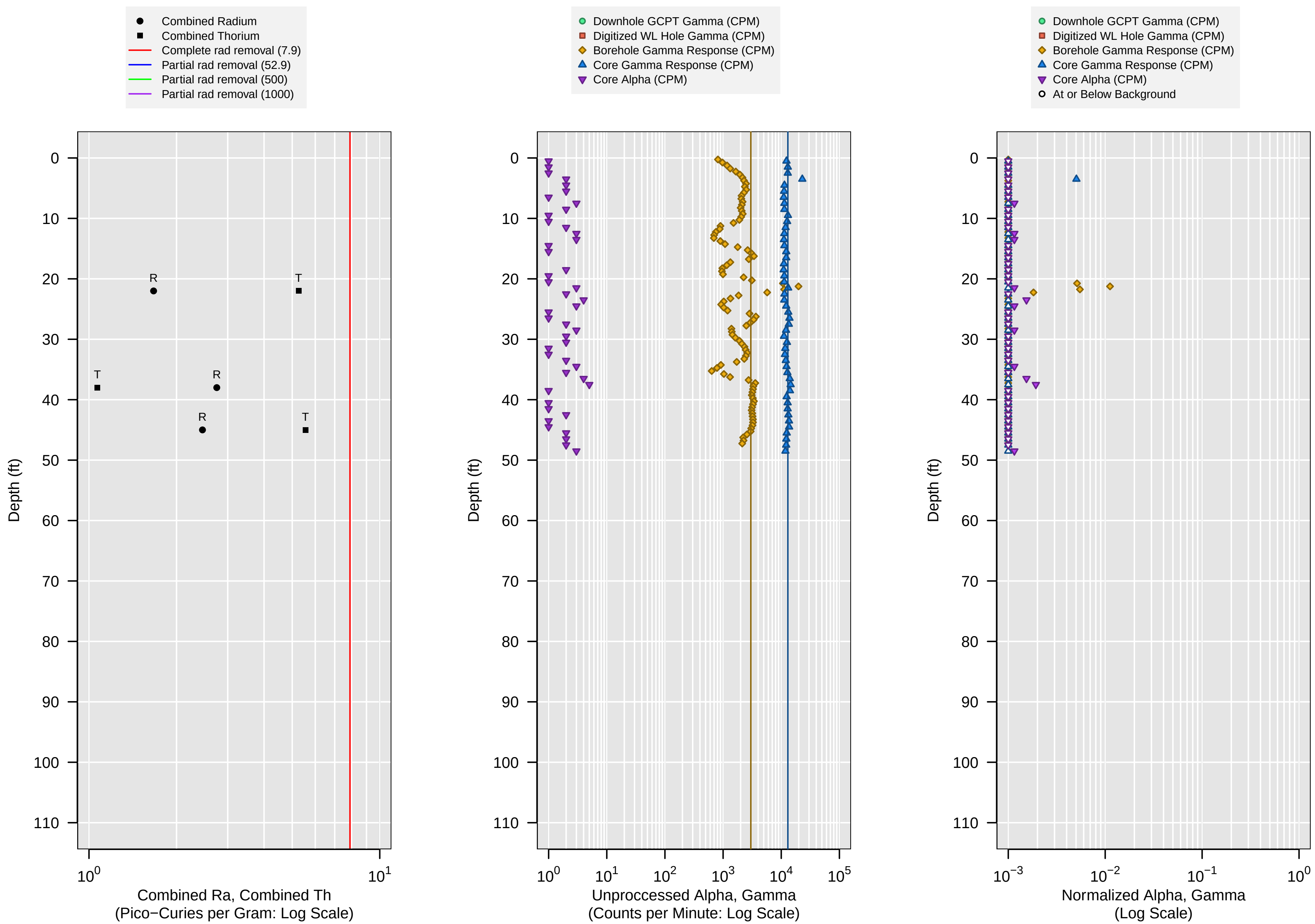
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

AC−25

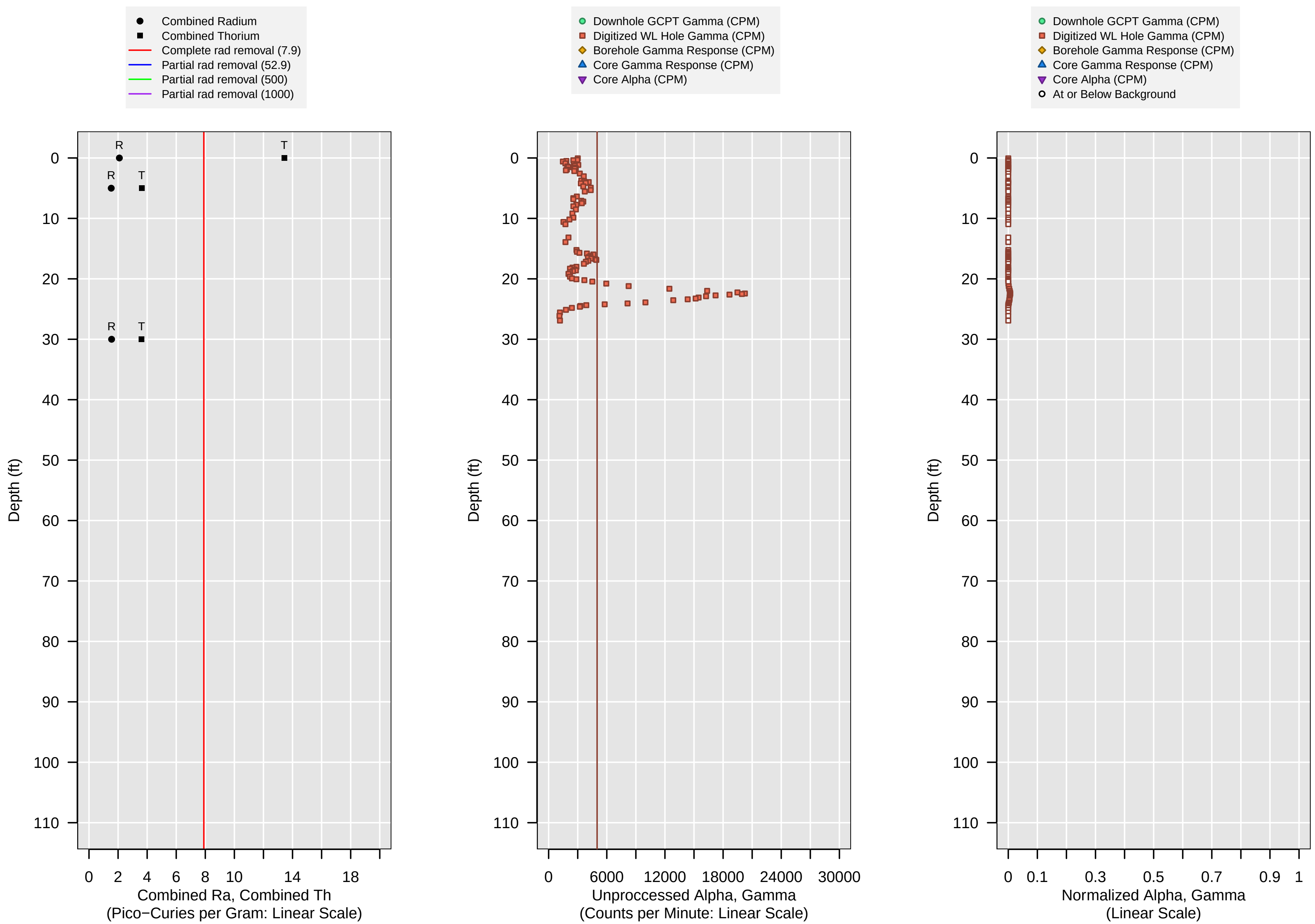


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

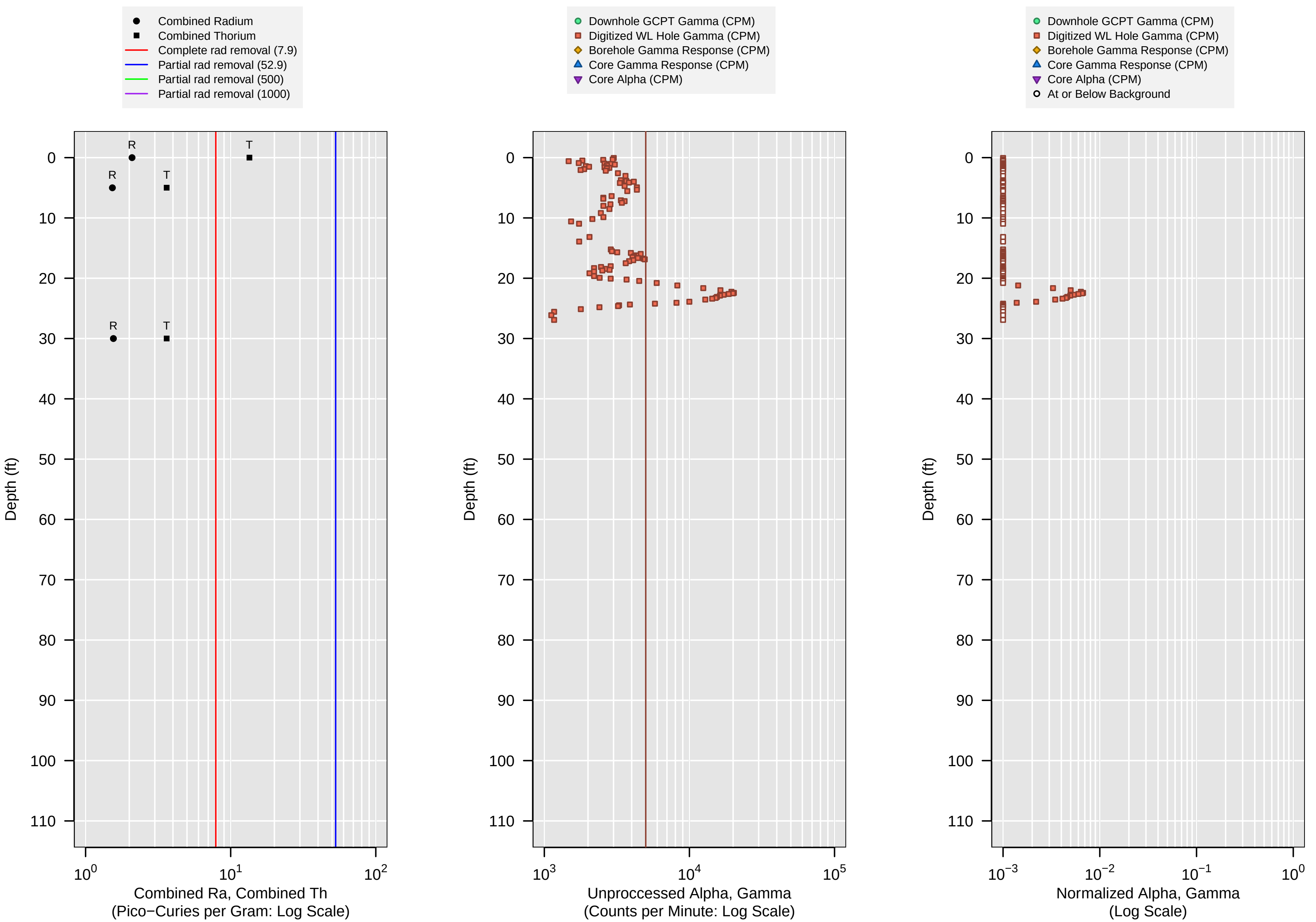
AC−25


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−235−MH

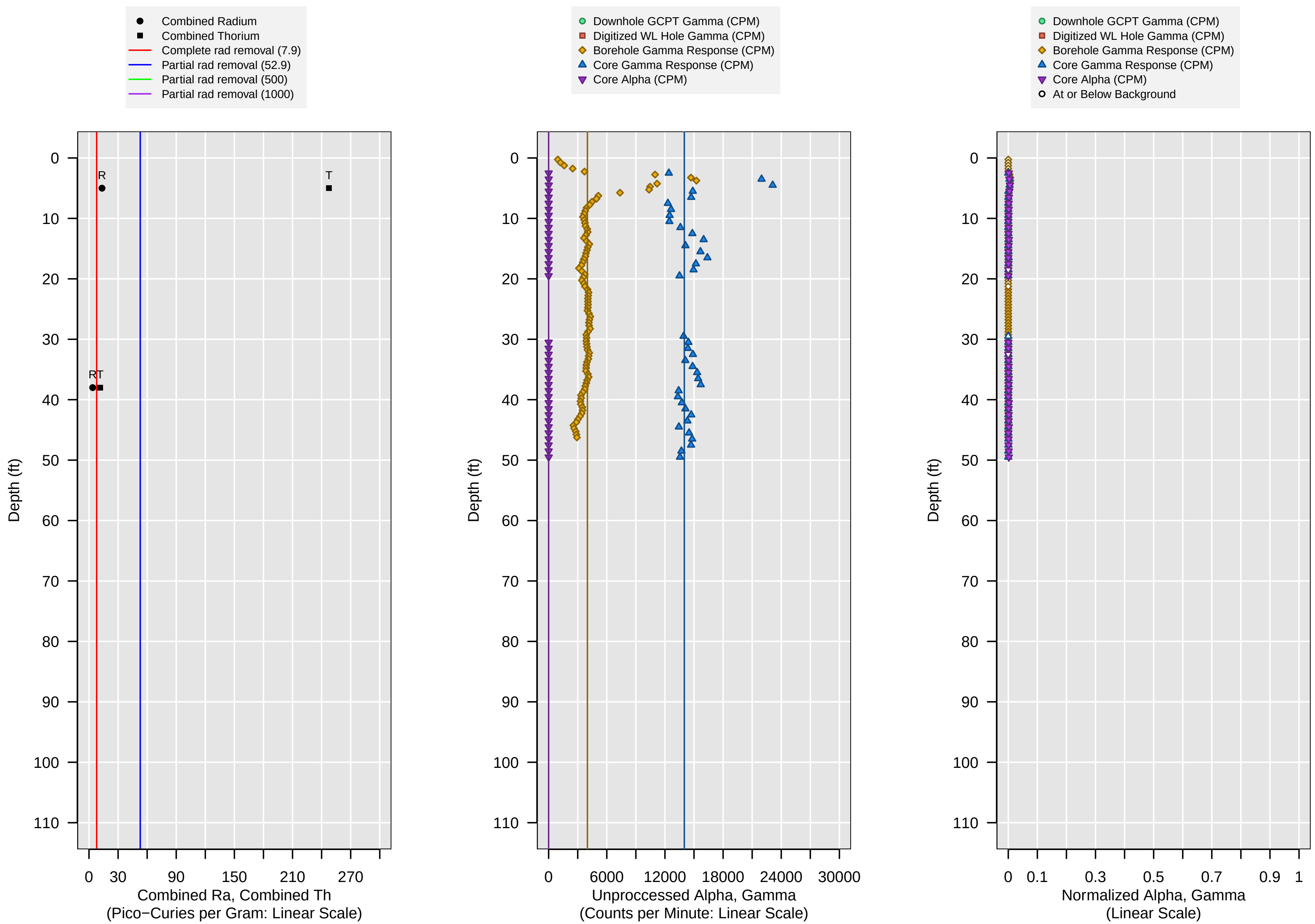

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
0 10 20 30 40 50 60 70 80 90 100 110
0 2 4 6 8 10 14 18
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0 6000 12000 18000 24000 30000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

WL−235−MH

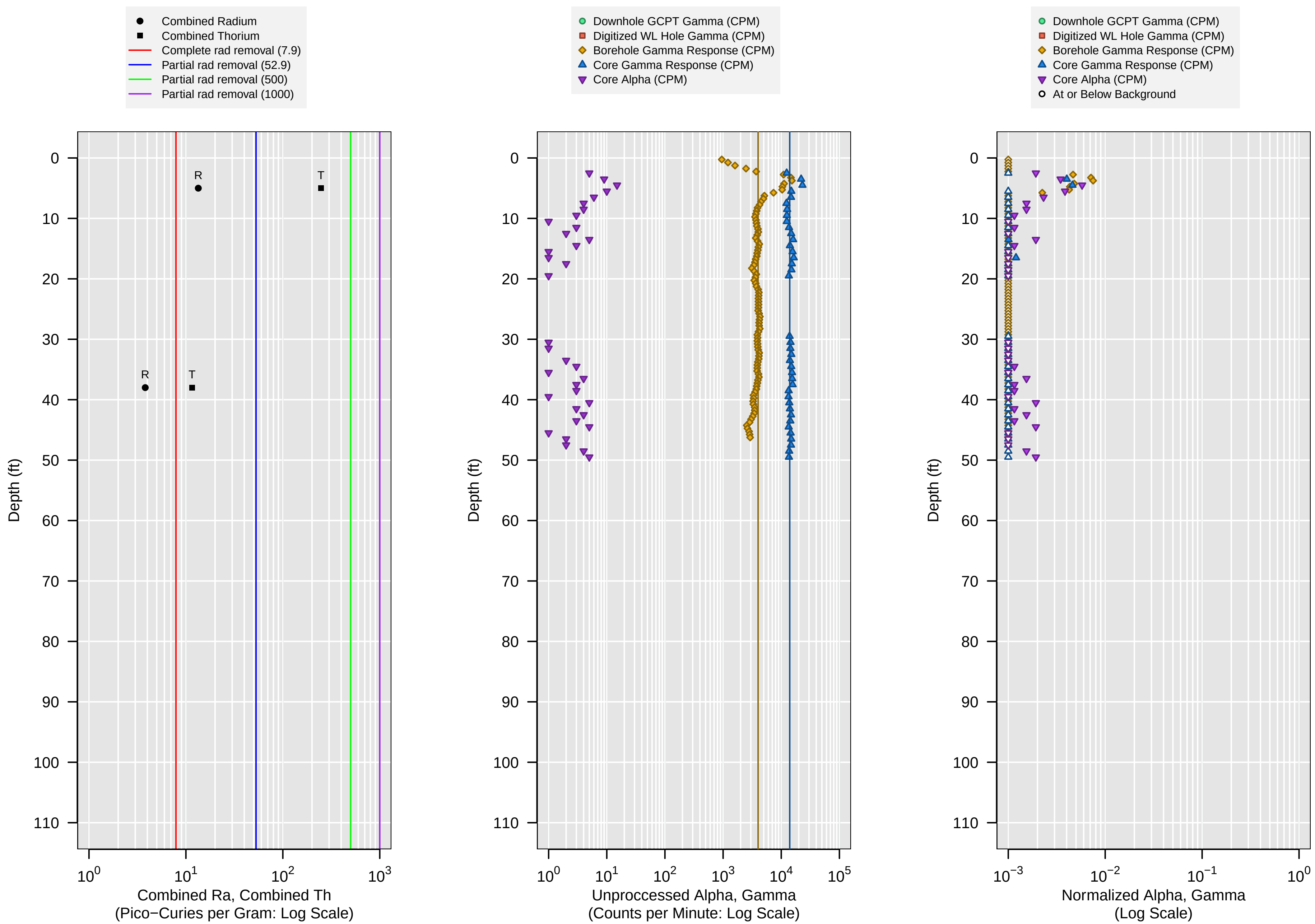


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

AC−26A

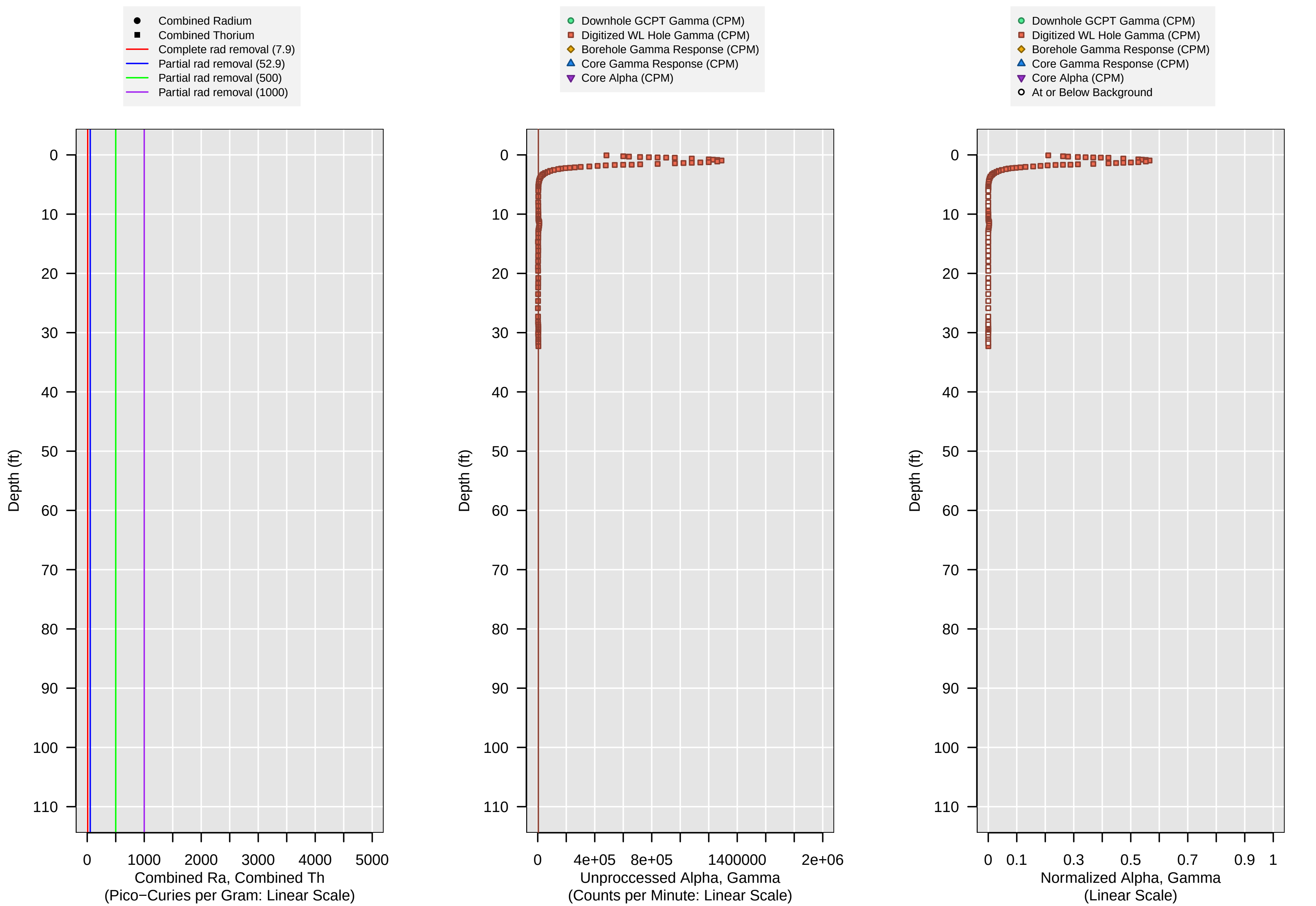

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
RT
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

AC−26A

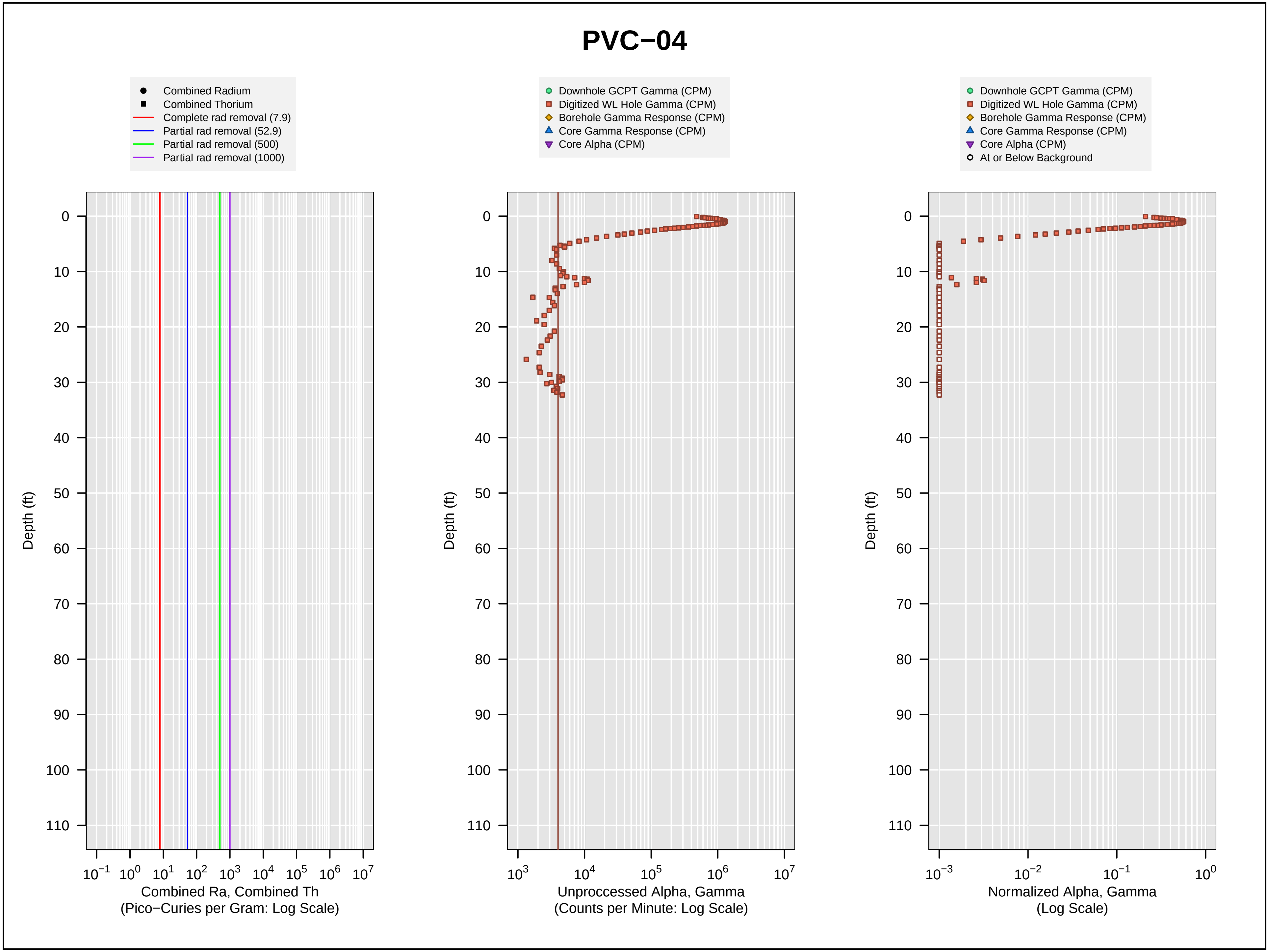


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
R
T
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

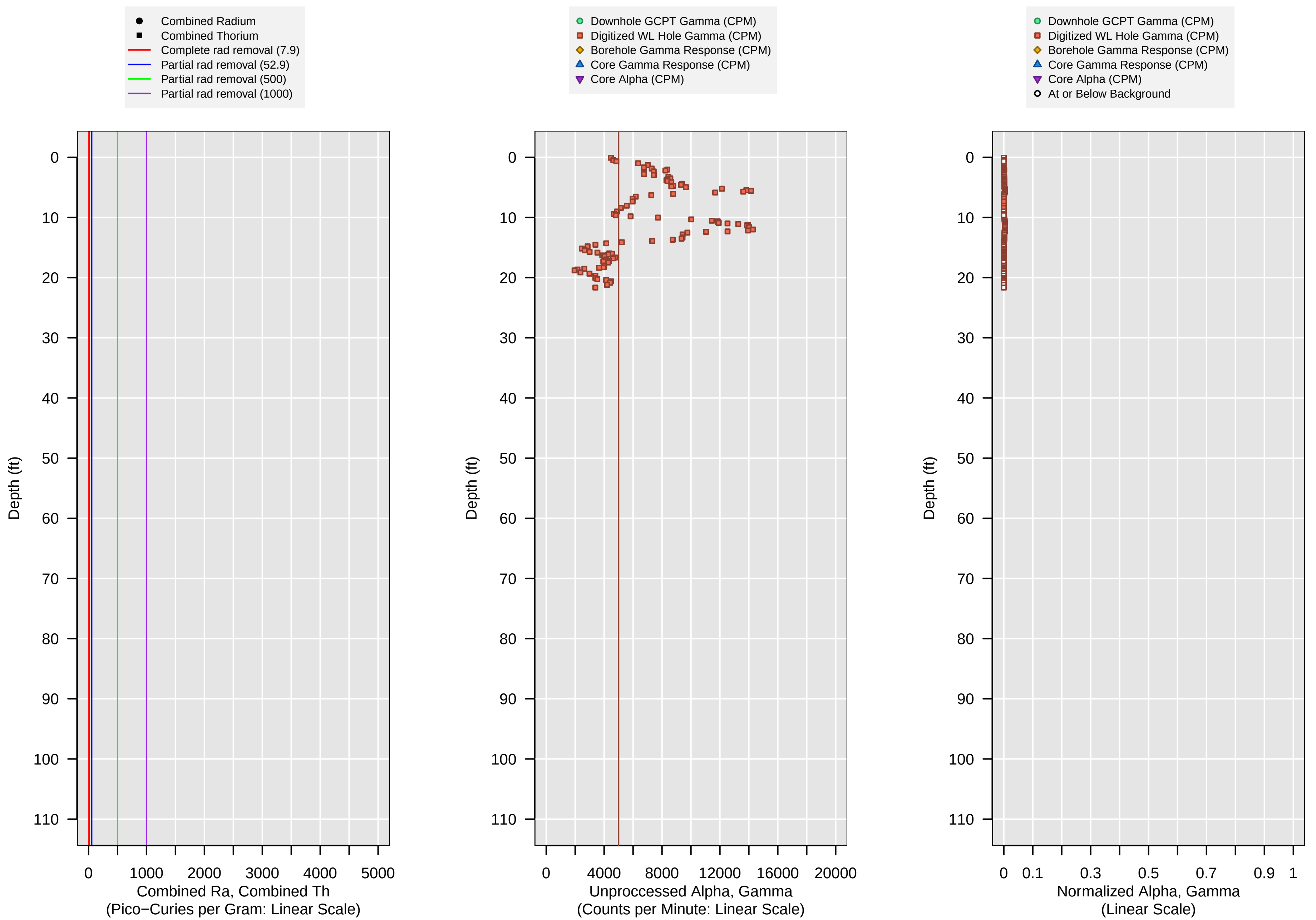
PVC−04



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
4e+05
8e+05
1400000
2e+06
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)


PVC−04
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

PVC−05



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0 1000 2000 3000 4000 5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0 4000 8000 12000 16000 20000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)
0 10 20 30 40 50 60 70 80 90 100 110

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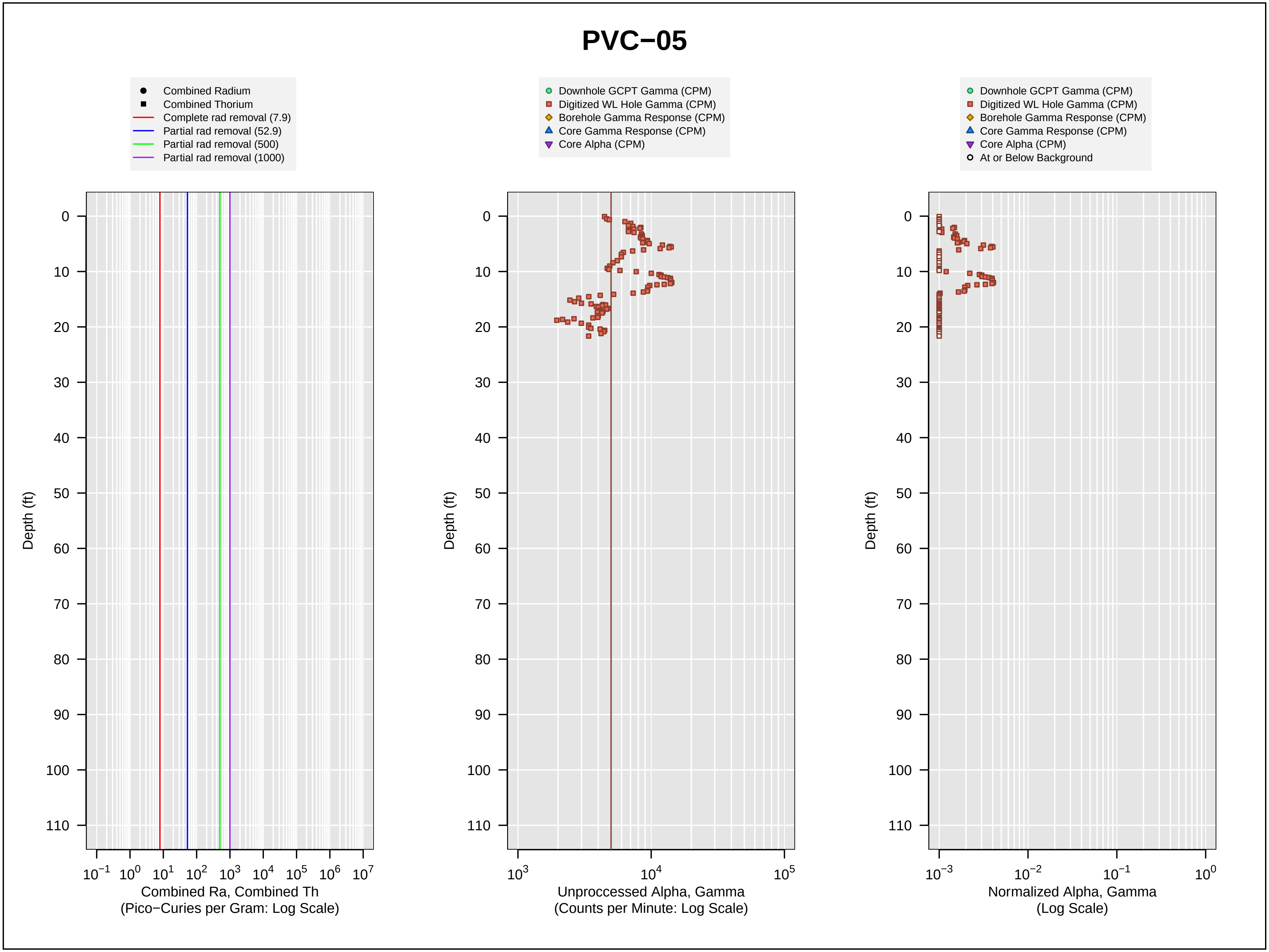
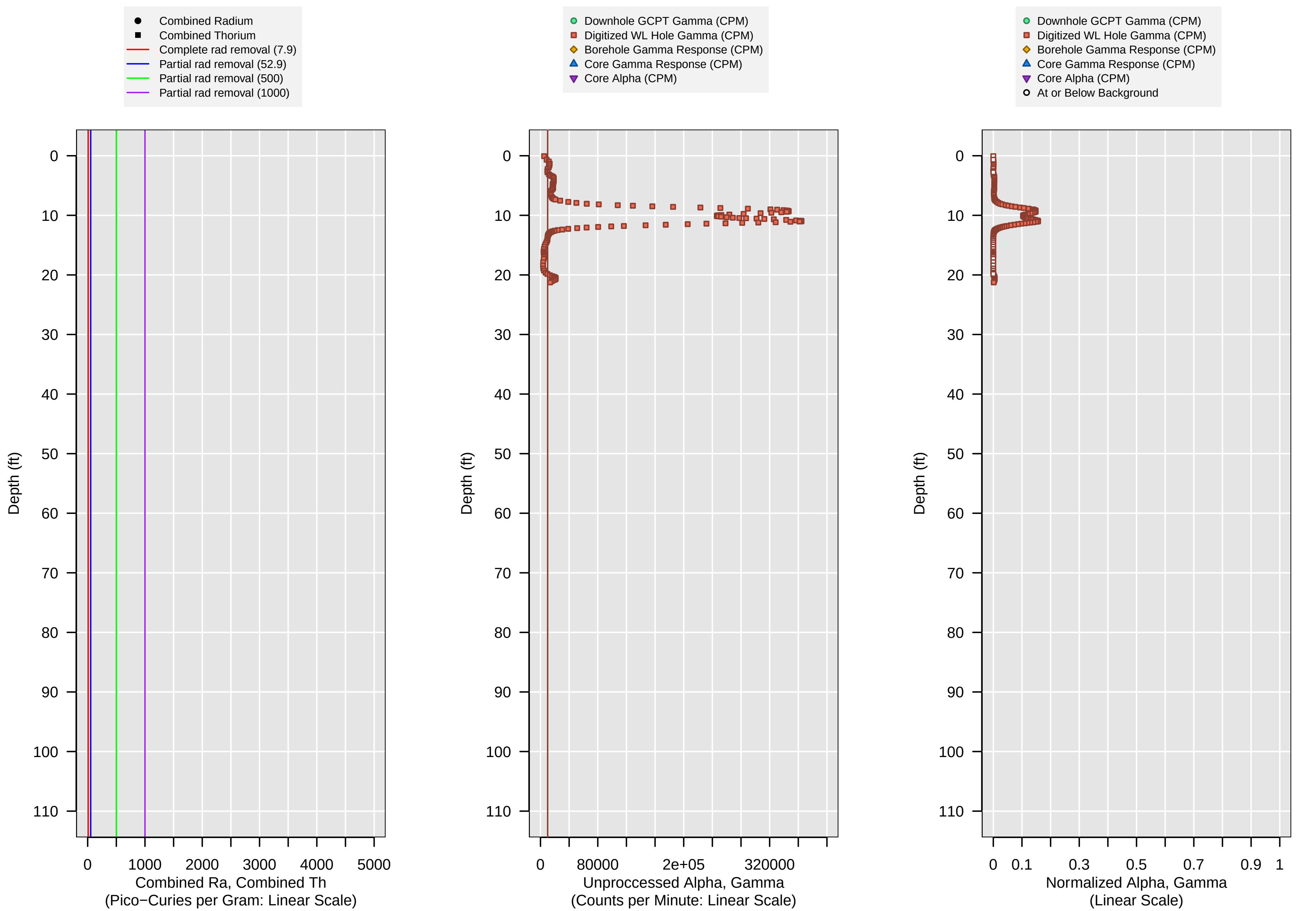
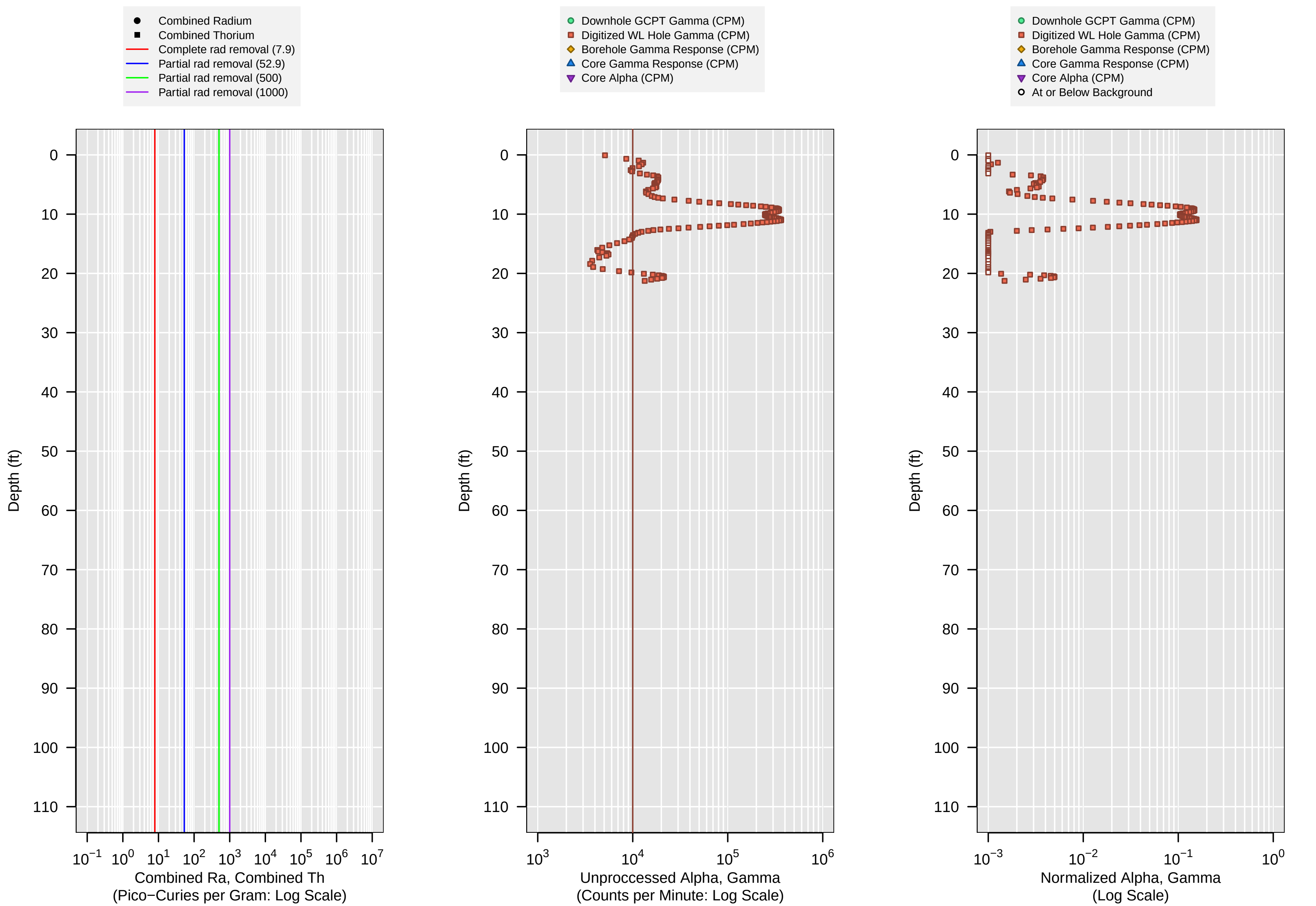


PVC−06

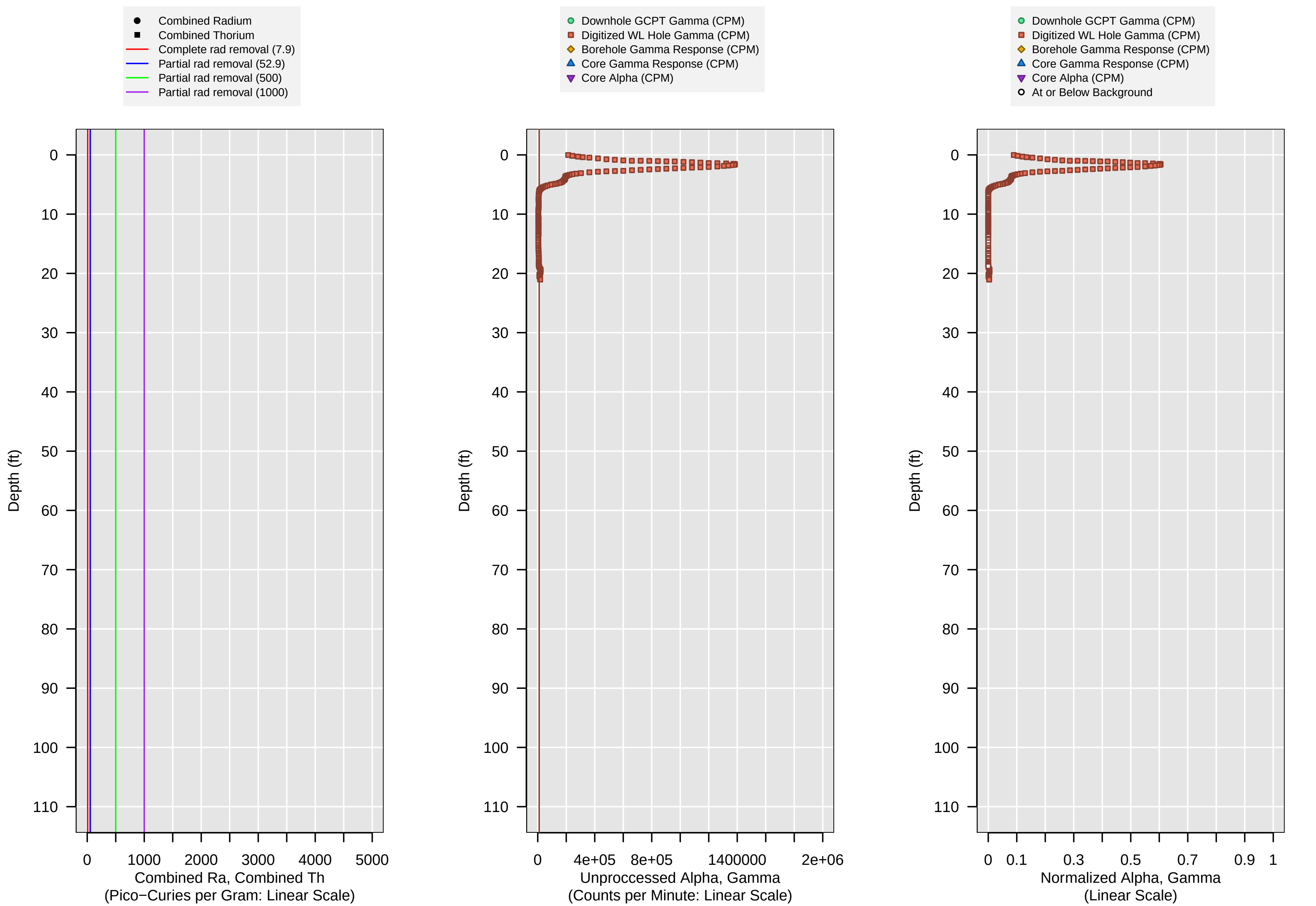

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 1000 2000 3000 4000 5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0 80000 2e+05 320000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

PVC−06

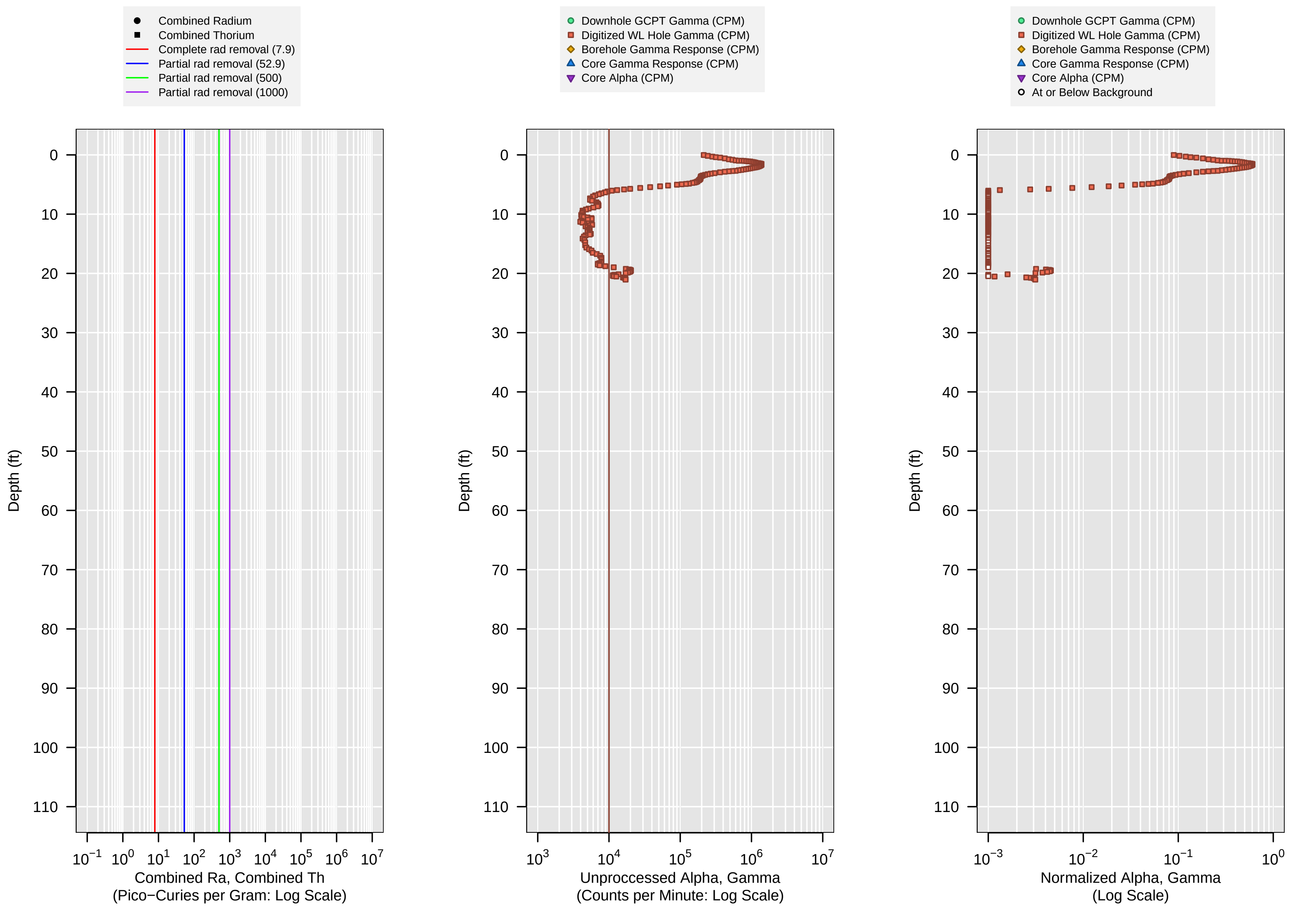


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

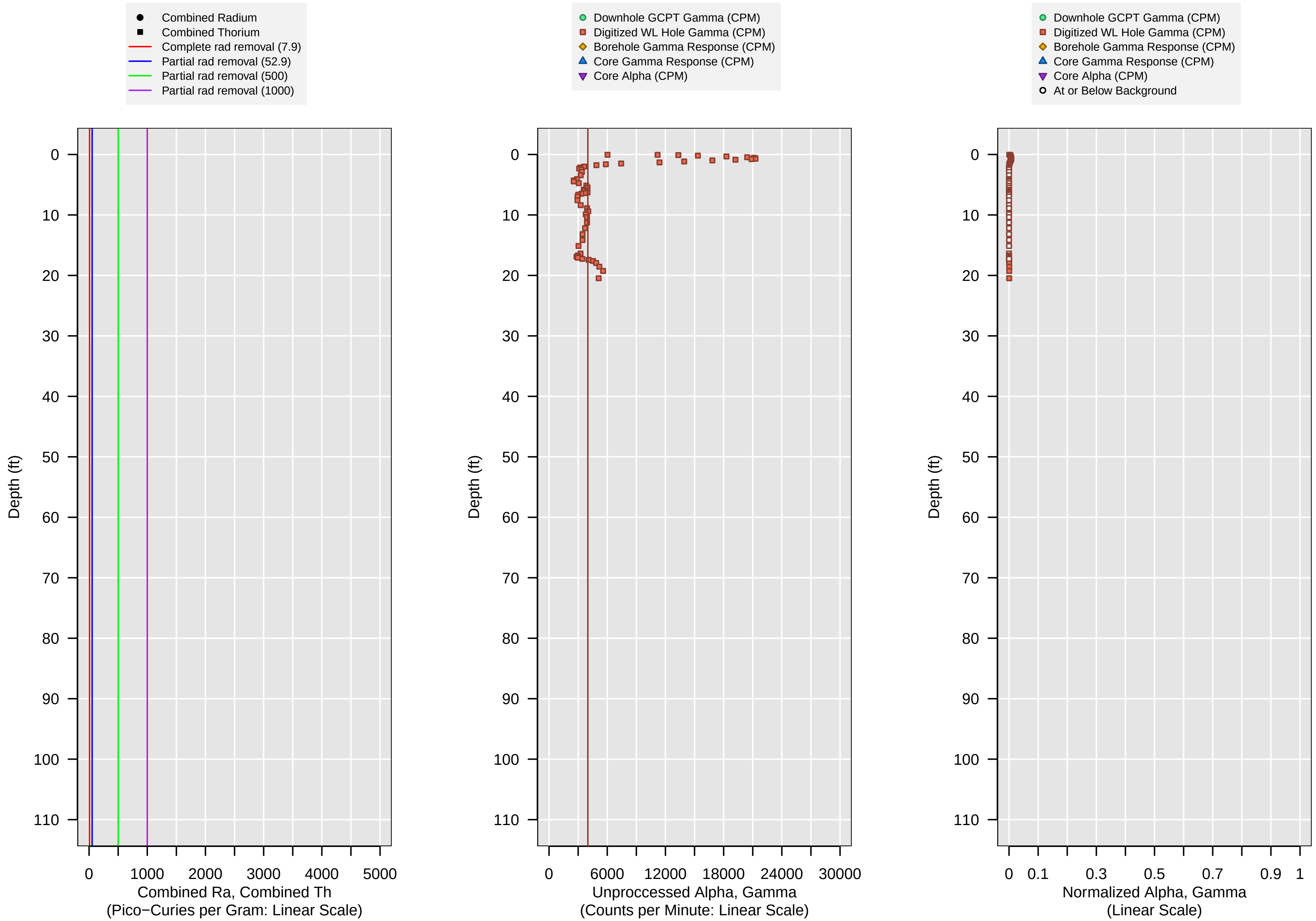
PVC−07


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

PVC−07

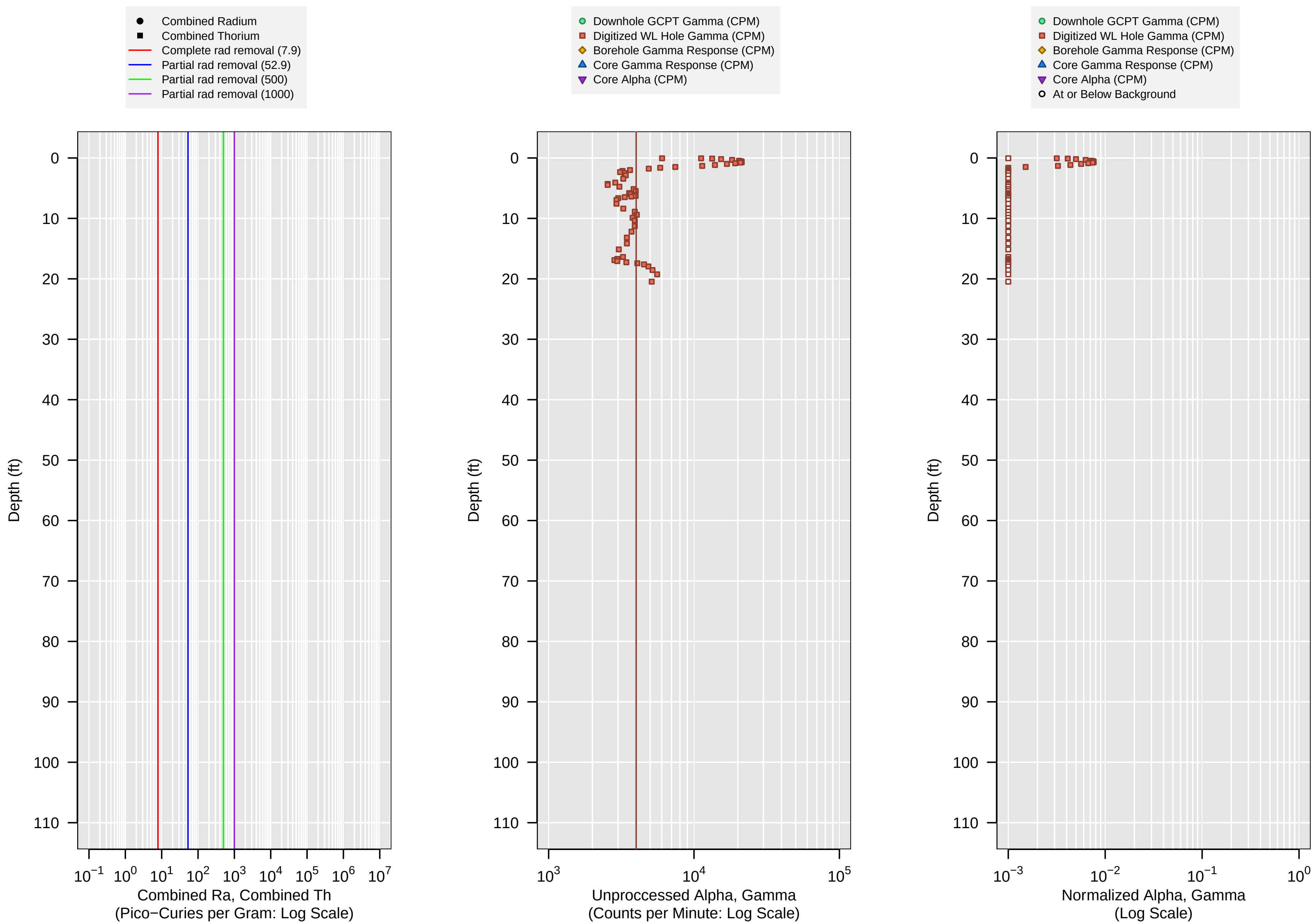

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

PVC−08

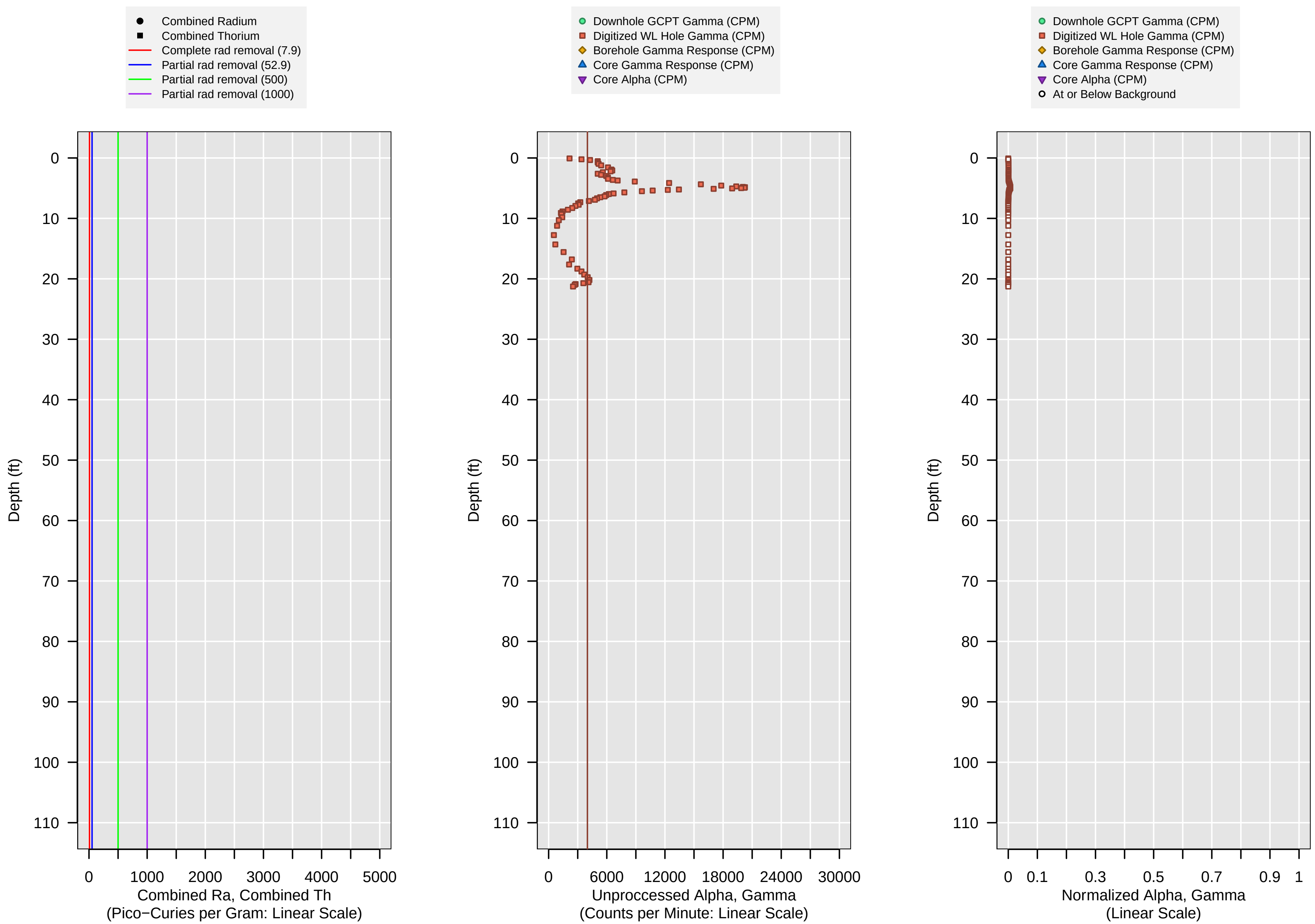


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

PVC−08

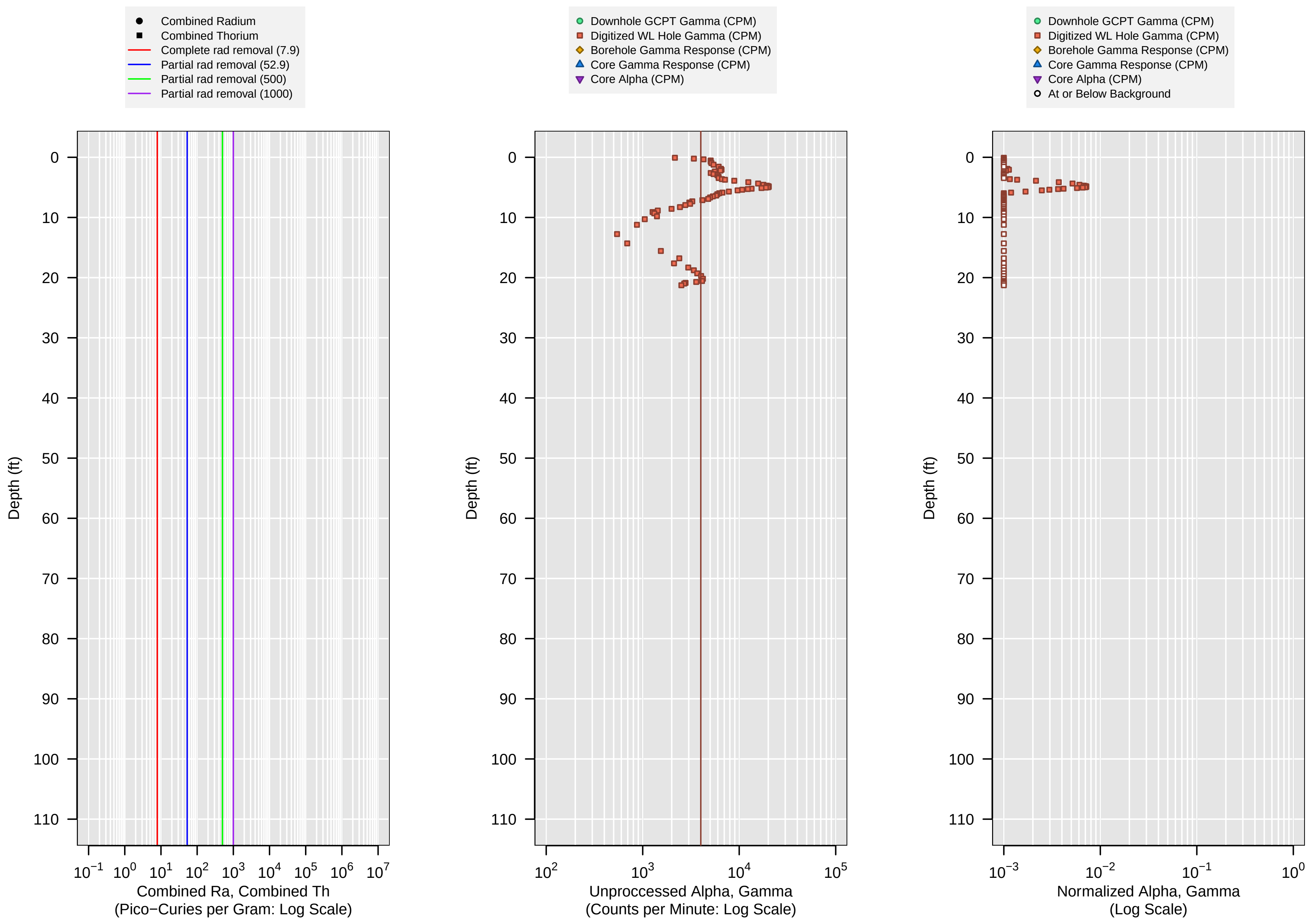

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{-1} 10^{0} 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6} 10^{7}
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
10^{3} 10^{4} 10^{5}
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
10^{-3} 10^{-2} 10^{-1} 10^{0}
Normalized Alpha, Gamma
(Log Scale)

PVC−09

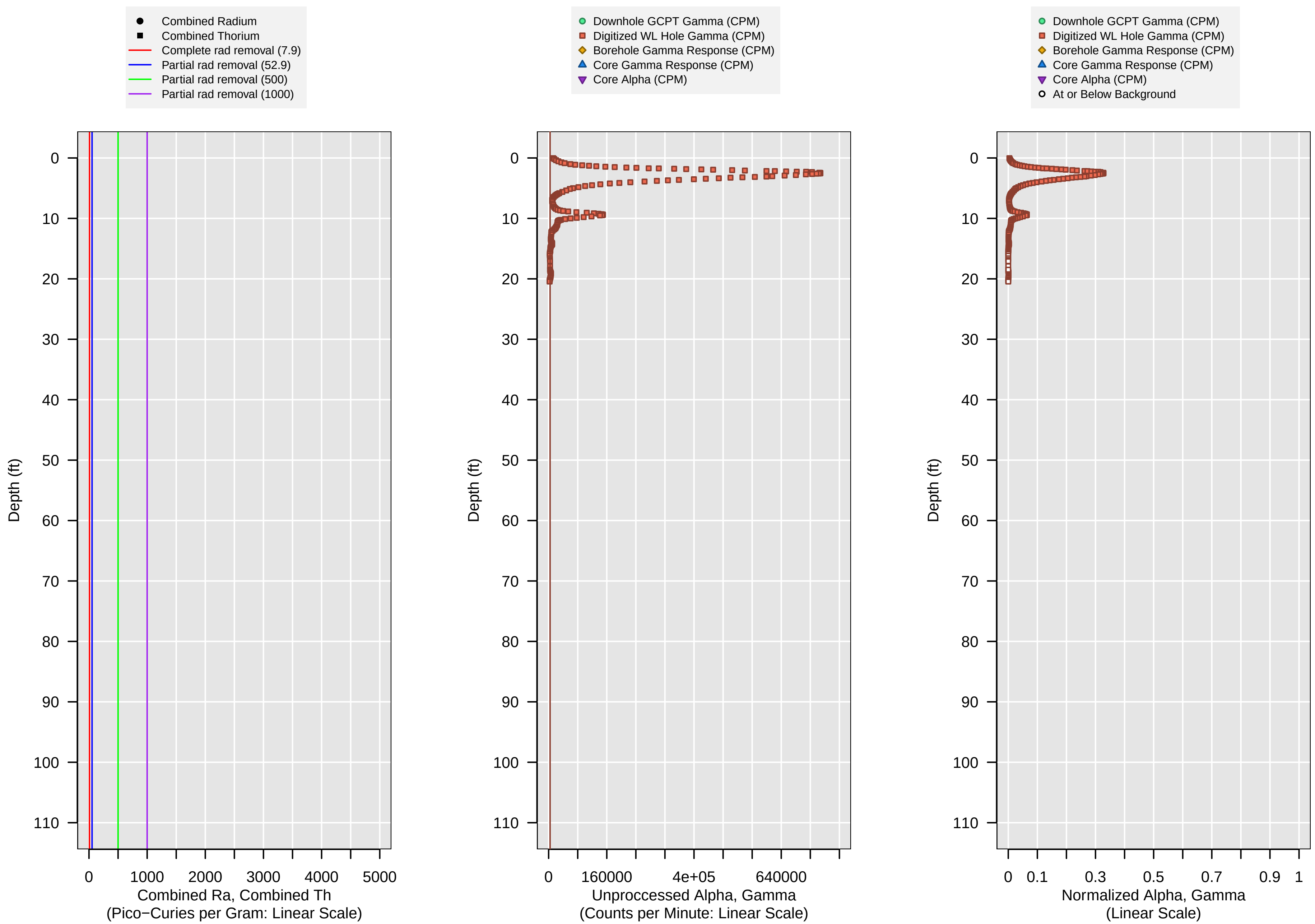


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

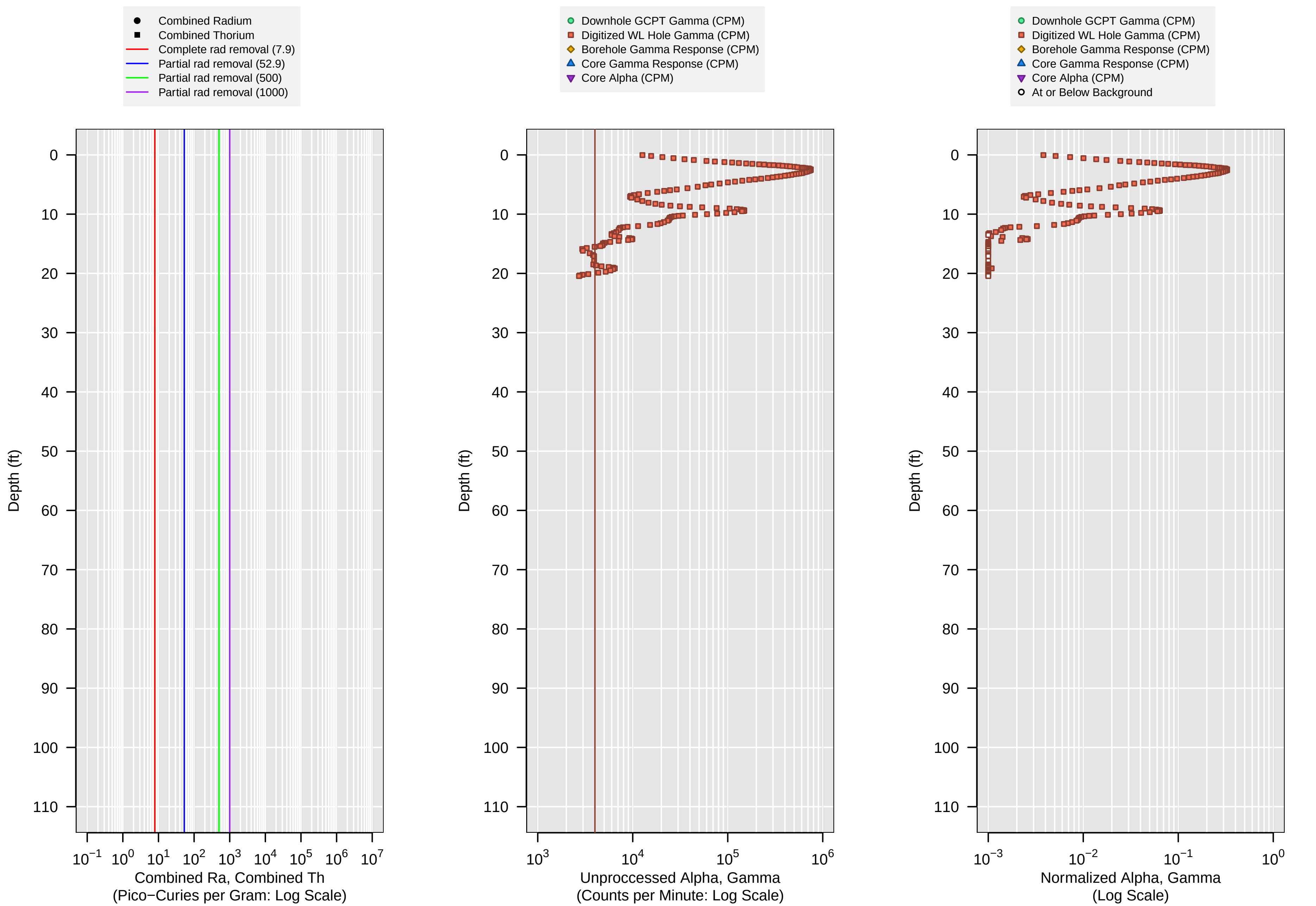
PVC−09


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{-1} 10^{0} 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6} 10^{7}
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
10^{2} 10^{3} 10^{4} 10^{5}
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
10^{-3} 10^{-2} 10^{-1} 10^{0}
Normalized Alpha, Gamma
(Log Scale)

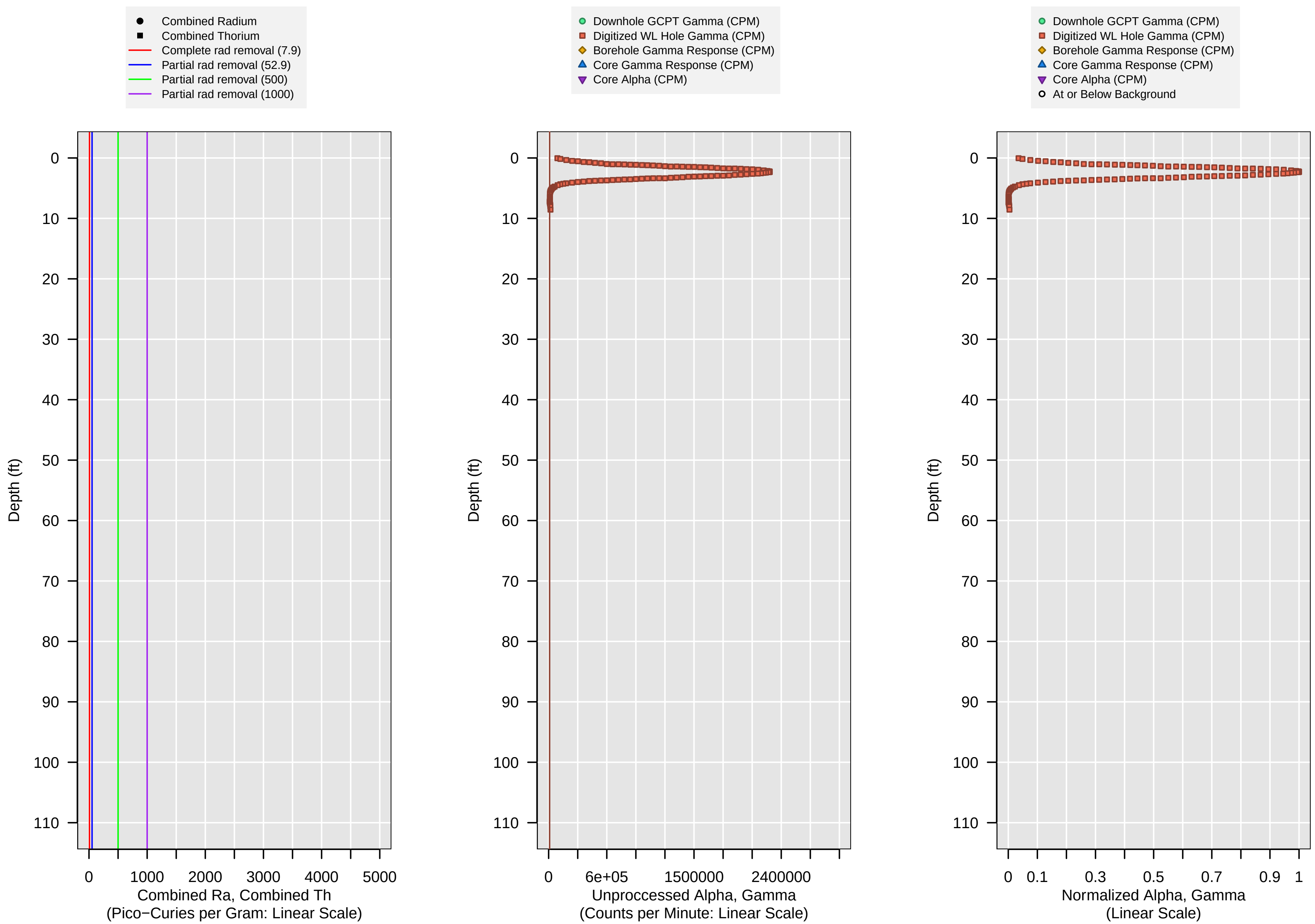
PVC−10


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
160000
4e+05
640000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

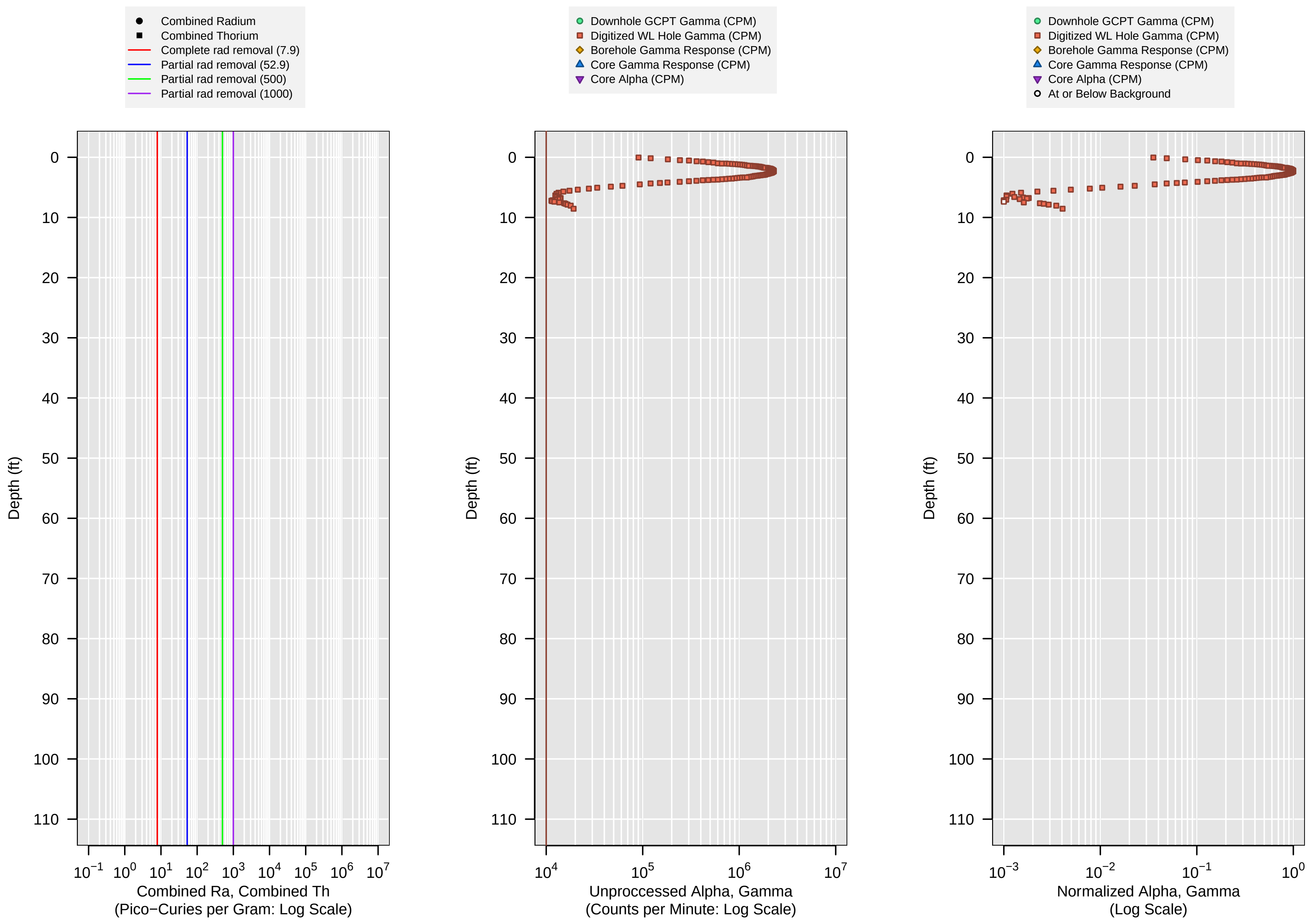
PVC−10


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{-1} 10^{0} 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6} 10^{7}
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
10^{3} 10^{4} 10^{5} 10^{6}
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
10^{-3} 10^{-2} 10^{-1} 10^{0}
Normalized Alpha, Gamma
(Log Scale)

PVC−11A

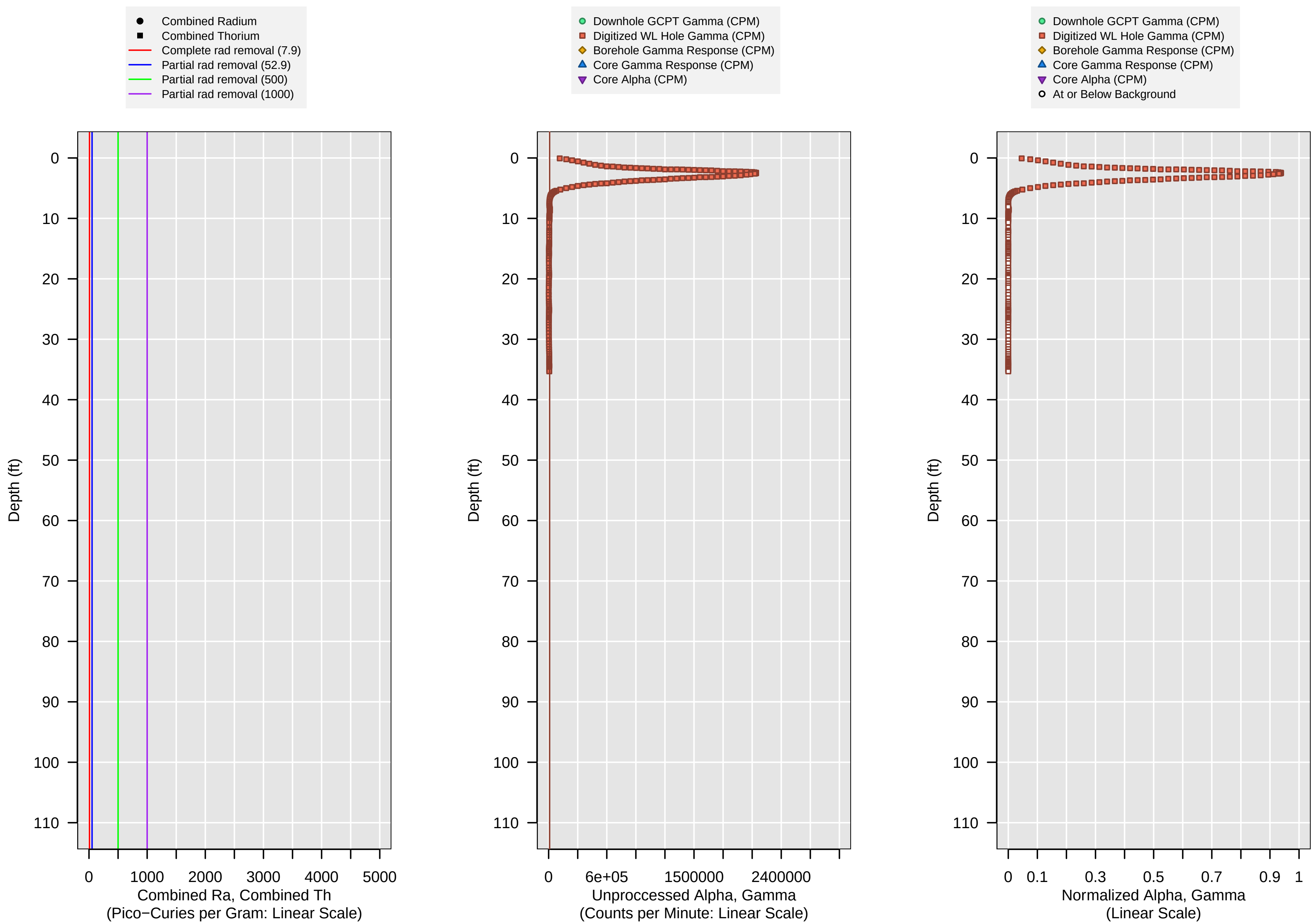

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0 1000 2000 3000 4000 5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0 6e+05 1500000 2400000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

PVC−11A

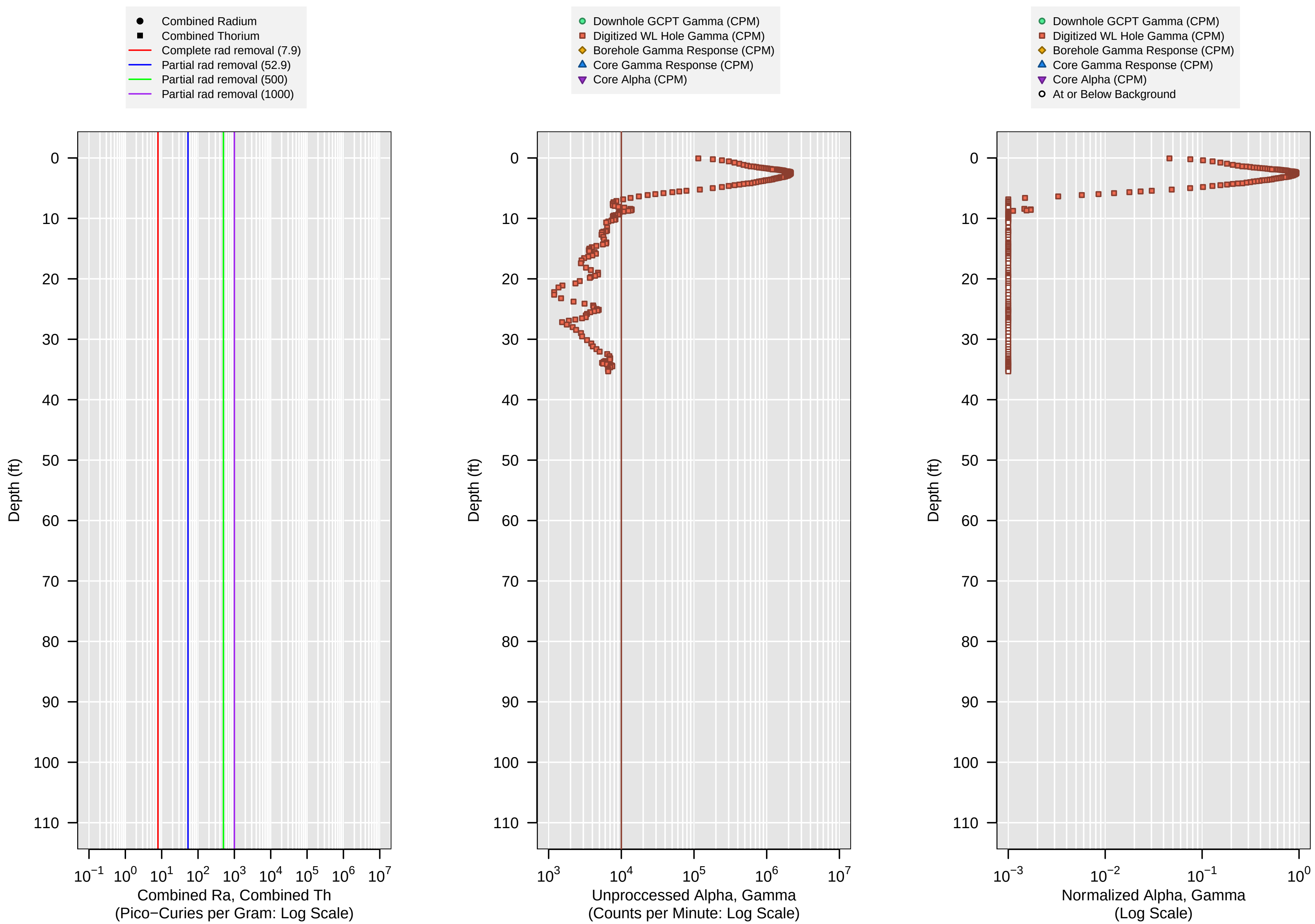


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{-1} 10^{0} 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6} 10^{7}
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
10^{4} 10^{5} 10^{6} 10^{7}
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
10^{-3} 10^{-2} 10^{-1} 10^{0}
Normalized Alpha, Gamma
(Log Scale)

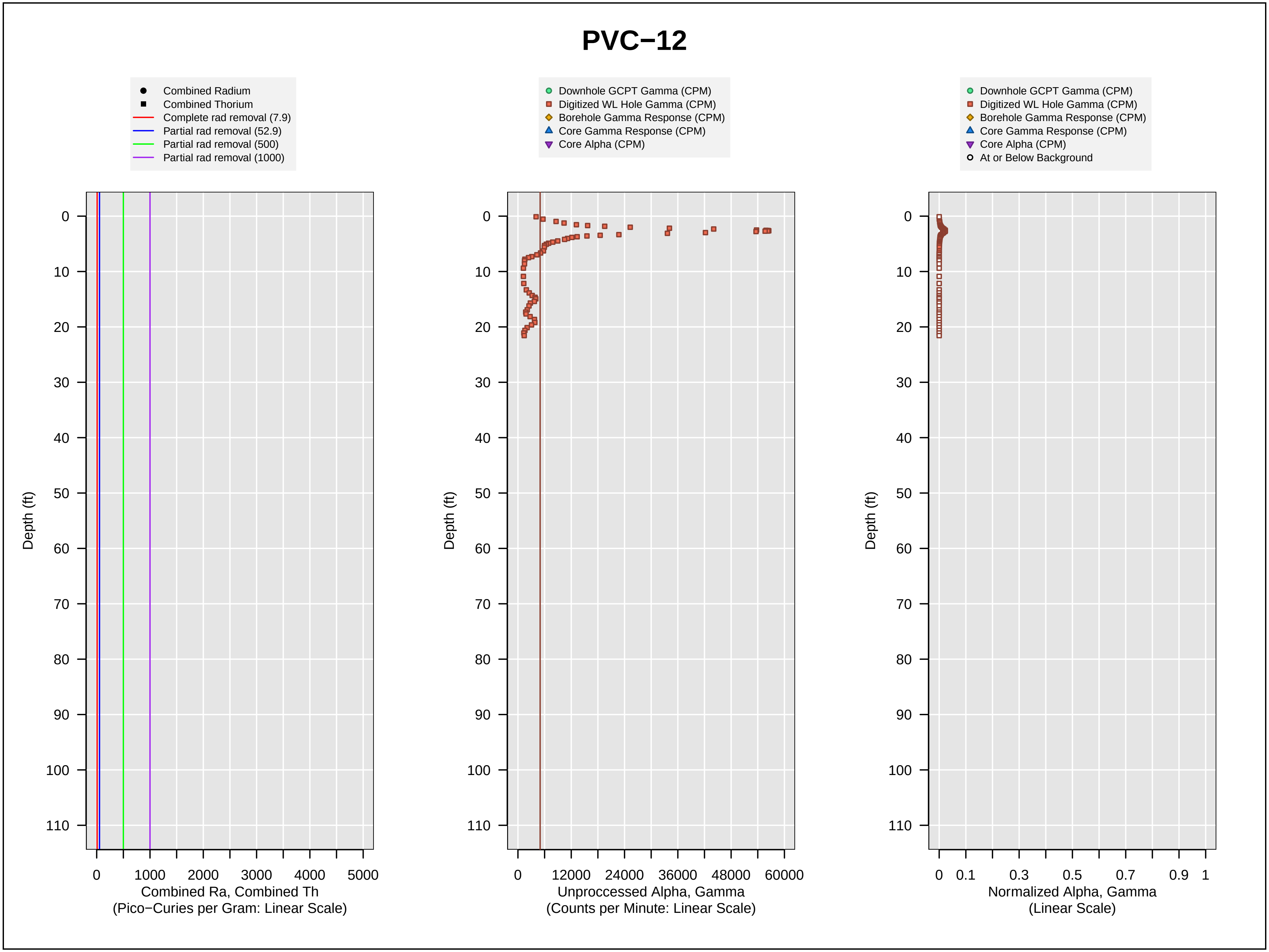
PVC−11B

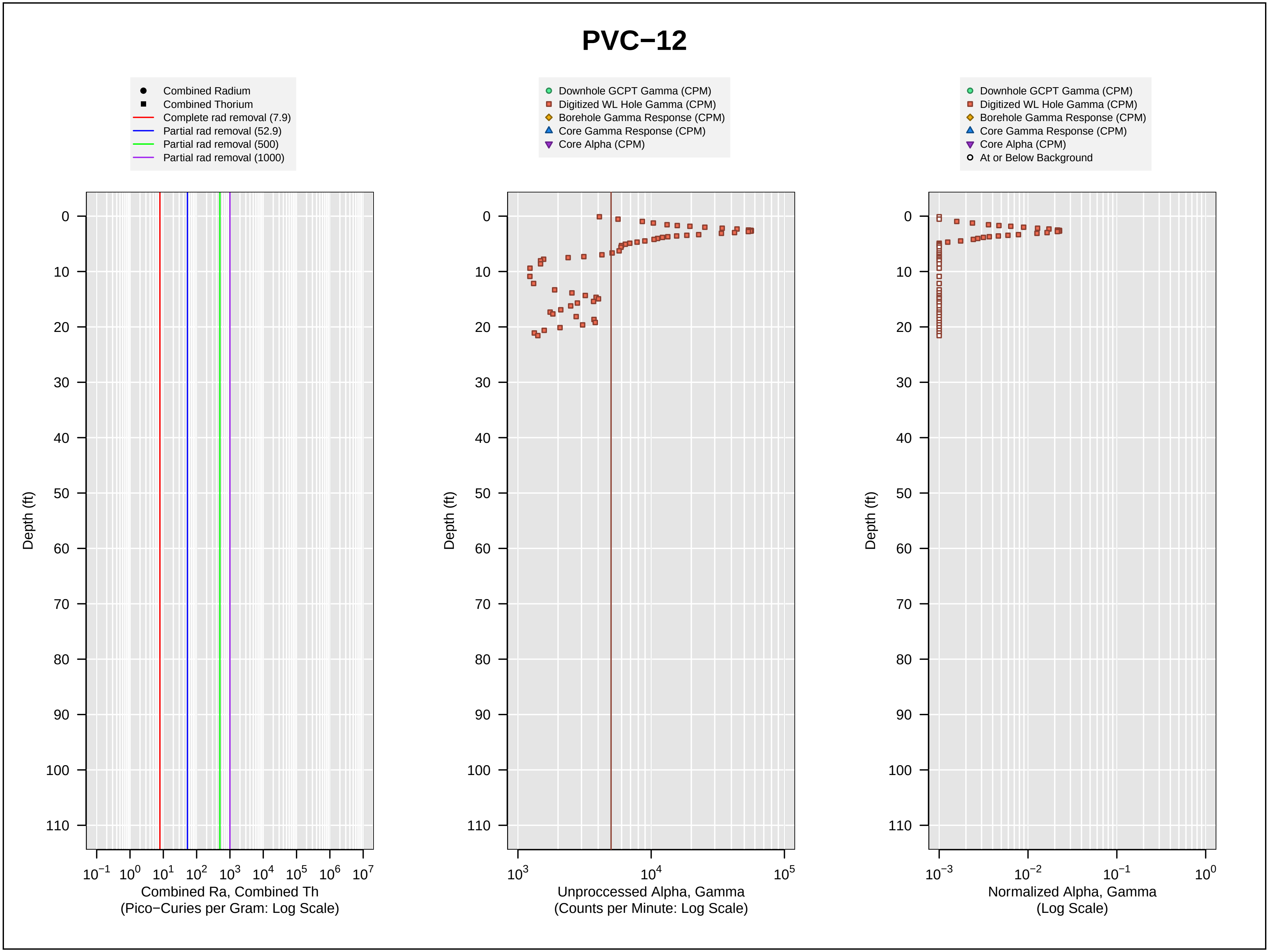

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
0
1000
2000
3000
4000
5000
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
0
6e+05
1500000
2400000
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)
0
0.1
0.3
0.5
0.7
0.9
1
0
10
20
30
40
50
60
70
80
90
100
110

PVC−11B

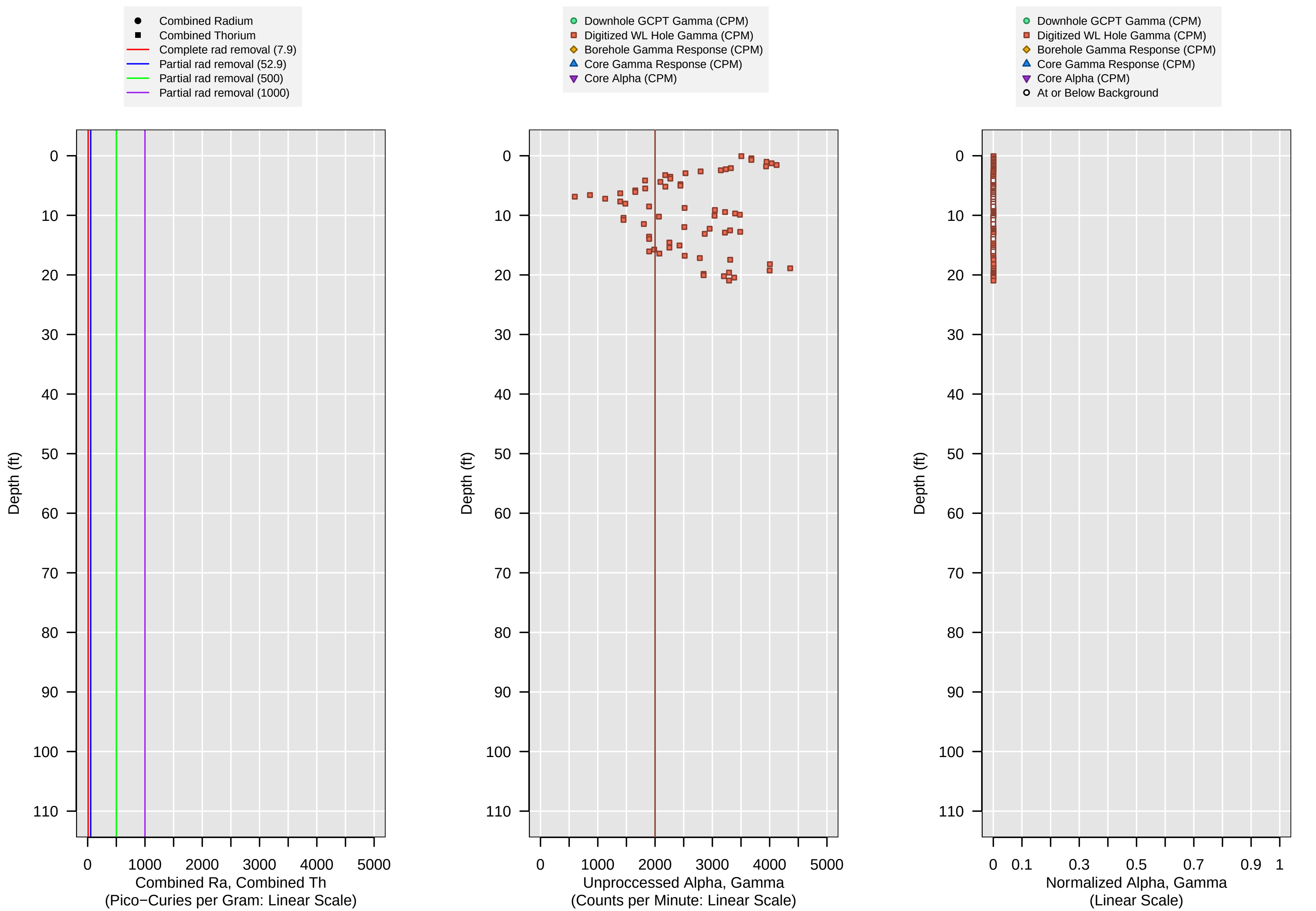


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

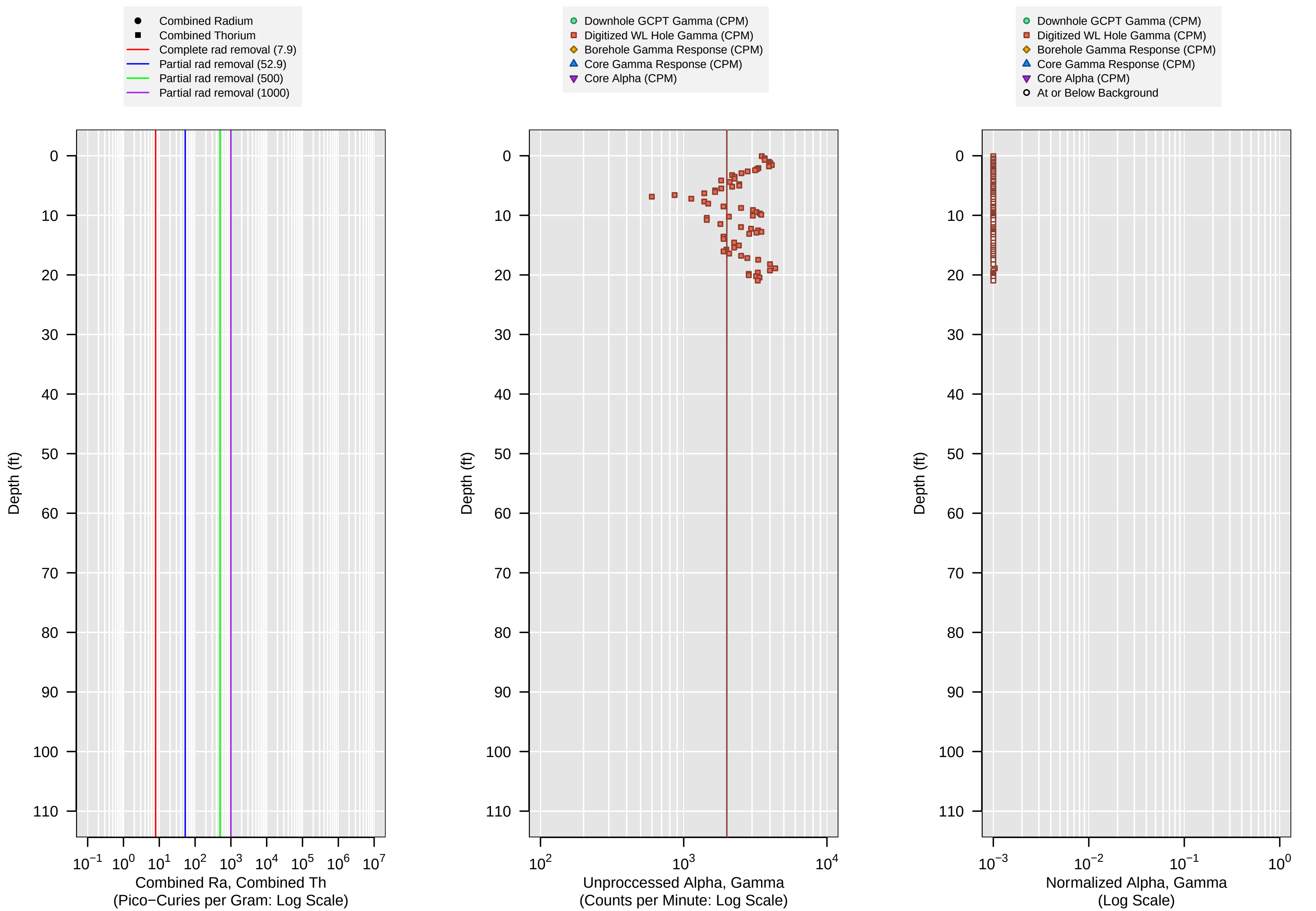

PVC−12
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)


PVC−12
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

PVC−13

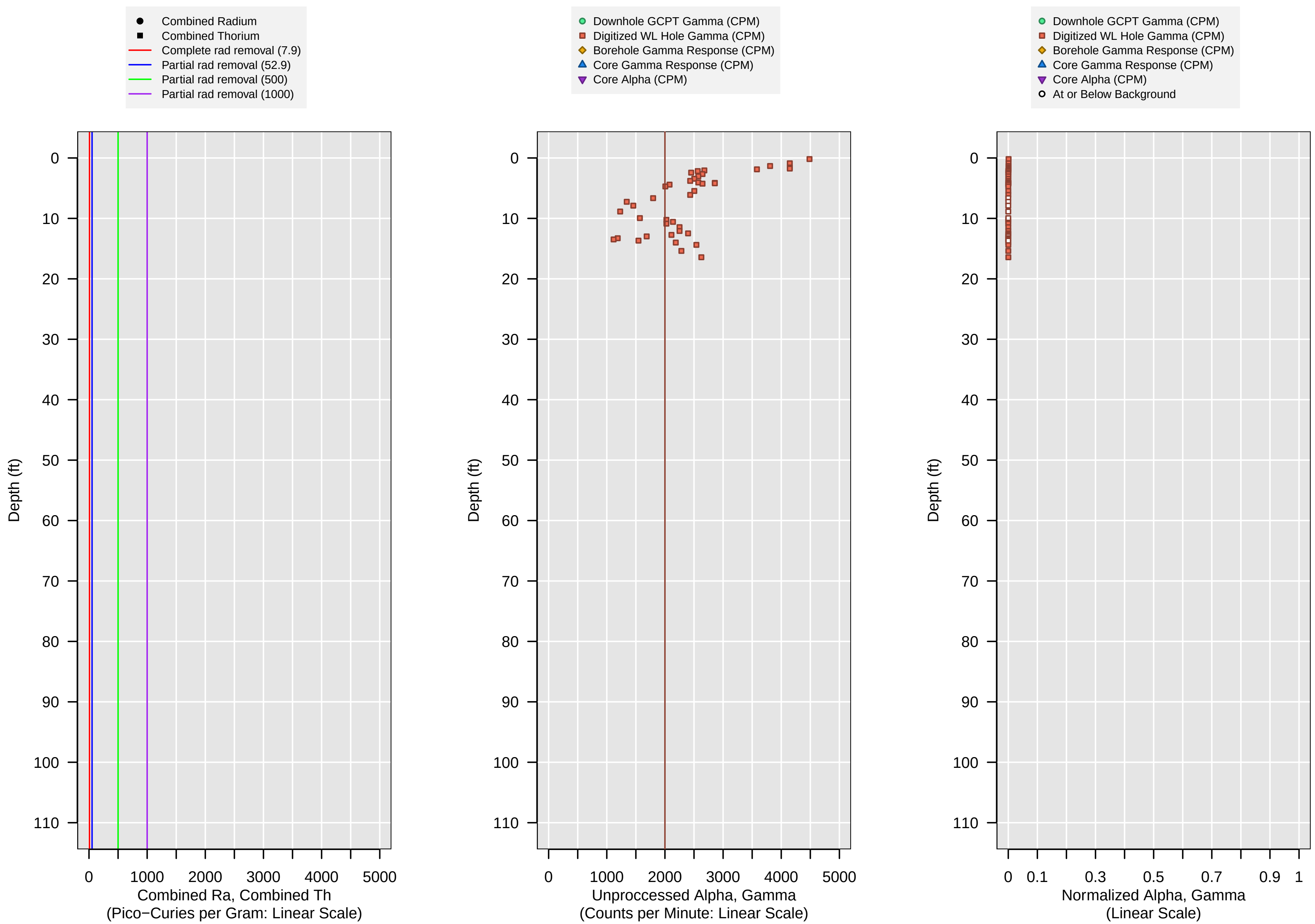

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

PVC−13

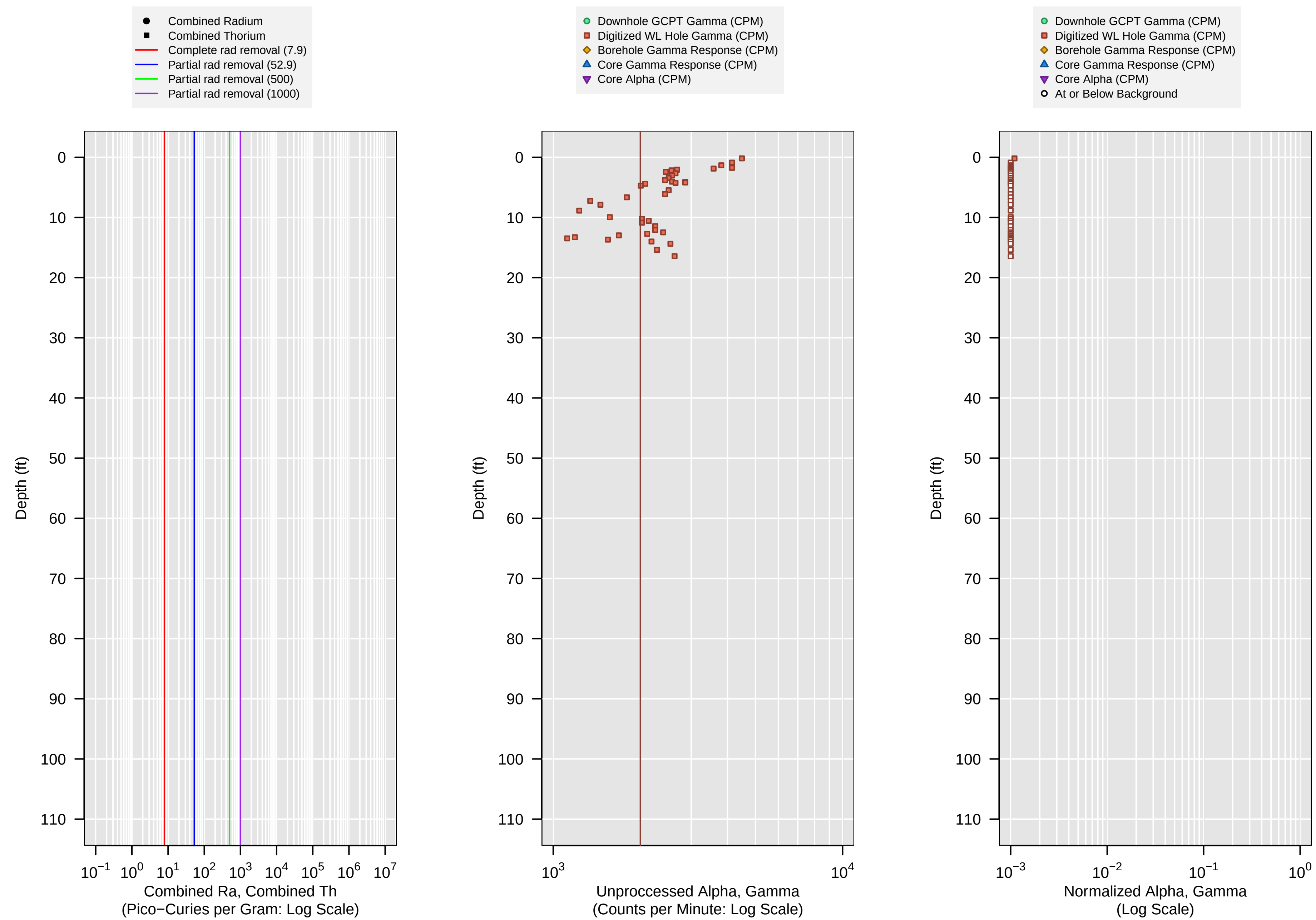


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

PVC−18

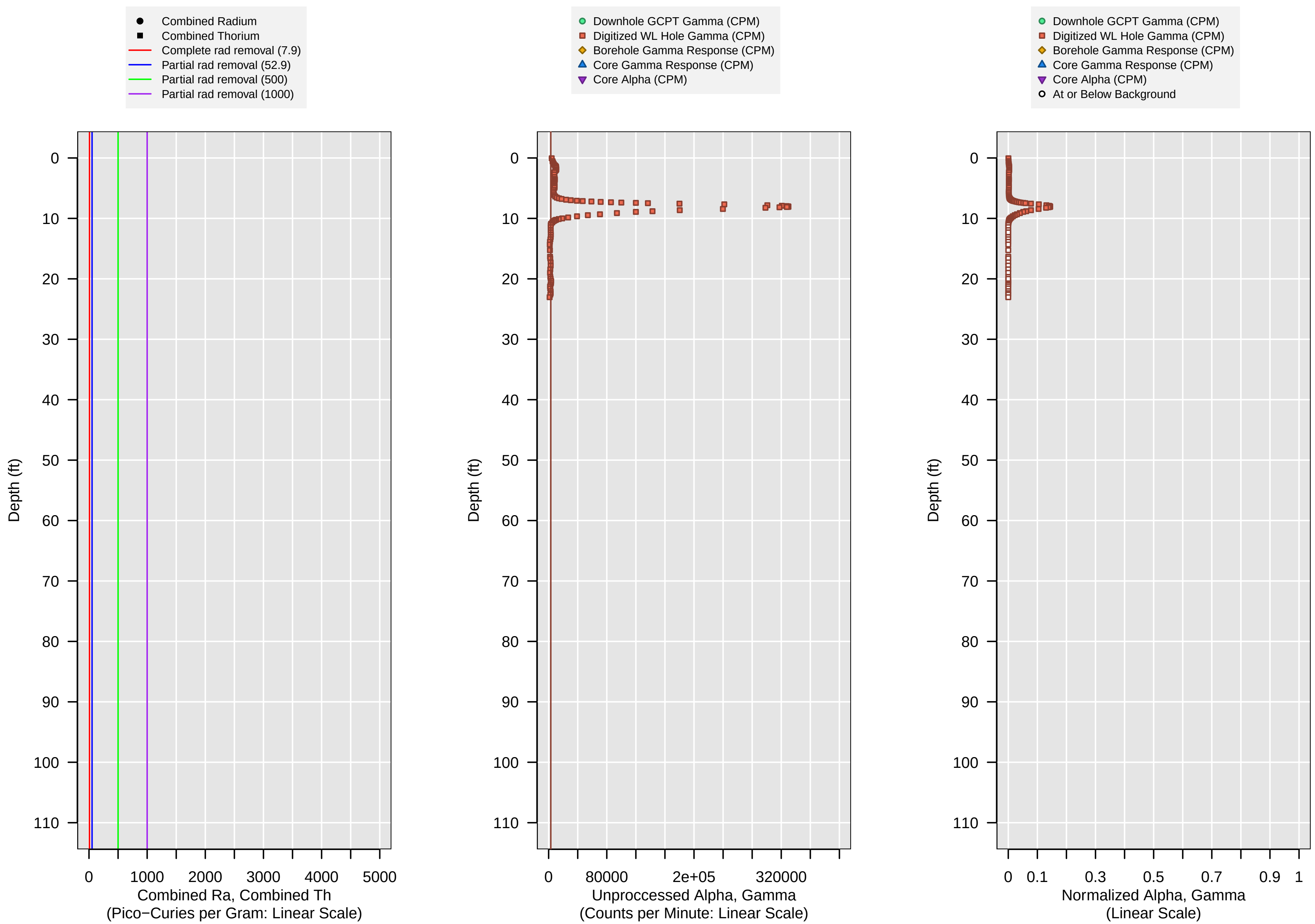

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

PVC−18



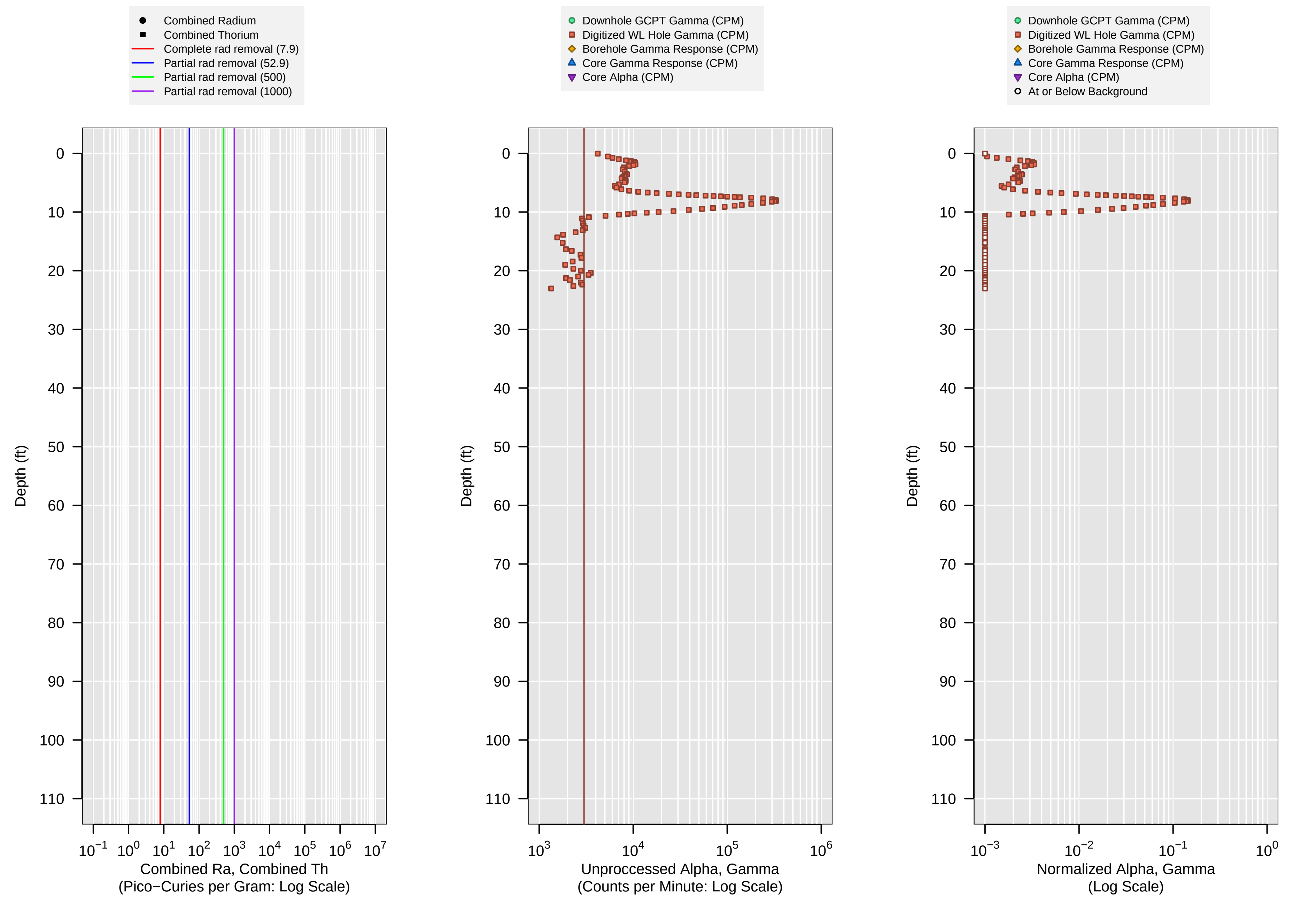
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{-1} 10^{0} 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6} 10^{7}
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
10^{3} 10^{4}
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
10^{-3} 10^{-2} 10^{-1} 10^{0}
Normalized Alpha, Gamma
(Log Scale)

PVC−19

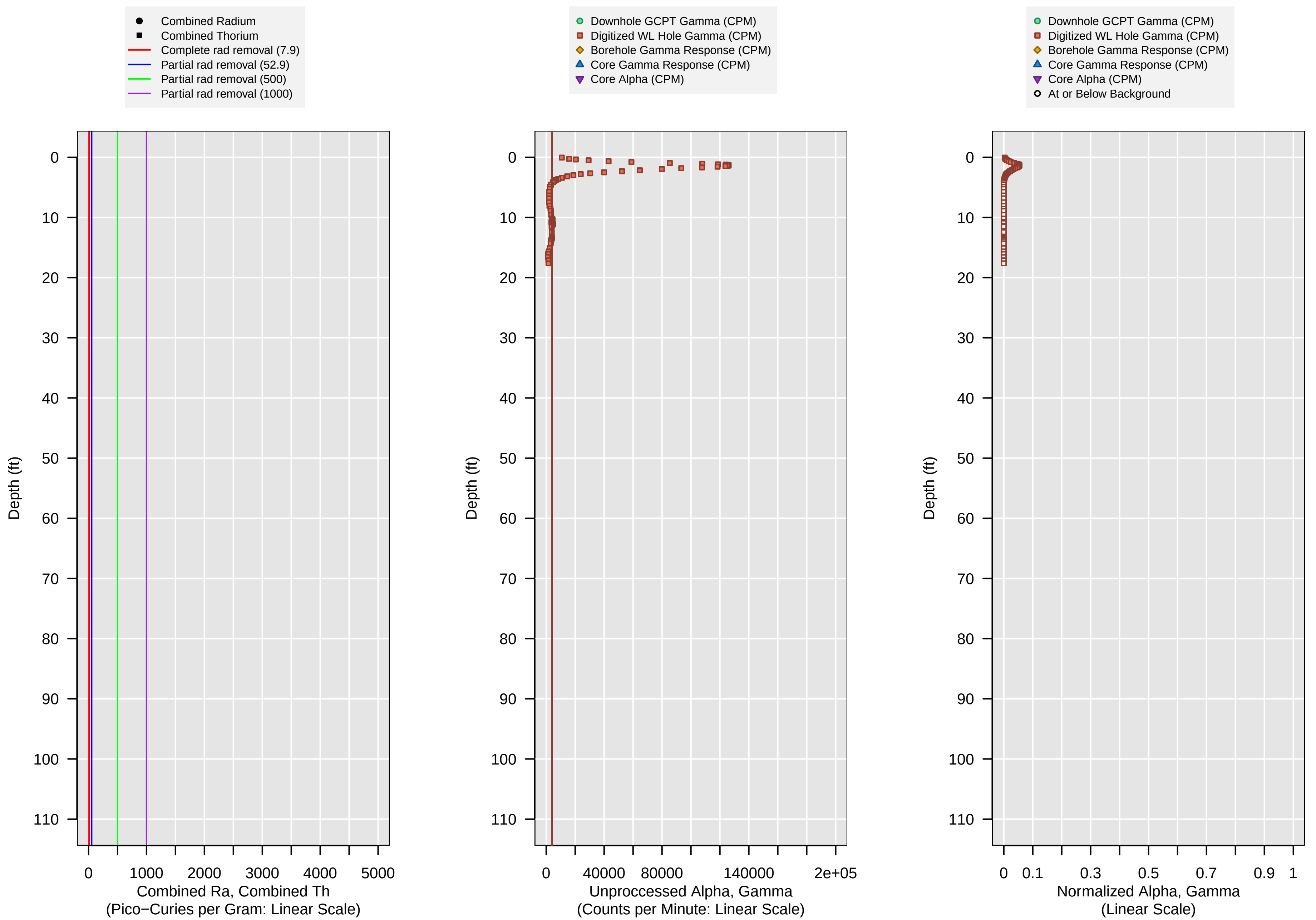


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
80000
2e+05
320000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

PVC−19

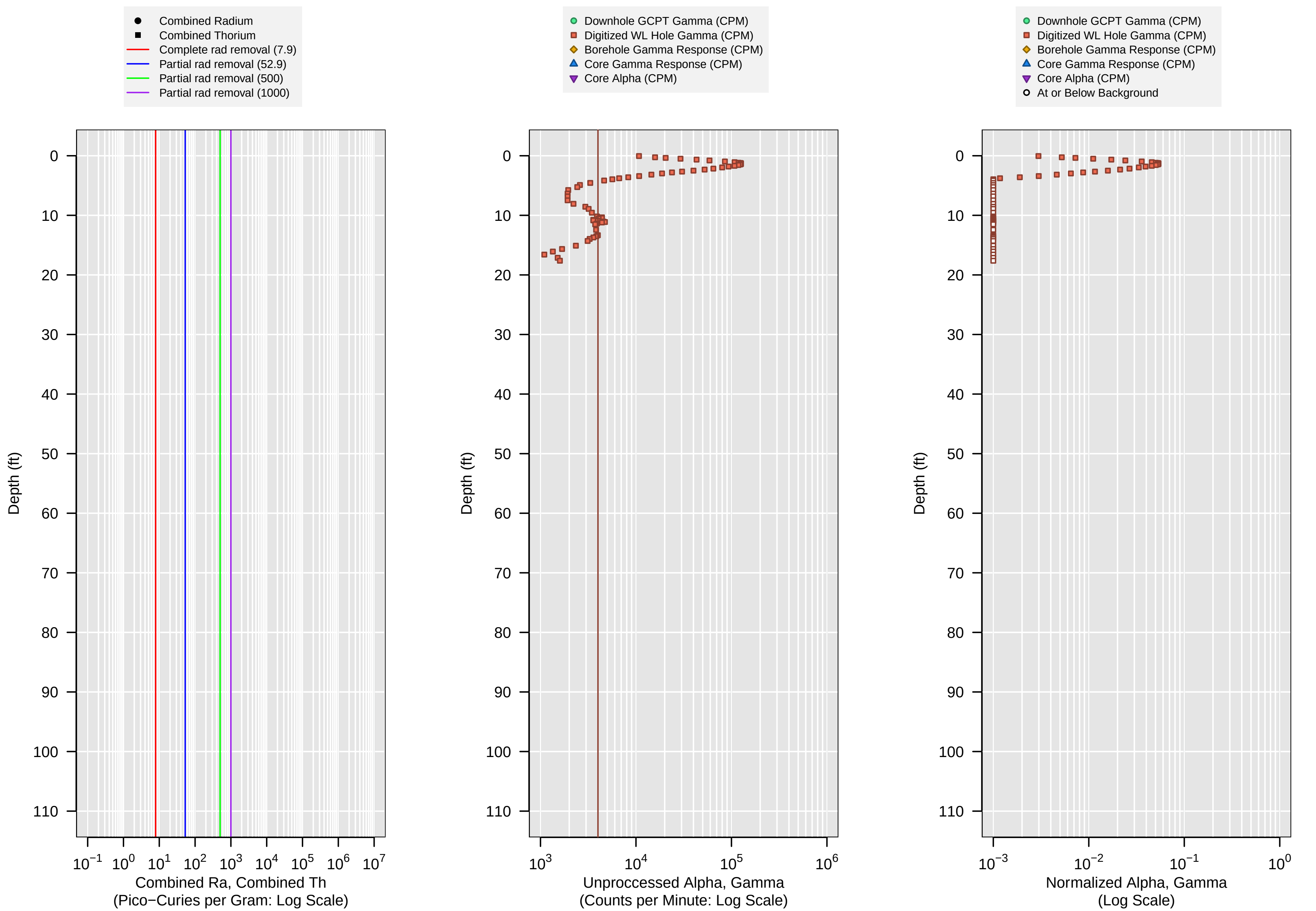

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

PVC−20



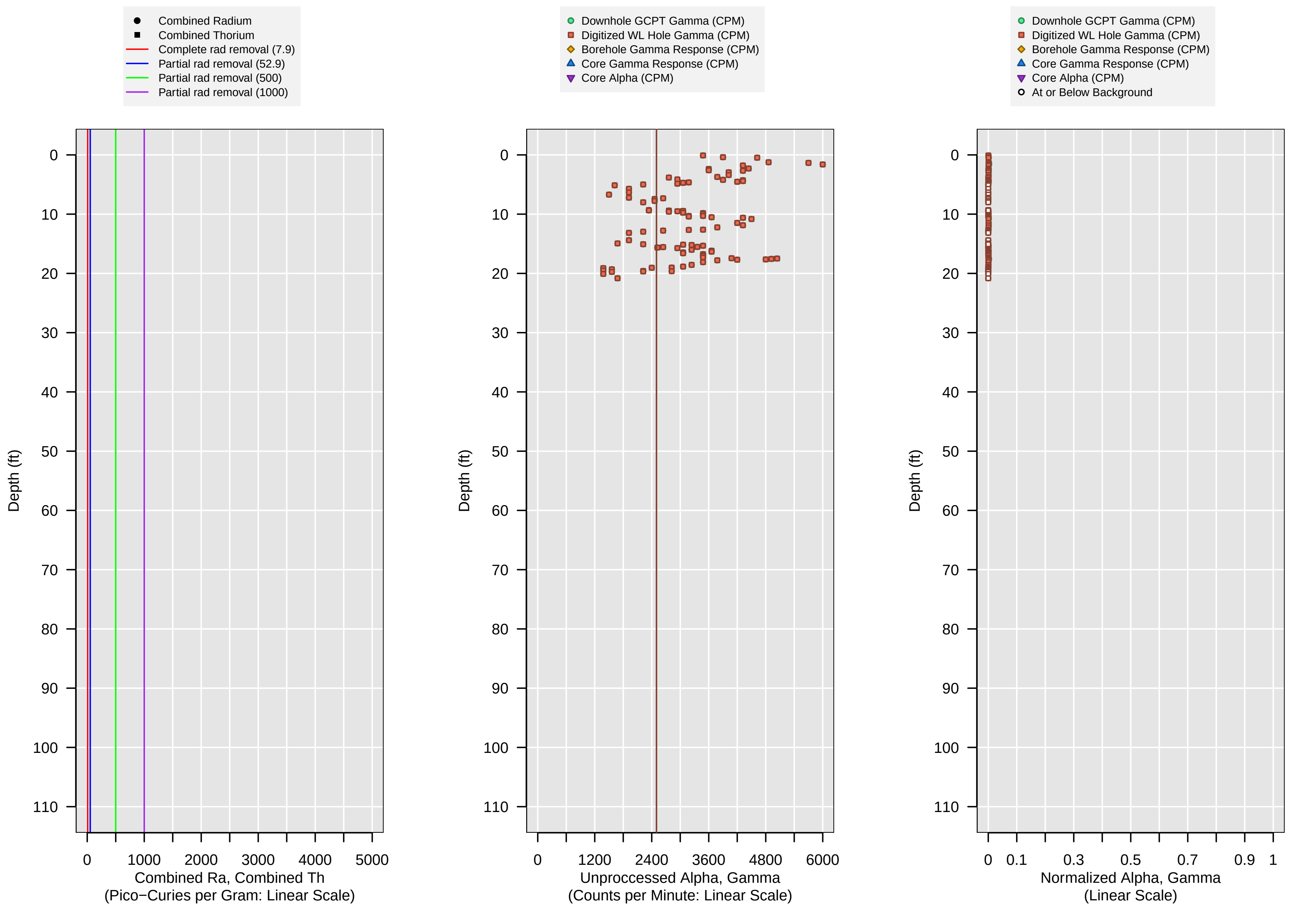
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
40000
80000
140000
2e+05
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

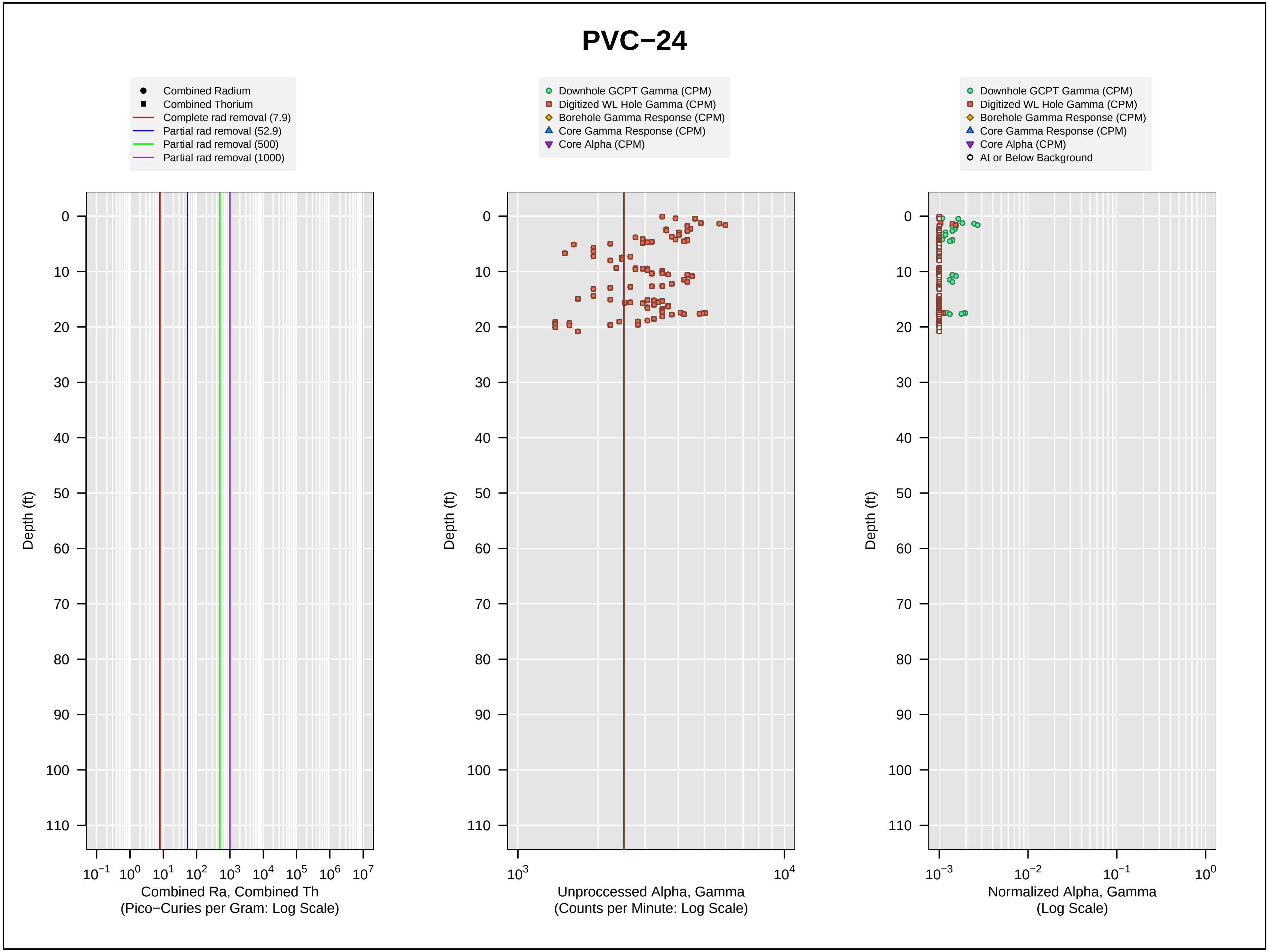
PVC−20



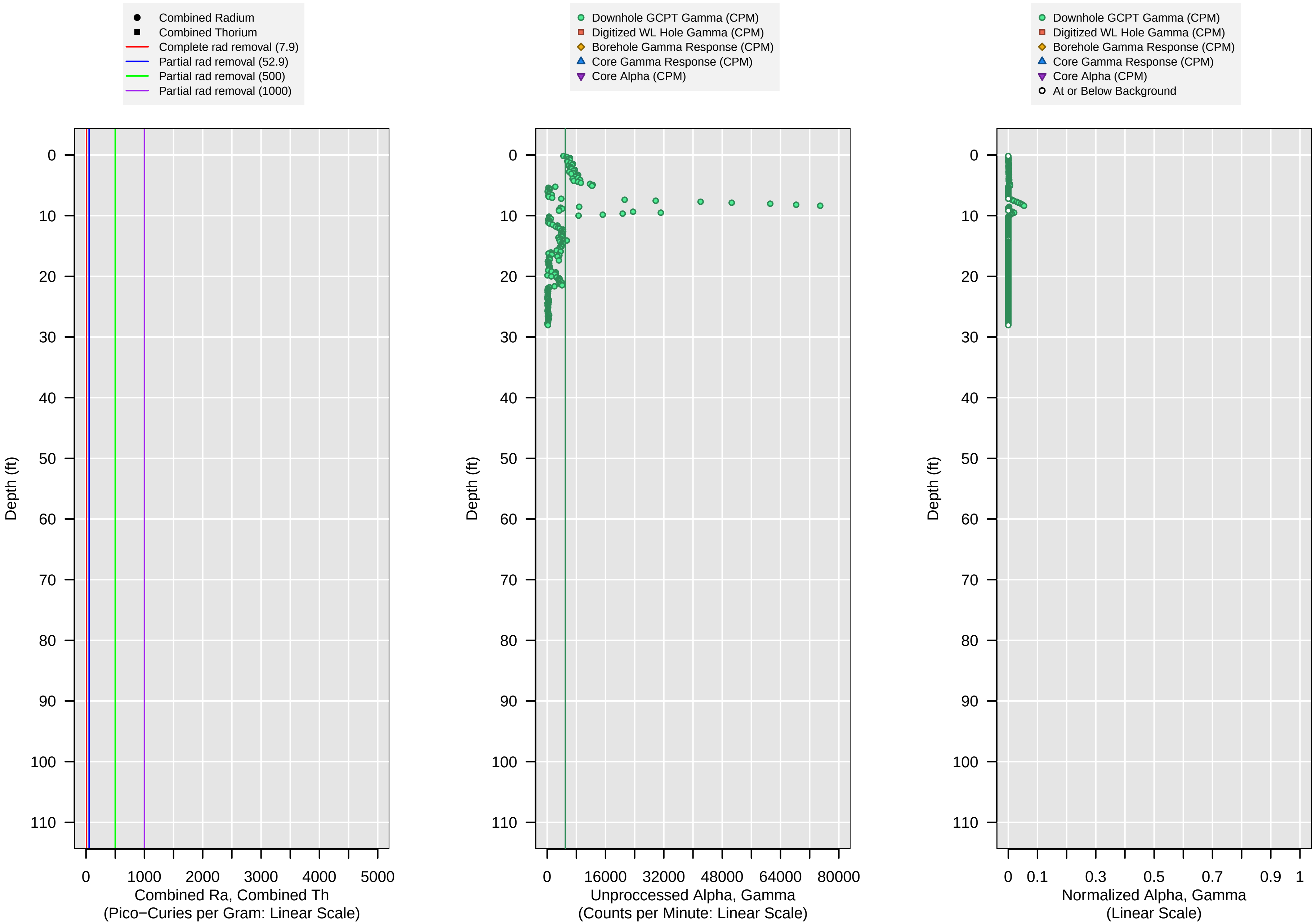
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

PVC−24


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1200
2400
3600
4800
6000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

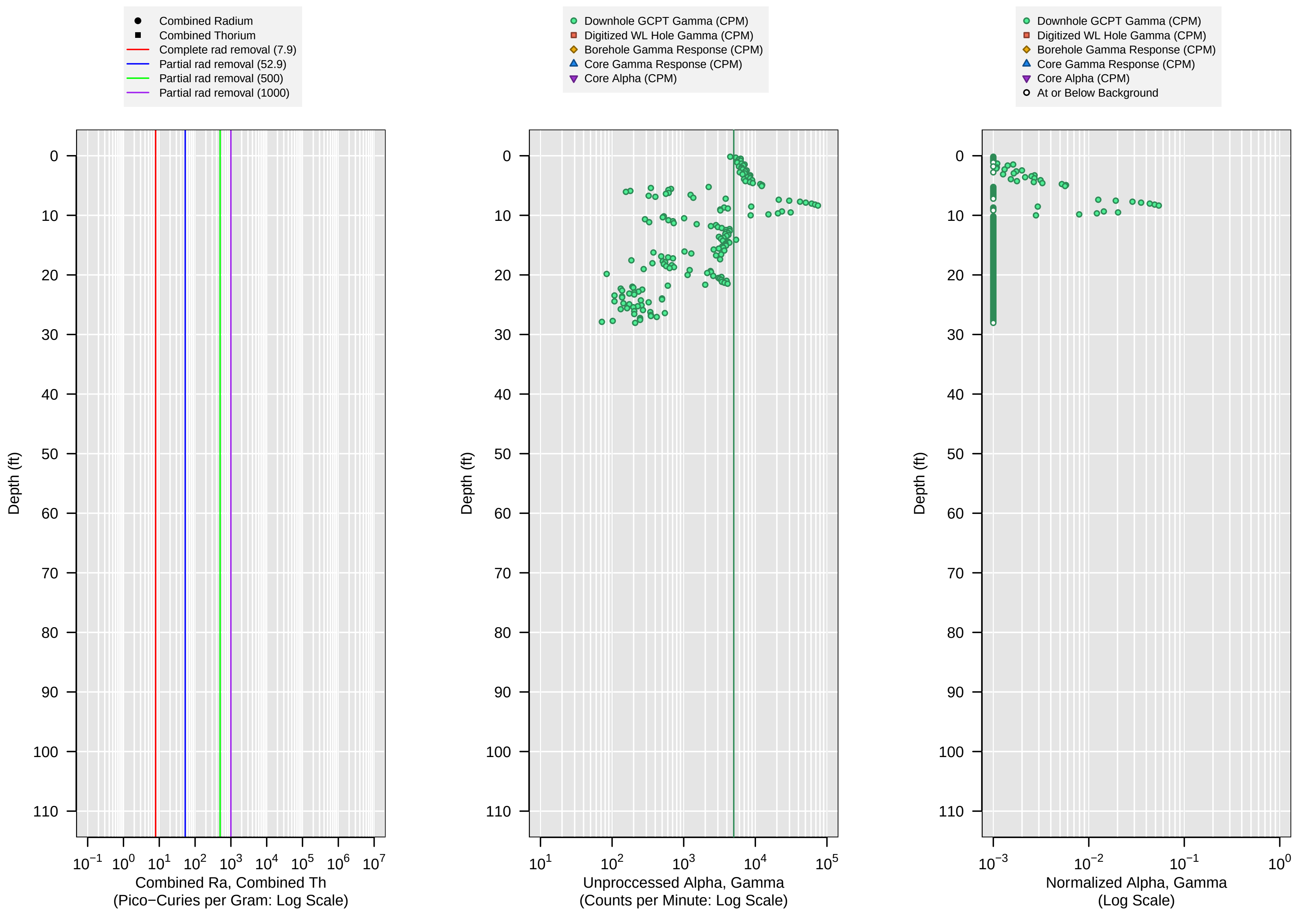

PVC−24
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

GCPT−25



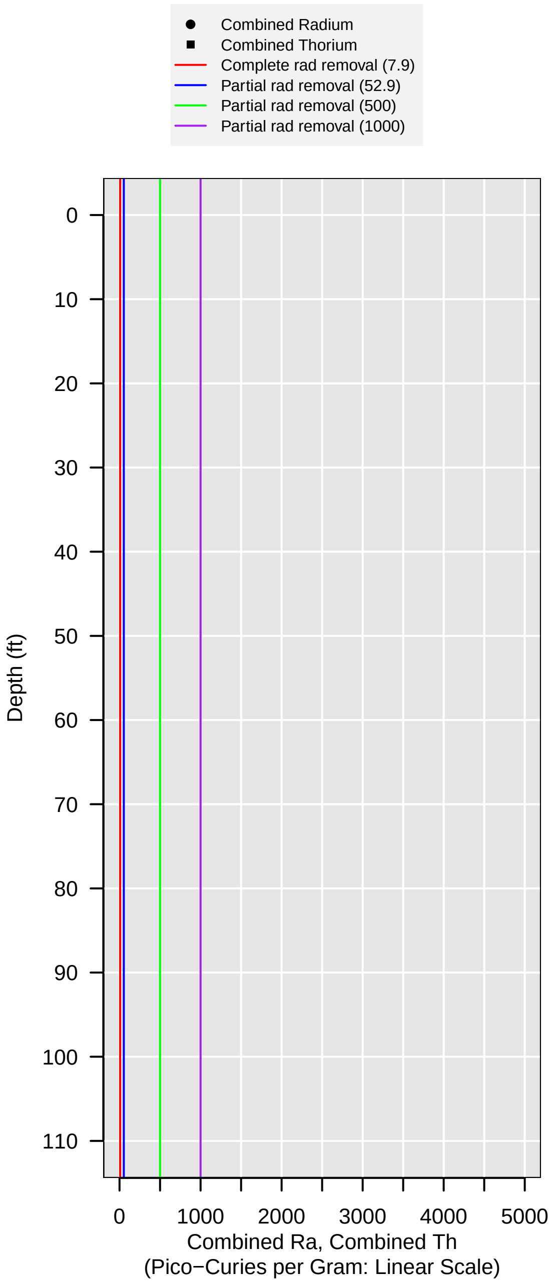
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

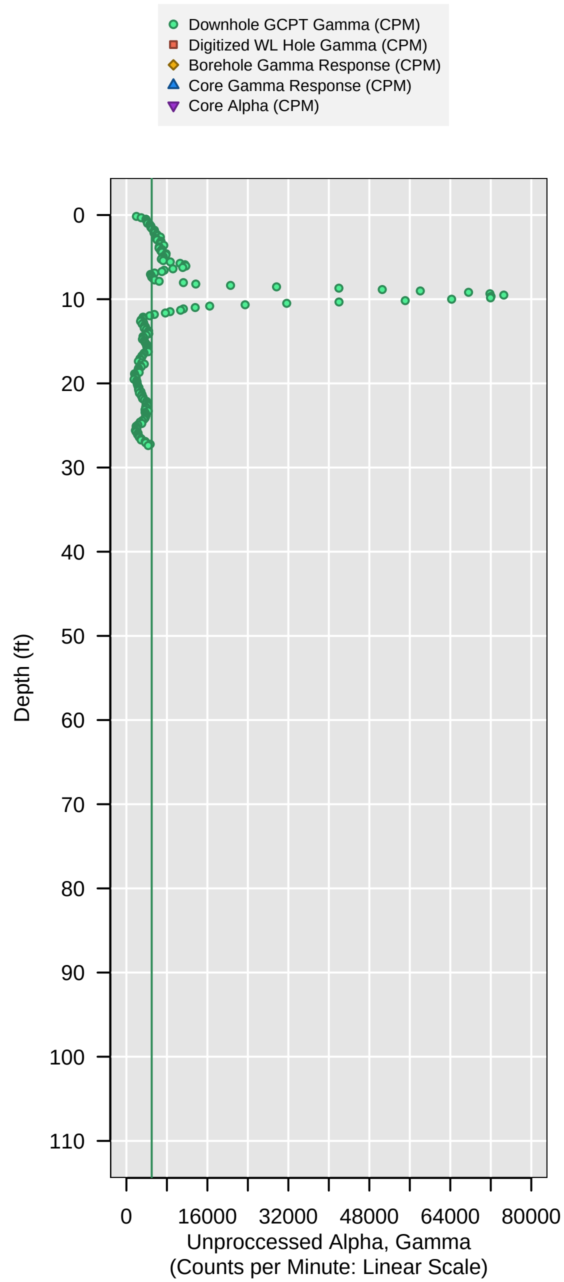
GCPT−25

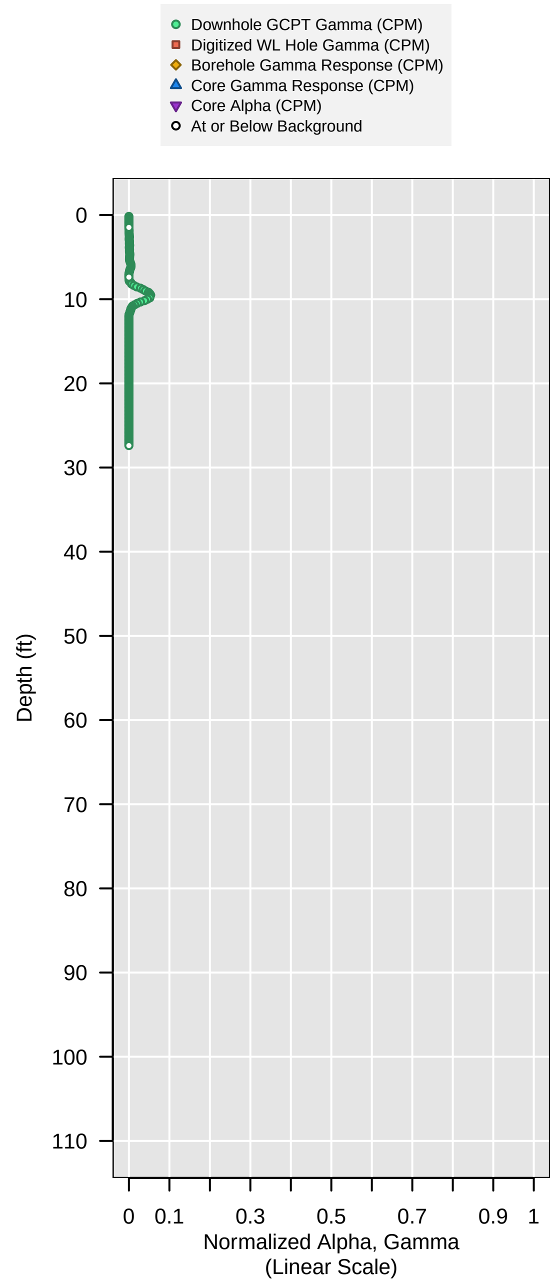


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

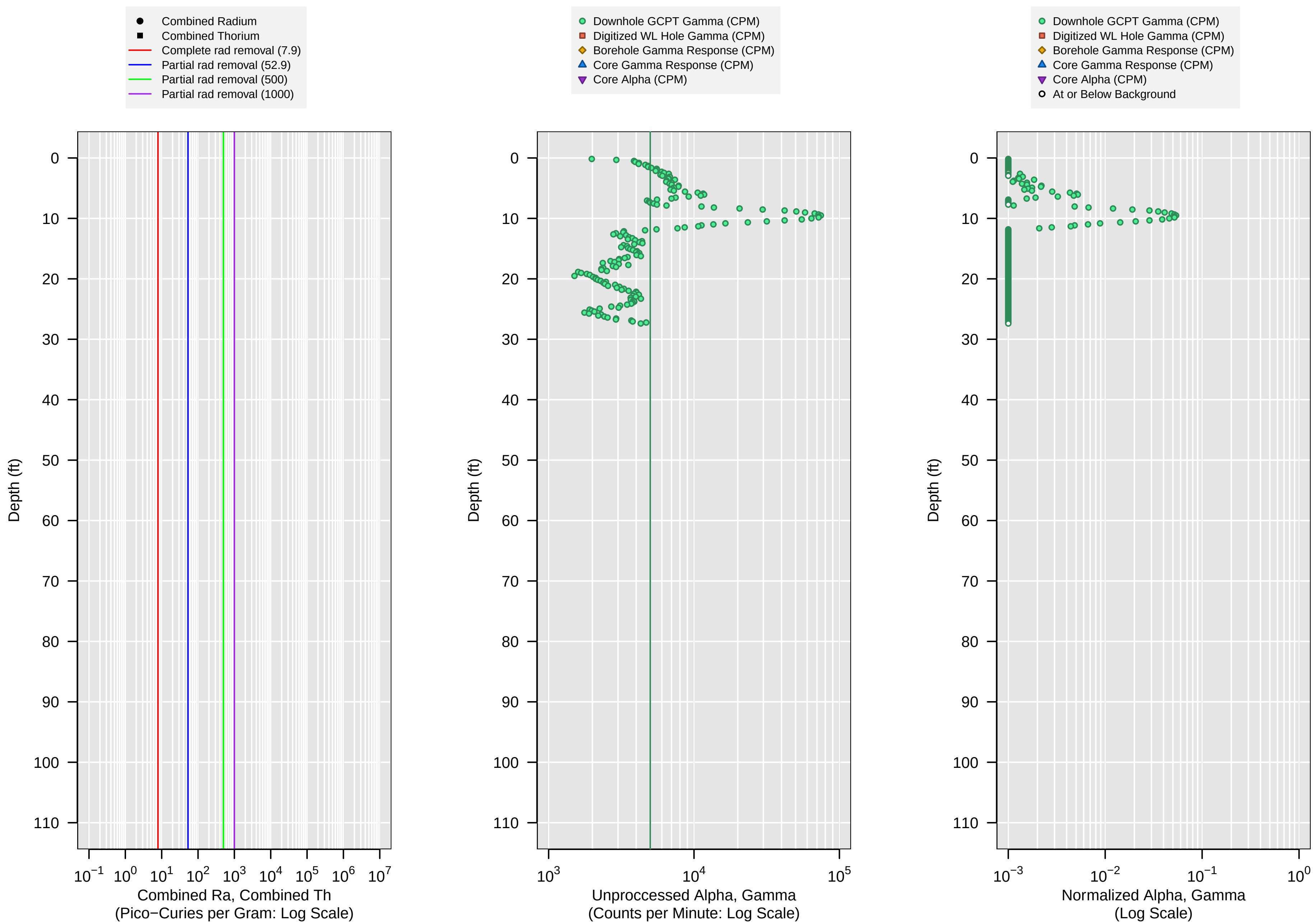
GCPT−25R


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)

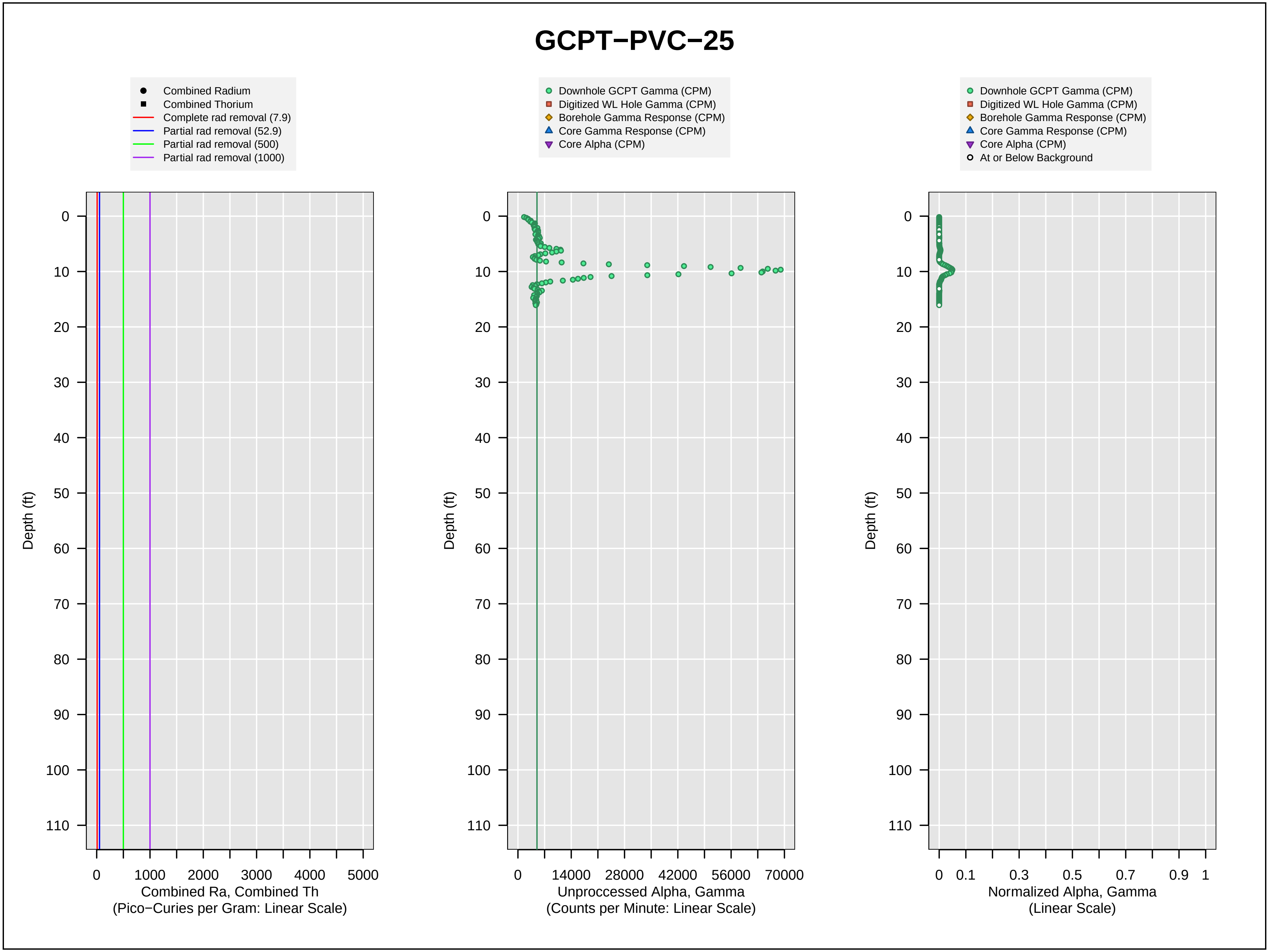

Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
16000
32000
48000
64000
80000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

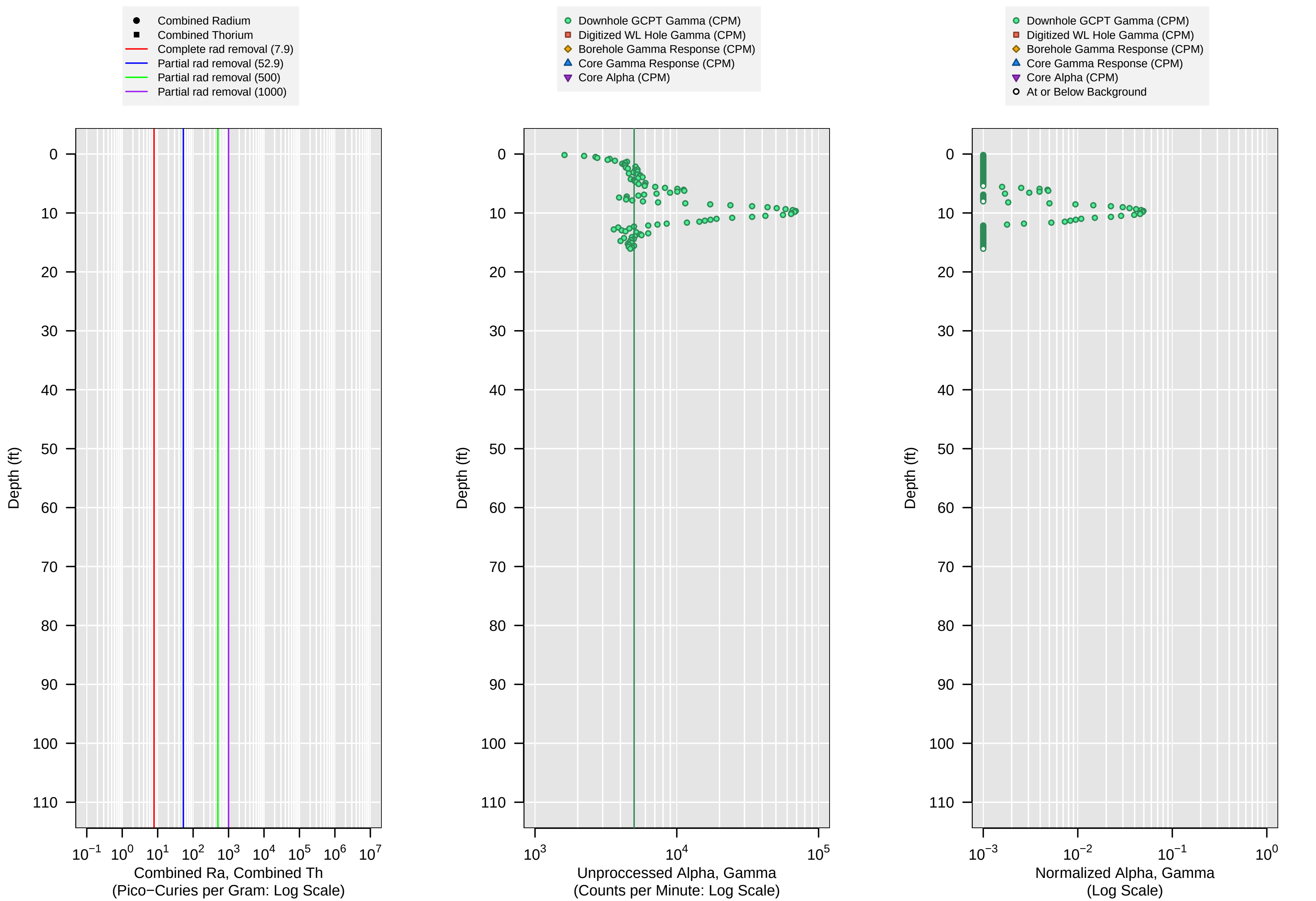
GCPT−25R



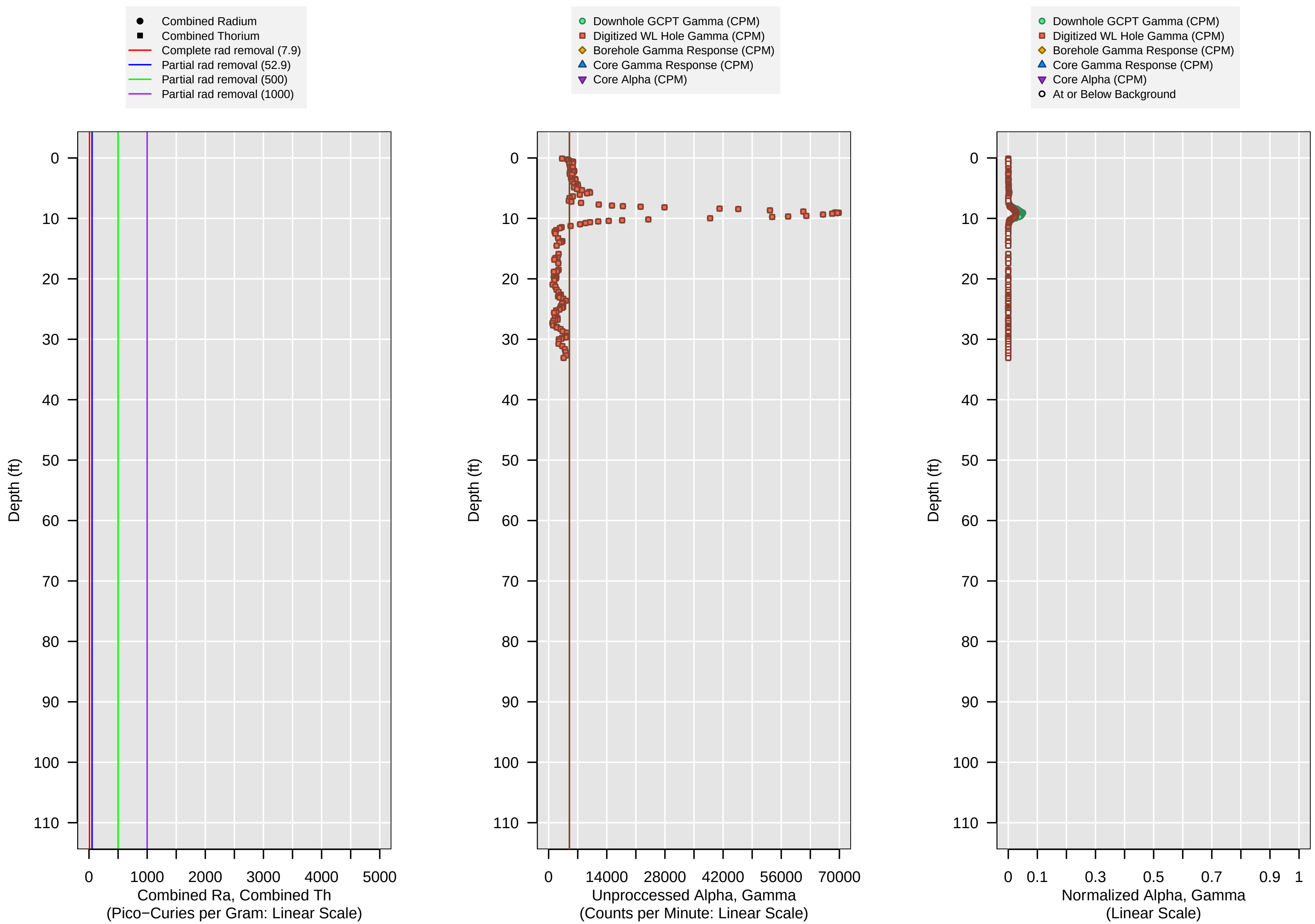
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)


GCPT−PVC−25
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

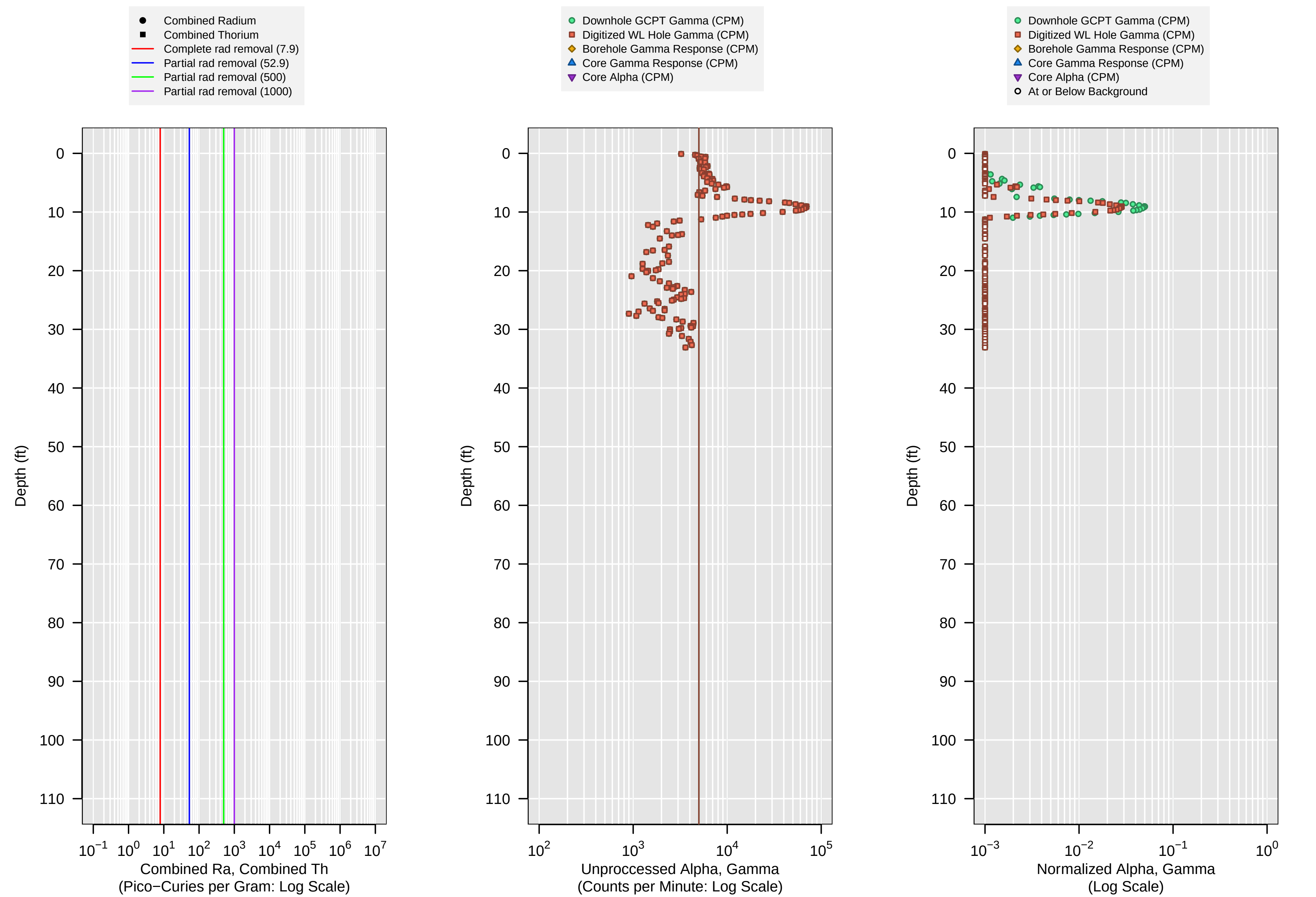
GCPT−PVC−25


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

PVC−25

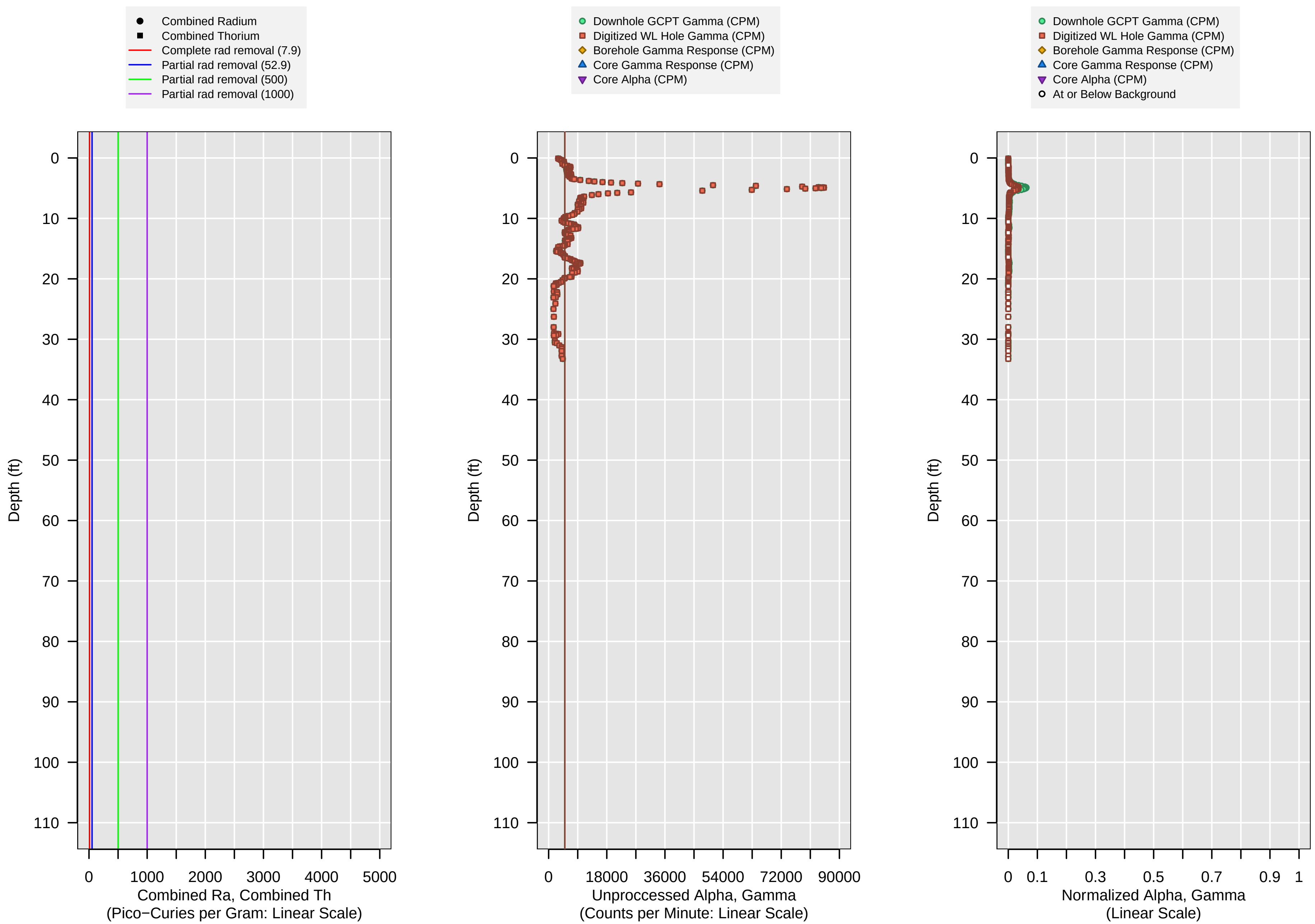

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

PVC−25



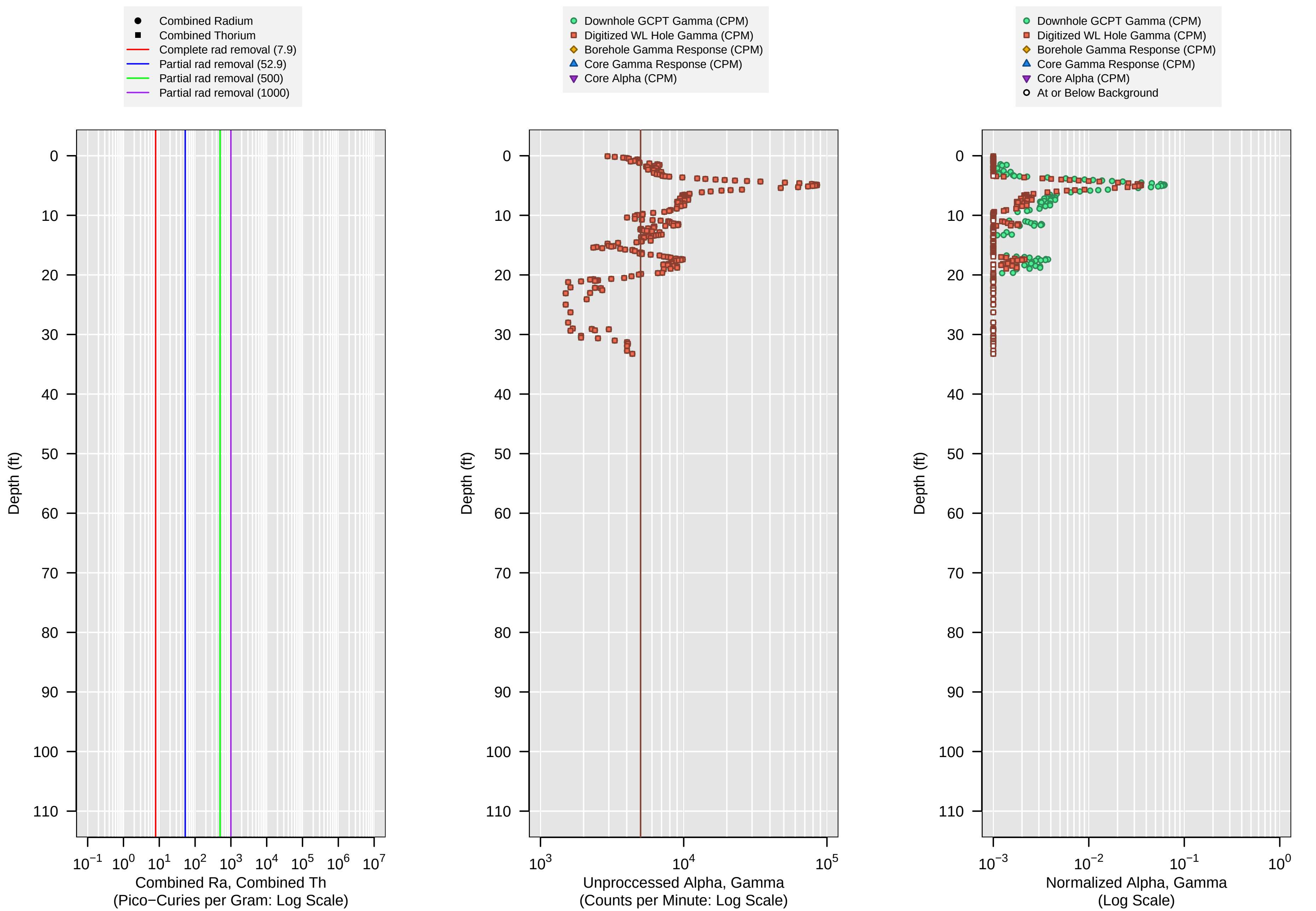
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

PVC−26

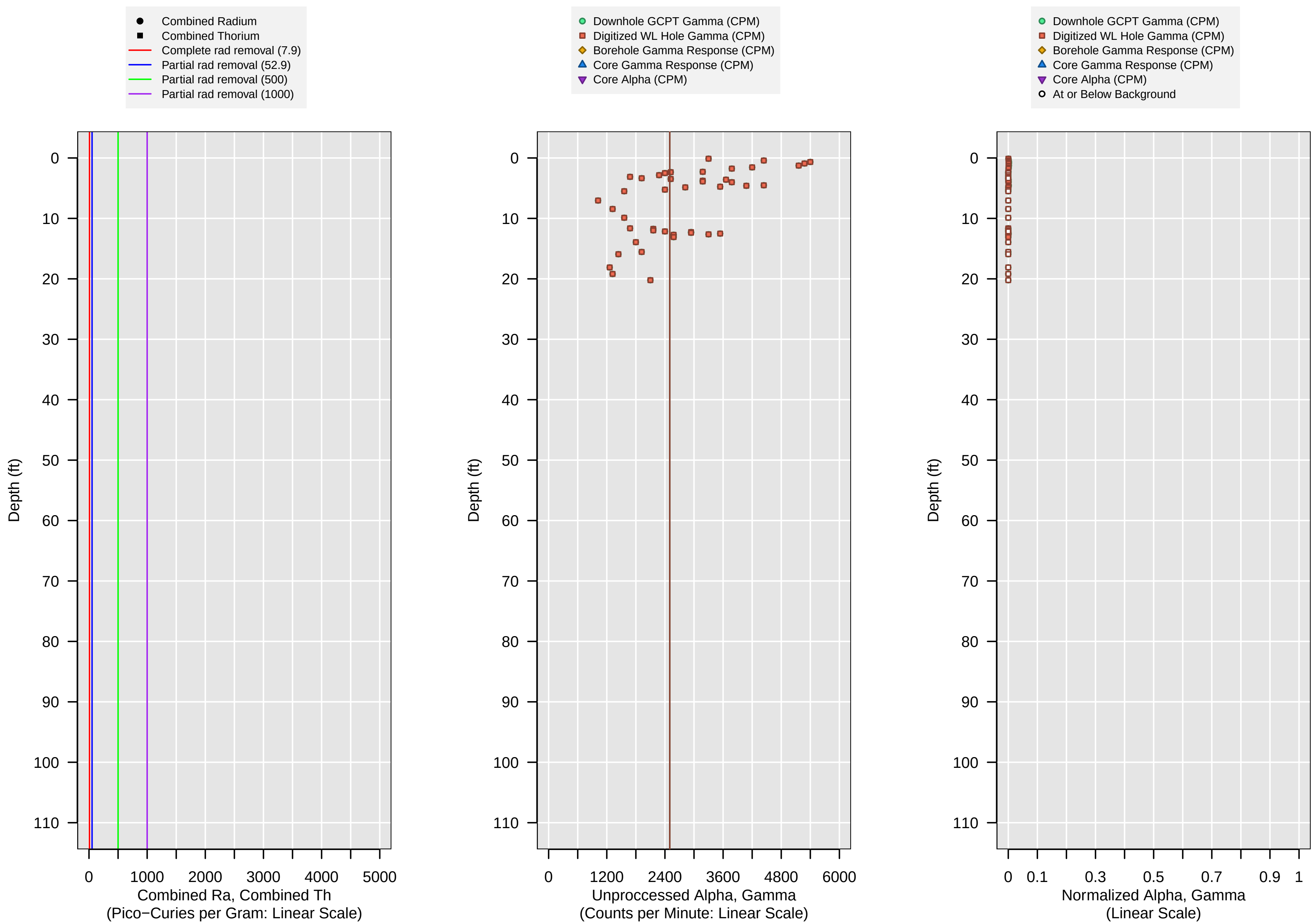


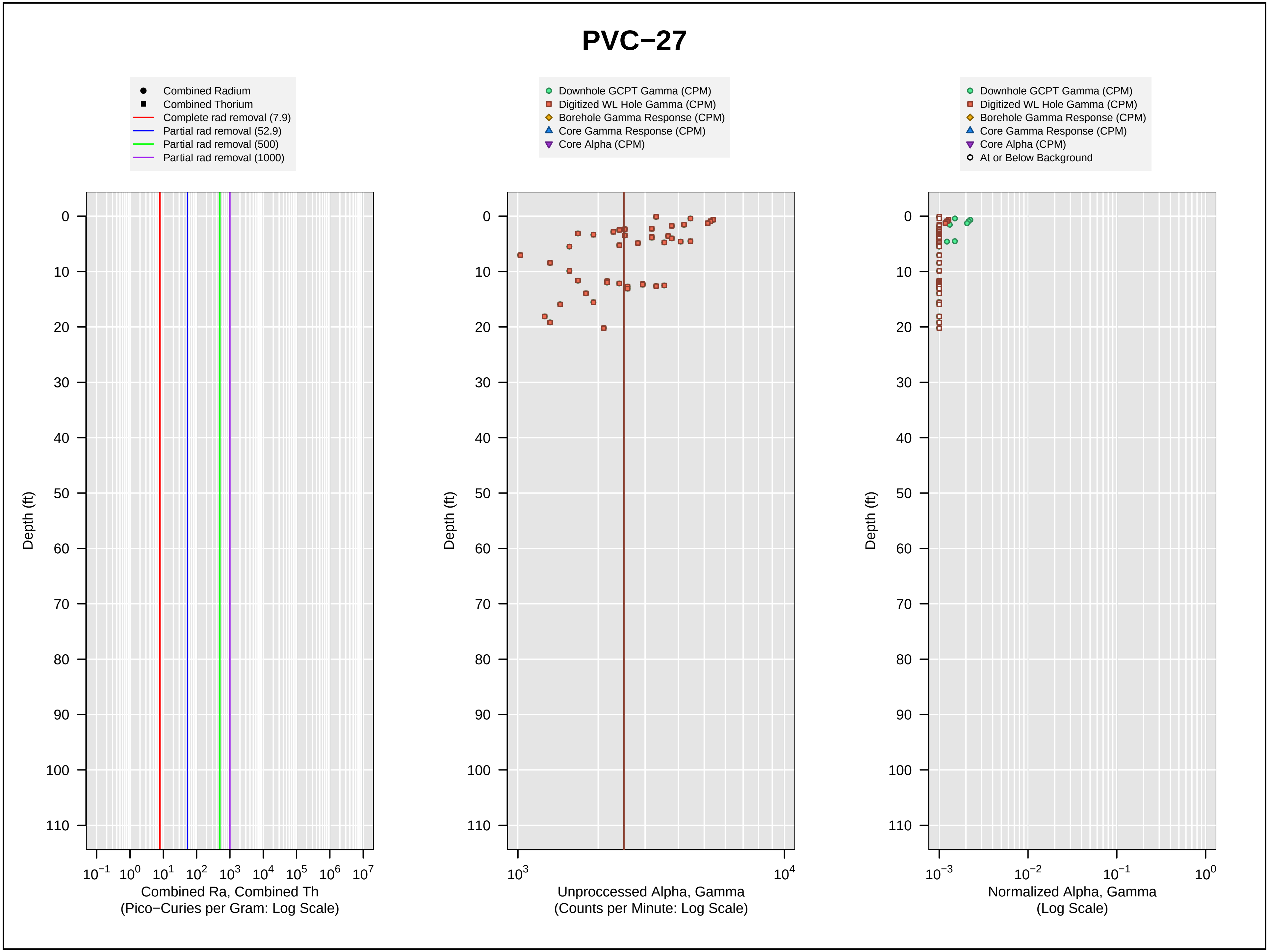
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
18000
36000
54000
72000
90000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

PVC−26

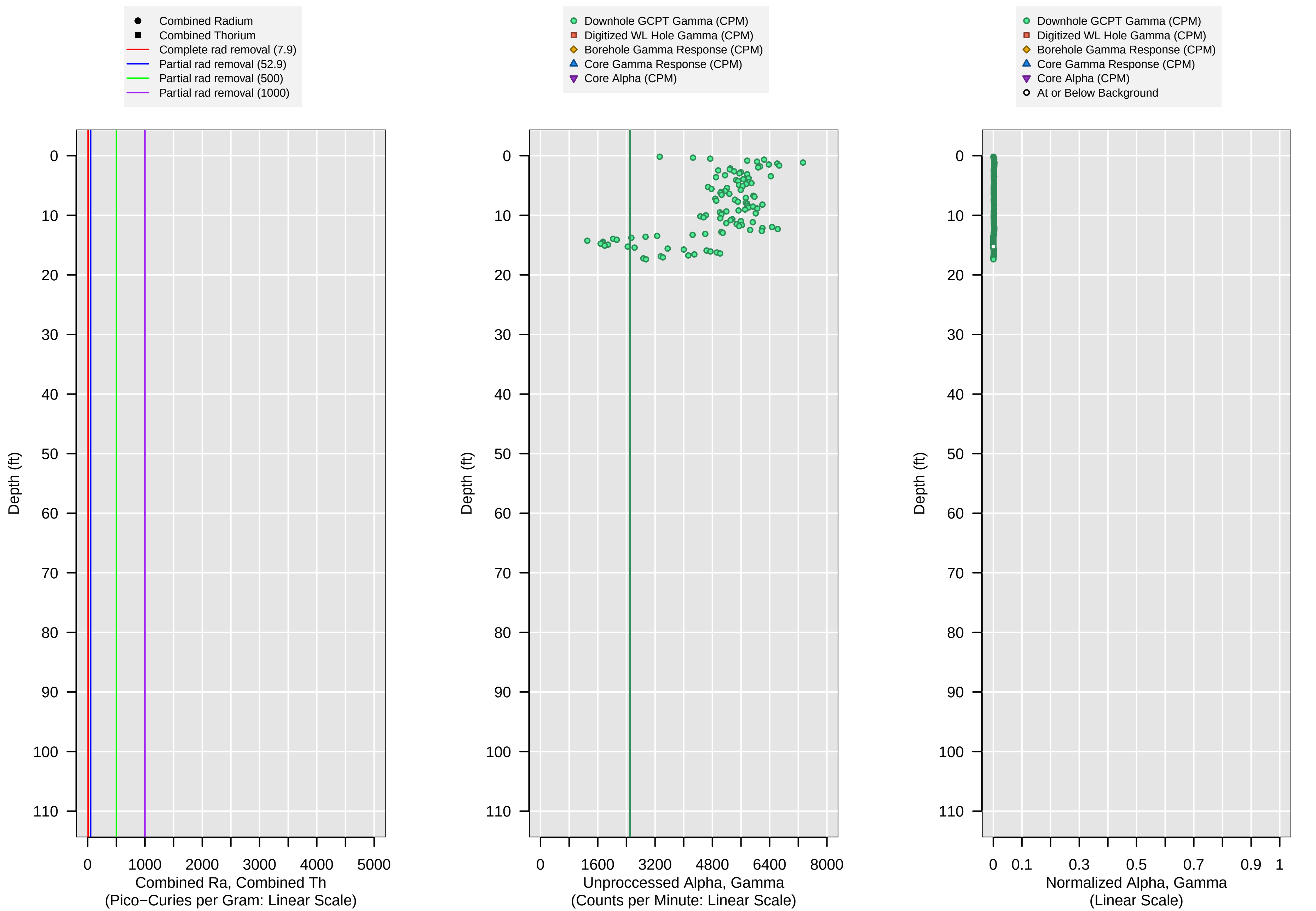

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

PVC−27

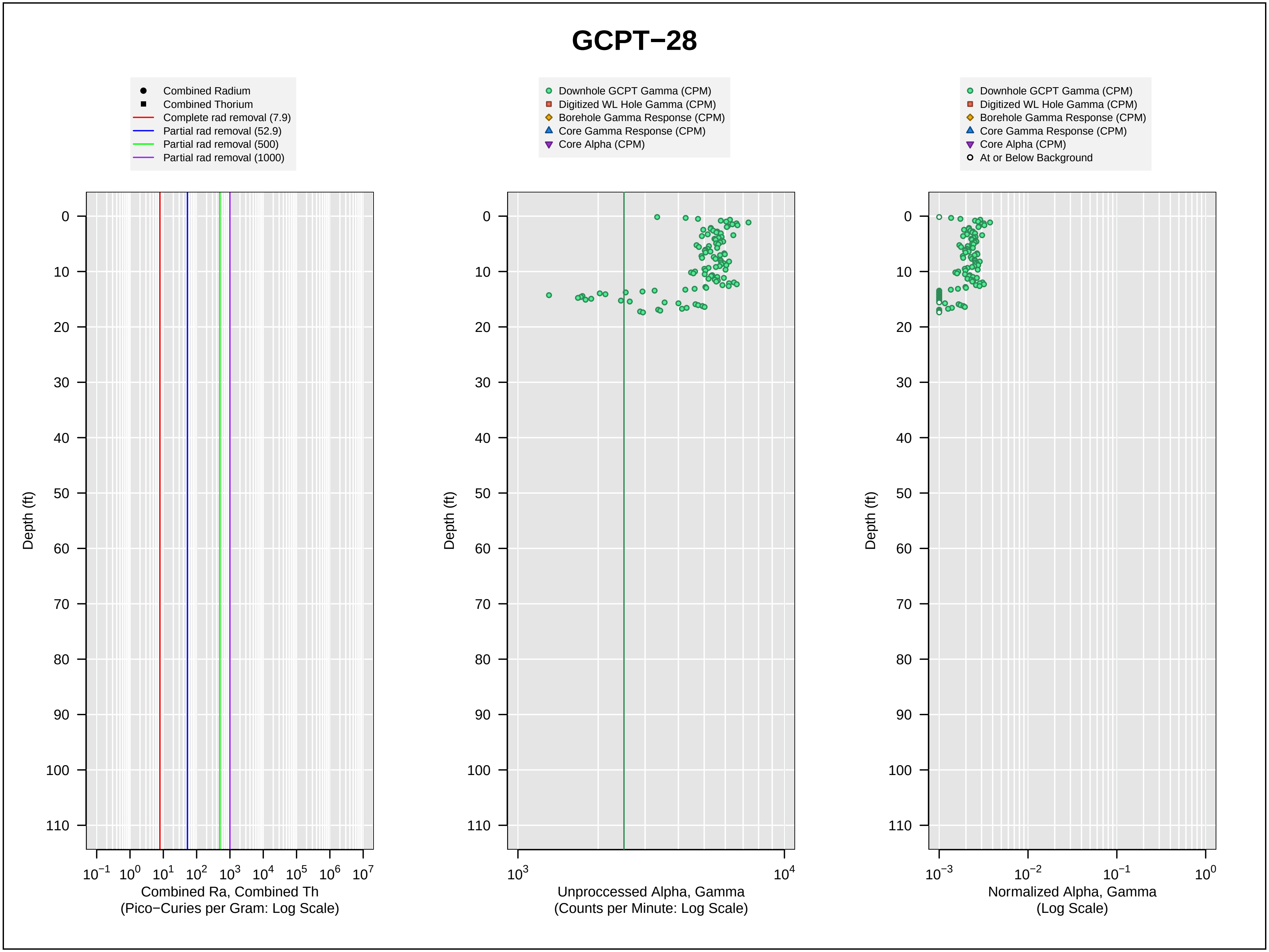

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1200
2400
3600
4800
6000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)


PVC−27
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

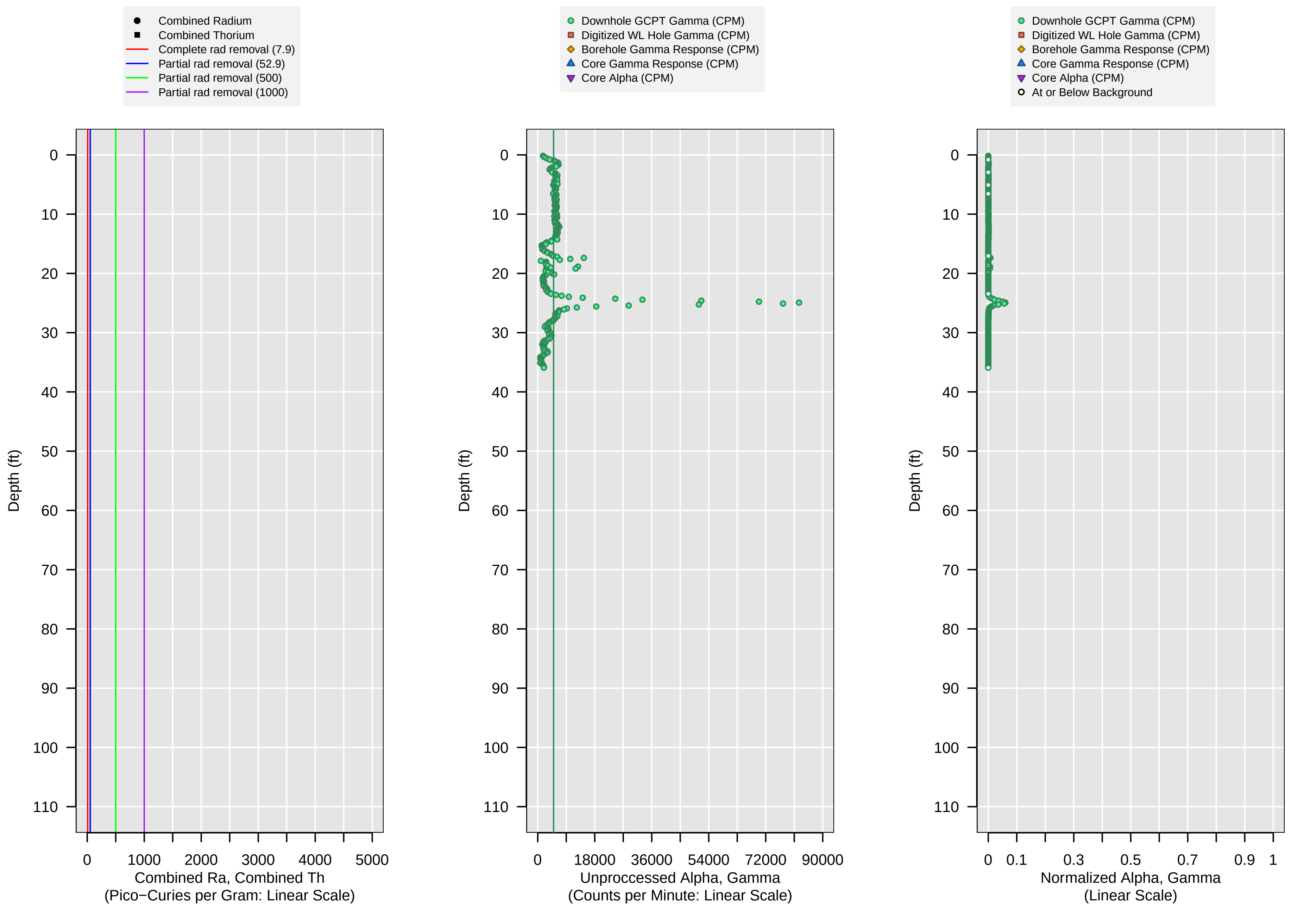
GCPT−28



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1600
3200
4800
6400
8000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

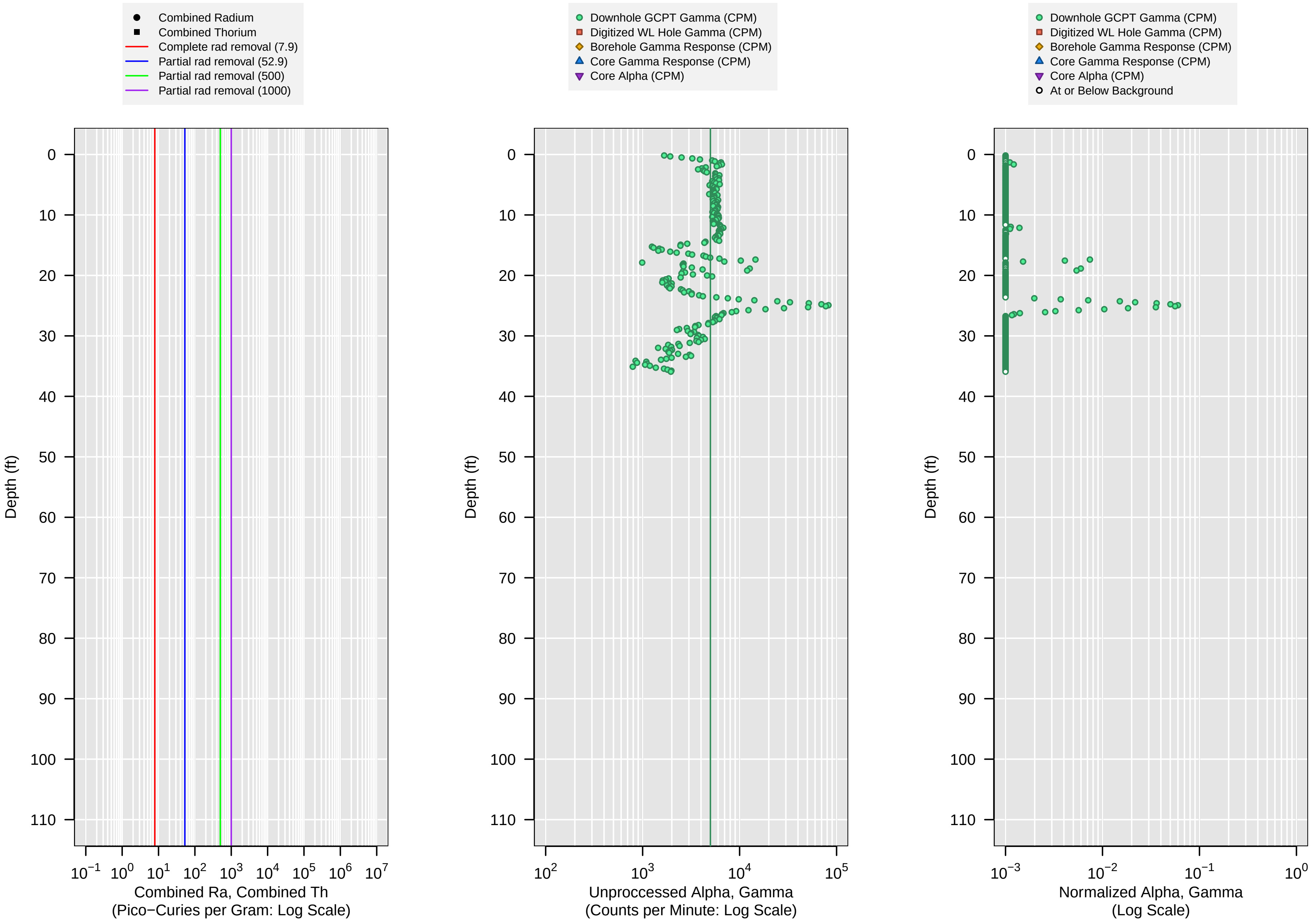

GCPT−28
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

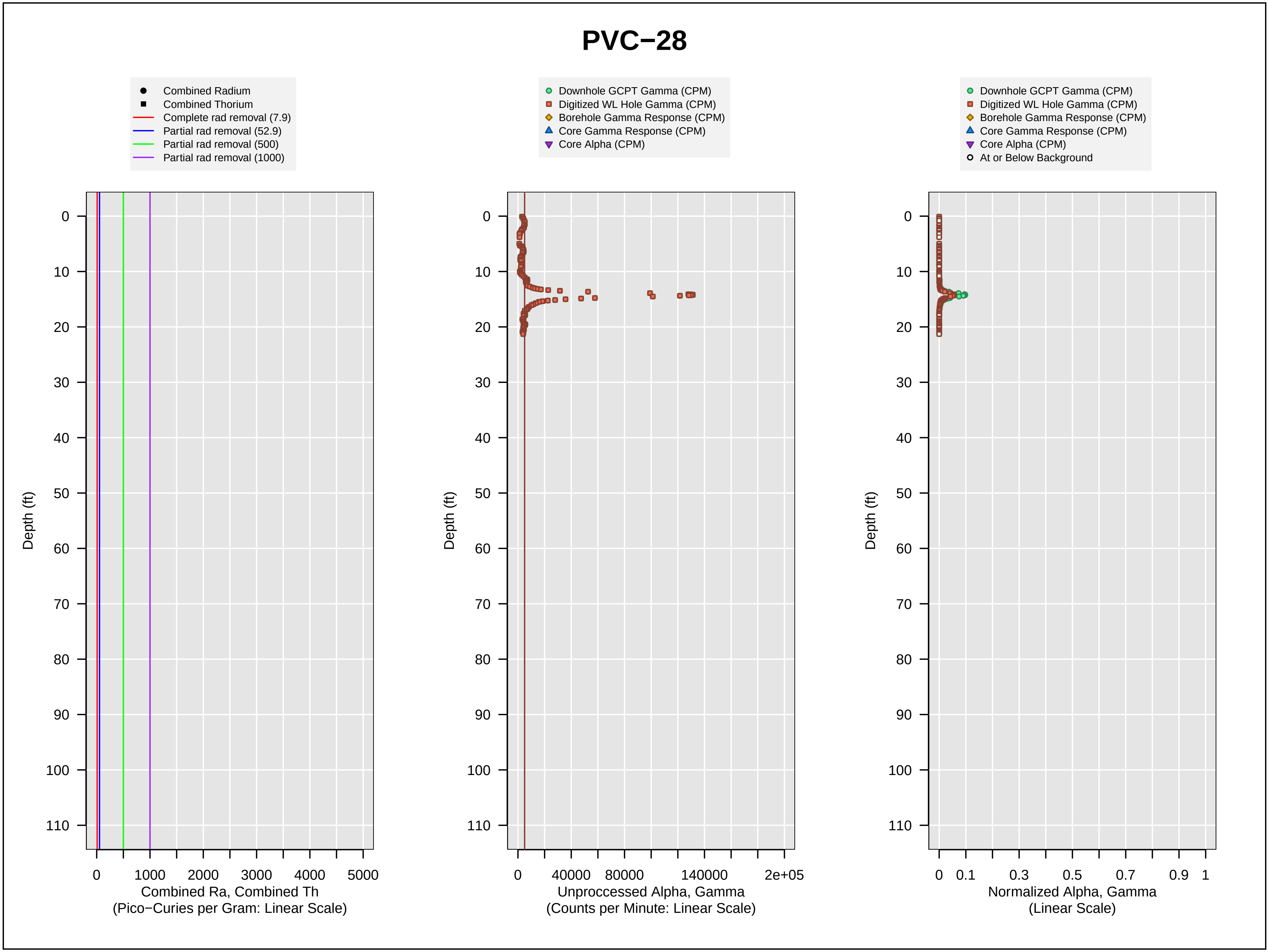
GCPT−28A



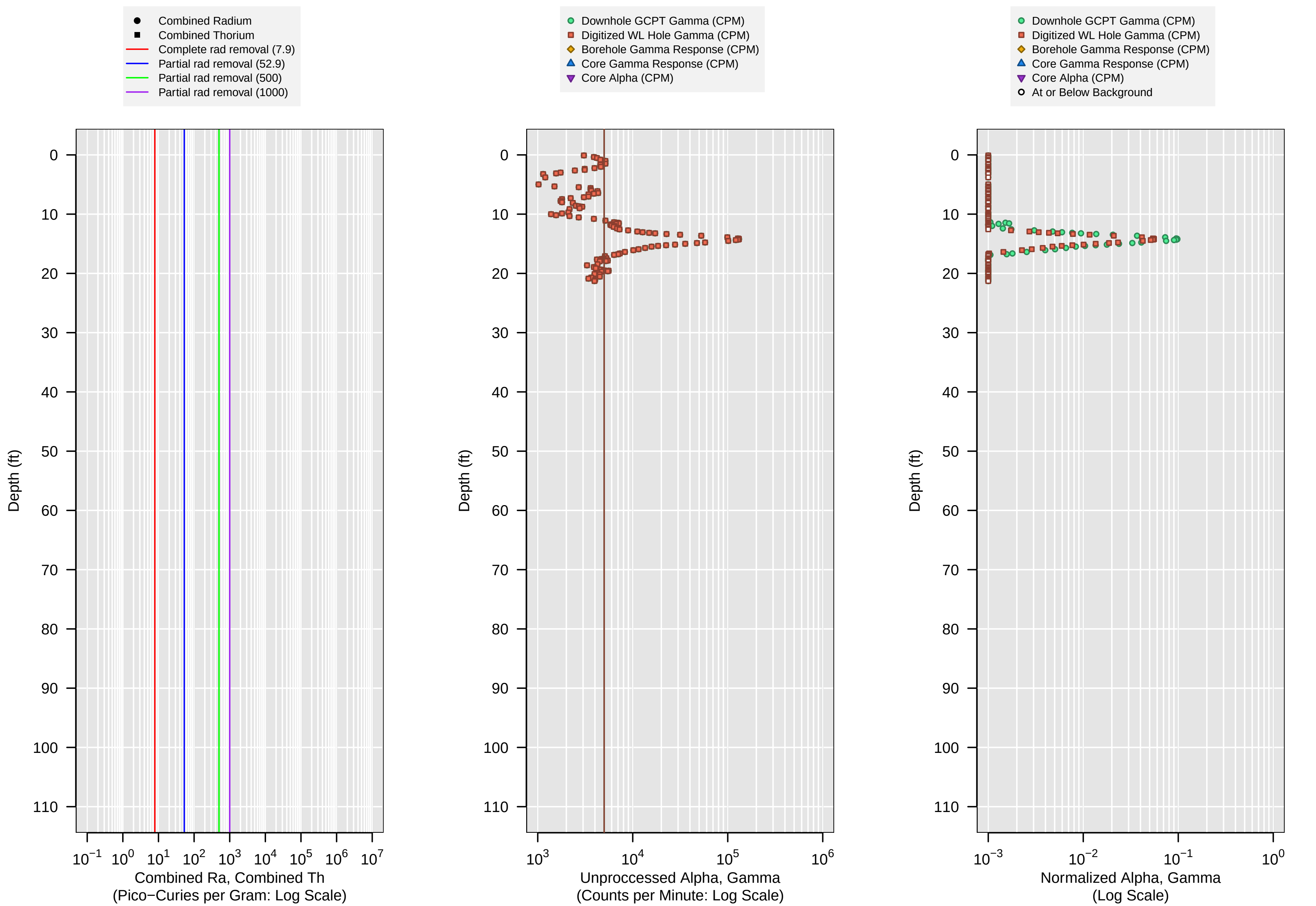
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−28A

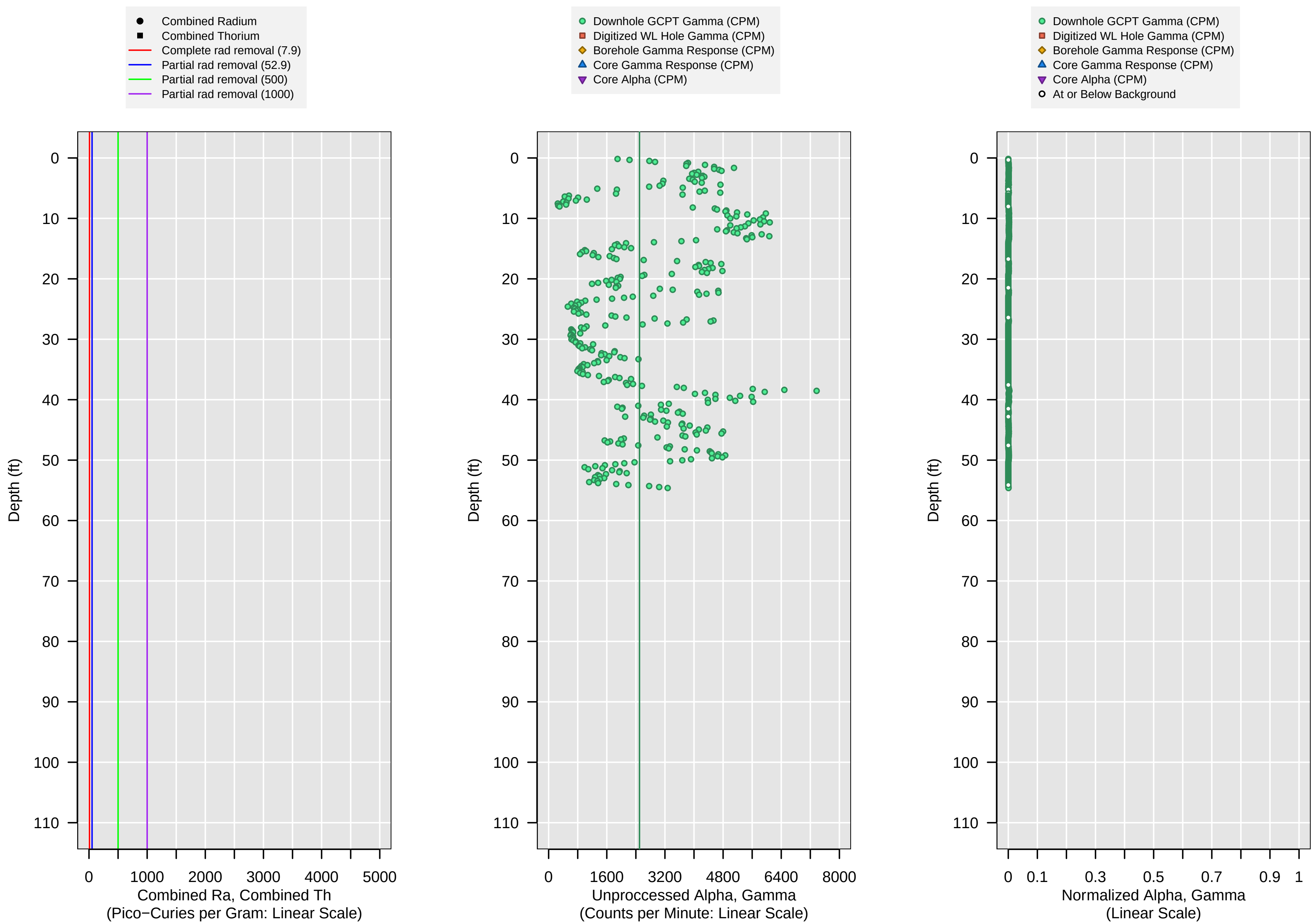

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)


PVC−28
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

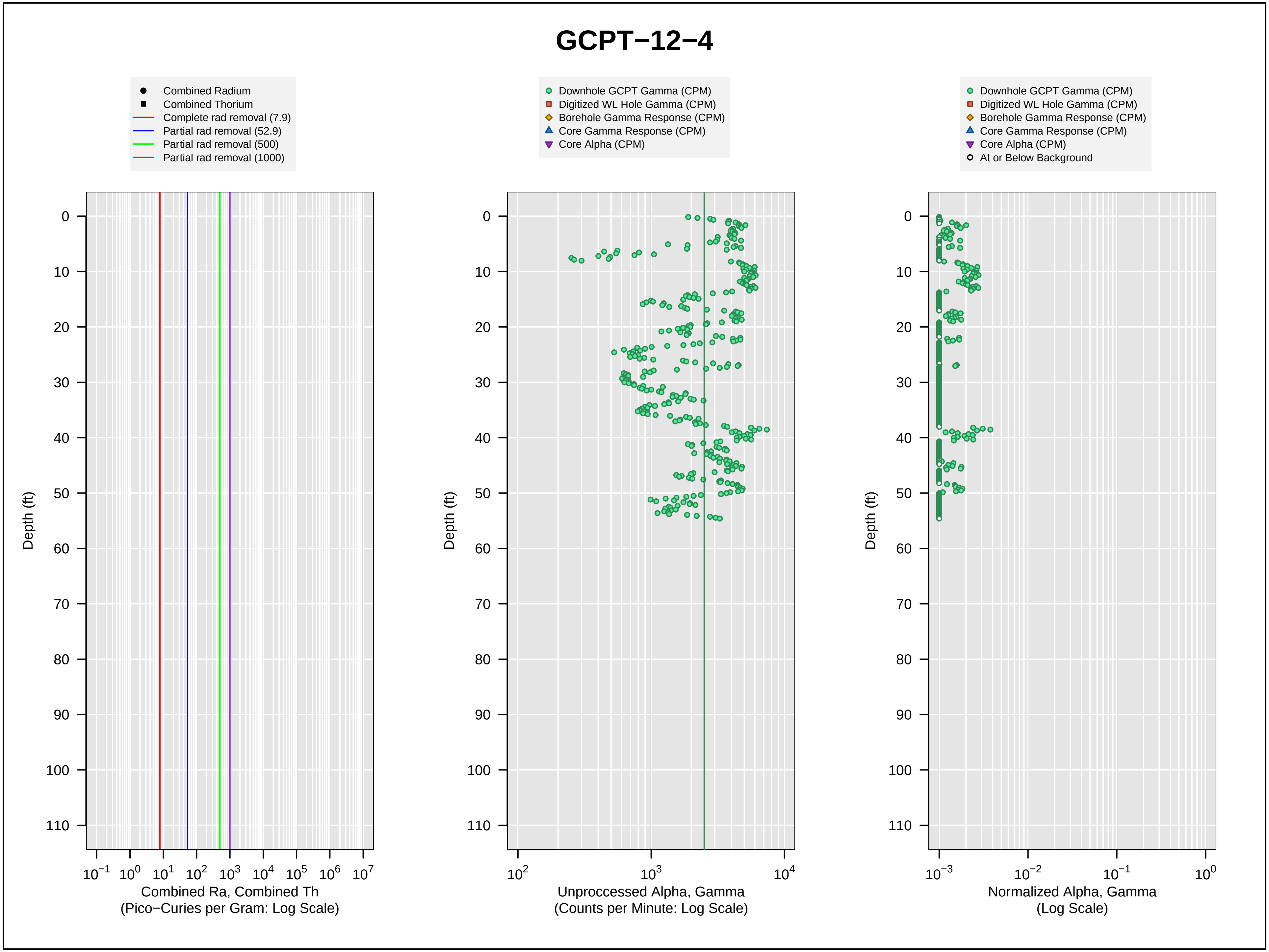
PVC−28


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

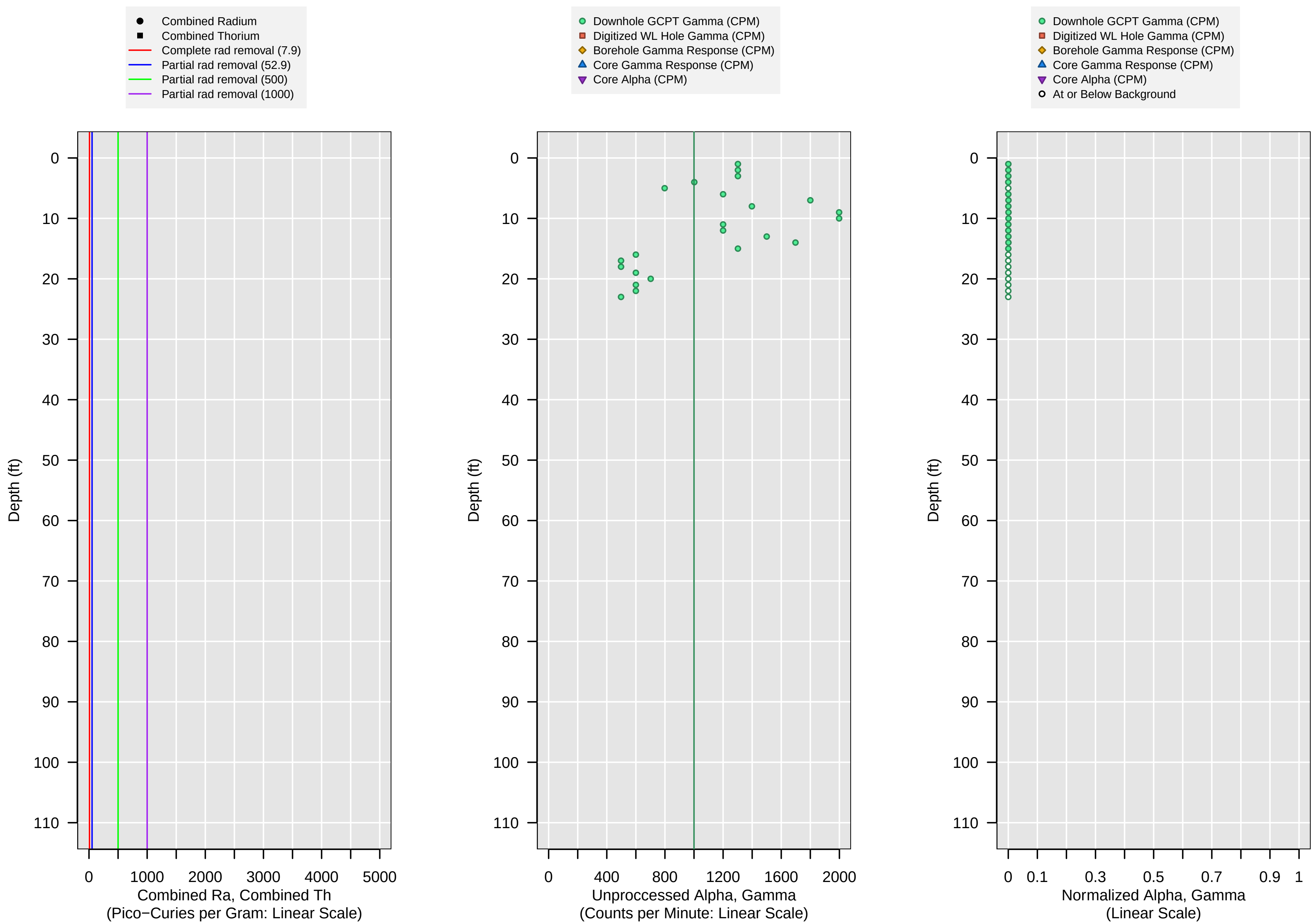
GCPT−12−4



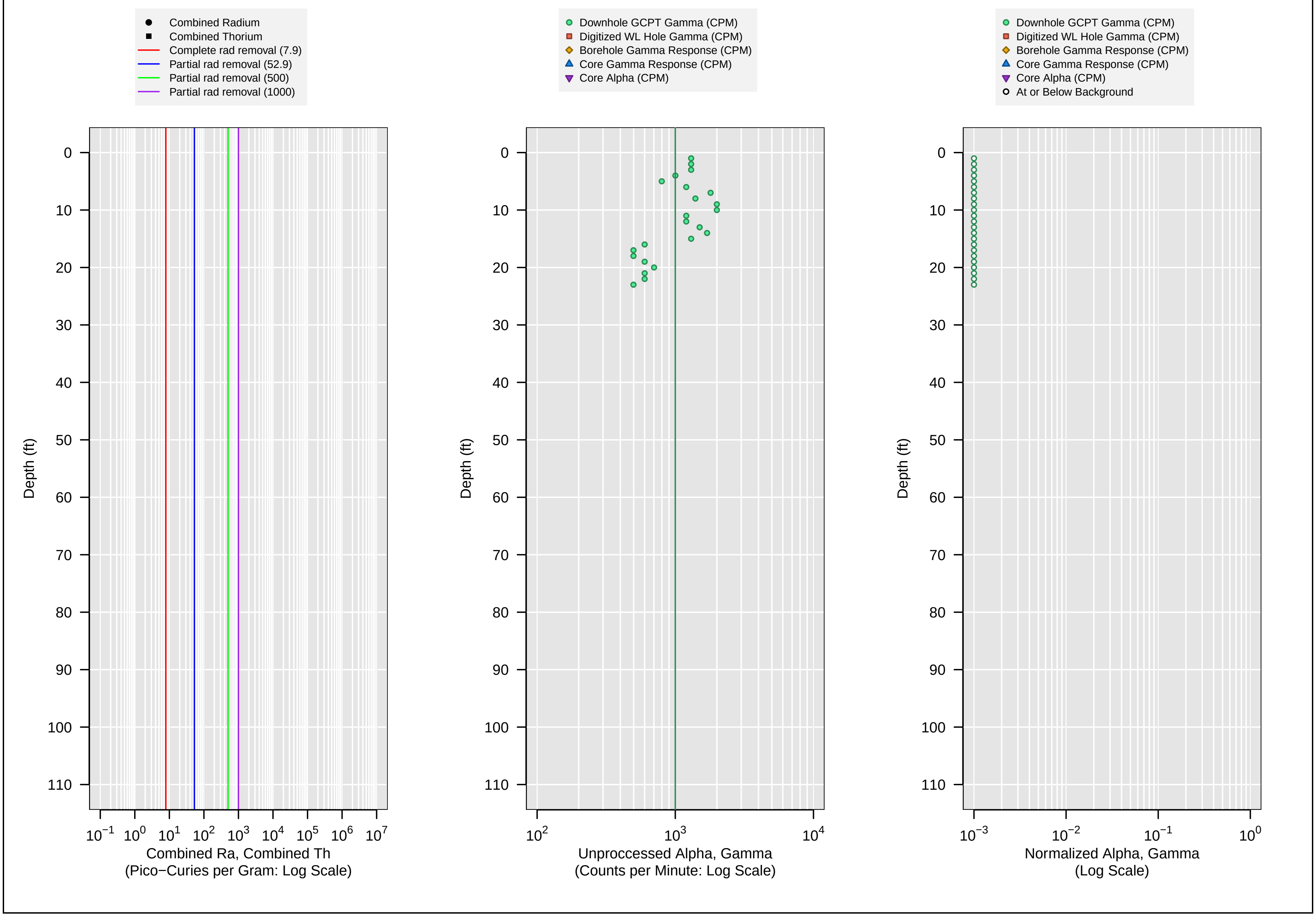
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)


GCPT−12−4
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

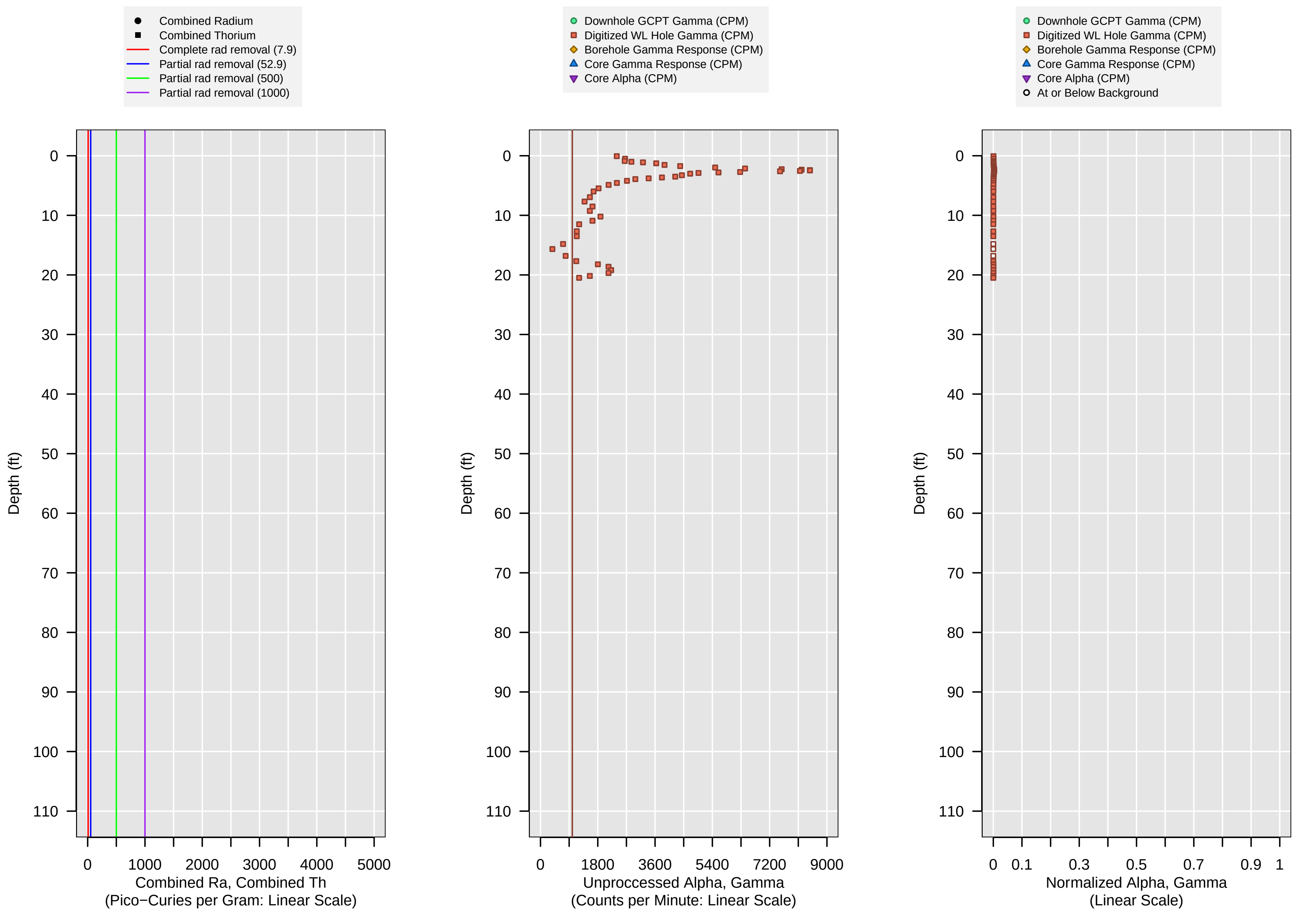
PVC−29


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
400
800
1200
1600
2000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

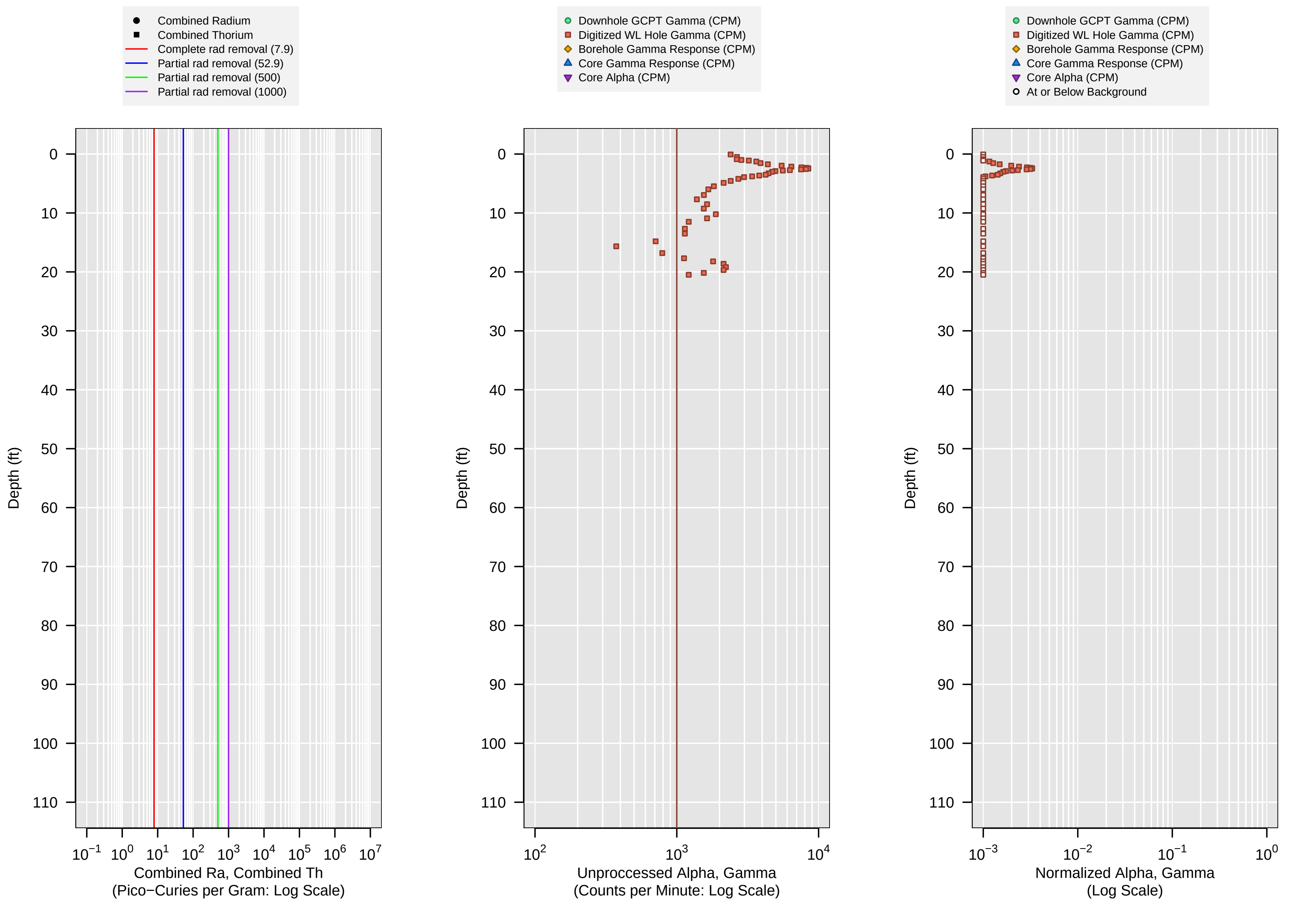
PVC−29


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

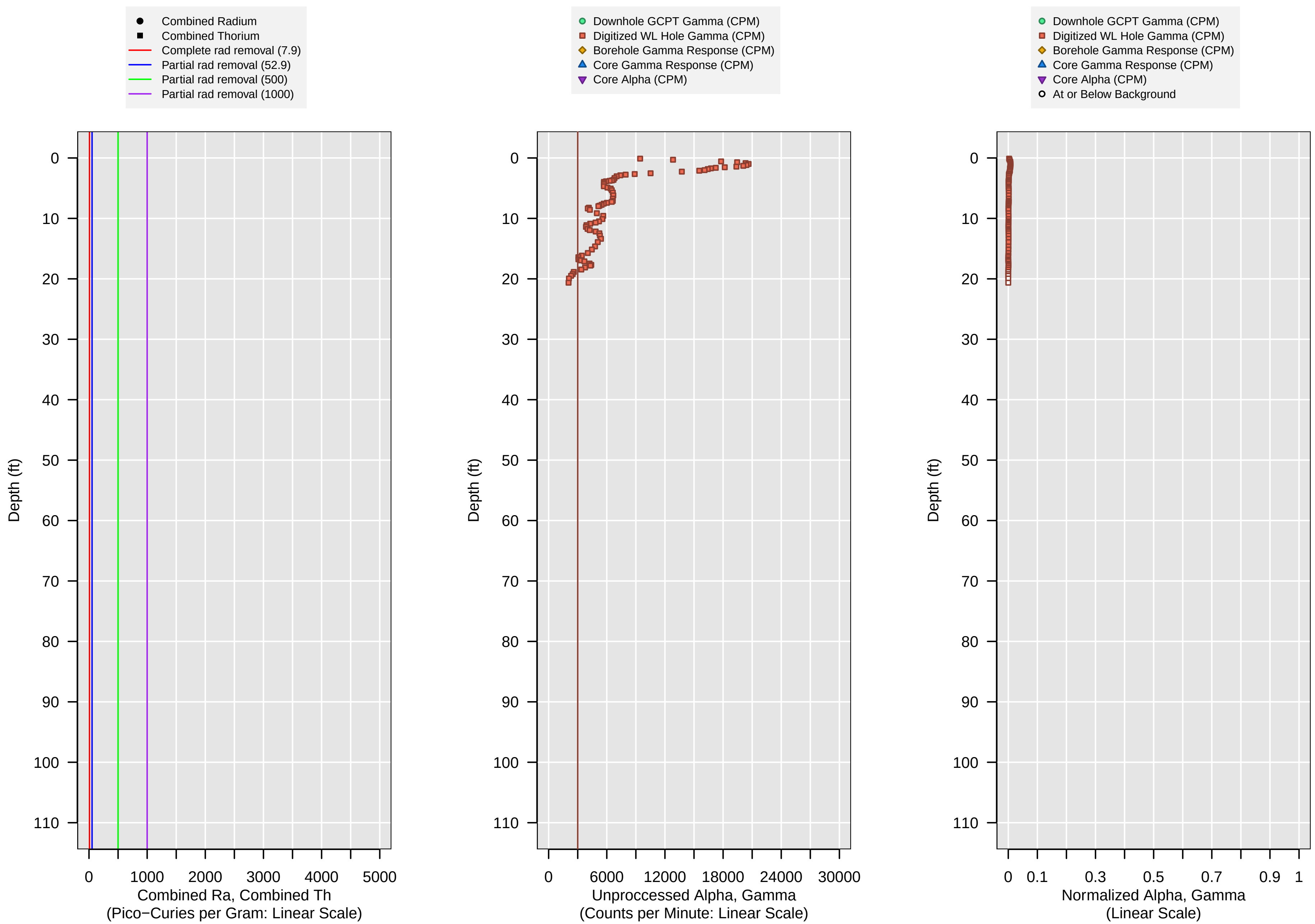
PVC−33


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
1800
3600
5400
7200
9000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

PVC−33

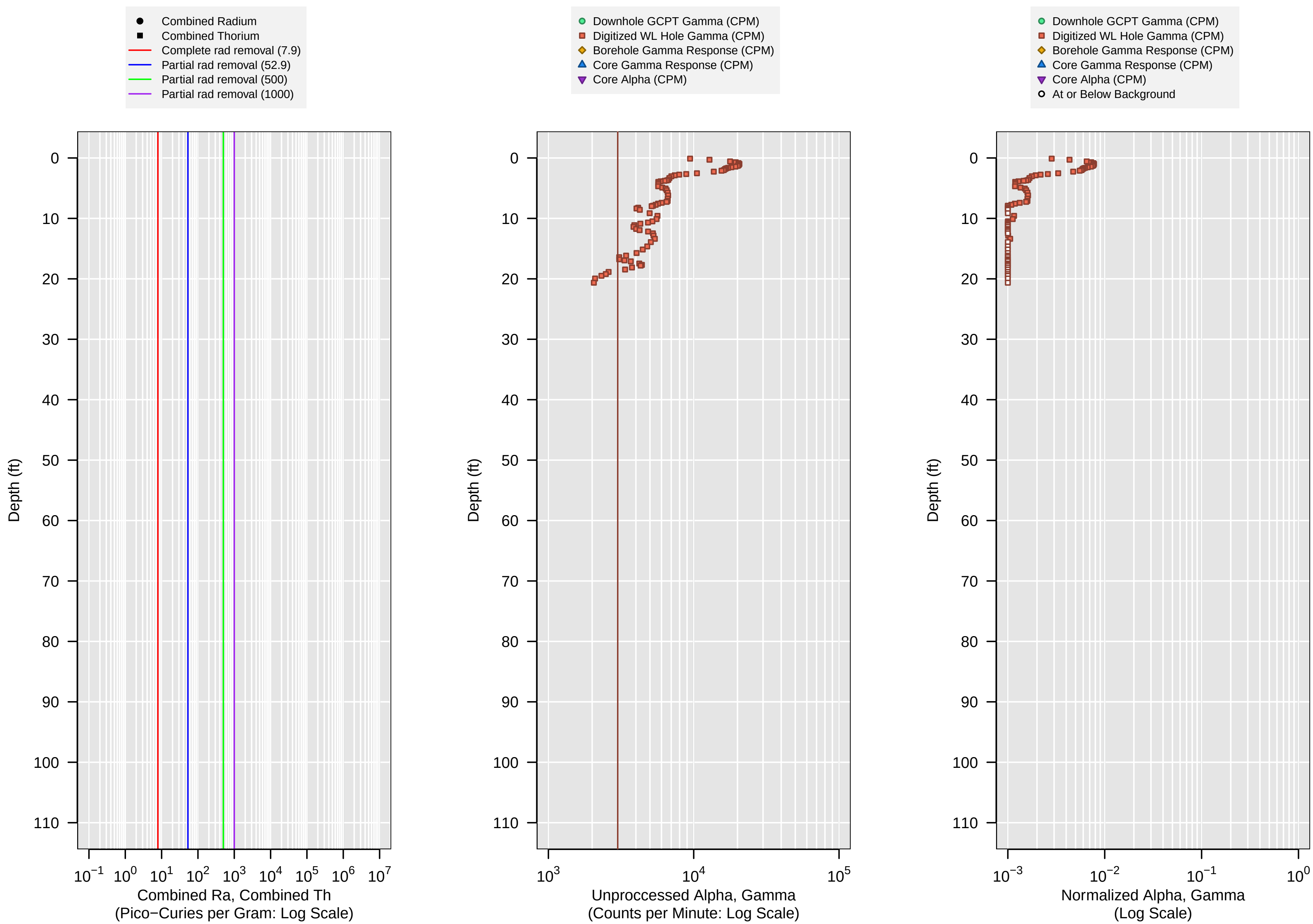

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

PVC−34



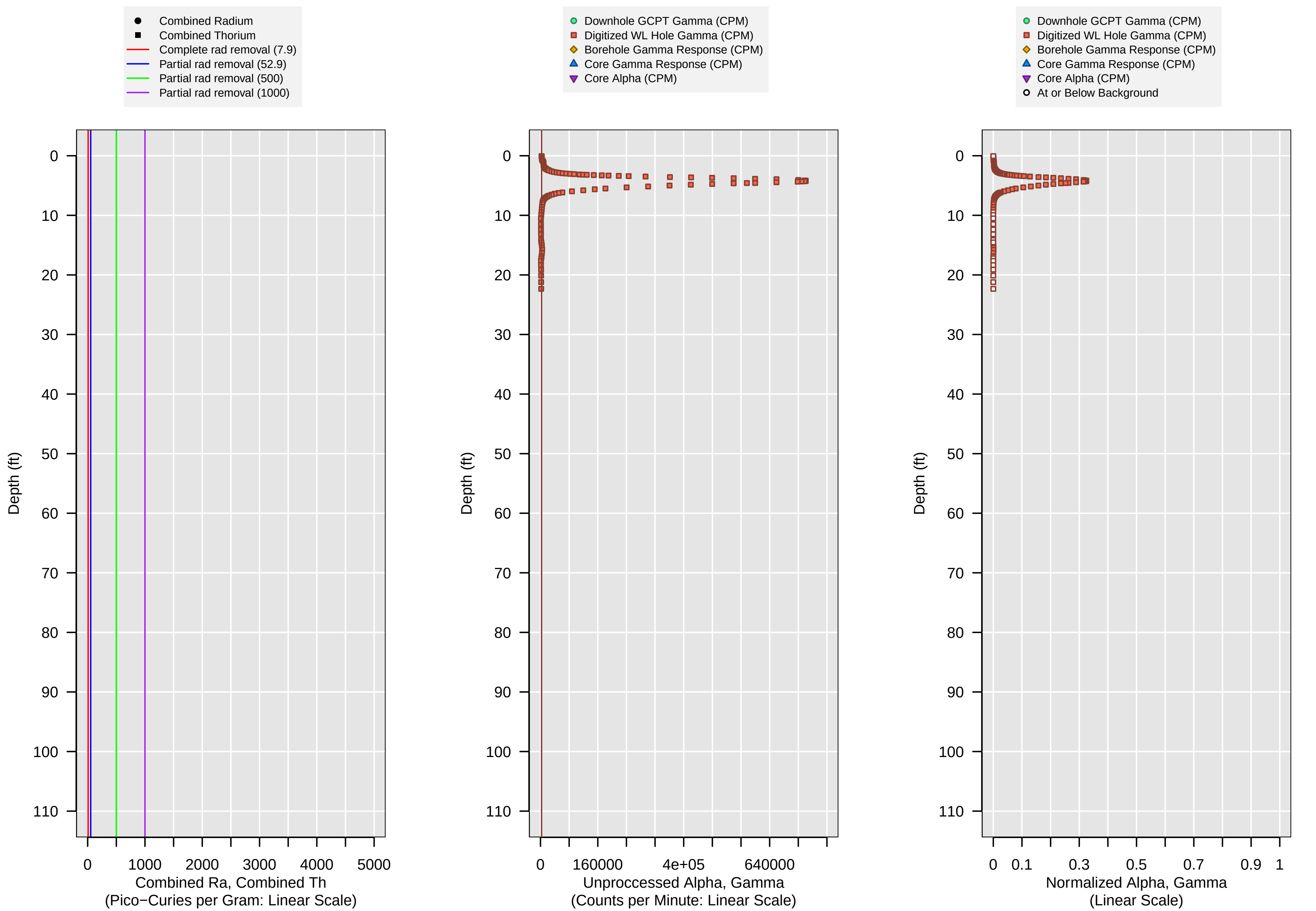
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
6000
12000
18000
24000
30000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

PVC−34

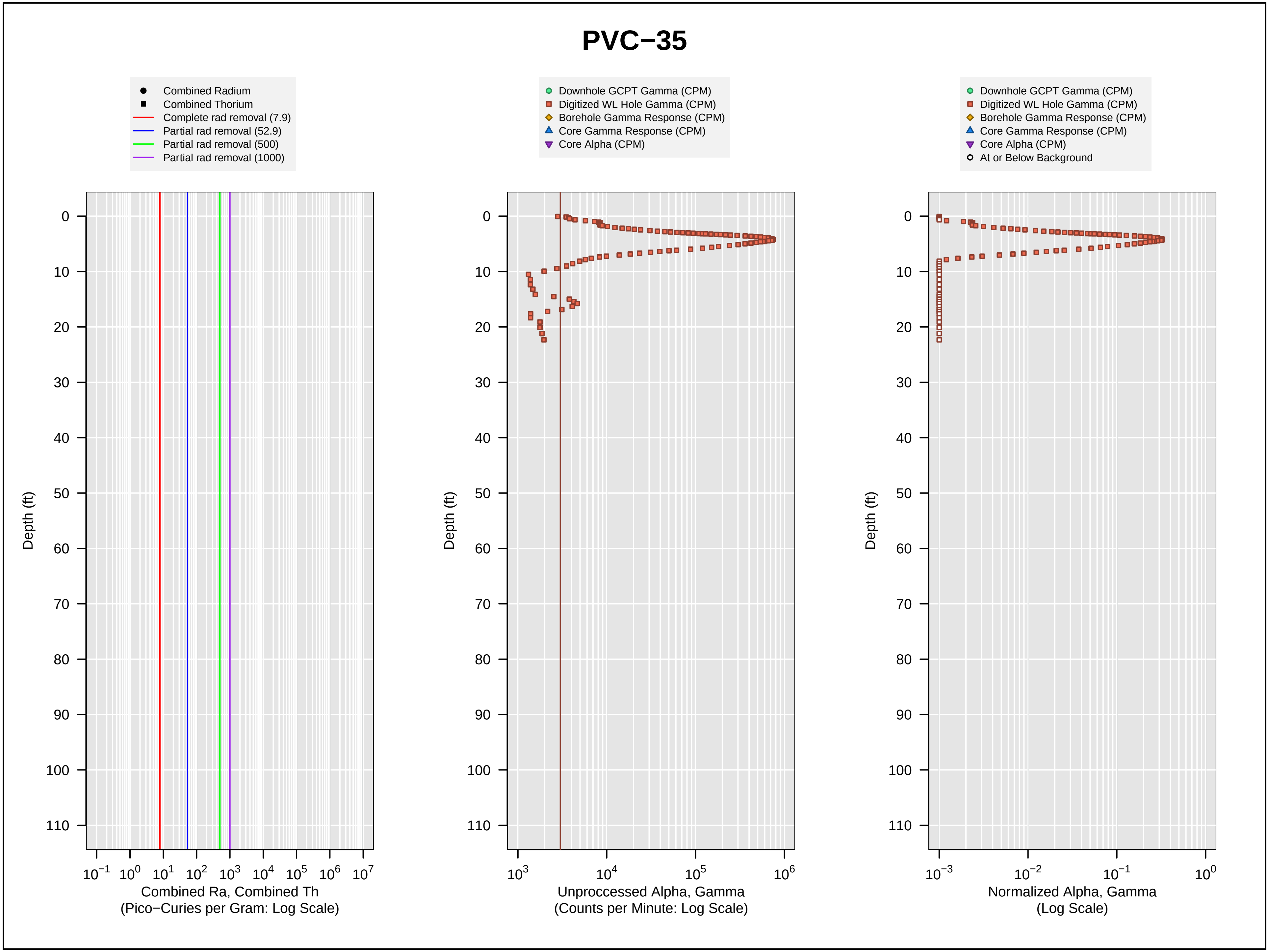


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{-1} 10^{0} 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6} 10^{7}
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
10^{3} 10^{4} 10^{5}
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
10^{-3} 10^{-2} 10^{-1} 10^{0}
Normalized Alpha, Gamma
(Log Scale)

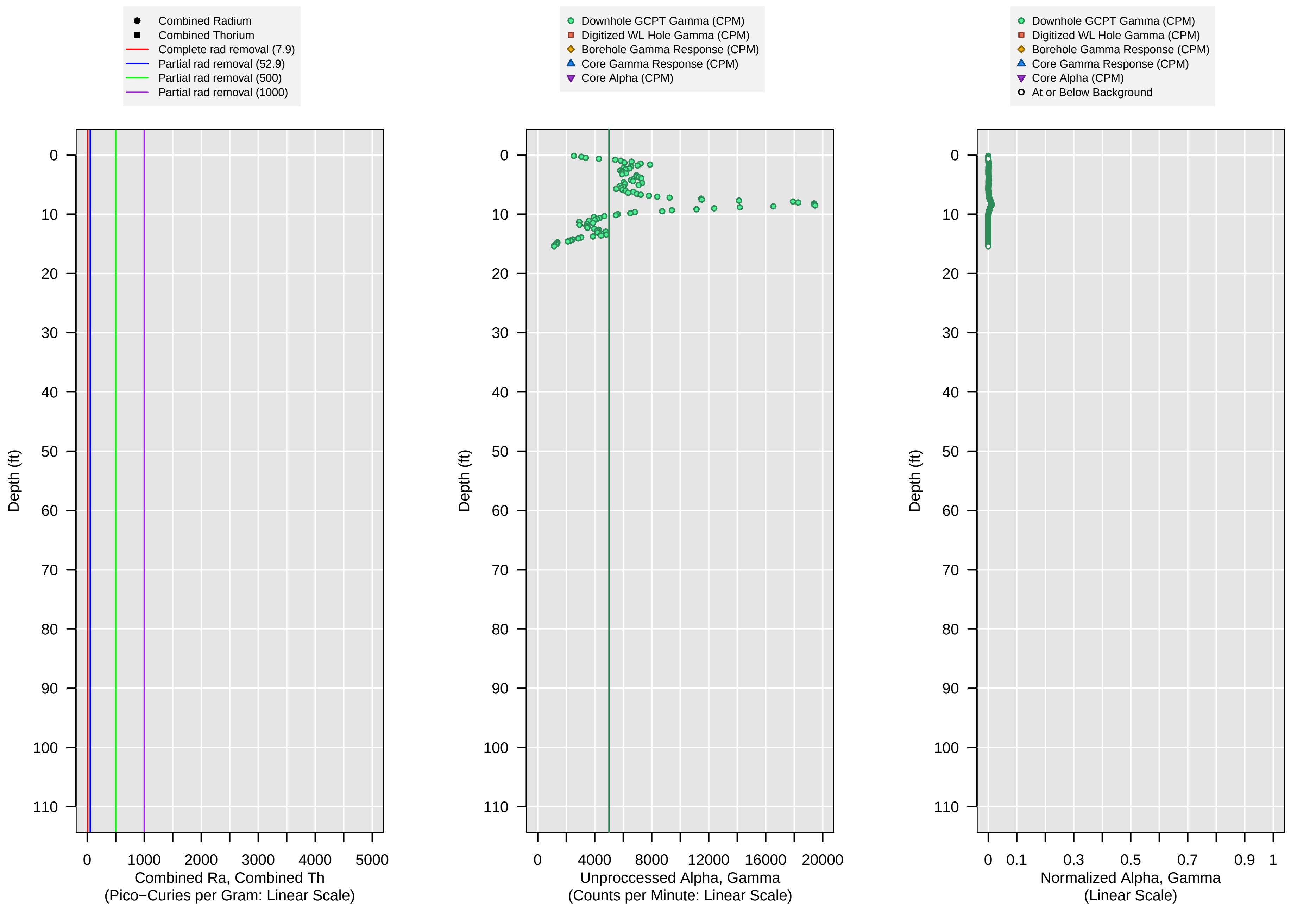
PVC−35



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
160000
4e+05
640000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

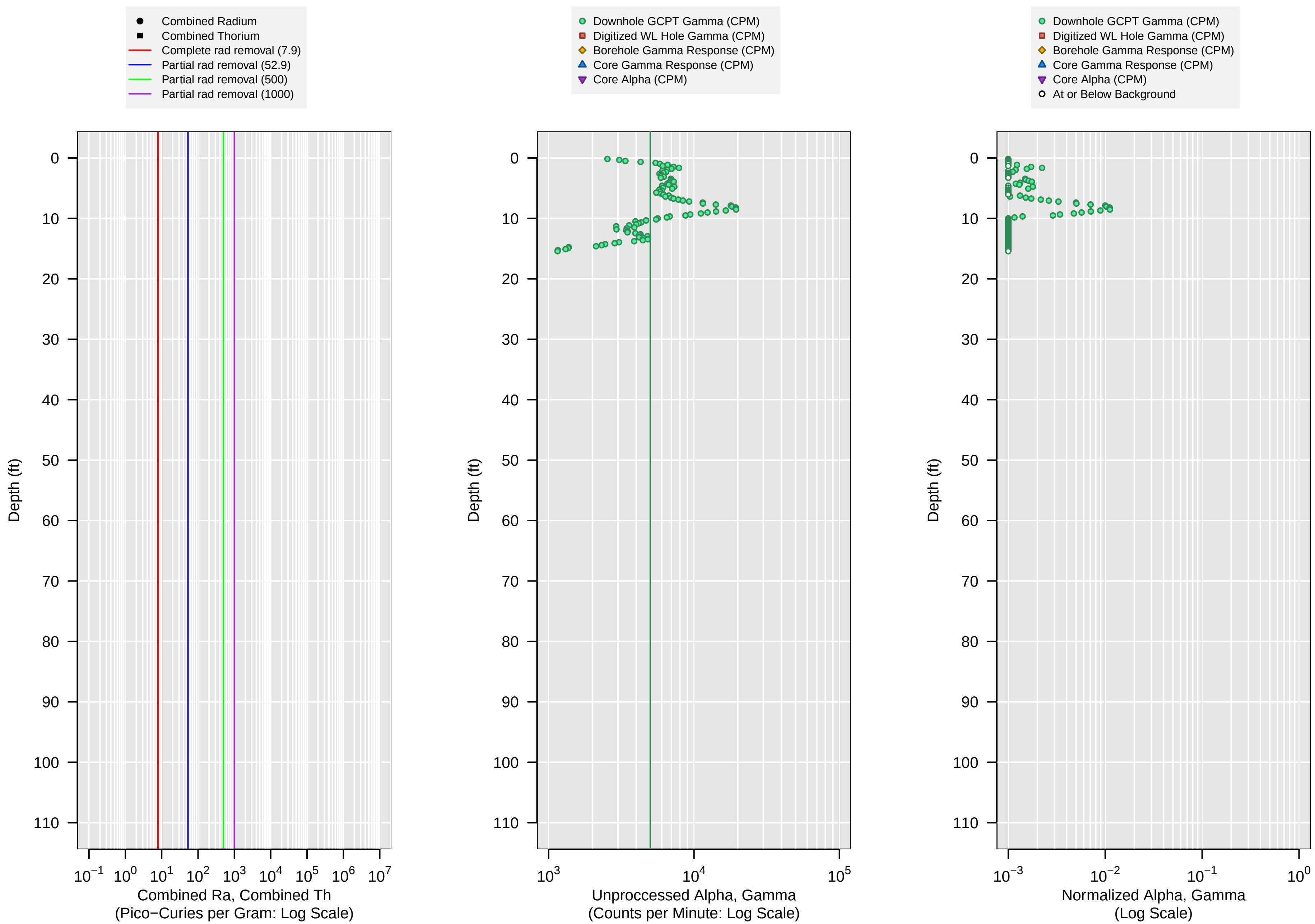

PVC−35
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

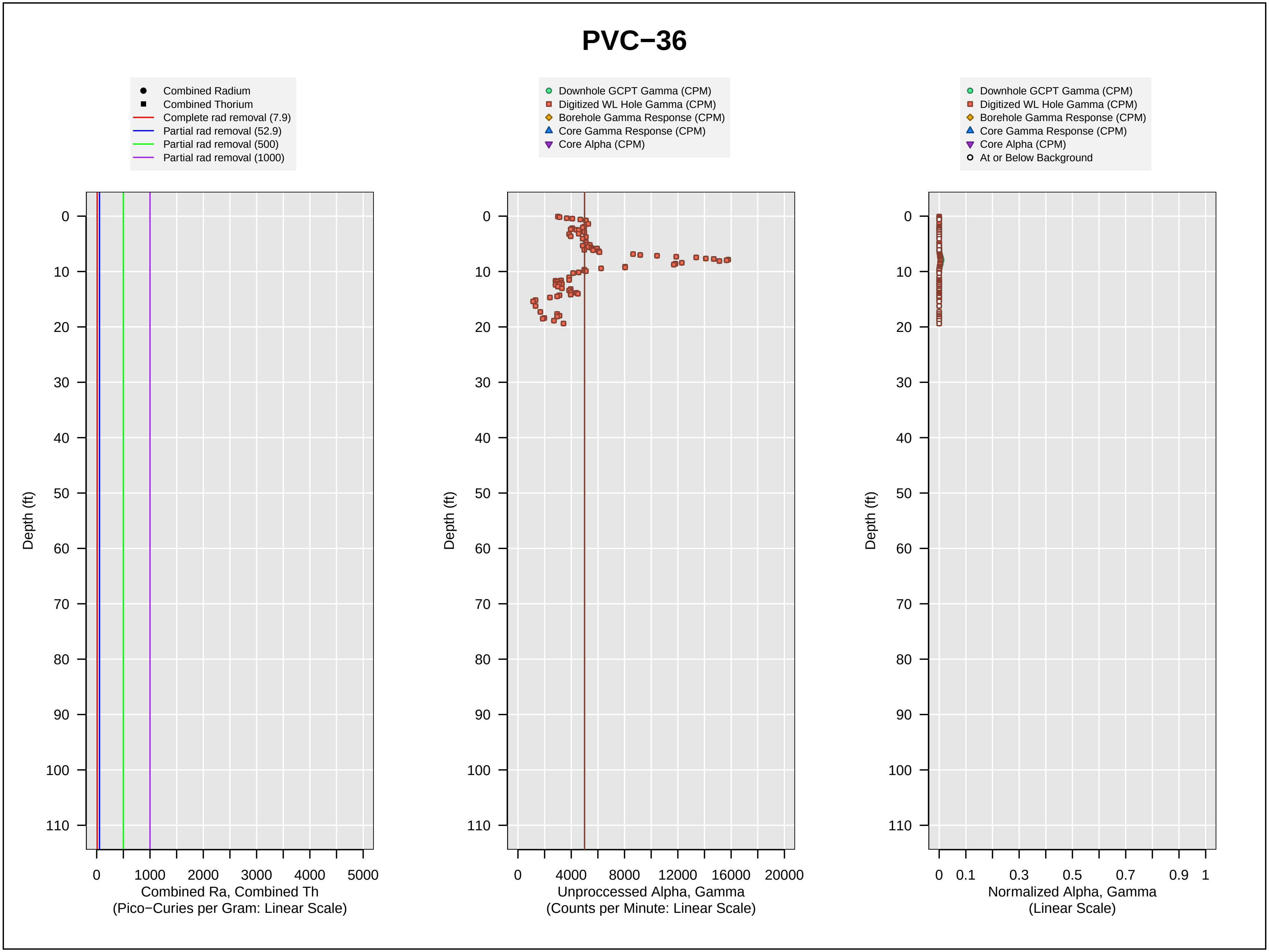
GCPT−36



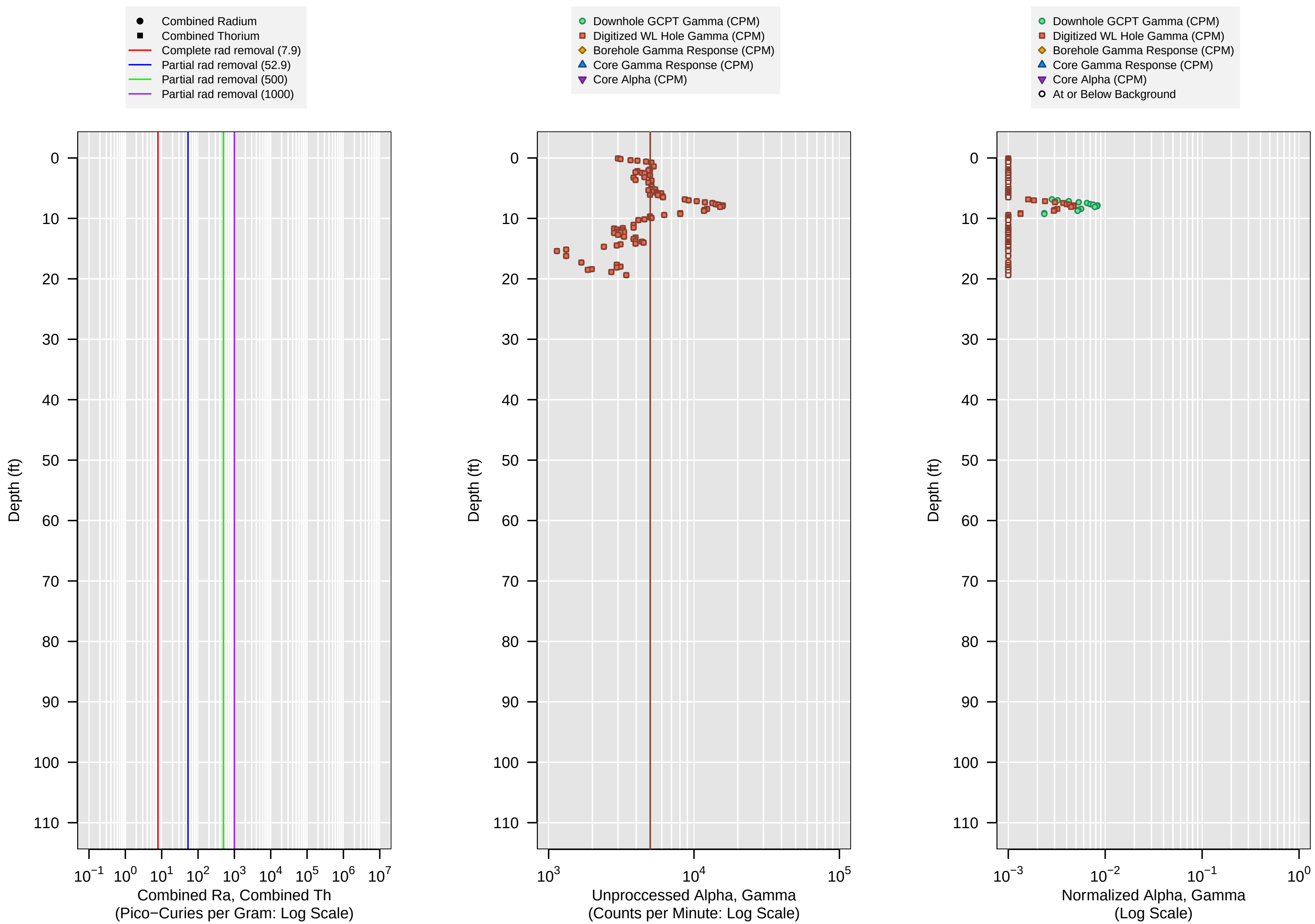
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 1000 2000 3000 4000 5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0 4000 8000 12000 16000 20000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

GCPT−36


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

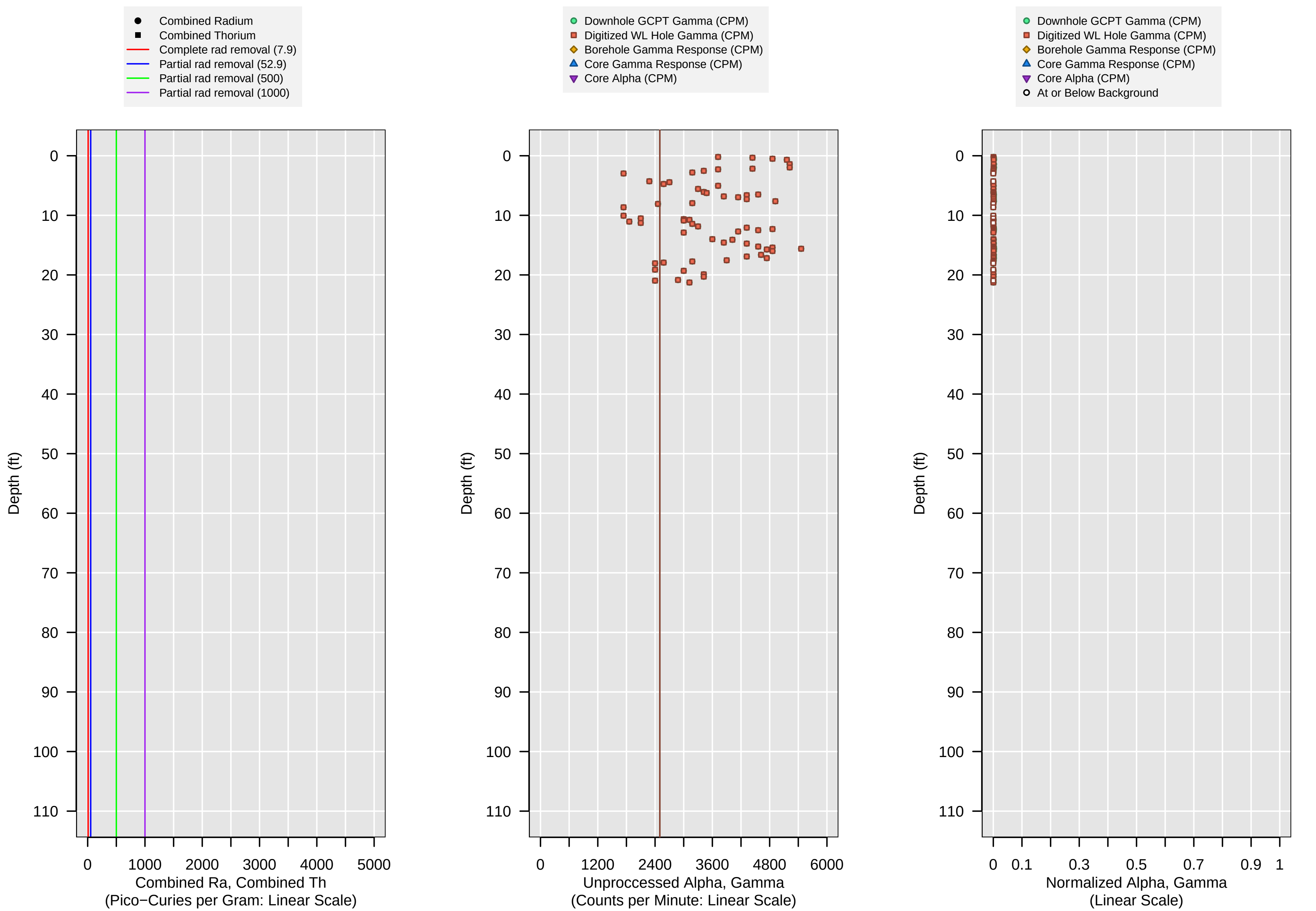

PVC−36
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Linear Scale)

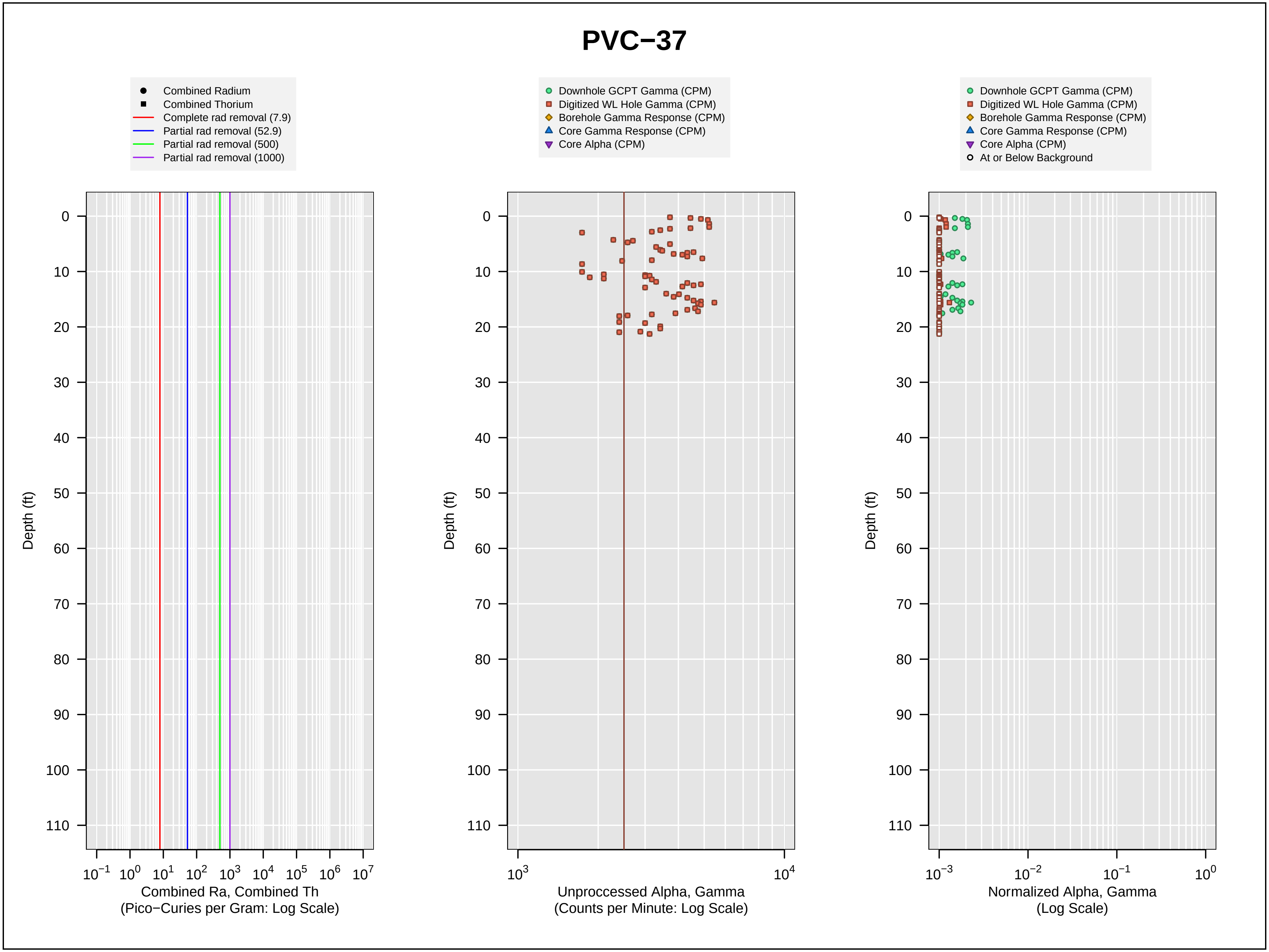
PVC−36



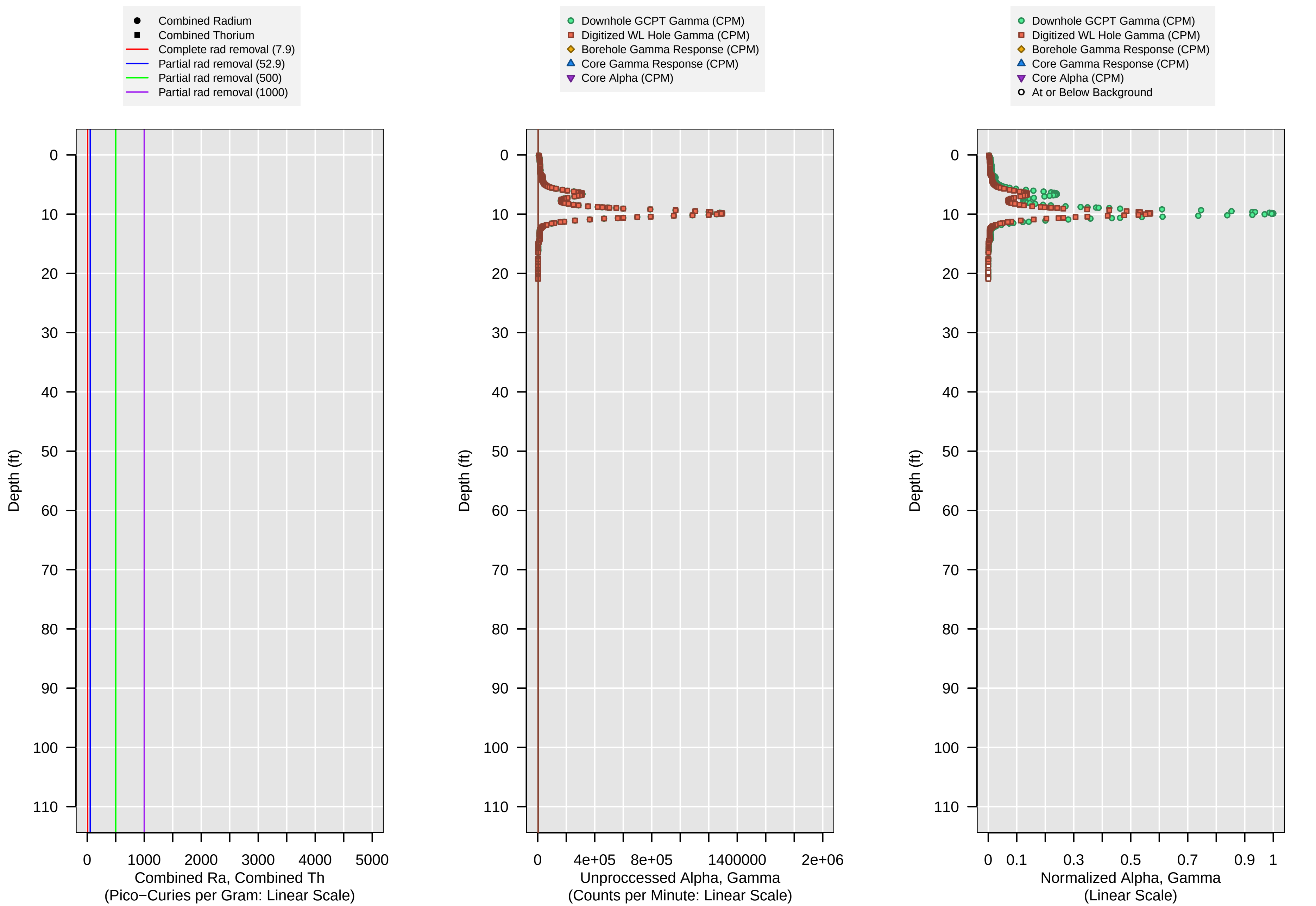
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

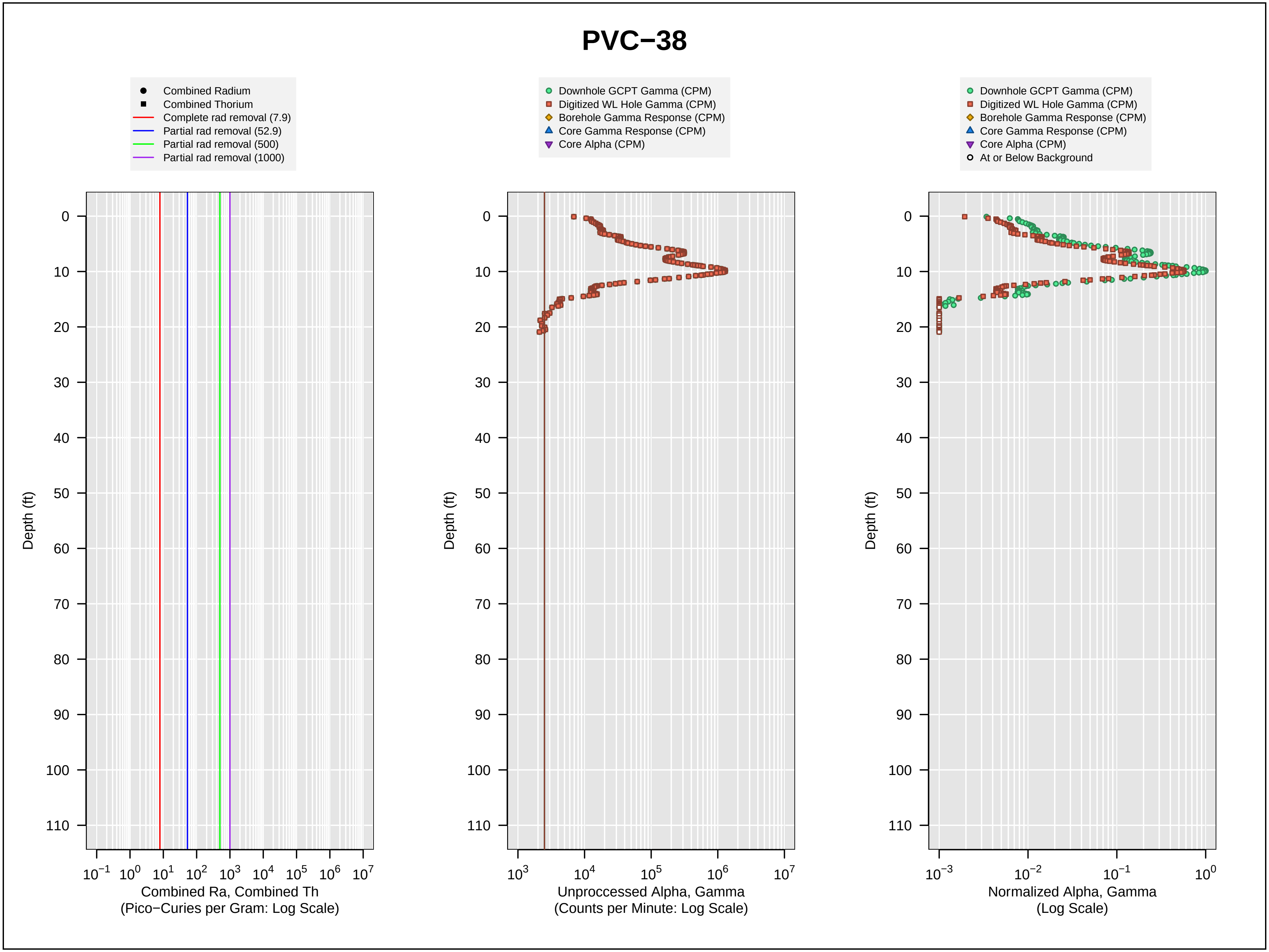
PVC−37


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 1000 2000 3000 4000 5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0 1200 2400 3600 4800 6000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

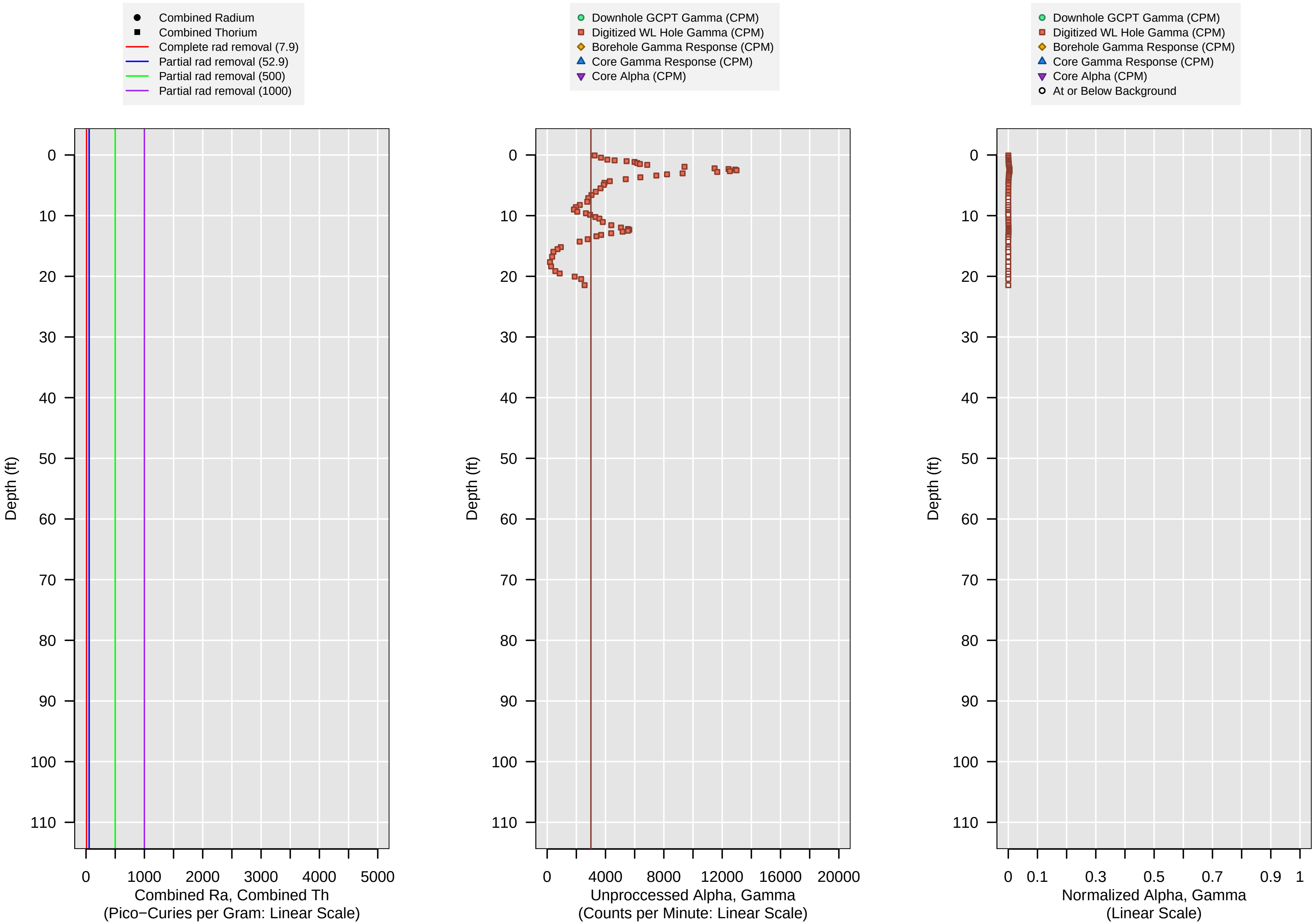

PVC−37
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

PVC−38

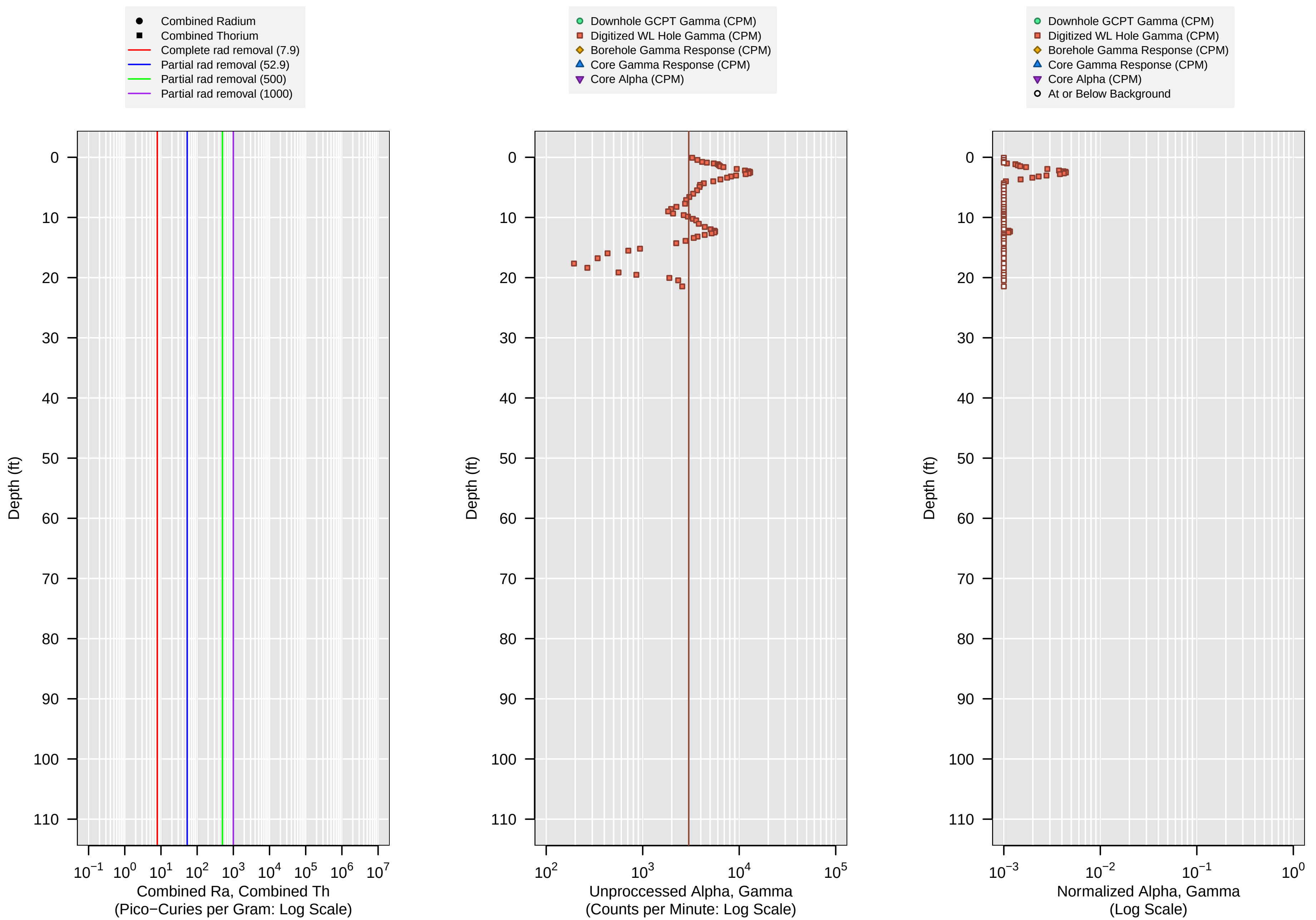

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 1000 2000 3000 4000 5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0 4e+05 8e+05 1400000 2e+06
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)


PVC−38
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

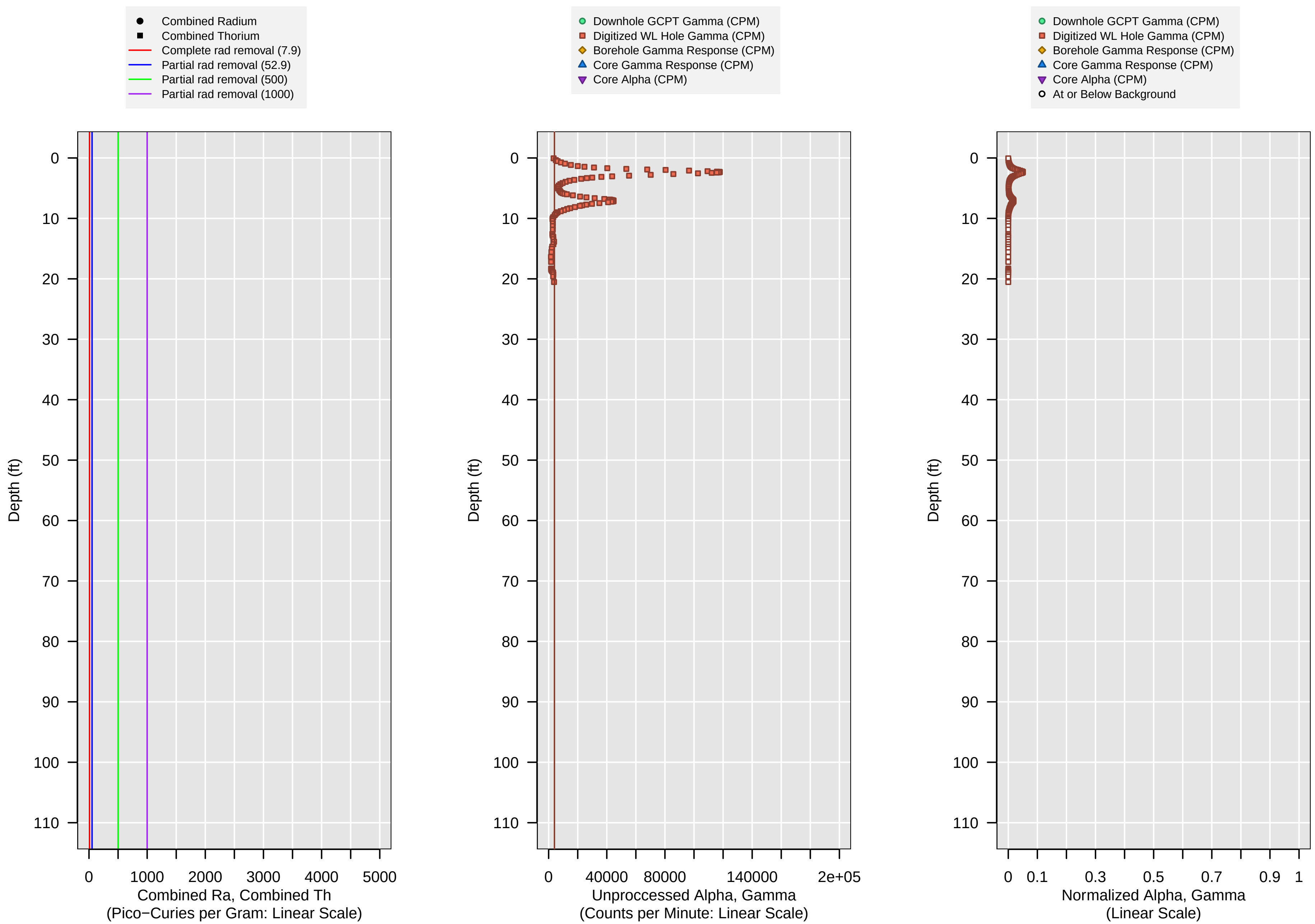
PVC−39


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

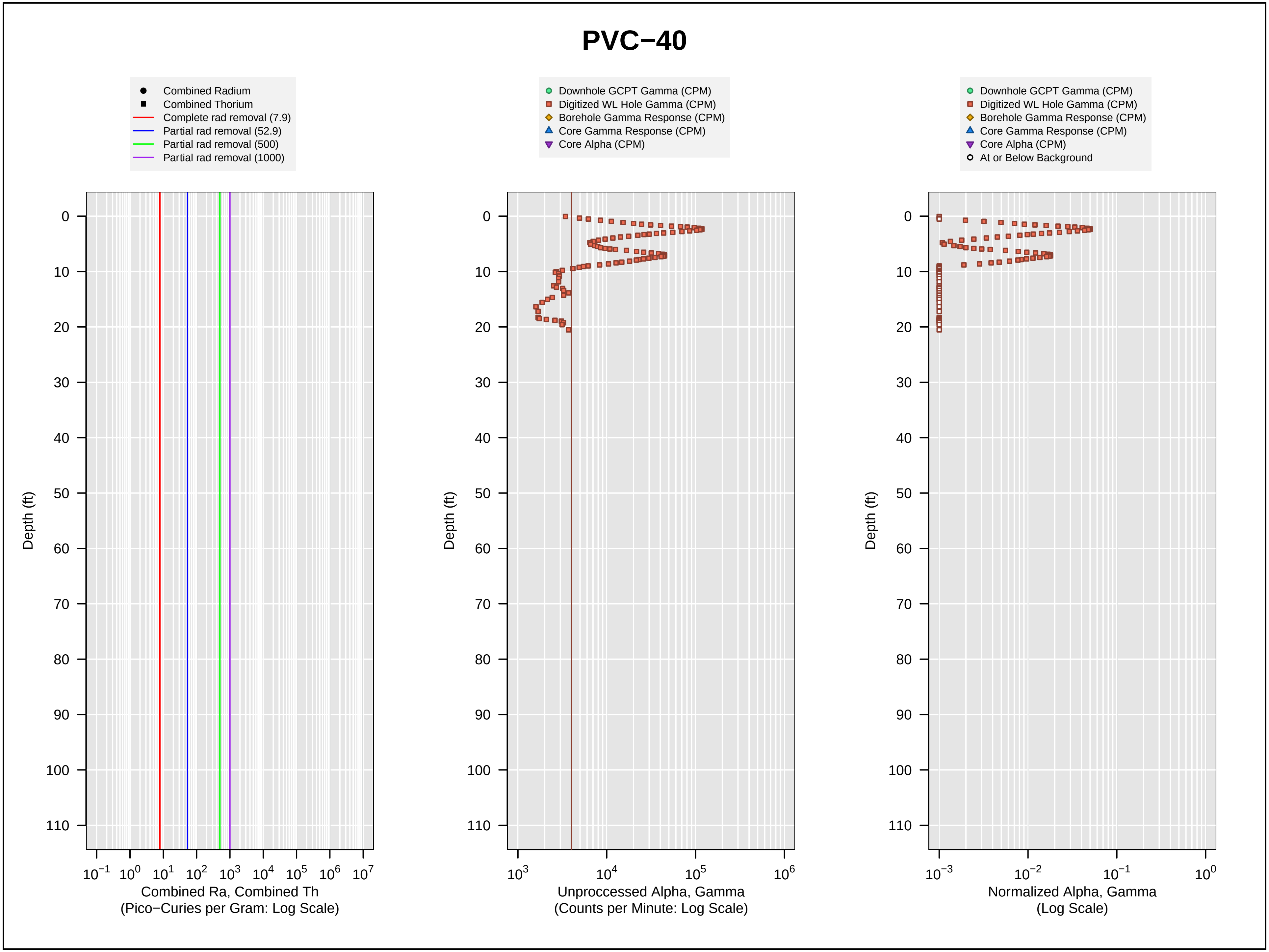
PVC−39

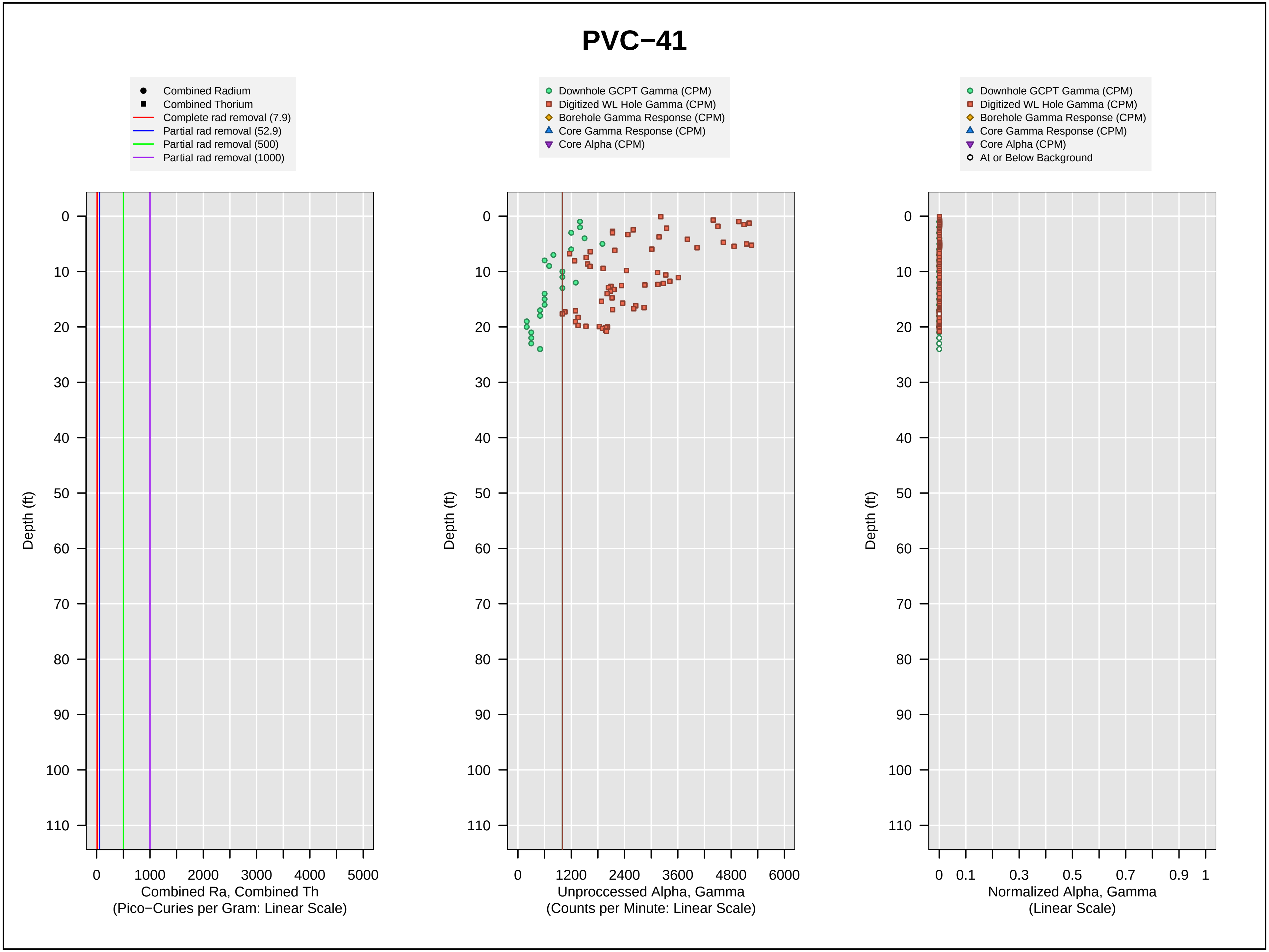

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

PVC−40

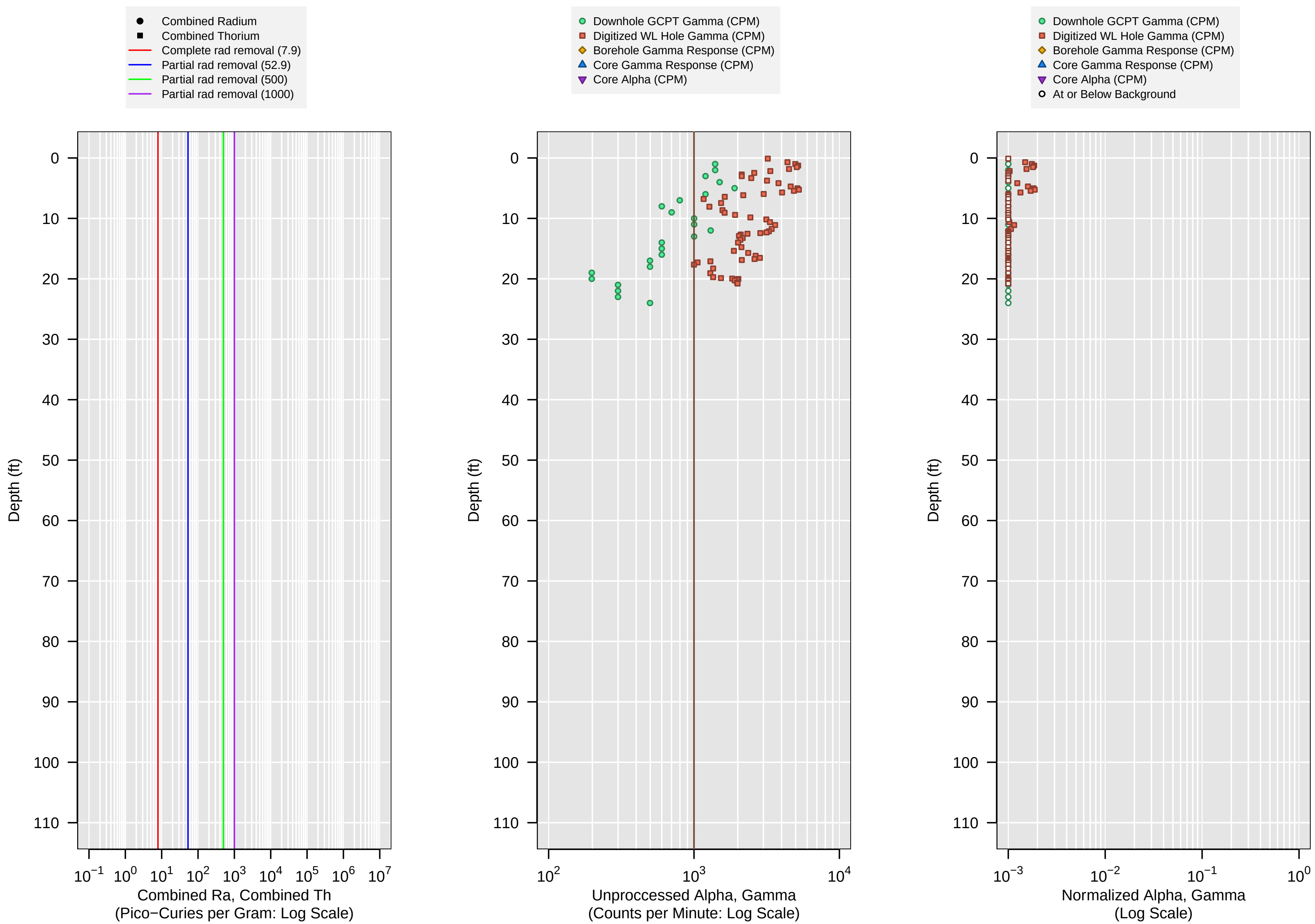


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0 1000 2000 3000 4000 5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0 40000 80000 140000 2e+05
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)
0 10 20 30 40 50 60 70 80 90 100 110

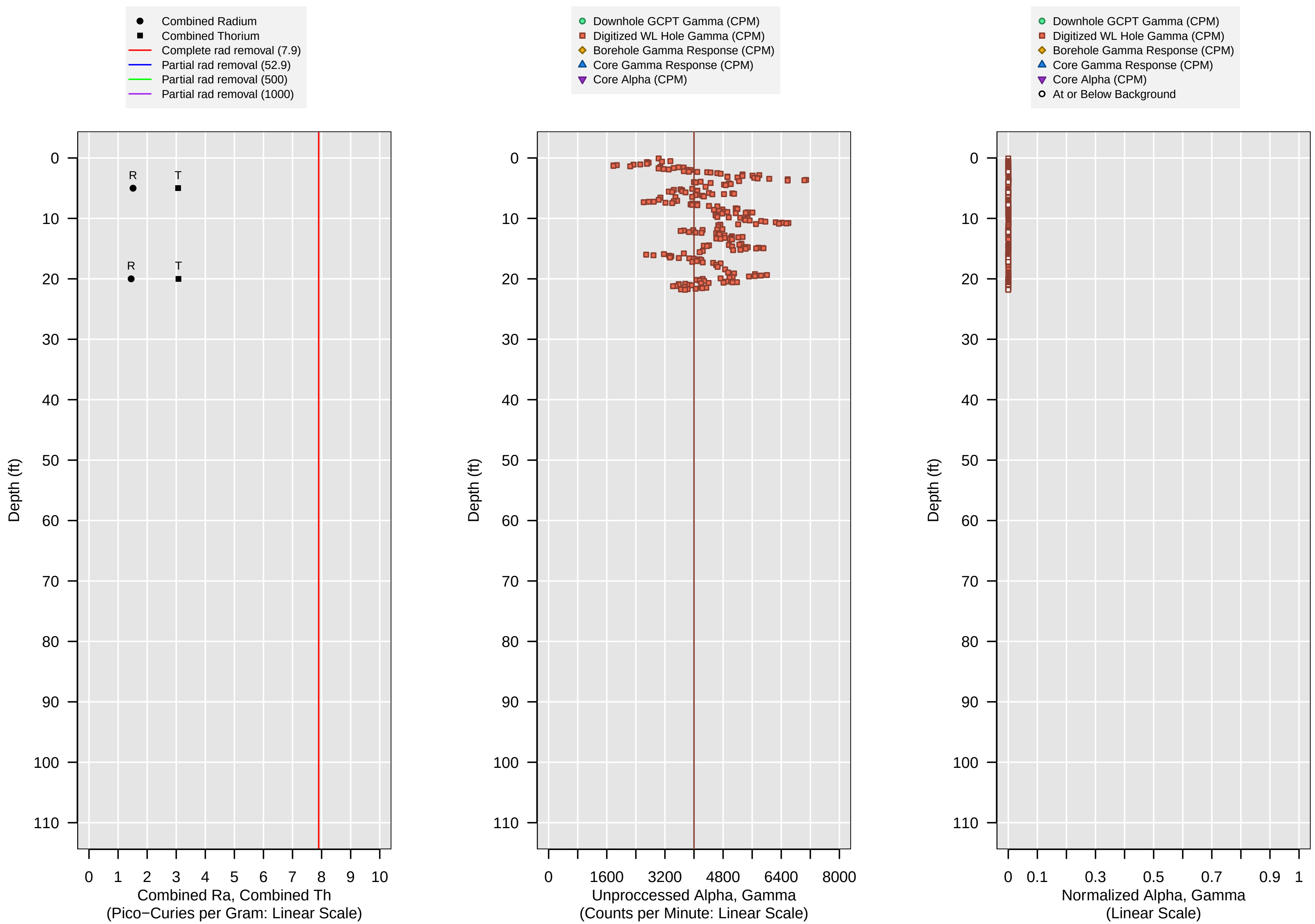

PVC−40
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)


PVC−41
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

PVC−41

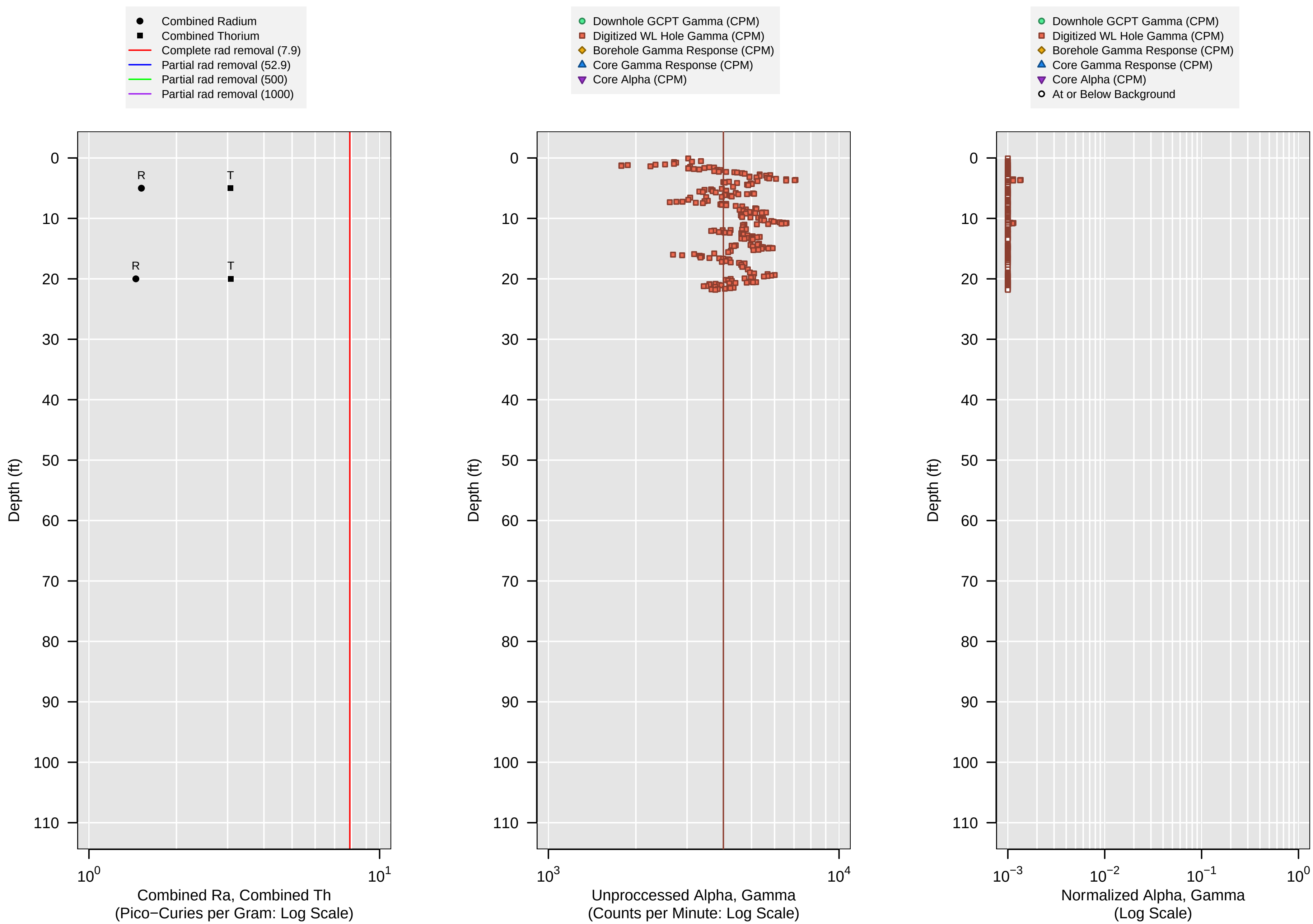

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

WL−101−MH



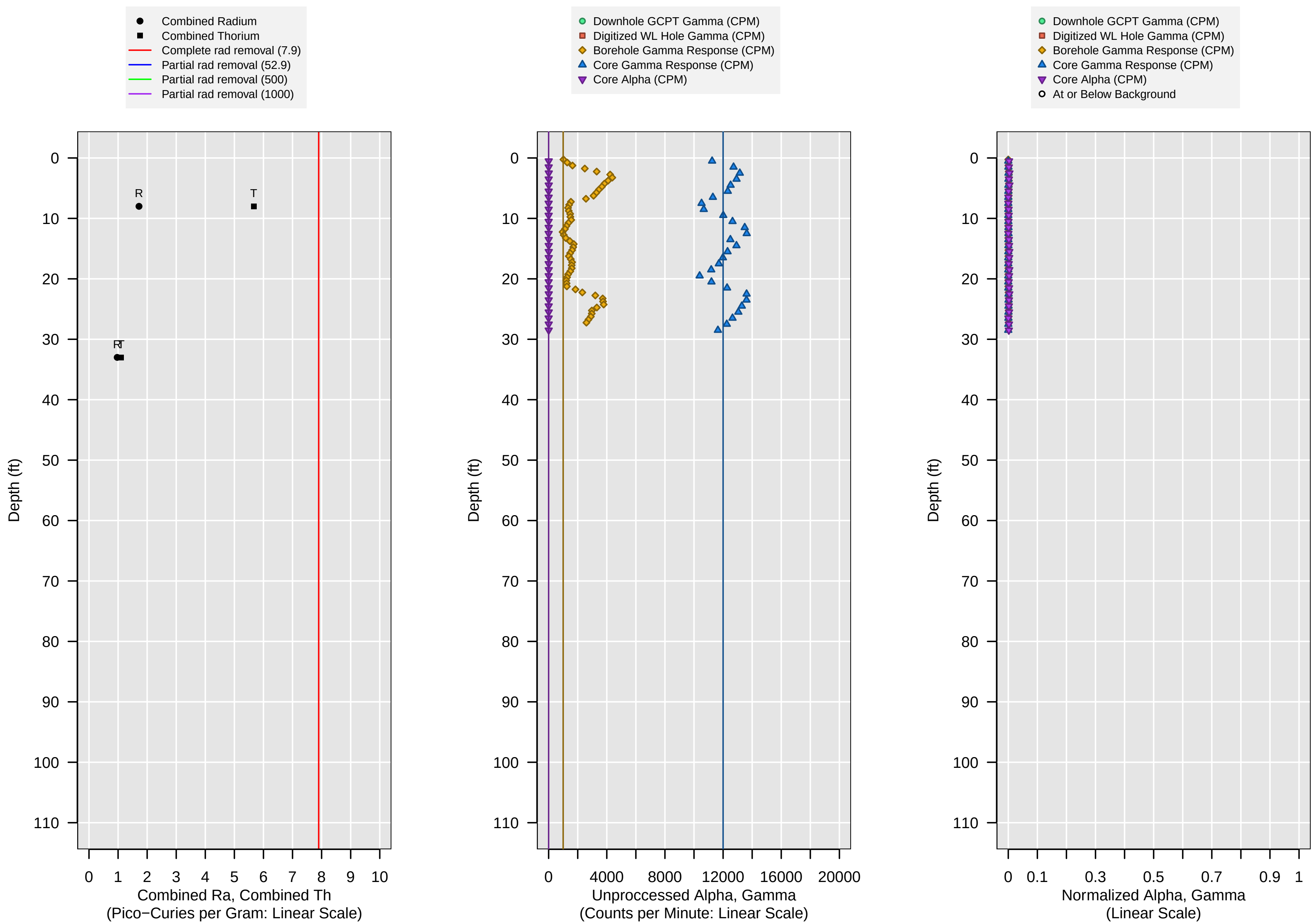
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−101−MH

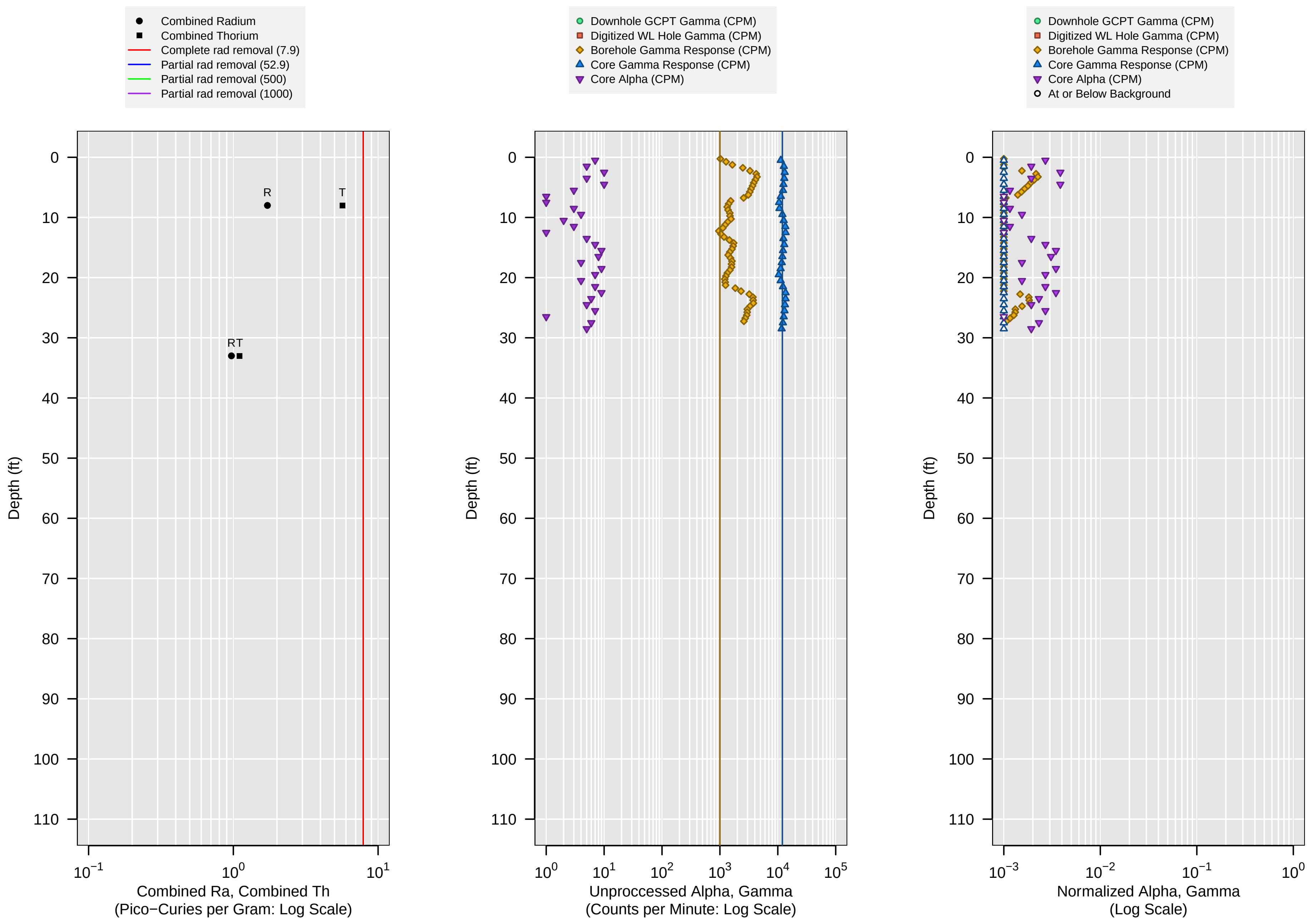


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

WL−102A−CT

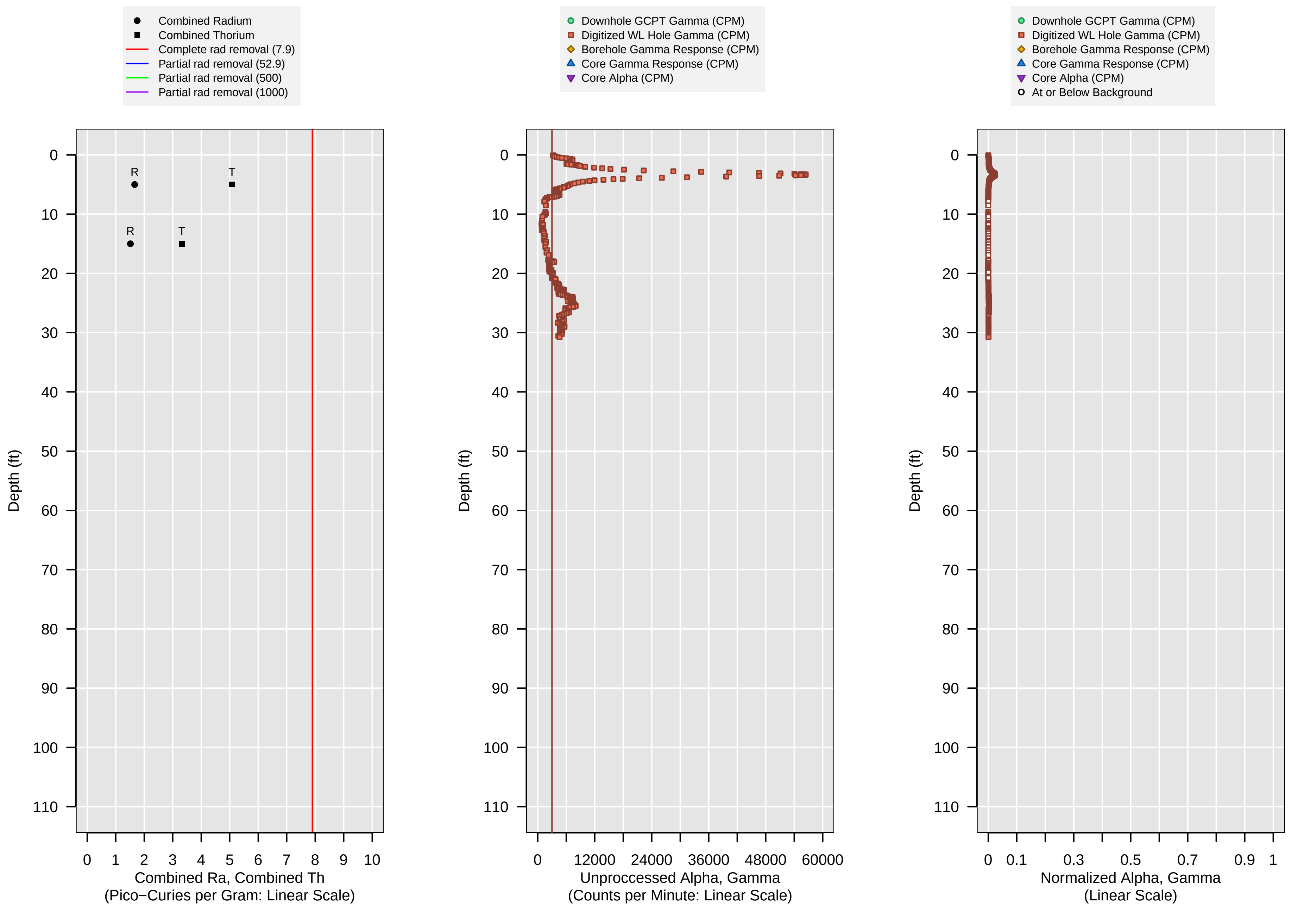

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
RT
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 1 2 3 4 5 6 7 8 9 10
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0 4000 8000 12000 16000 20000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

WL−102A−CT



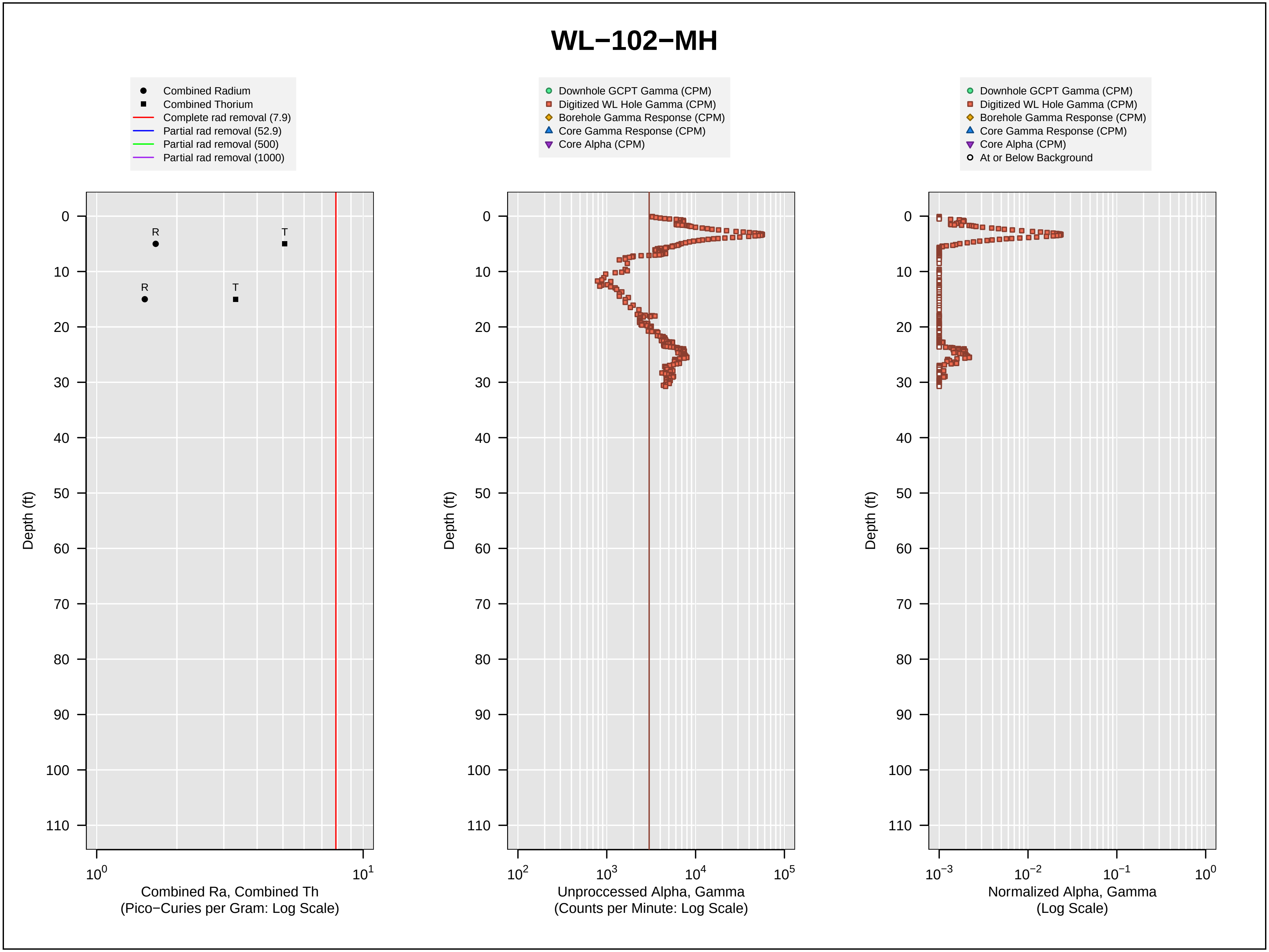
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
RT
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−102−MH

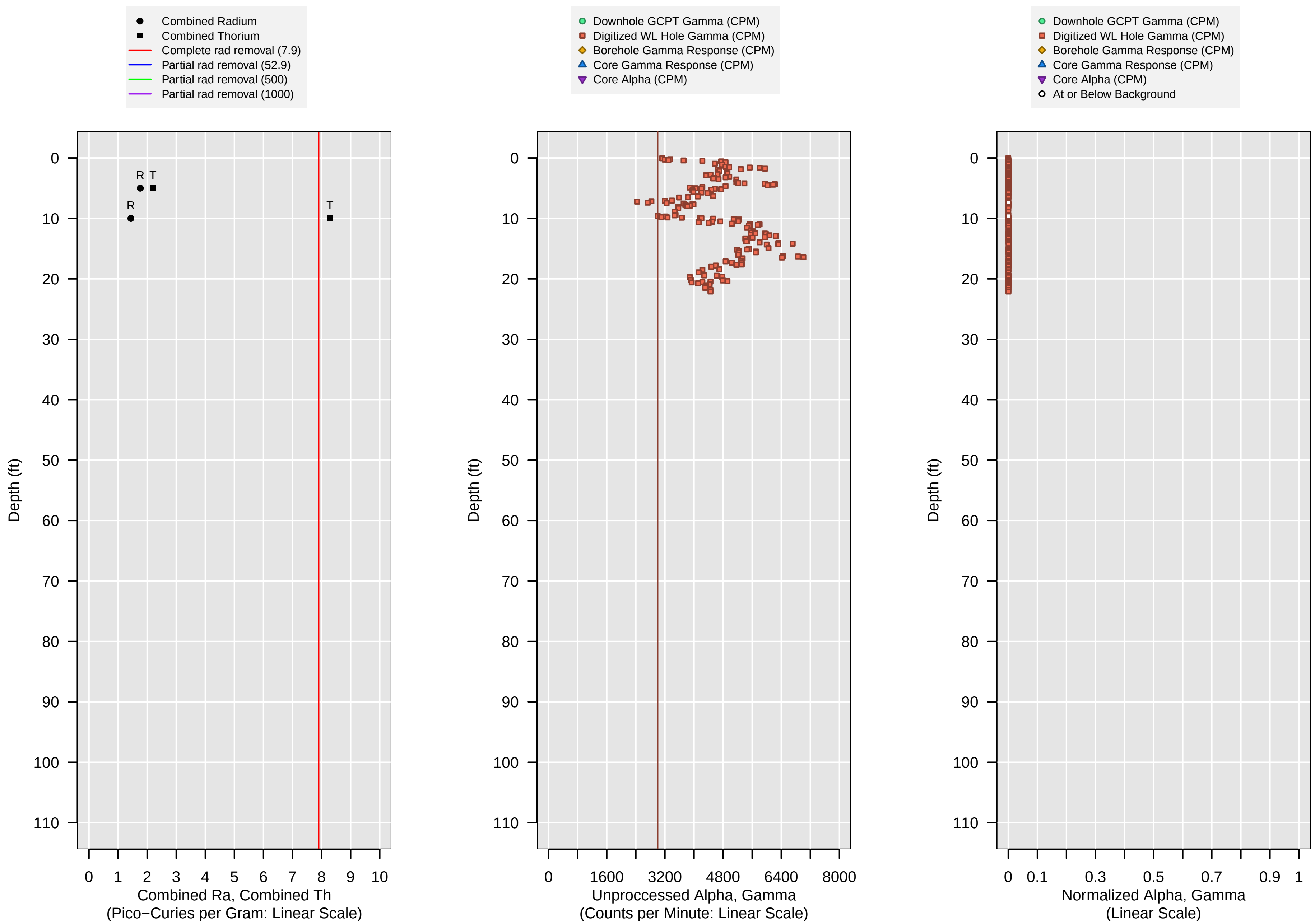


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

S.S. Papadopulos & Associates, Inc.

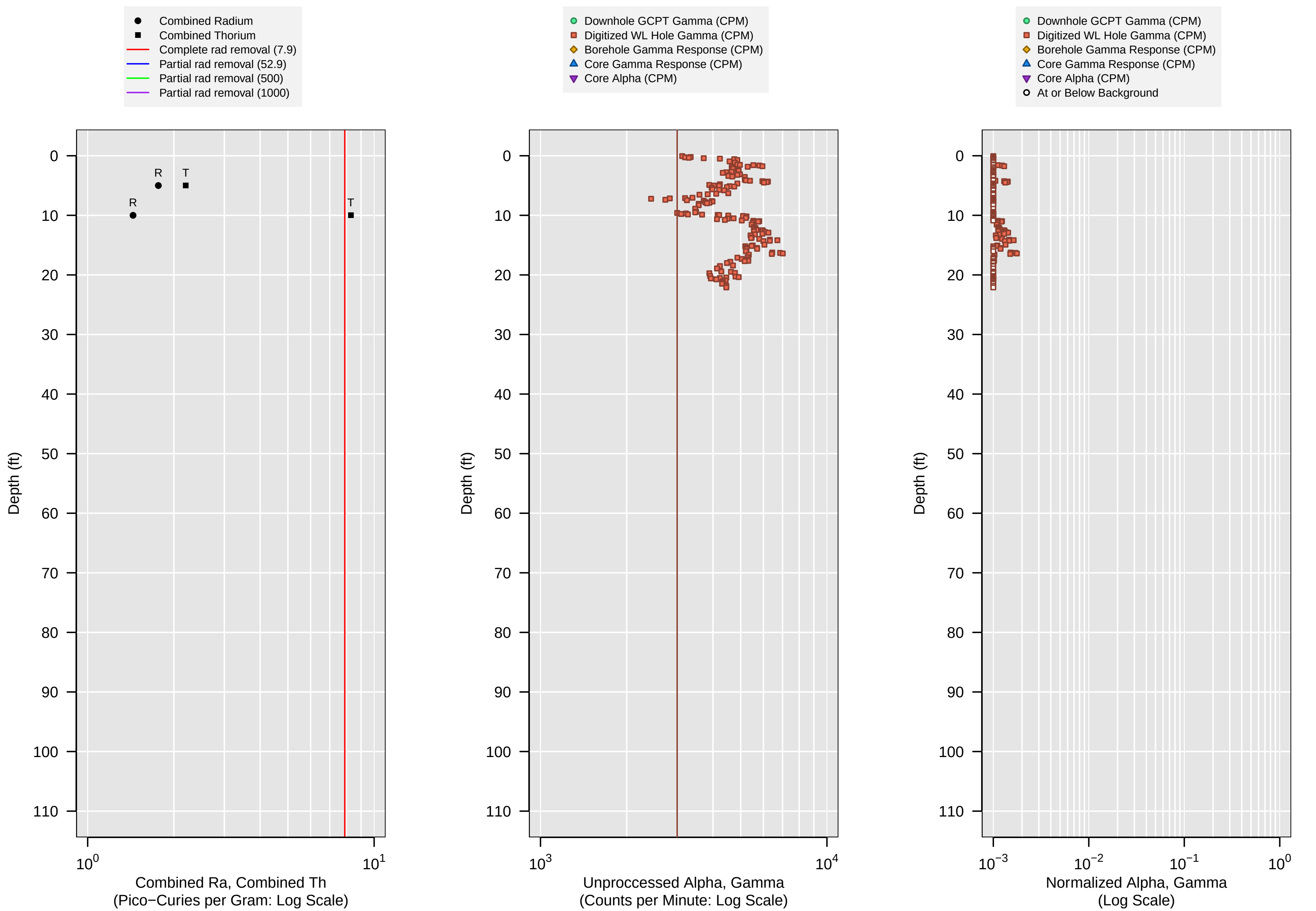


WL−103−MH

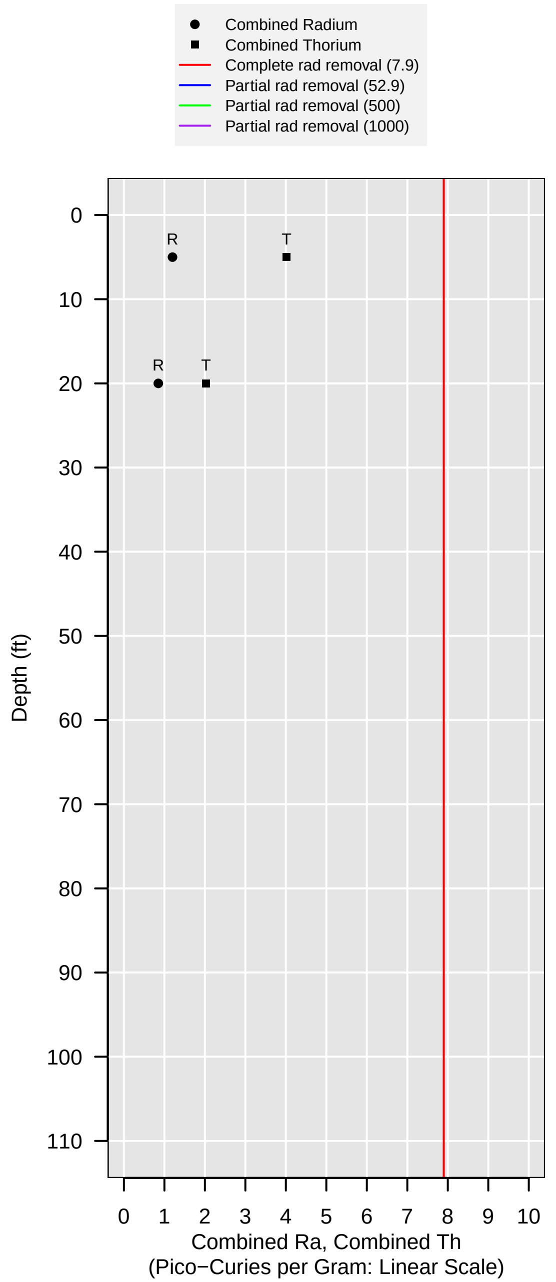


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R T
R
T
Depth (ft)
0 10 20 30 40 50 60 70 80 90 100 110
0 1 2 3 4 5 6 7 8 9 10
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0 1600 3200 4800 6400 8000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

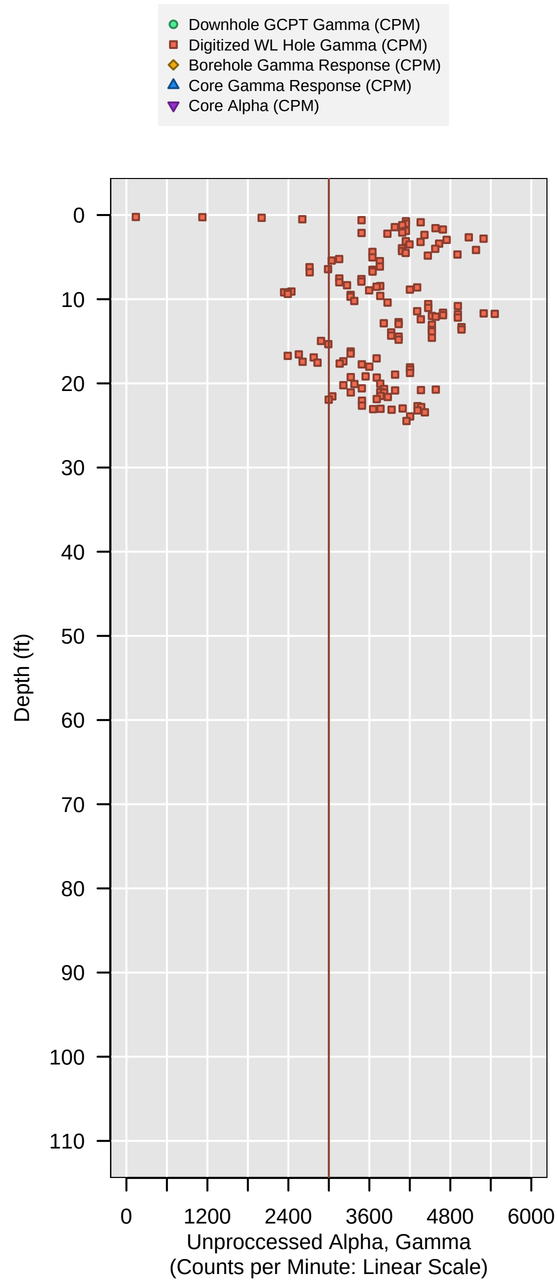
WL−103−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

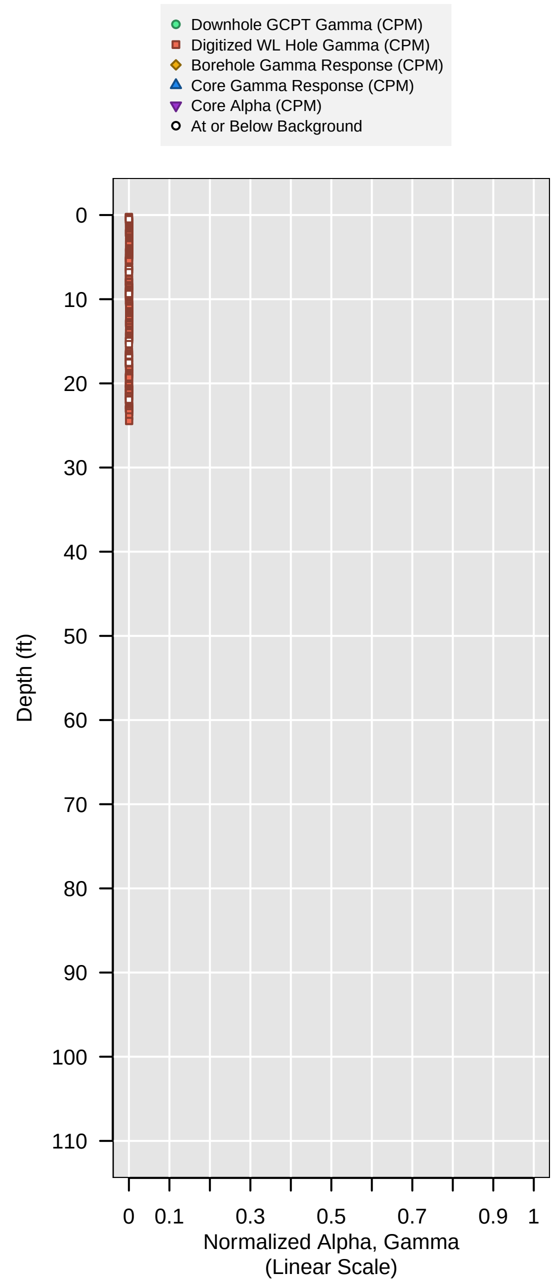
WL−104−MH



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
R
T
Depth (ft)
0 10 20 30 40 50 60 70 80 90 100 110
0 1 2 3 4 5 6 7 8 9 10
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)

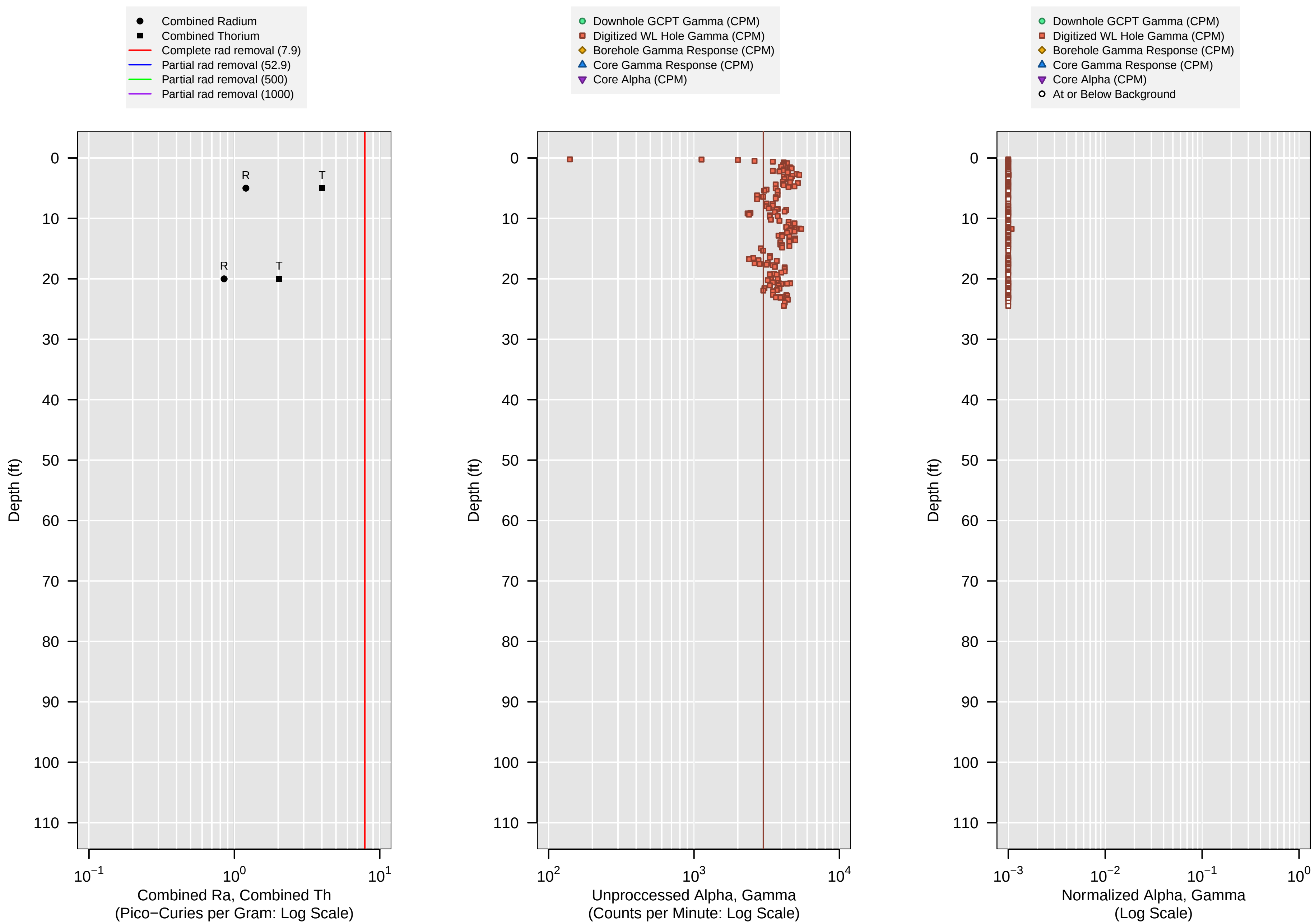


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0 10 20 30 40 50 60 70 80 90 100 110
0 1200 2400 3600 4800 6000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)

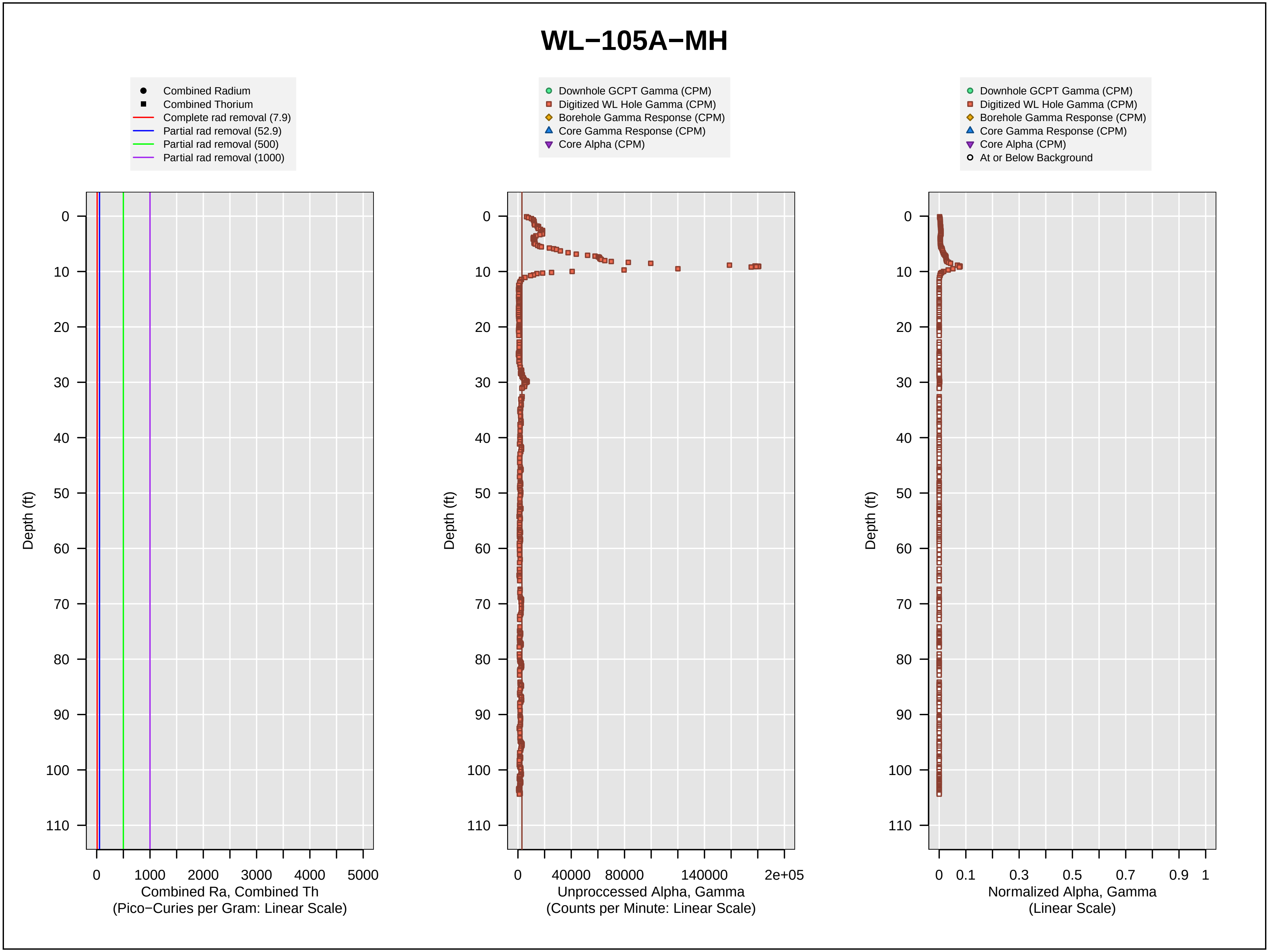


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0 10 20 30 40 50 60 70 80 90 100 110
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

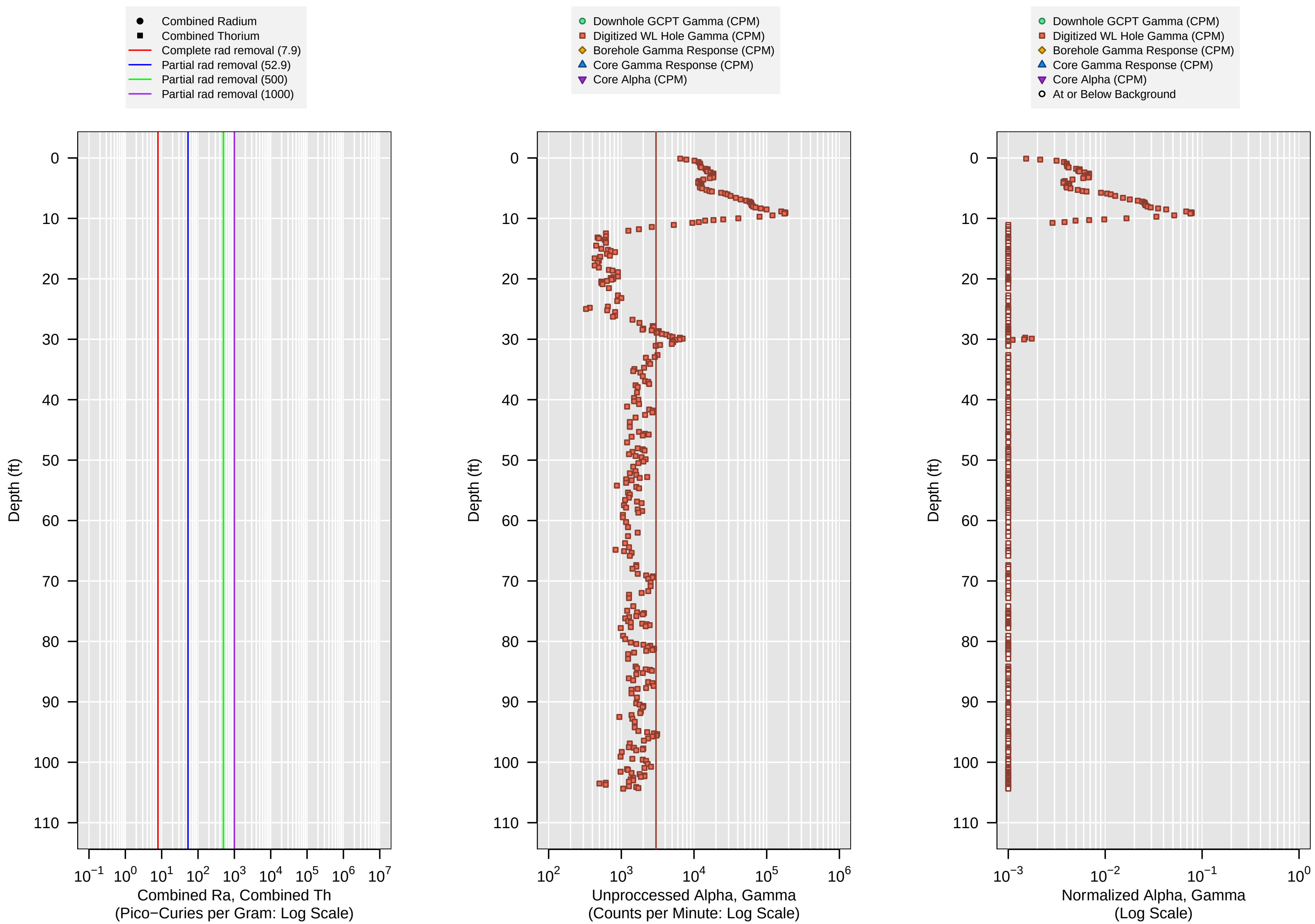
WL−104−MH



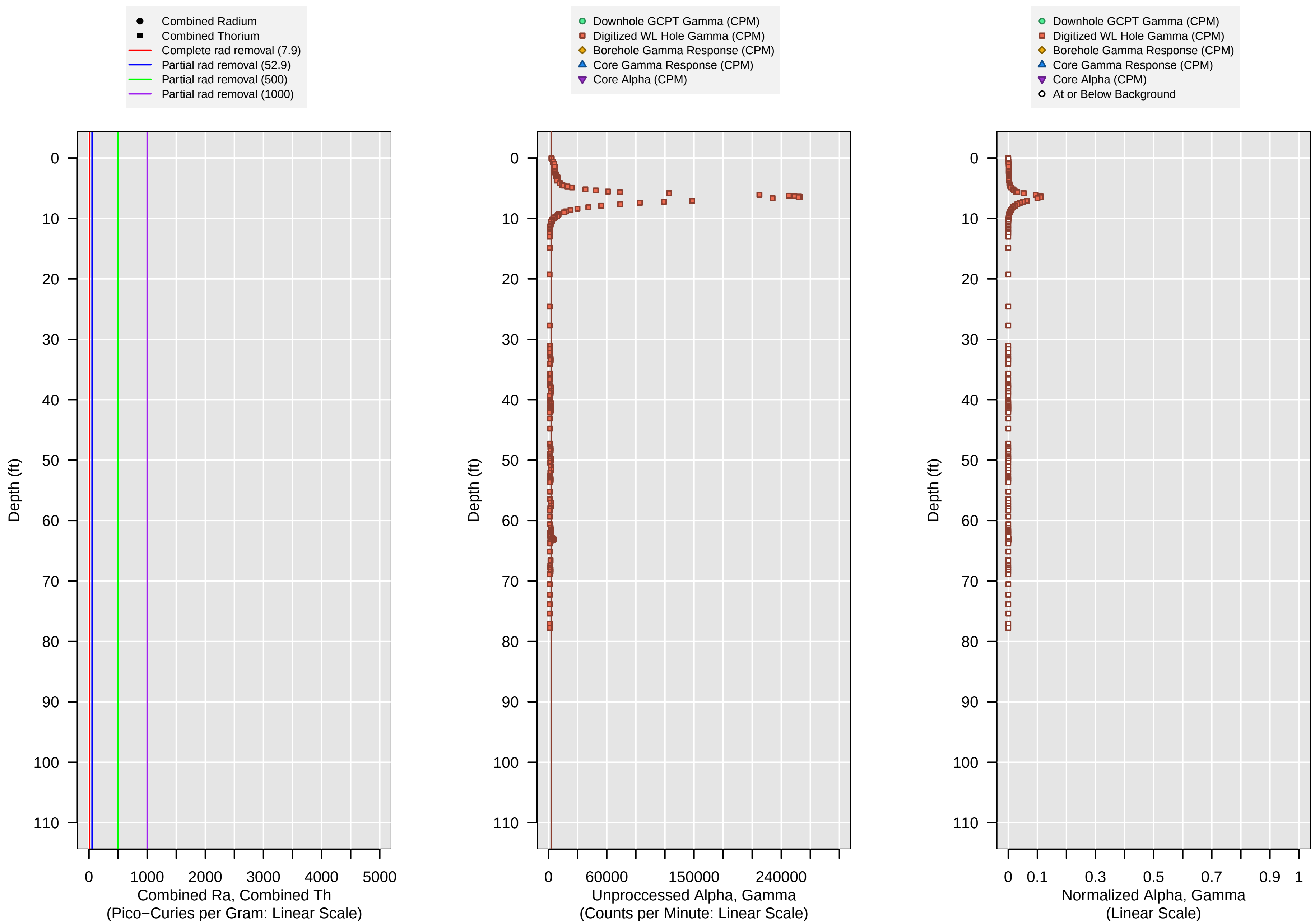
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{-1}
10^{0}
10^{1}
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
10^{2}
10^{3}
10^{4}
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
10^{-3}
10^{-2}
10^{-1}
10^{0}
Normalized Alpha, Gamma
(Log Scale)


WL−105A−MH
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−105A−MH

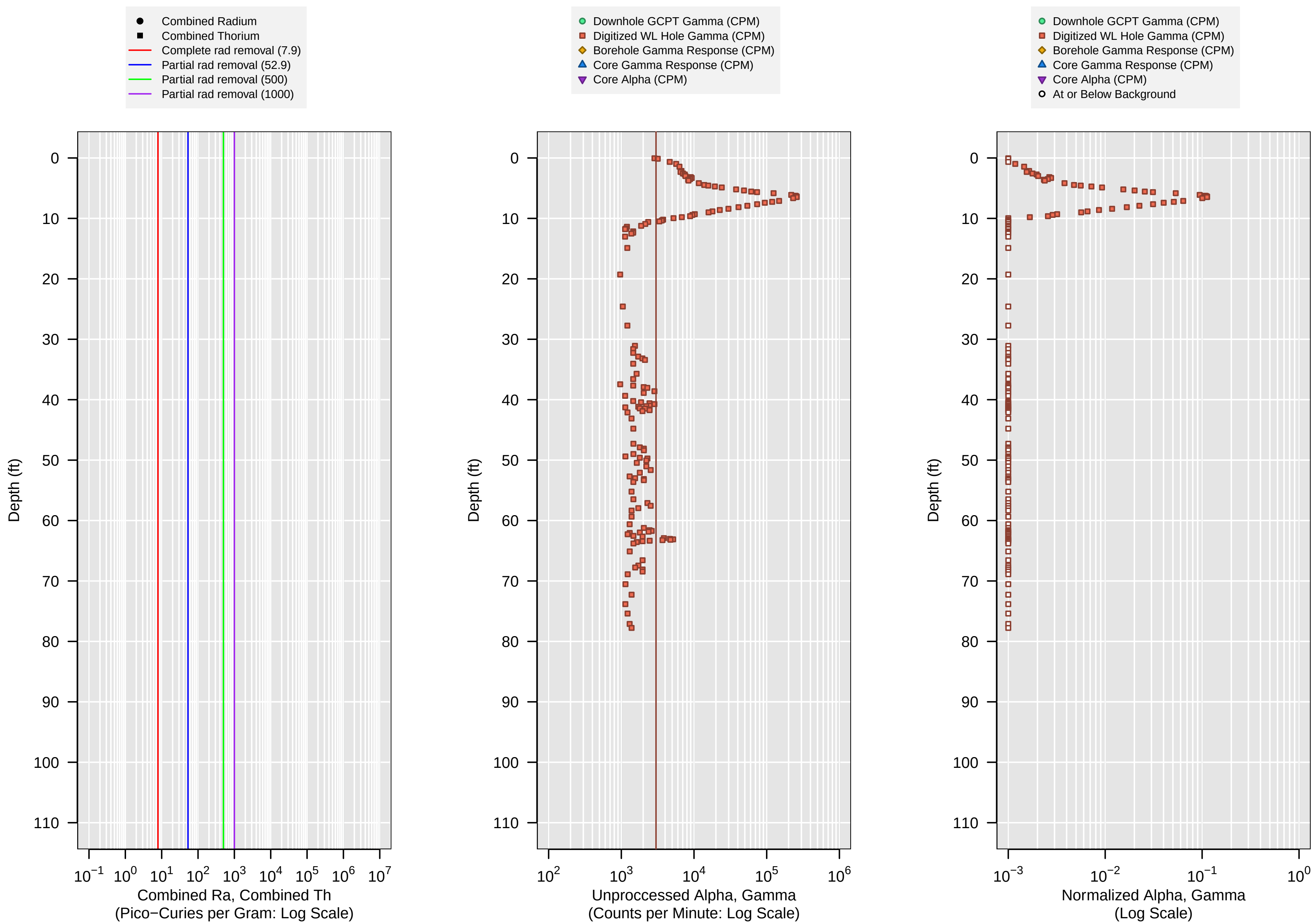

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−105B−MH

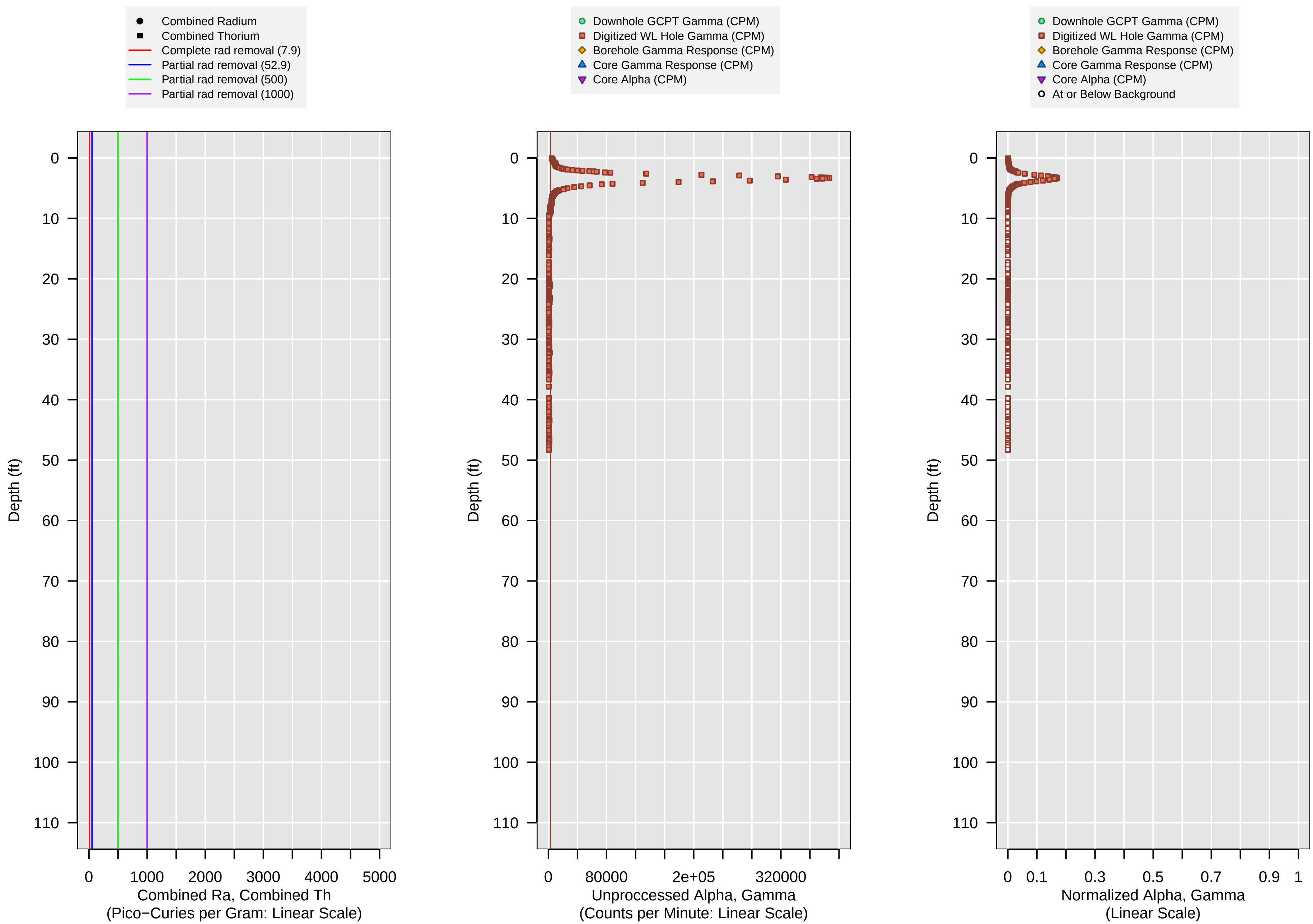


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−105B−MH

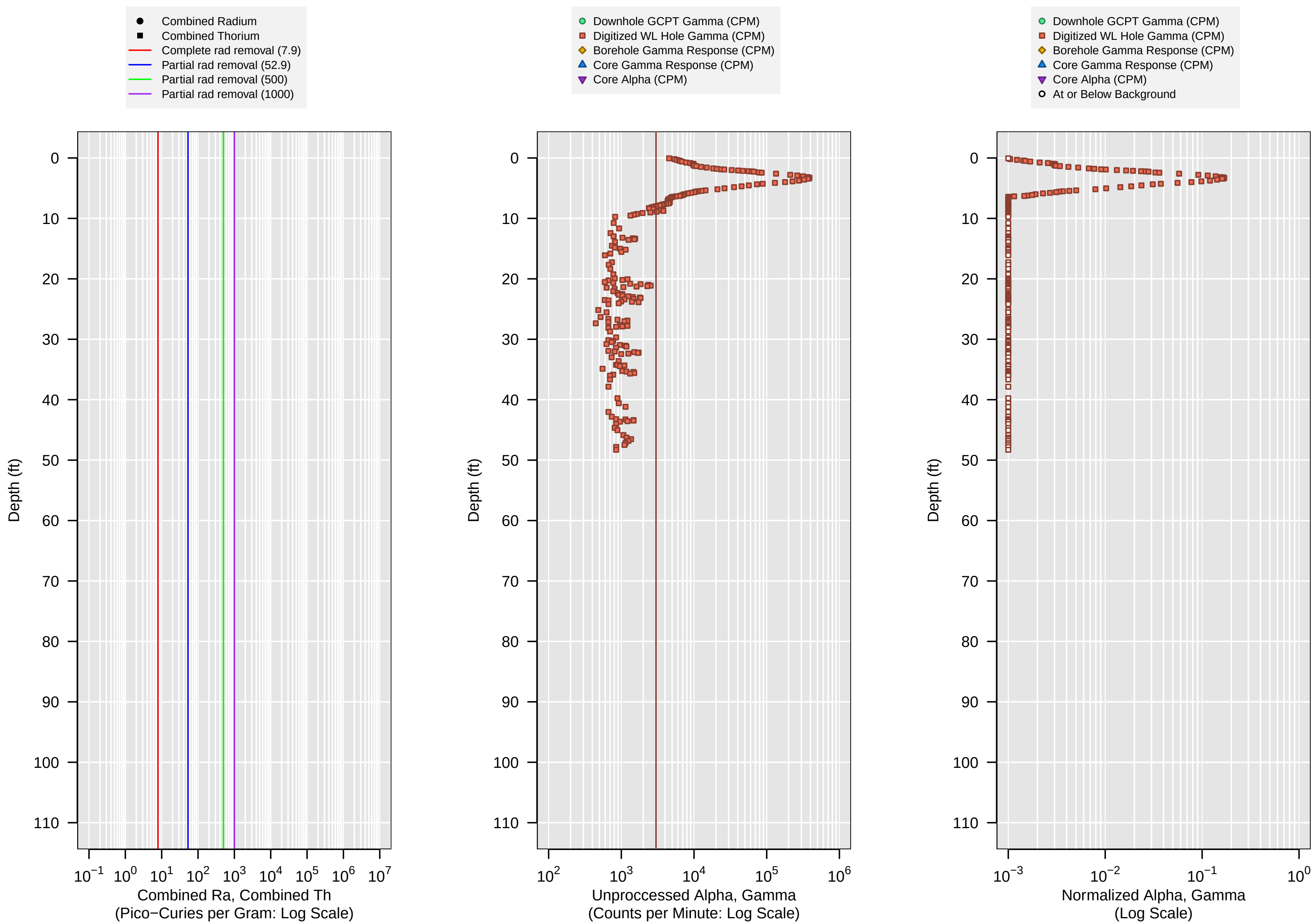

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−105C−MH



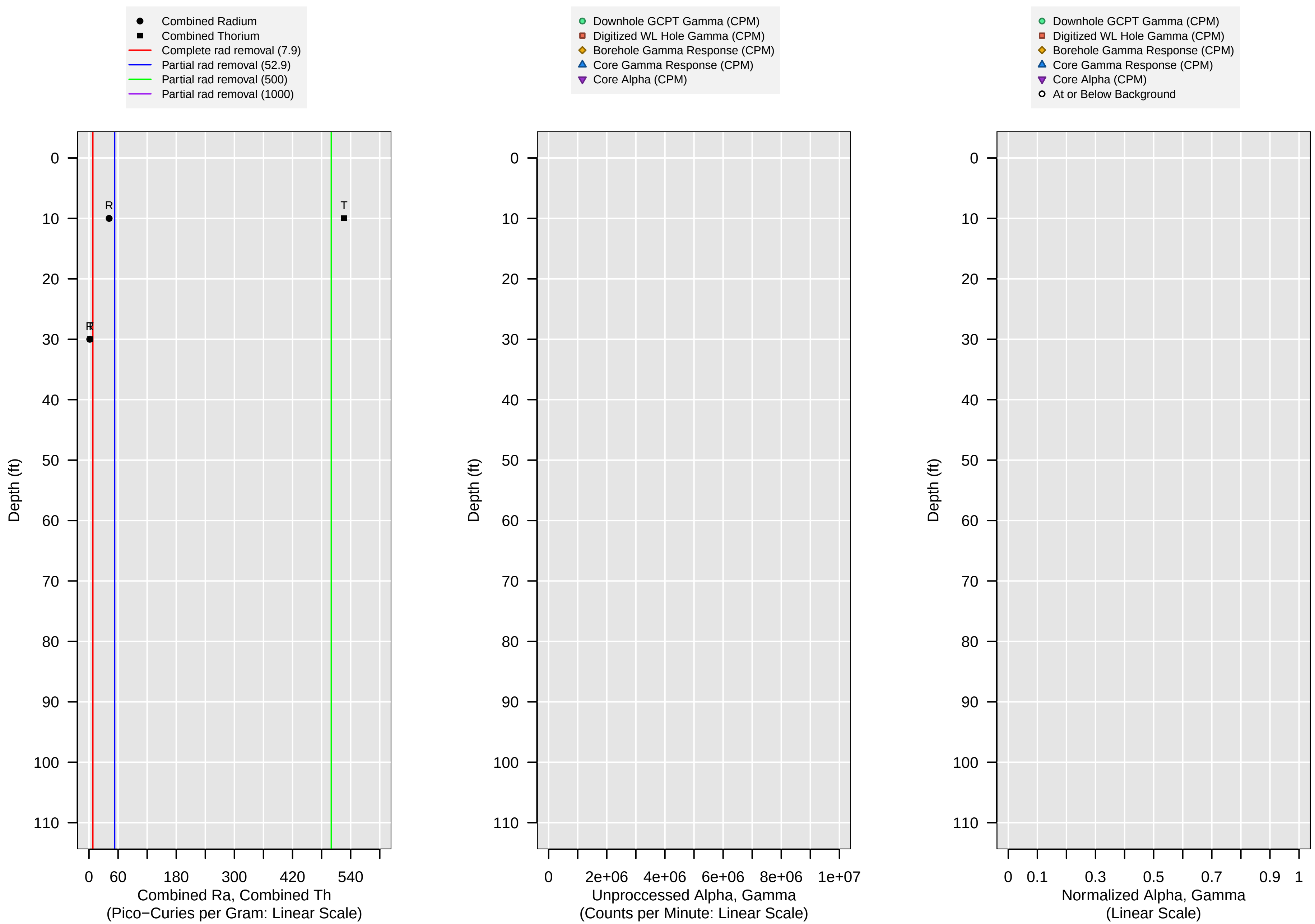
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
80000
2e+05
320000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

WL−105C−MH



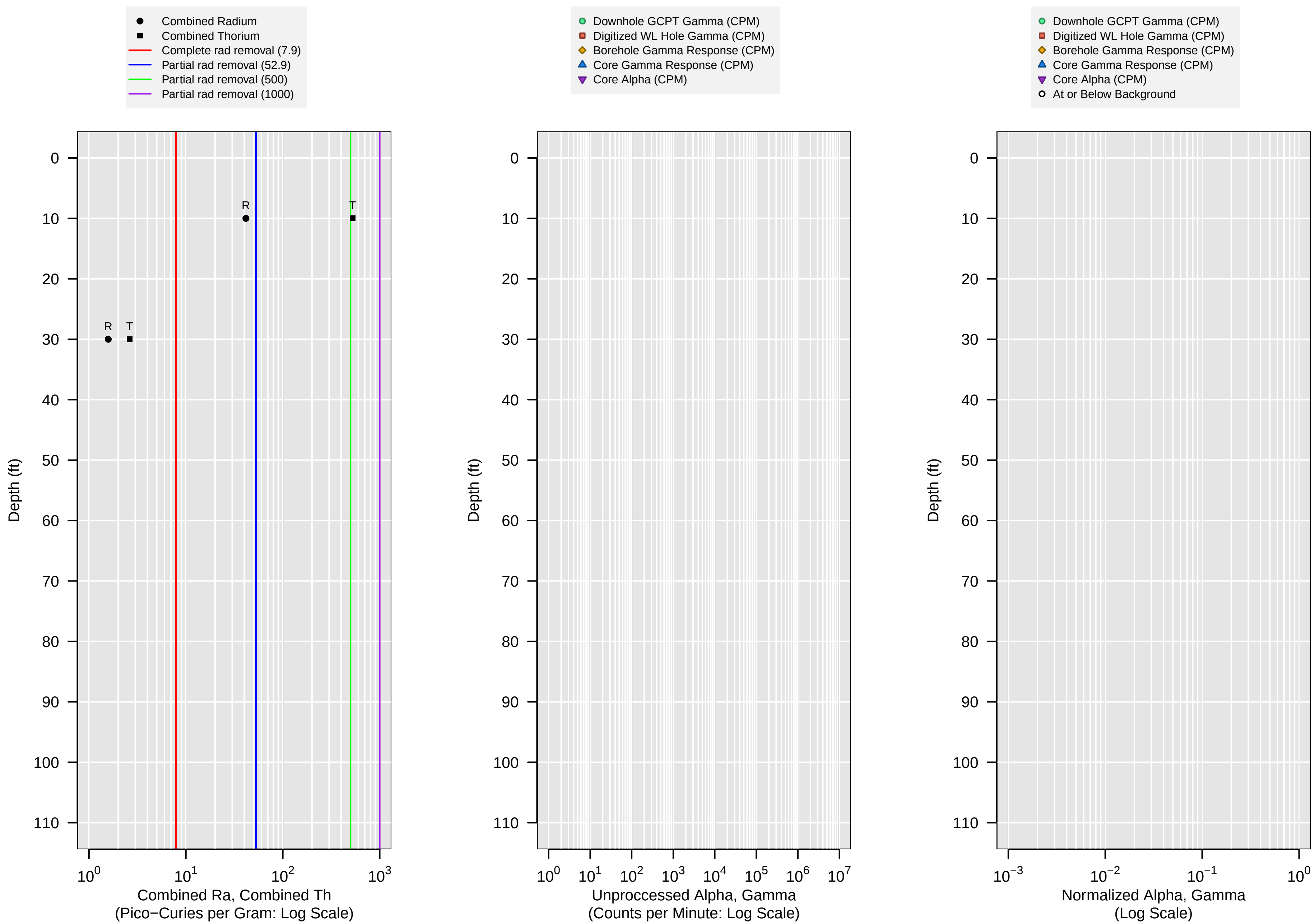
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

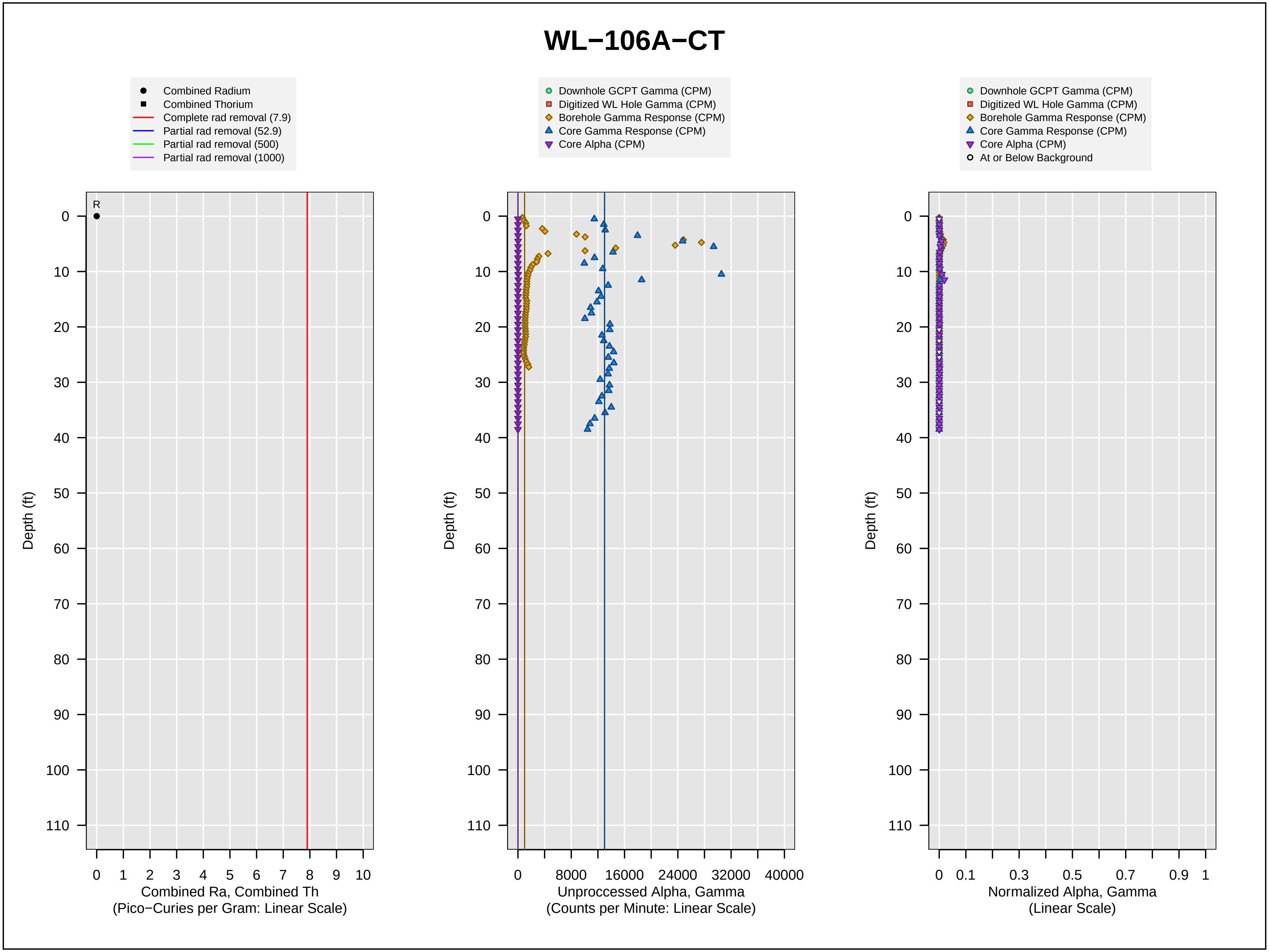
WL−105−MH



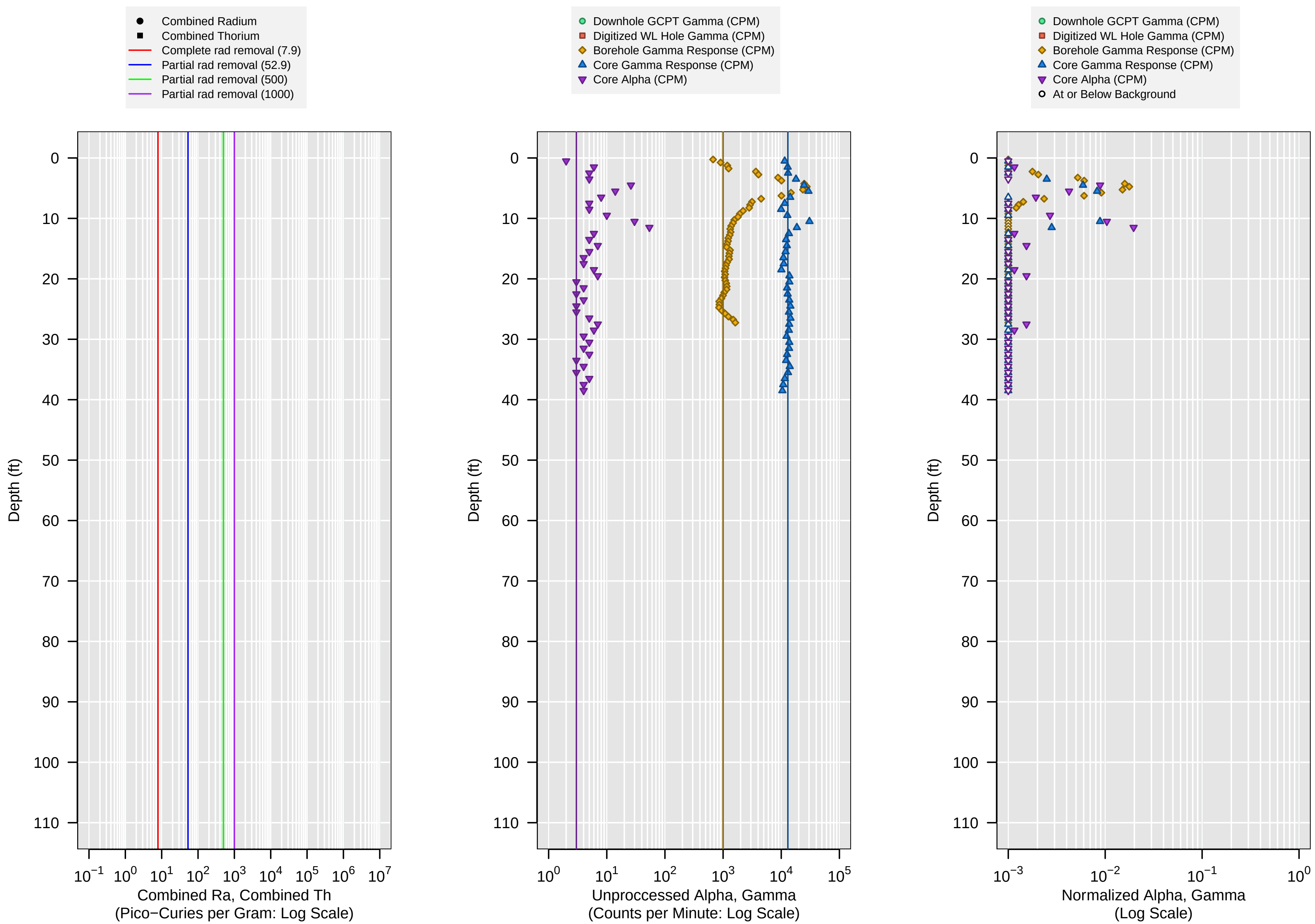
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
R
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
60
180
300
420
540
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
2e+06
4e+06
6e+06
8e+06
1e+07
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

WL−105−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

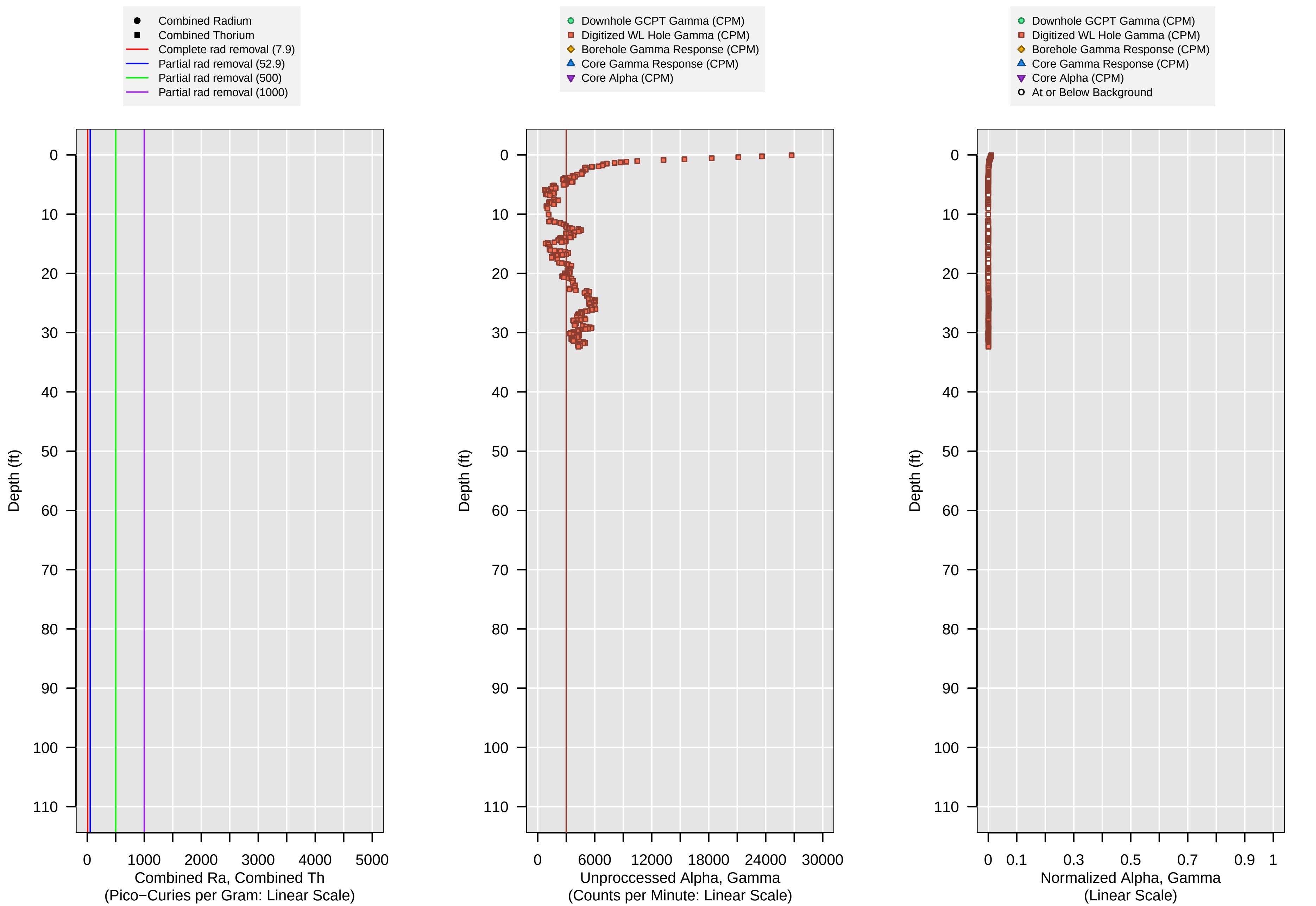

WL−106A−CT
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−106A−CT



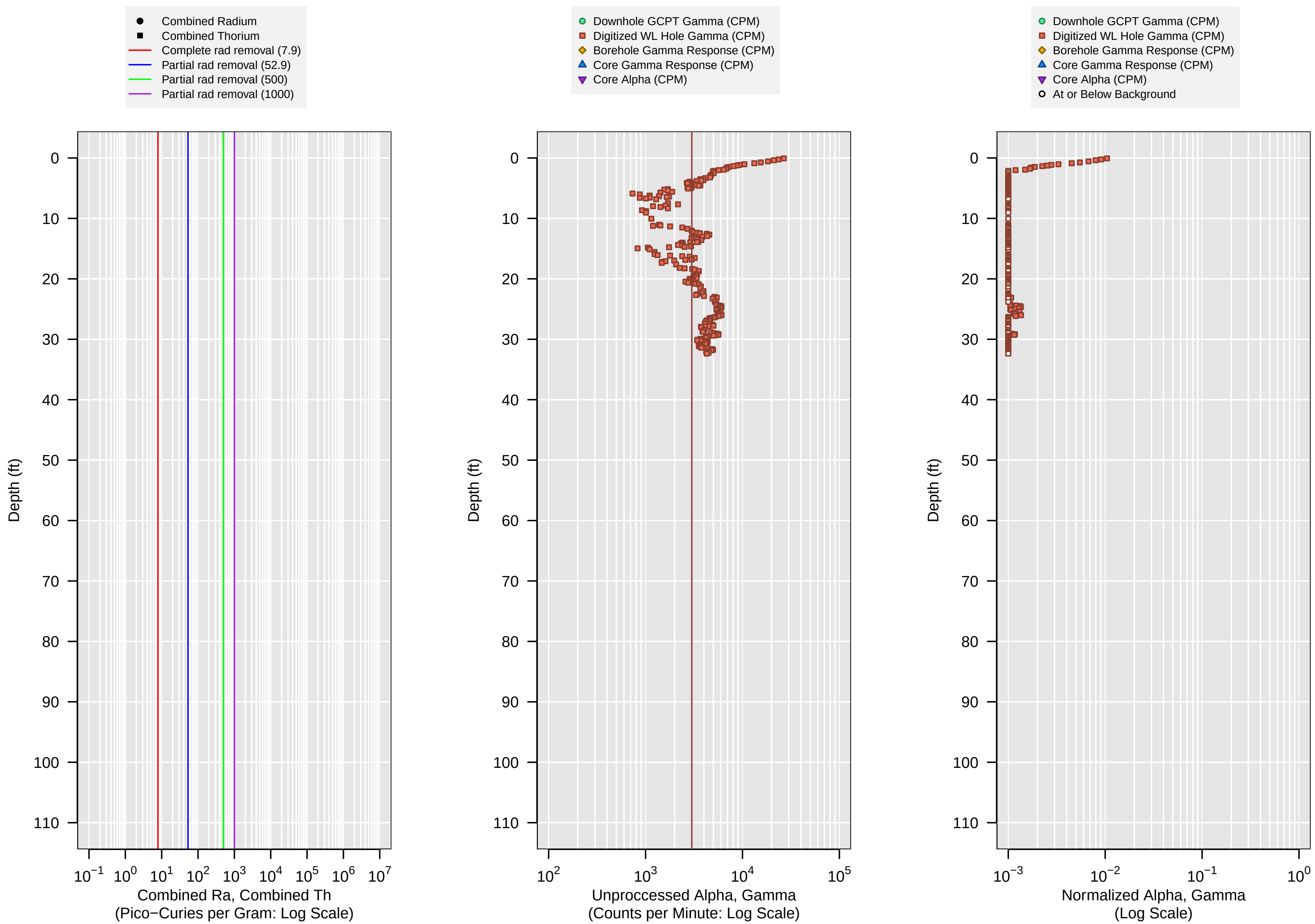
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−106A−MH



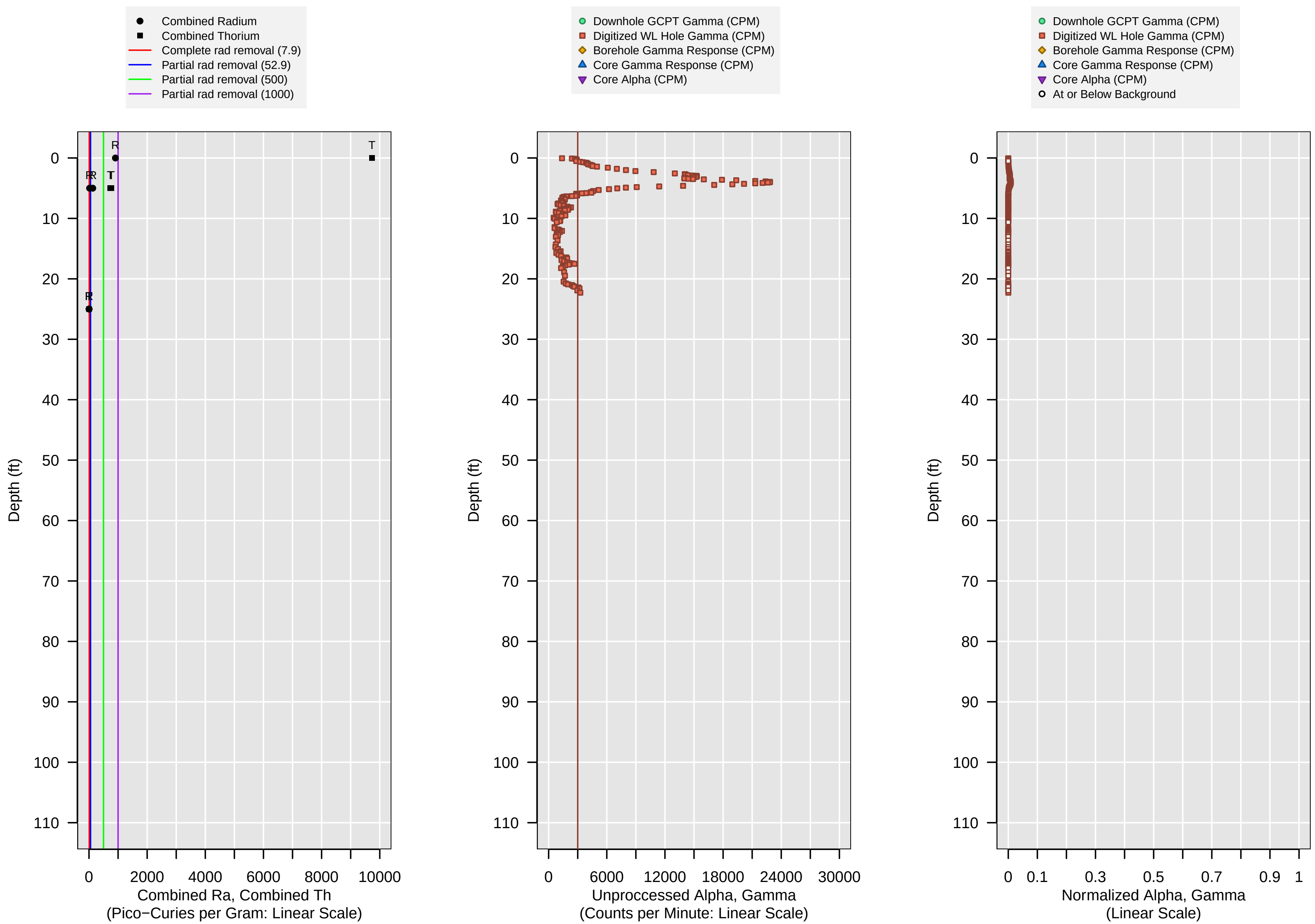
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−106A−MH

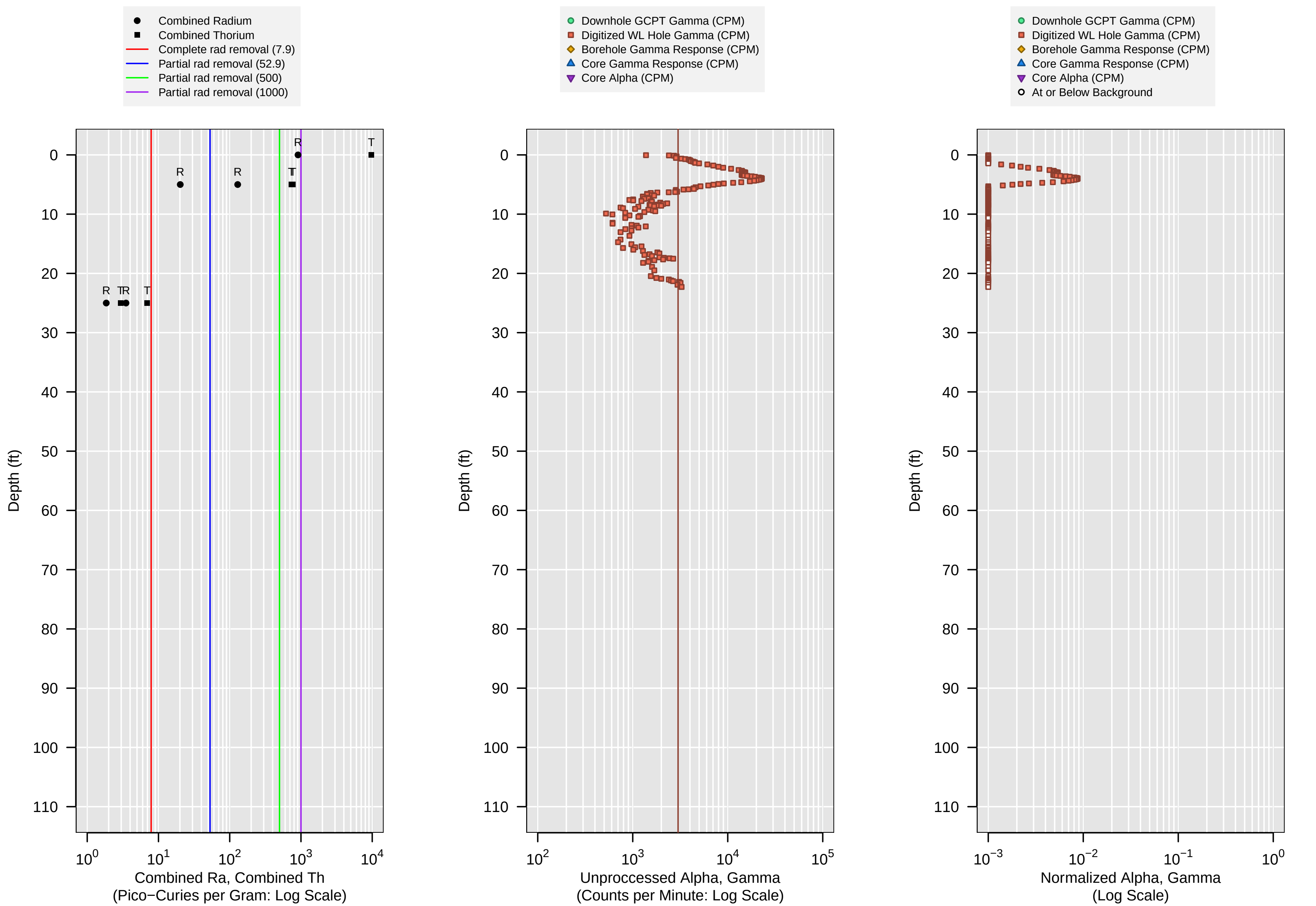


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

WL−106−MH

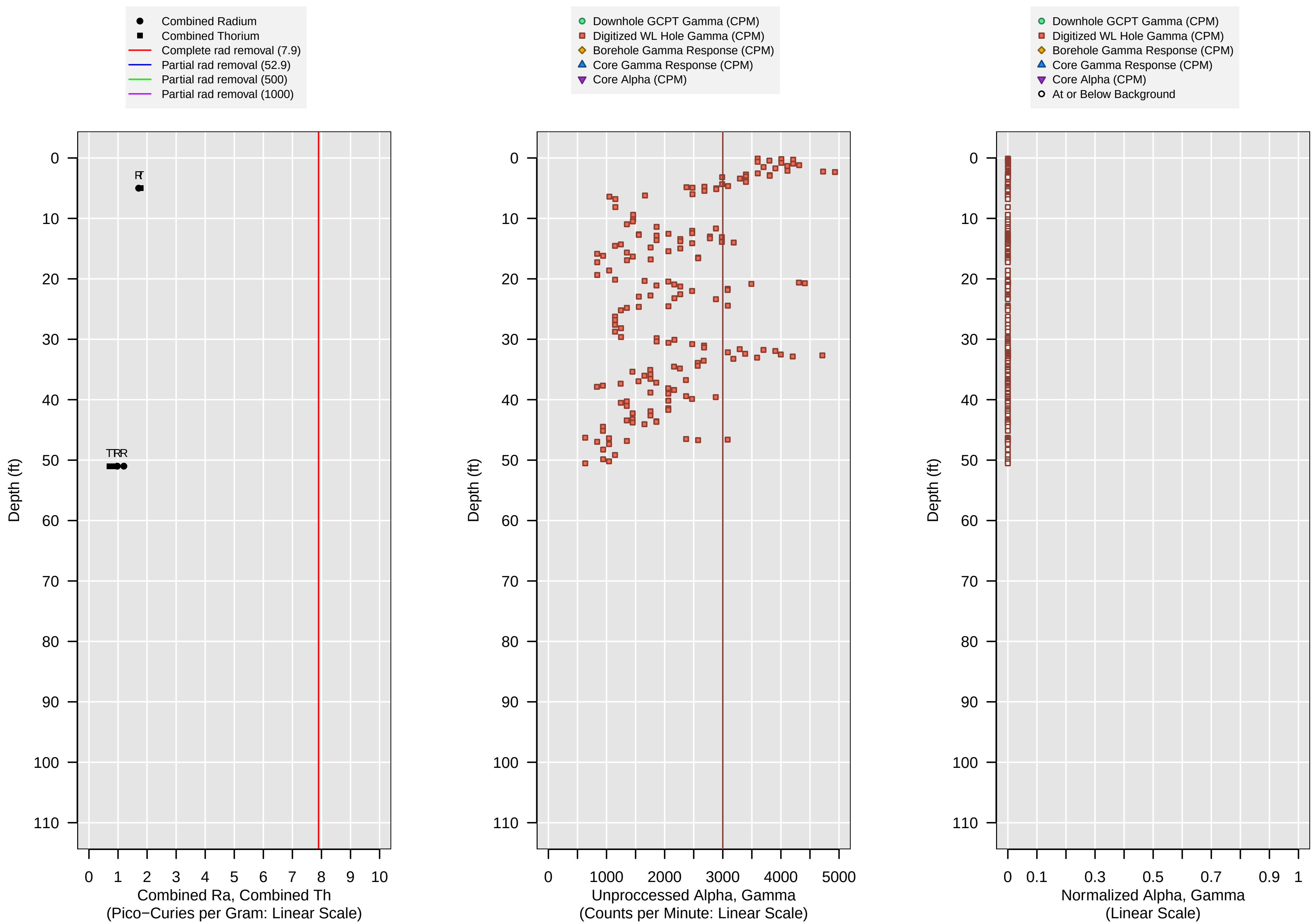

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−106−MH



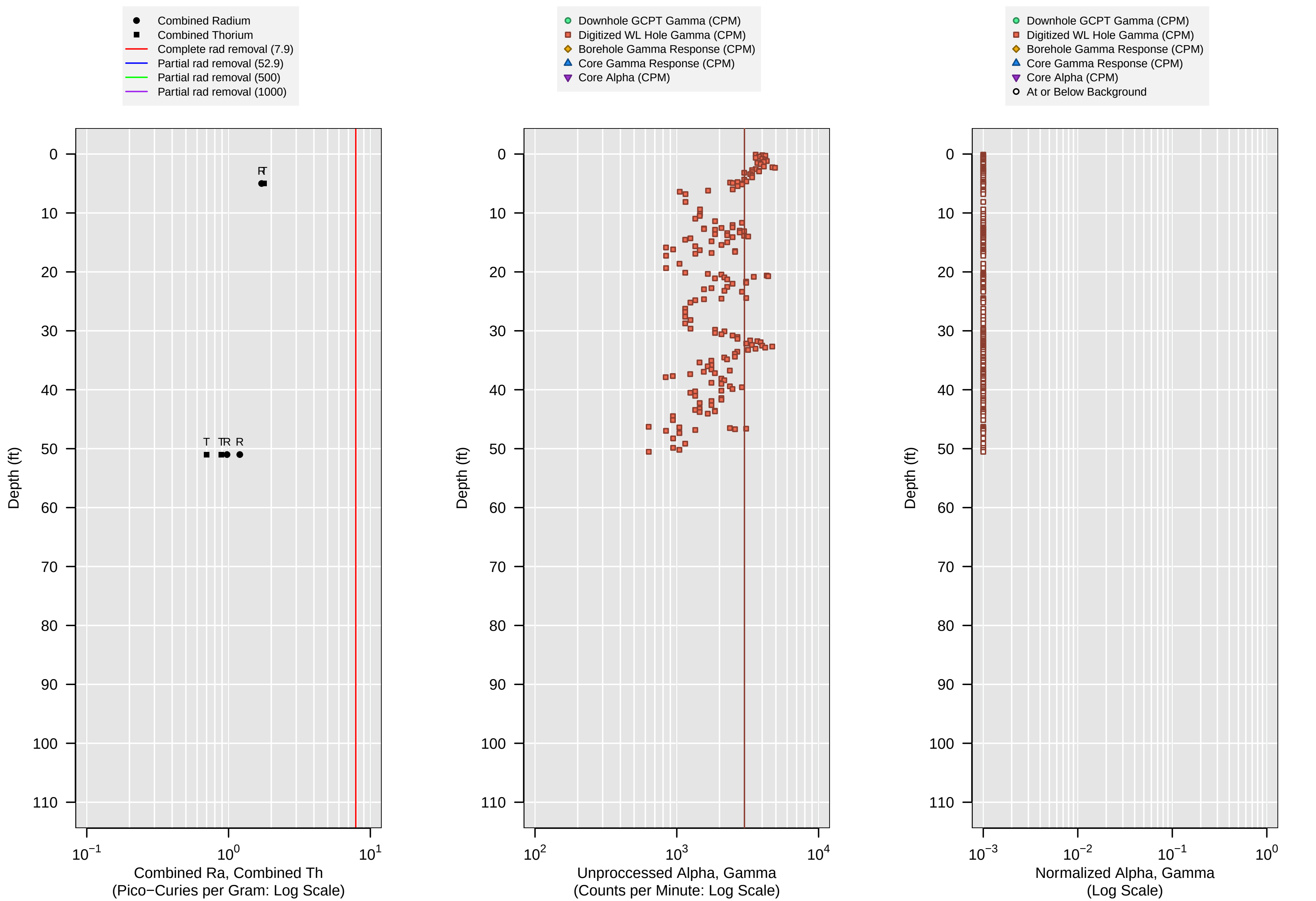
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−107−MH

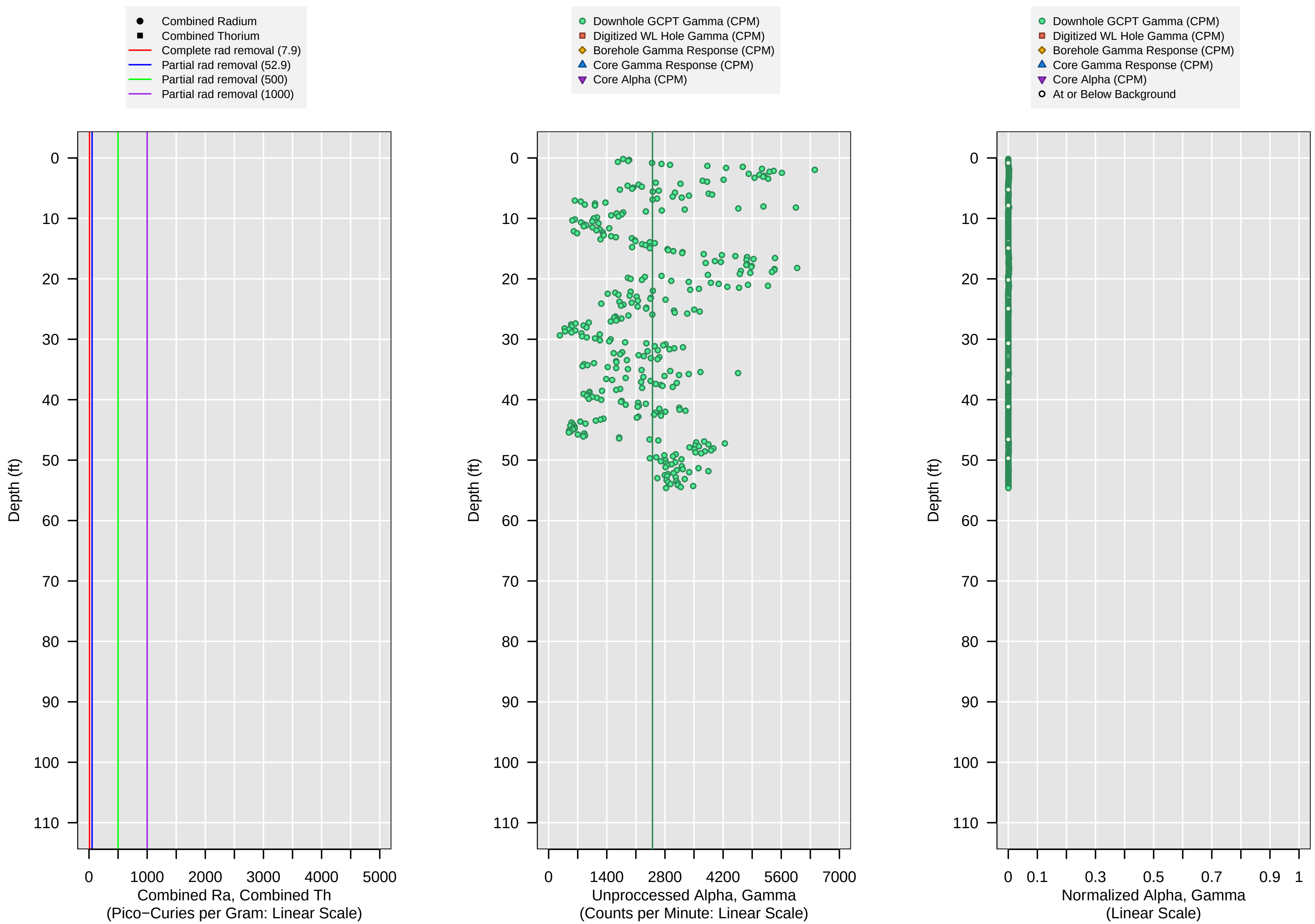


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−107−MH

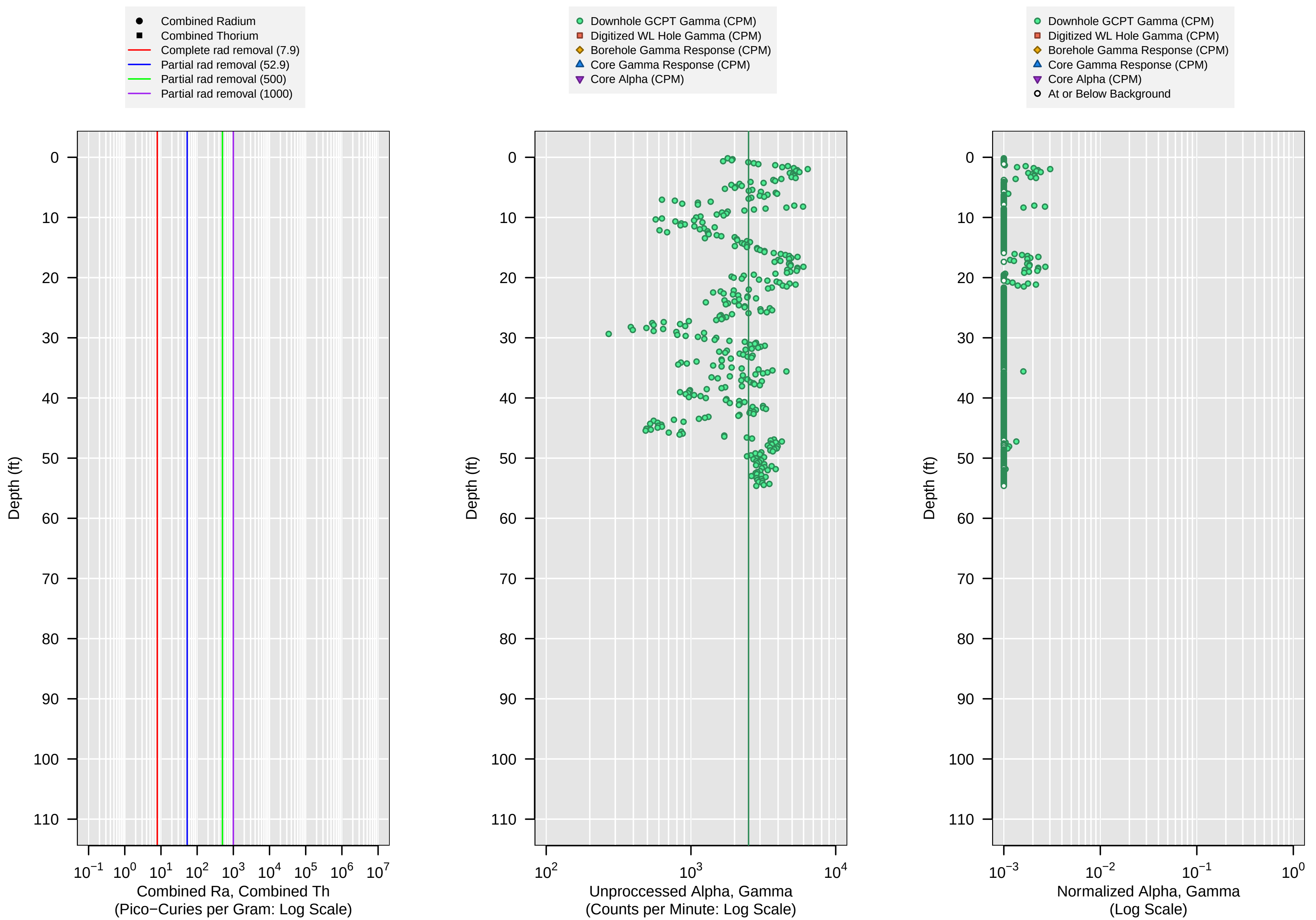

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

GCPT−108



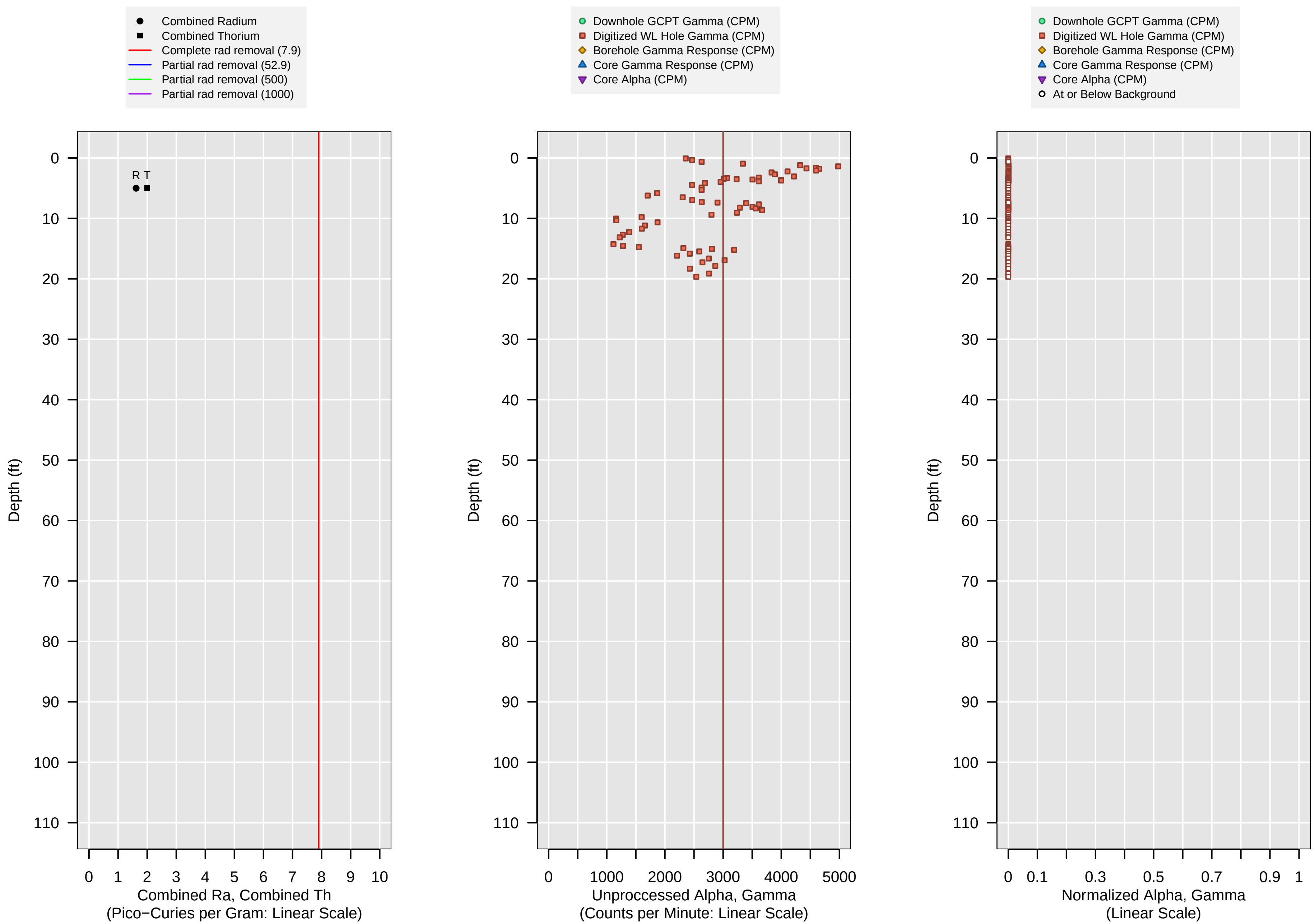
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−108



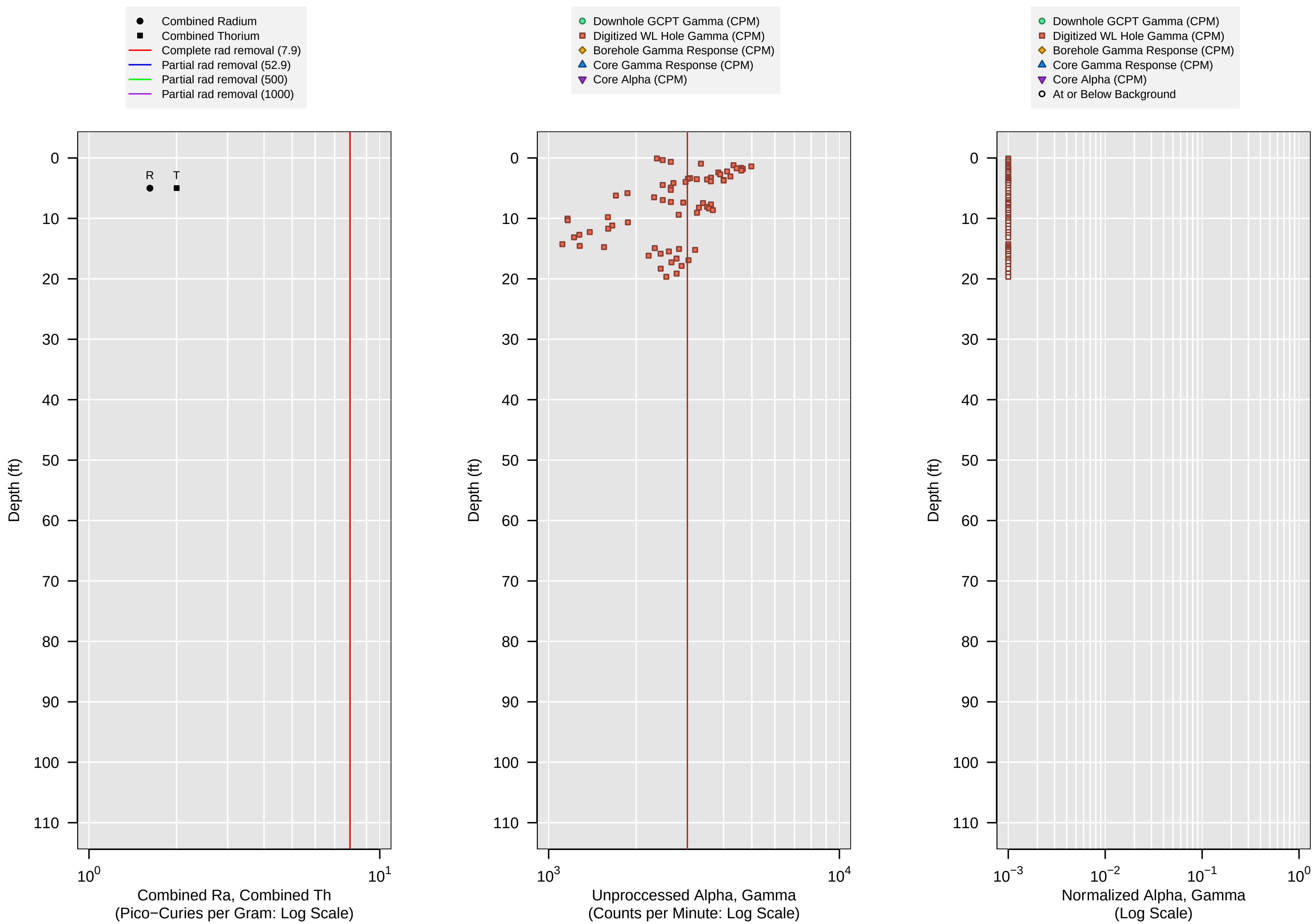
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

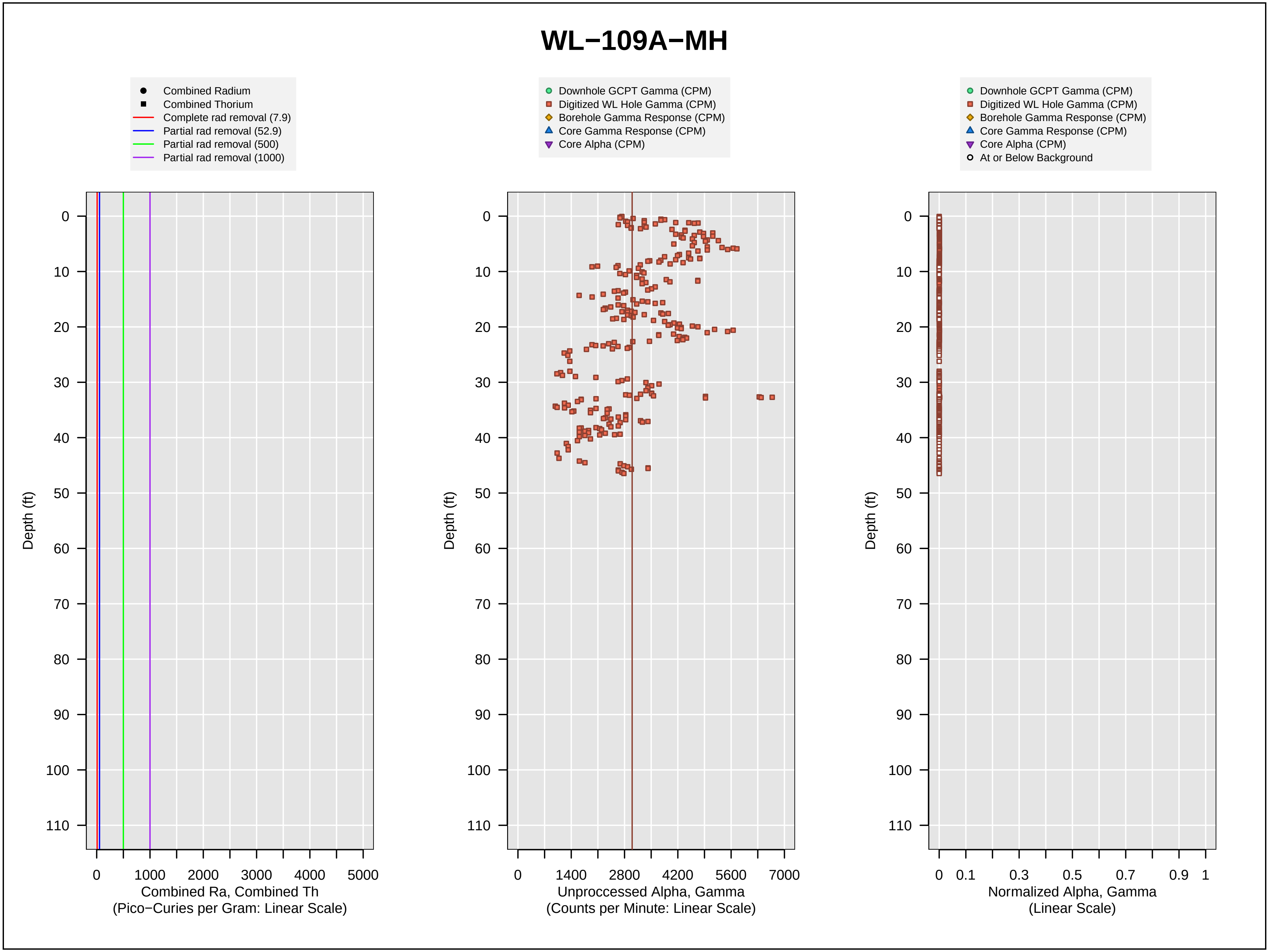
WL−108−MH



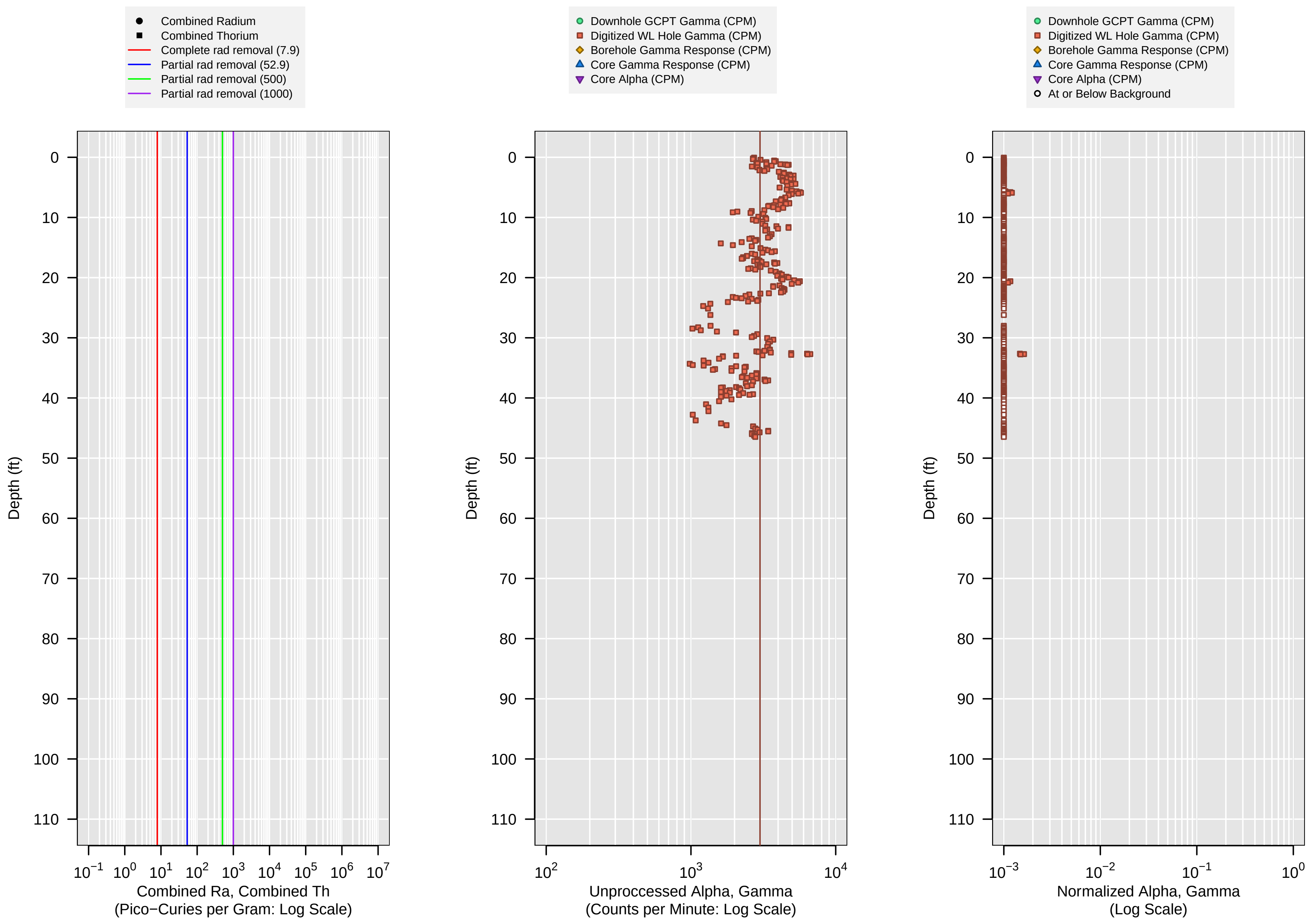
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Linear Scale)

WL−108−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

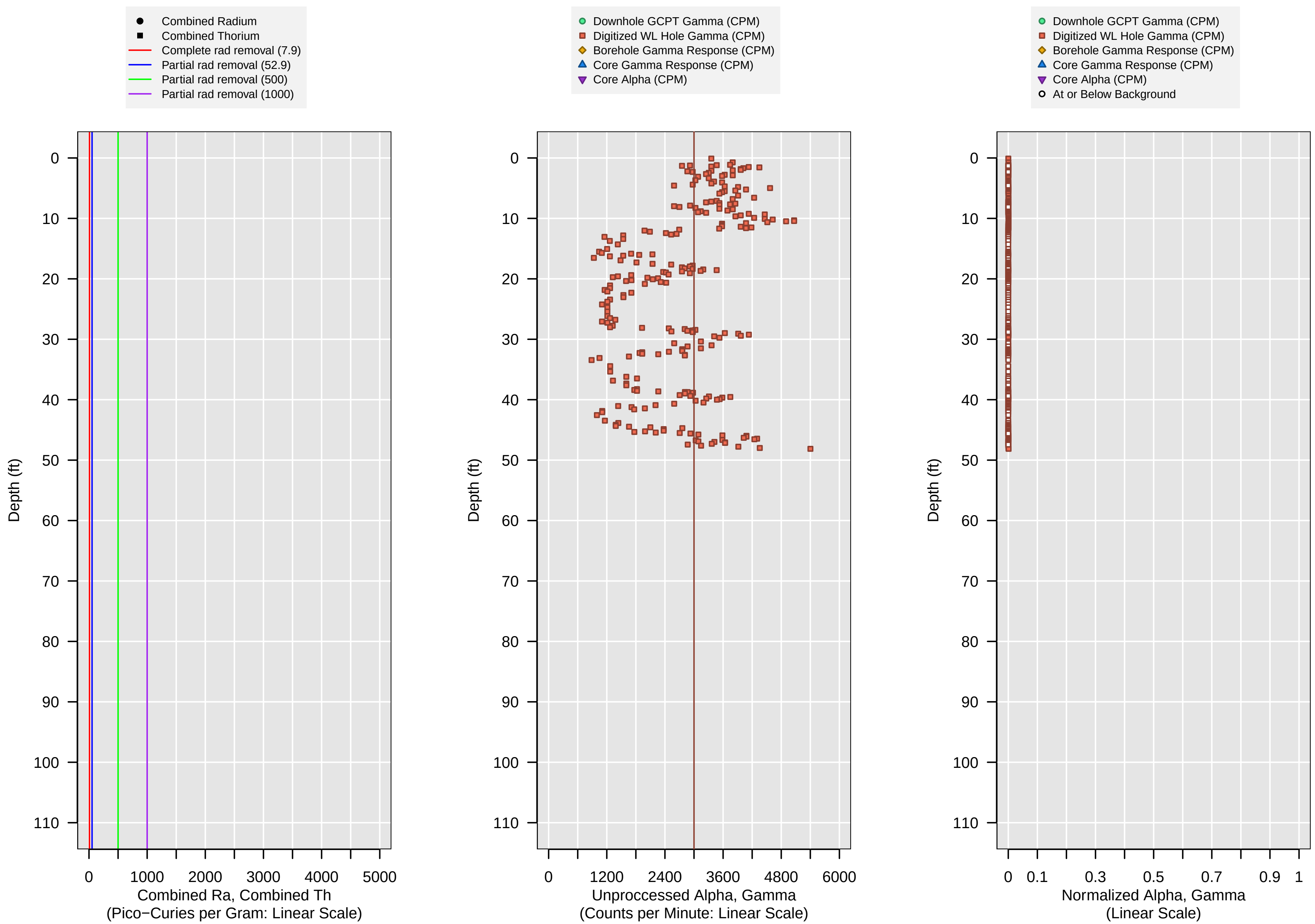

WL−109A−MH
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−109A−MH

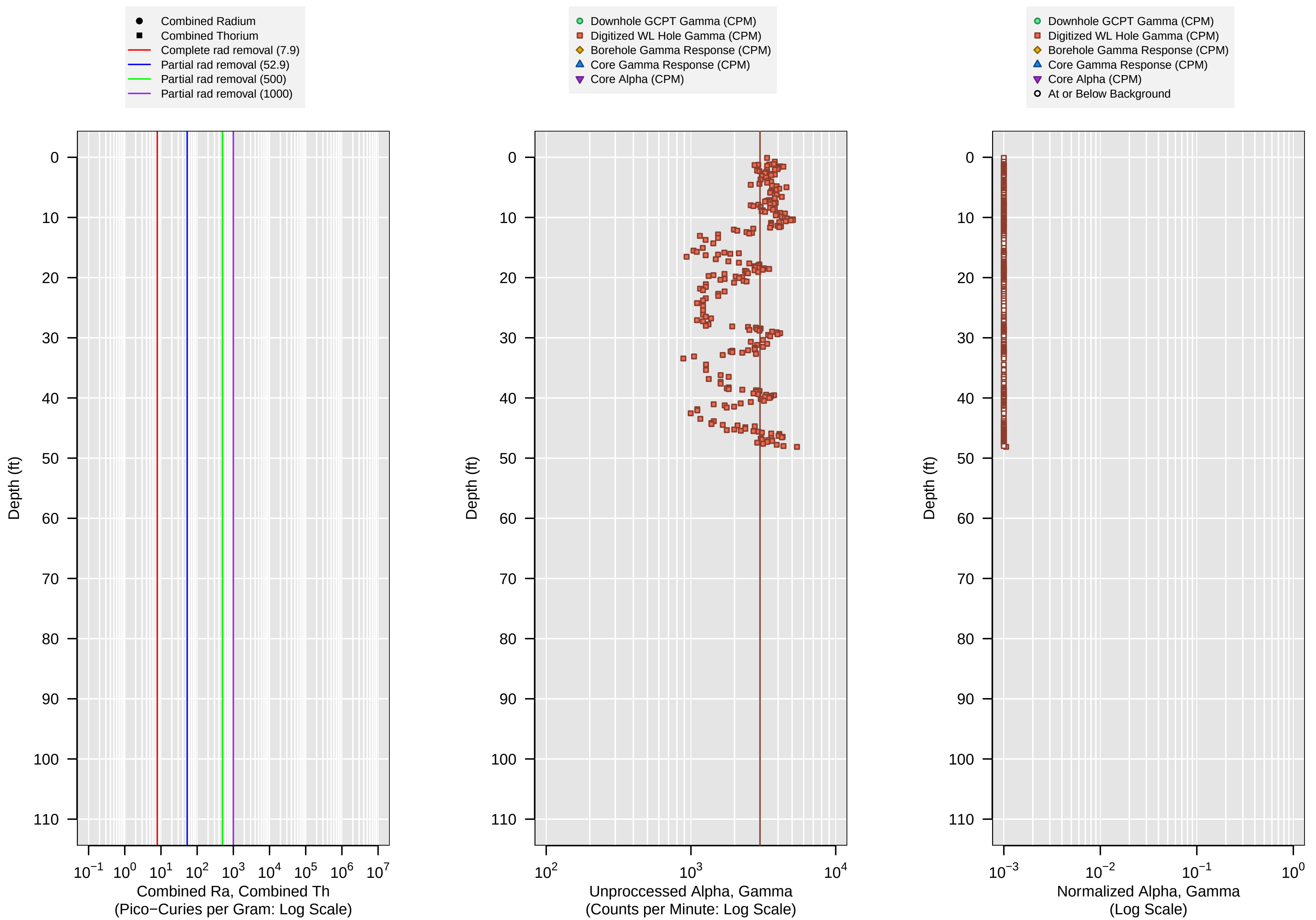


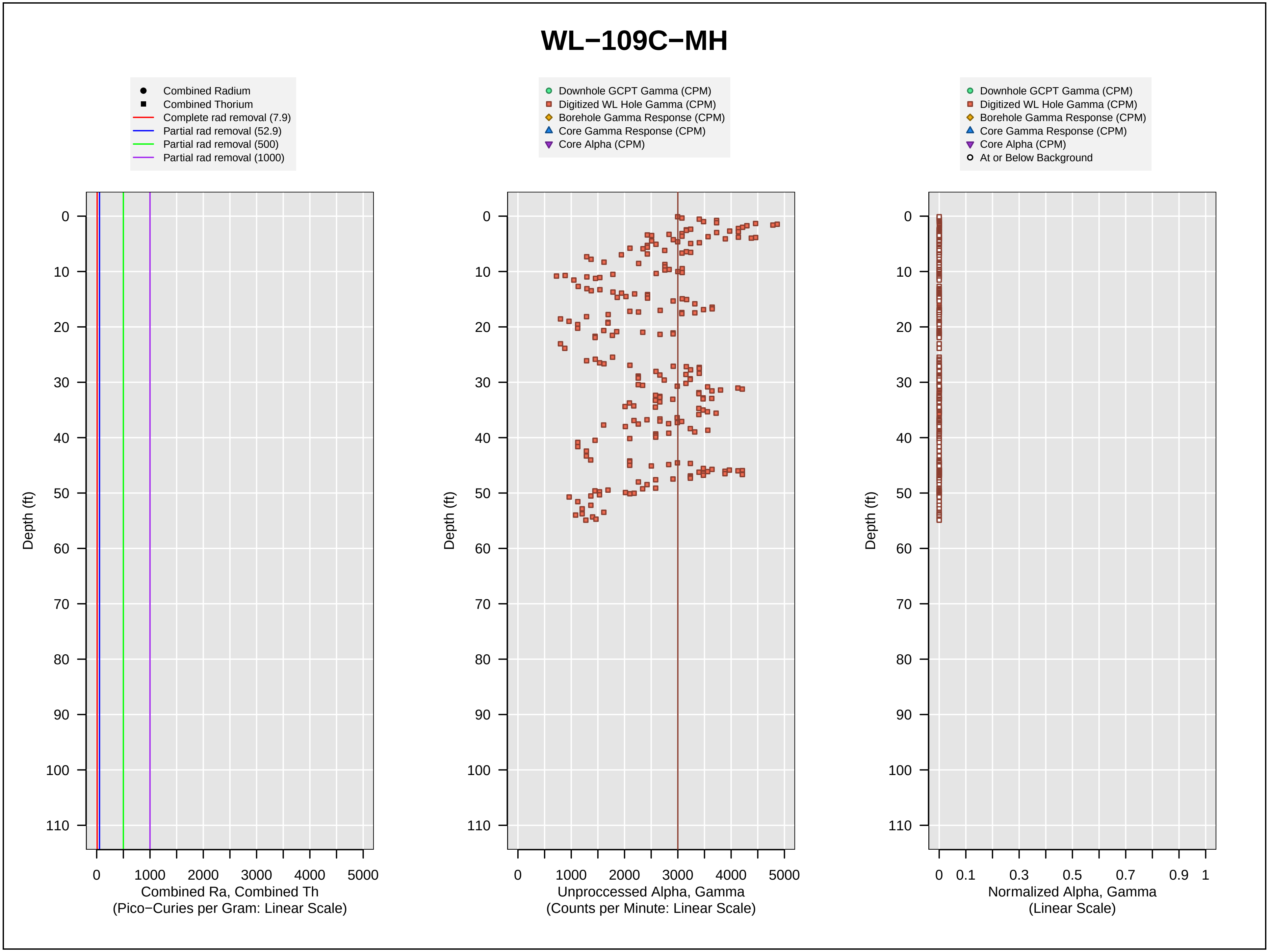
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

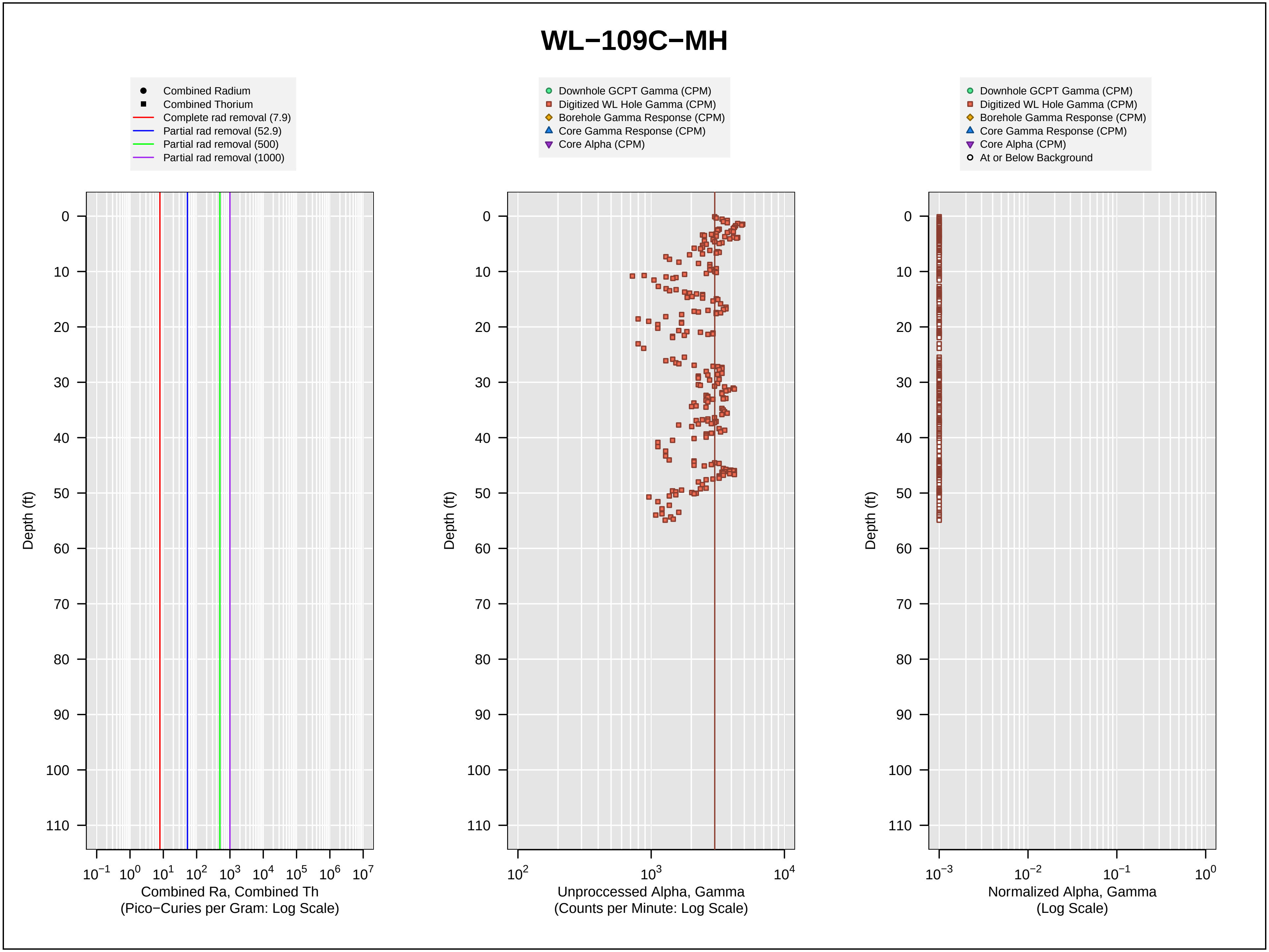
WL−109B−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

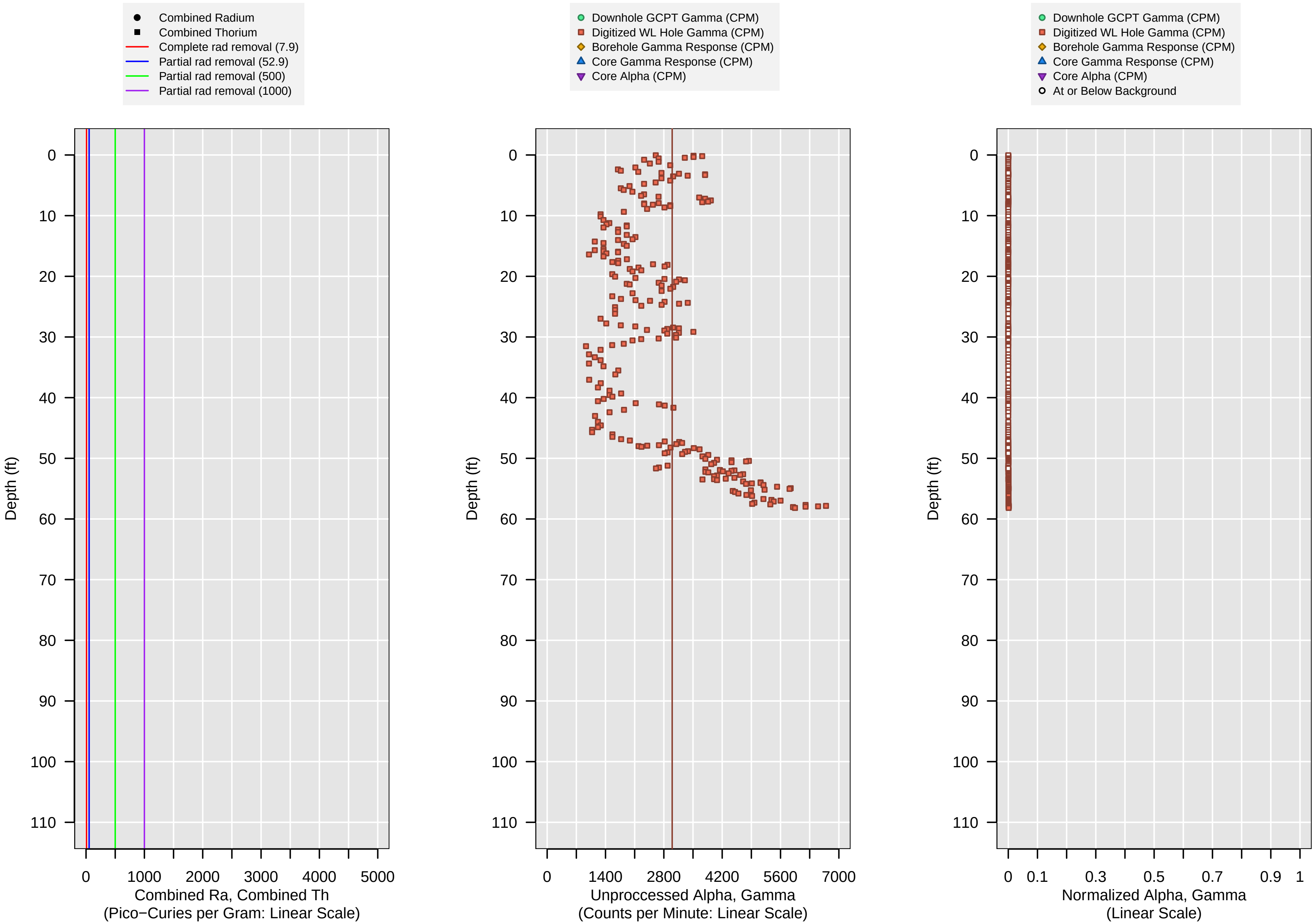
WL−109B−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

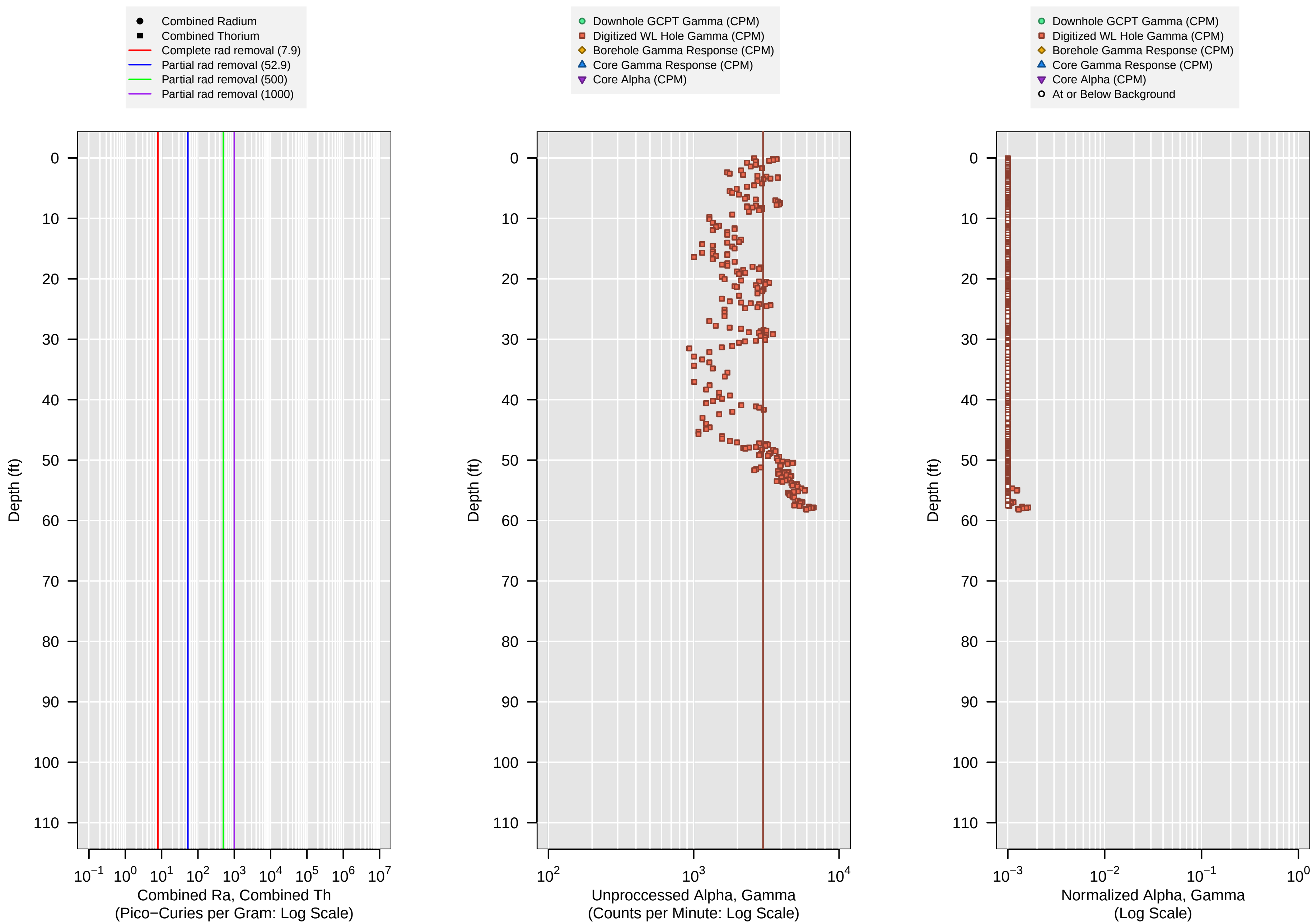

WL−109C−MH
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)


WL−109C−MH
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

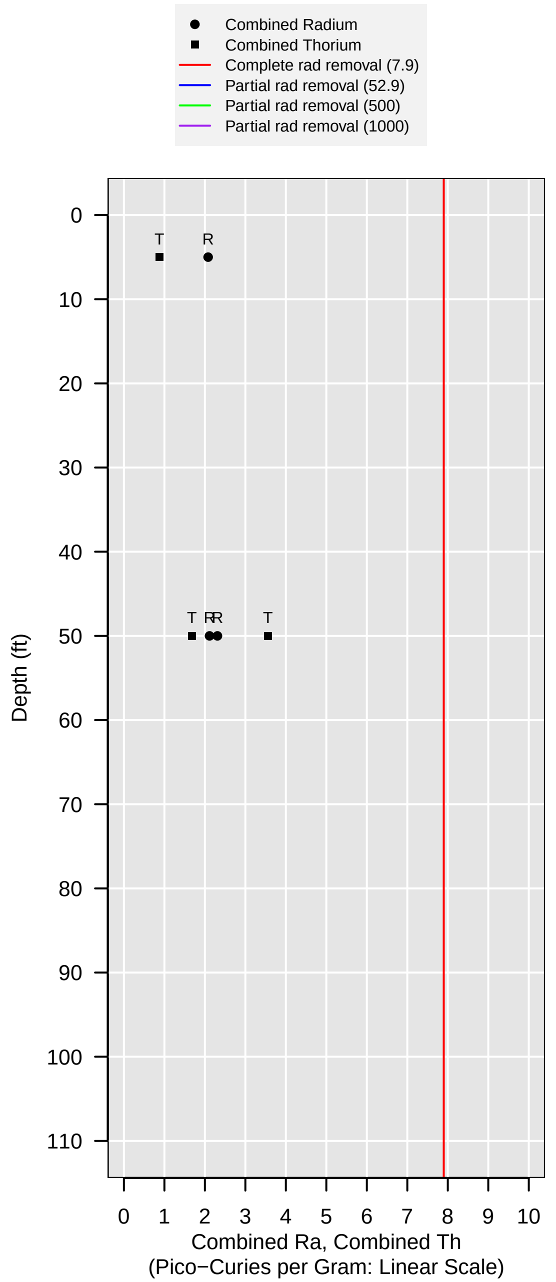
WL−109D−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1400
2800
4200
5600
7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

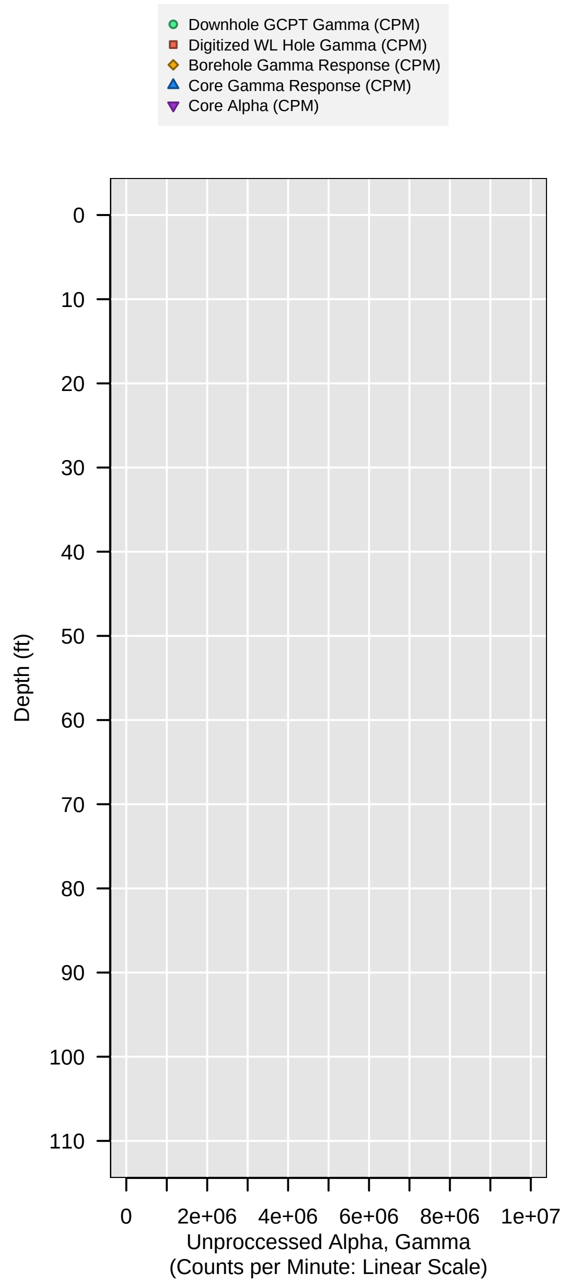
WL−109D−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

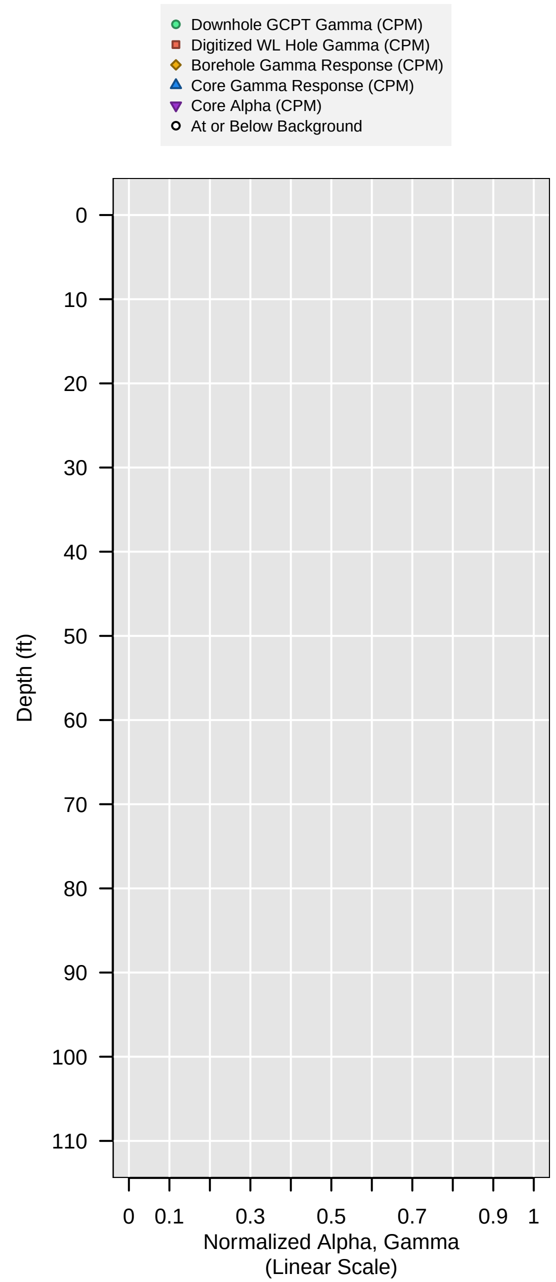
WL−109−MH



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
T
R
T
R
R
T
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)

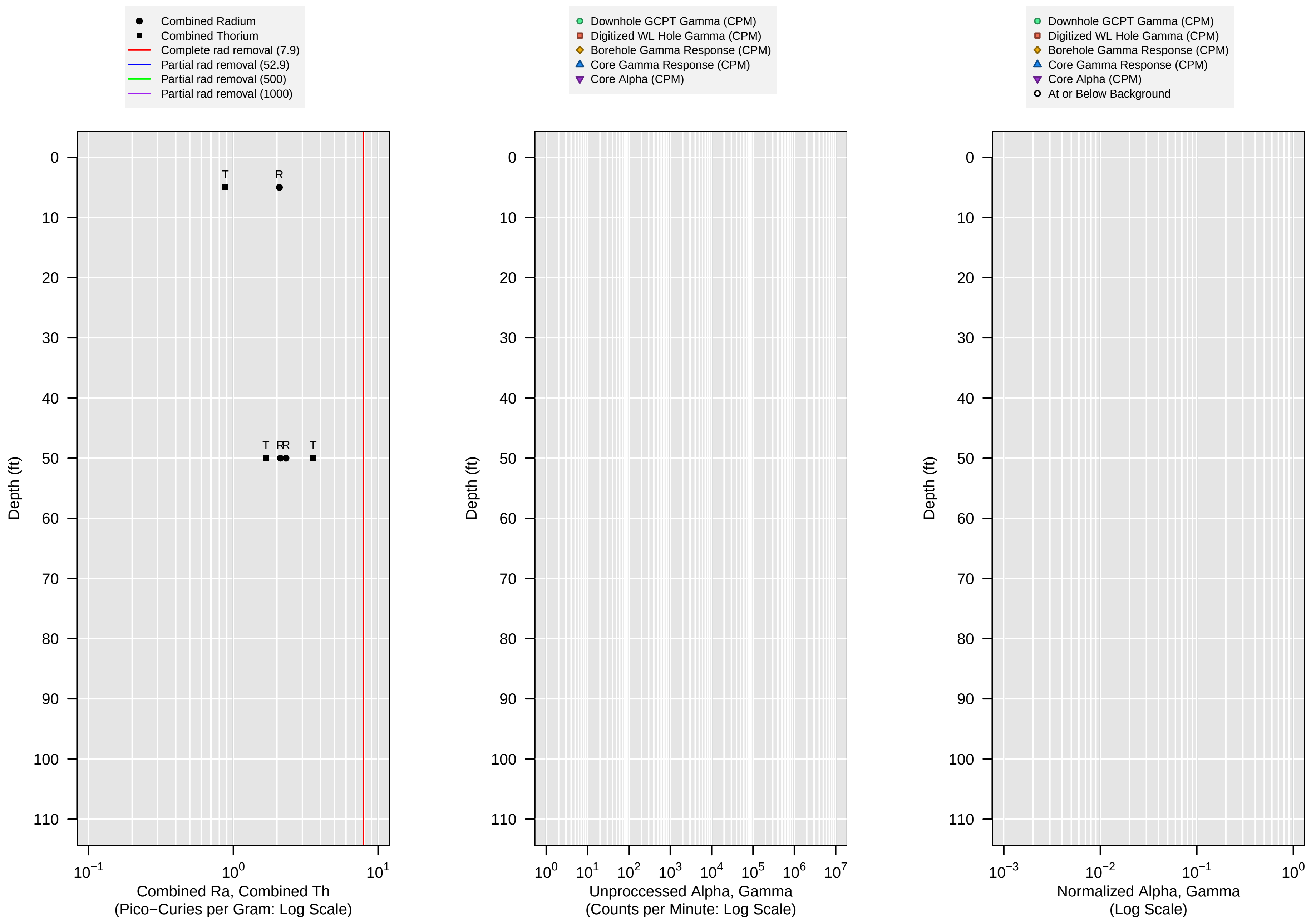


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)

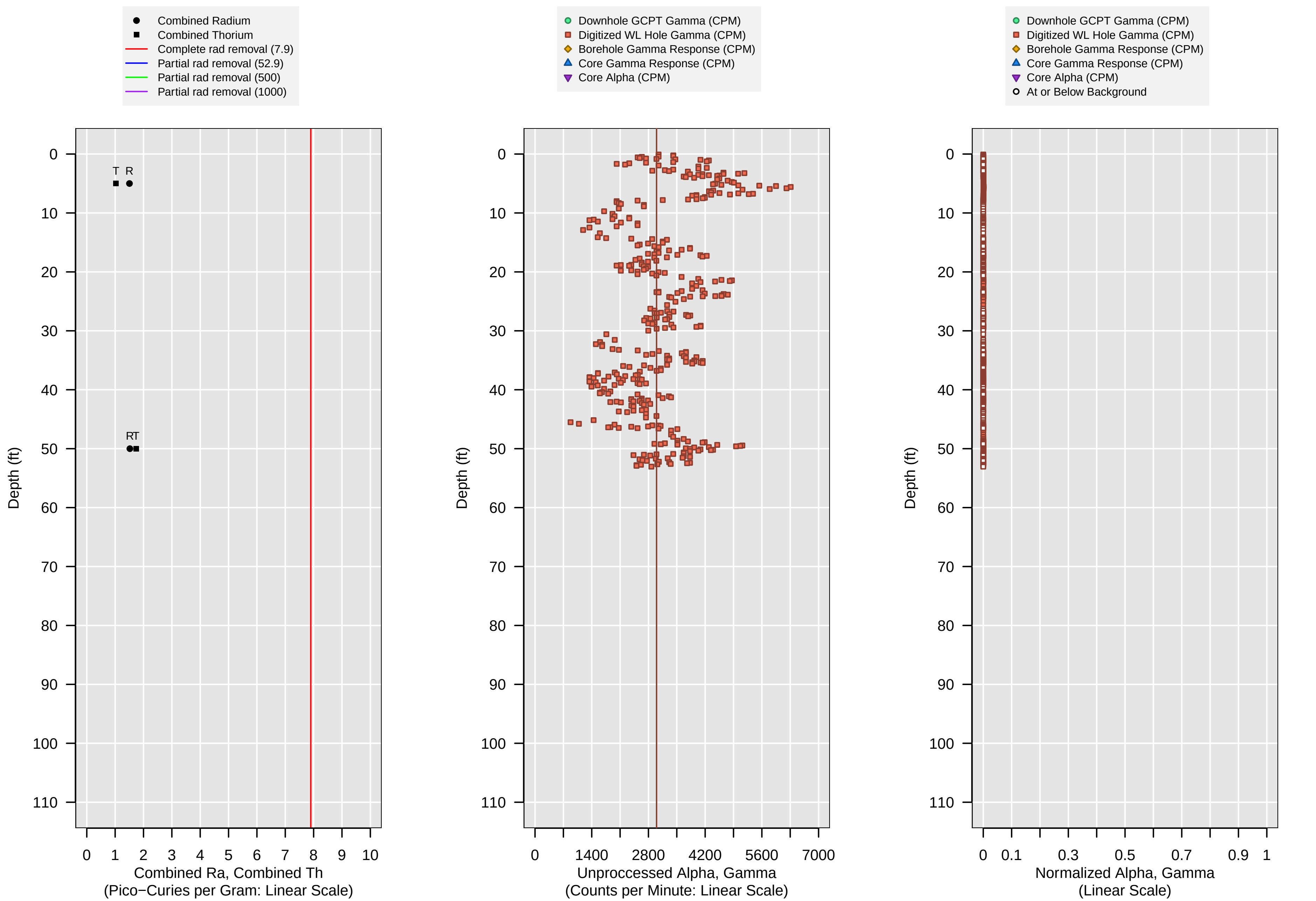


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Linear Scale)

WL−109−MH

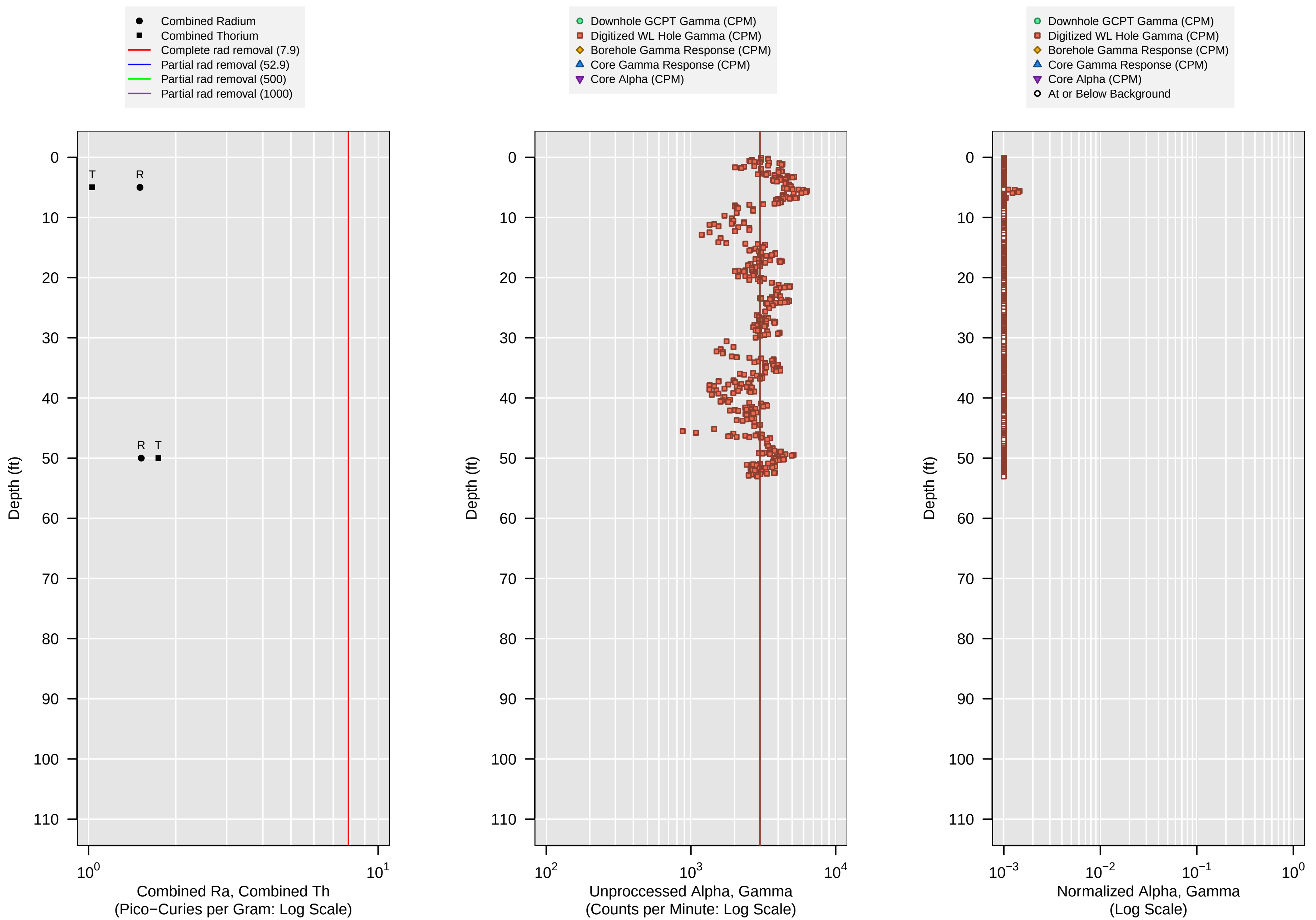

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
T
R
T
R
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

WL−110−MH

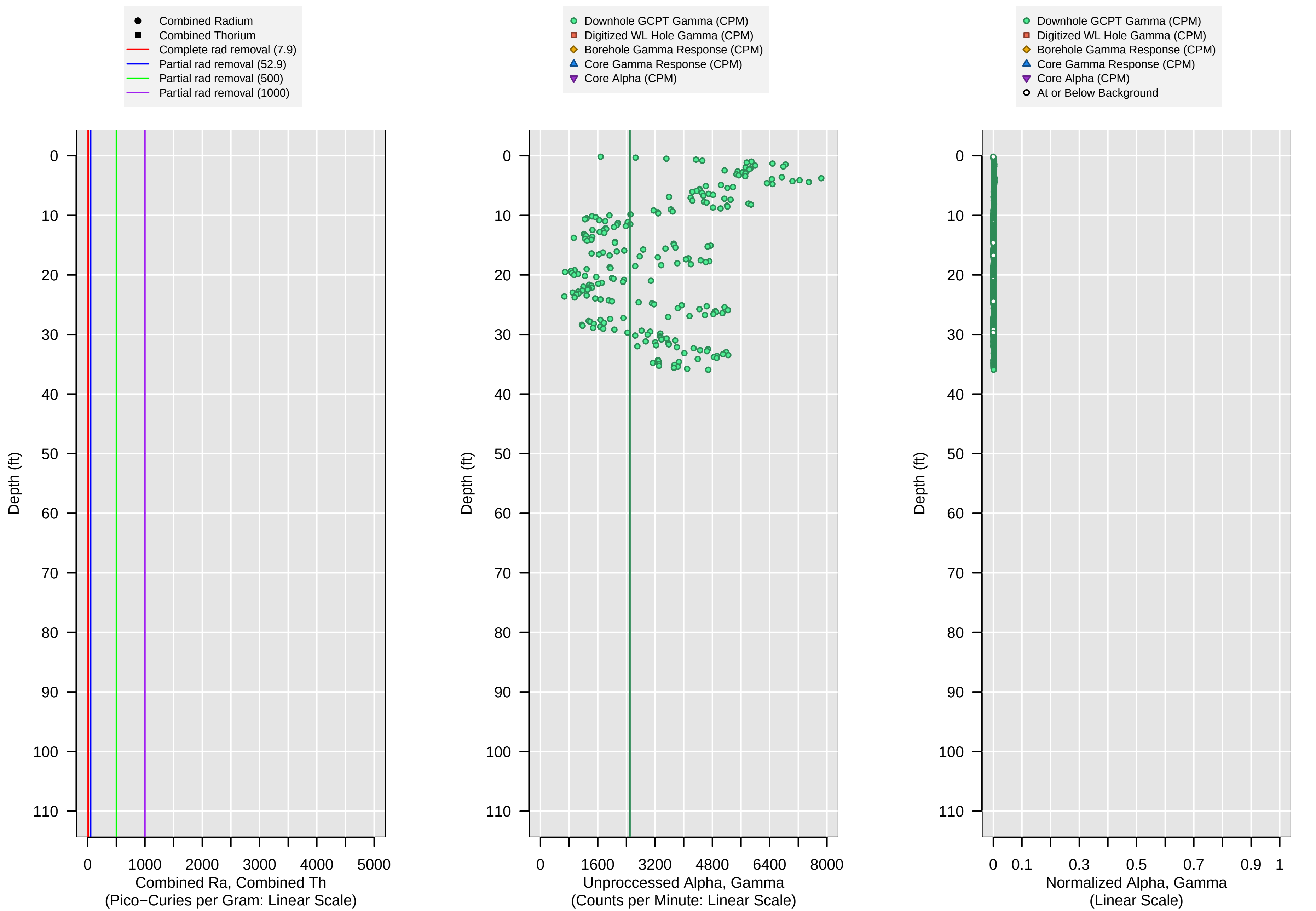


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
T R
RT
Depth (ft)
0 10 20 30 40 50 60 70 80 90 100 110
0 1 2 3 4 5 6 7 8 9 10
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0 1400 2800 4200 5600 7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

WL−110−MH

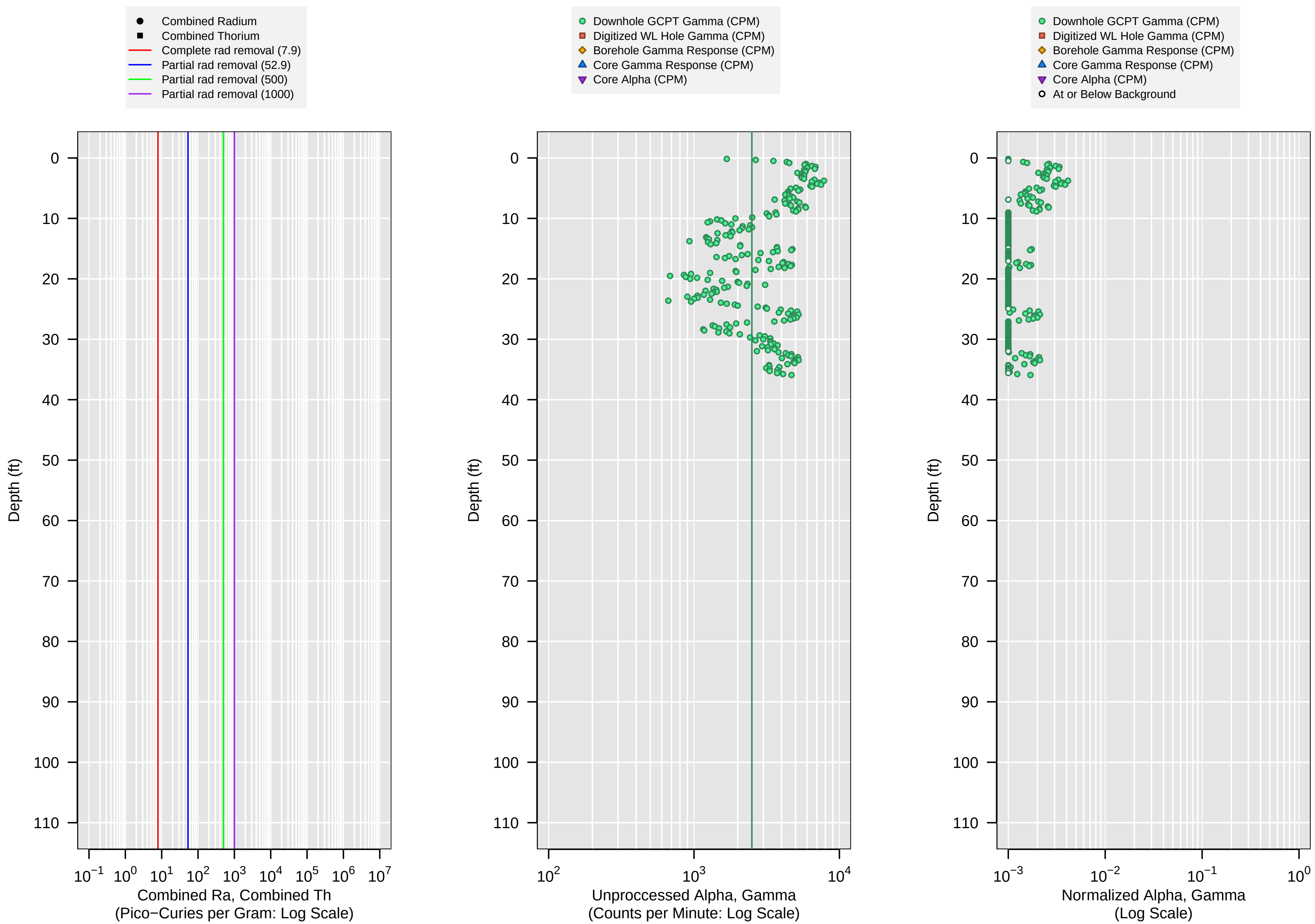

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
T
R
R
T
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^0
10^1
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
10^2
10^3
10^4
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
10^{-3}
10^{-2}
10^{-1}
10^0
Normalized Alpha, Gamma
(Log Scale)

GCPT−111



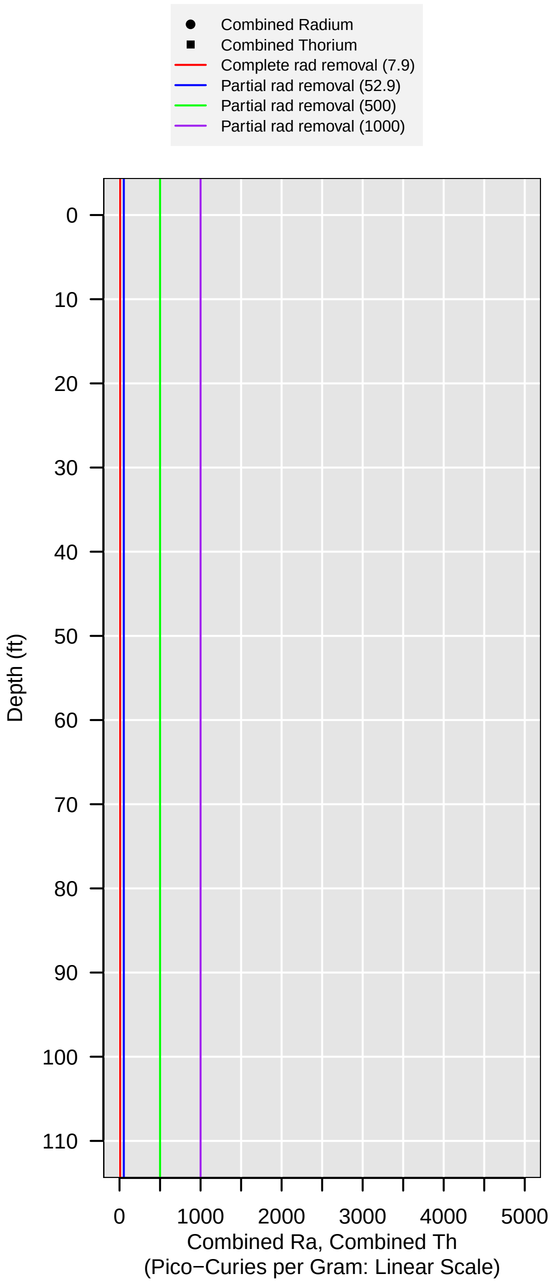
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1600
3200
4800
6400
8000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

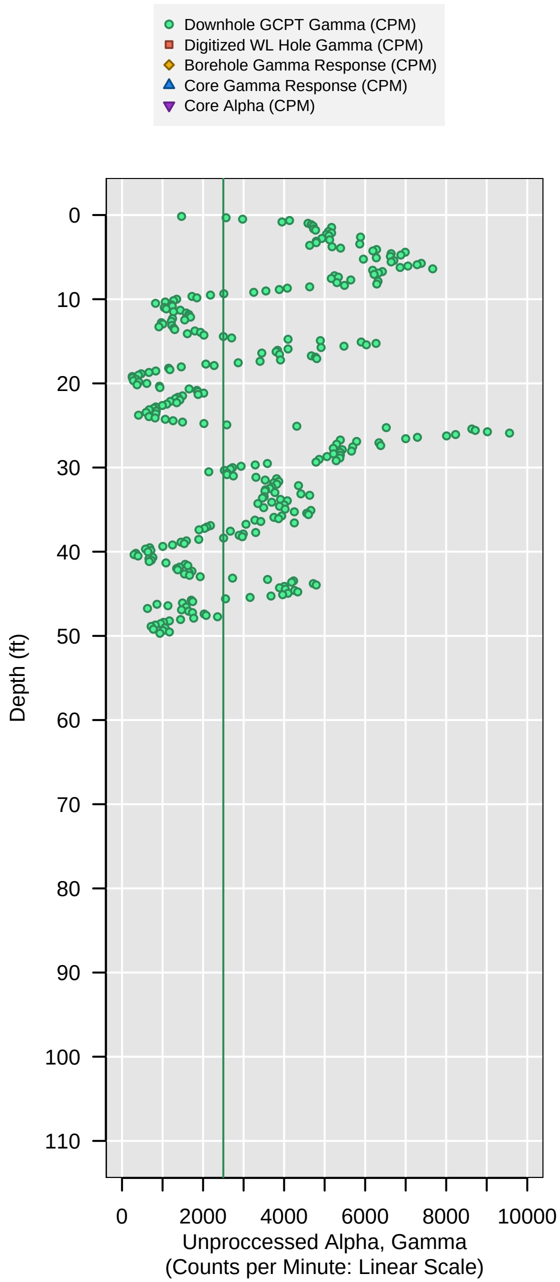
GCPT−111

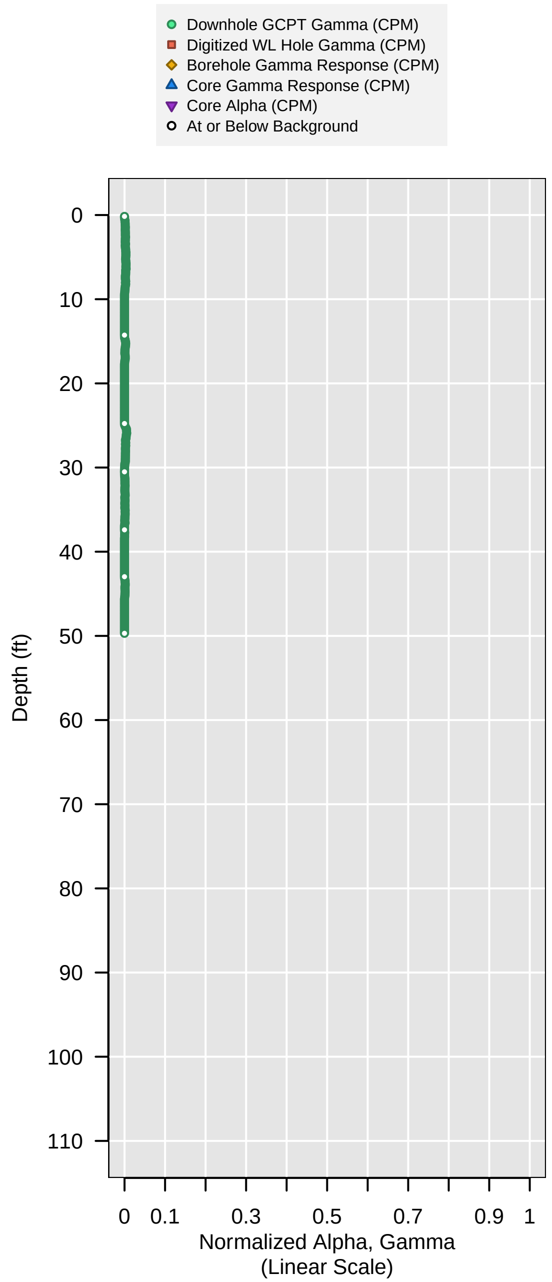


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

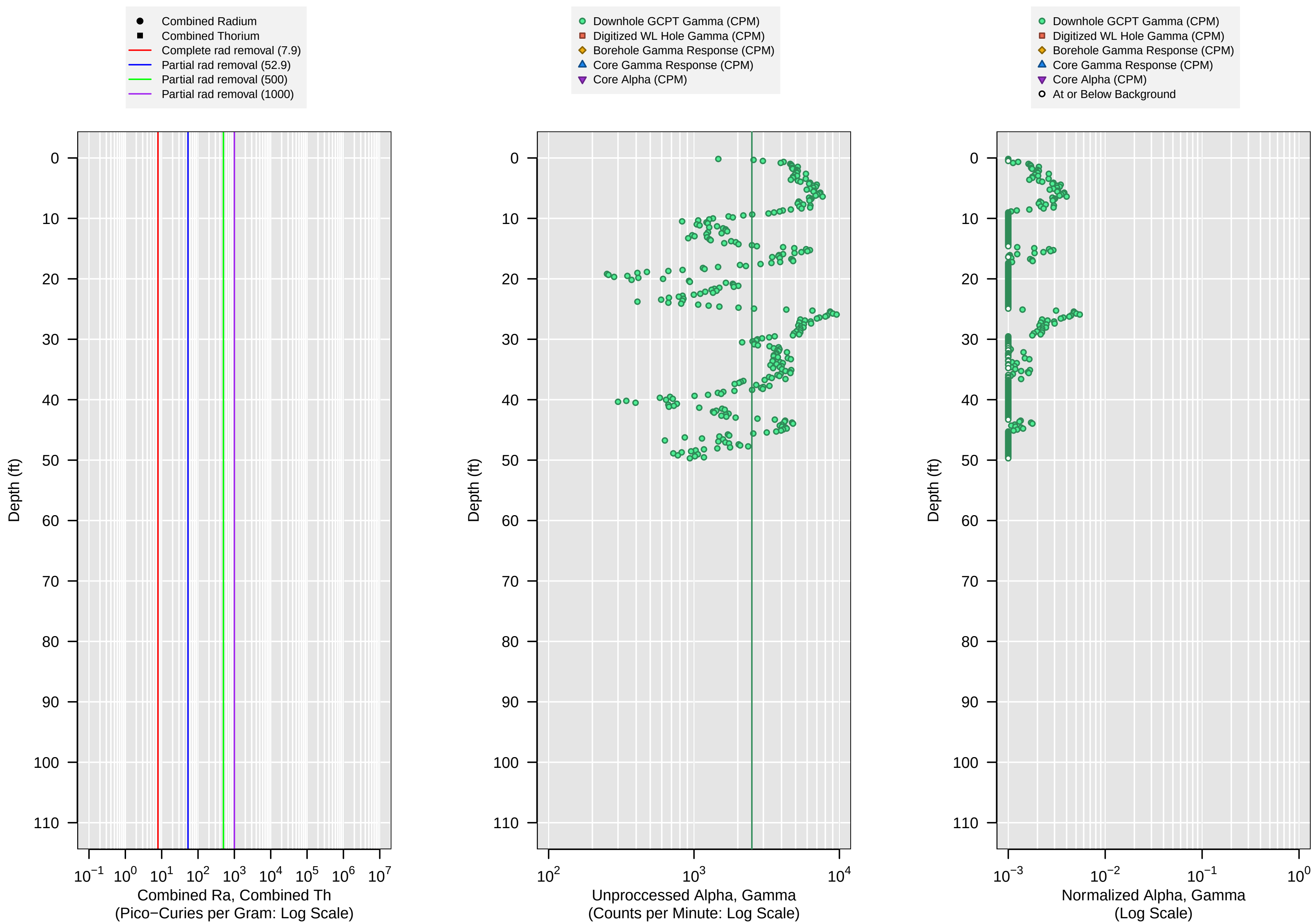
GCPT−111A


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)

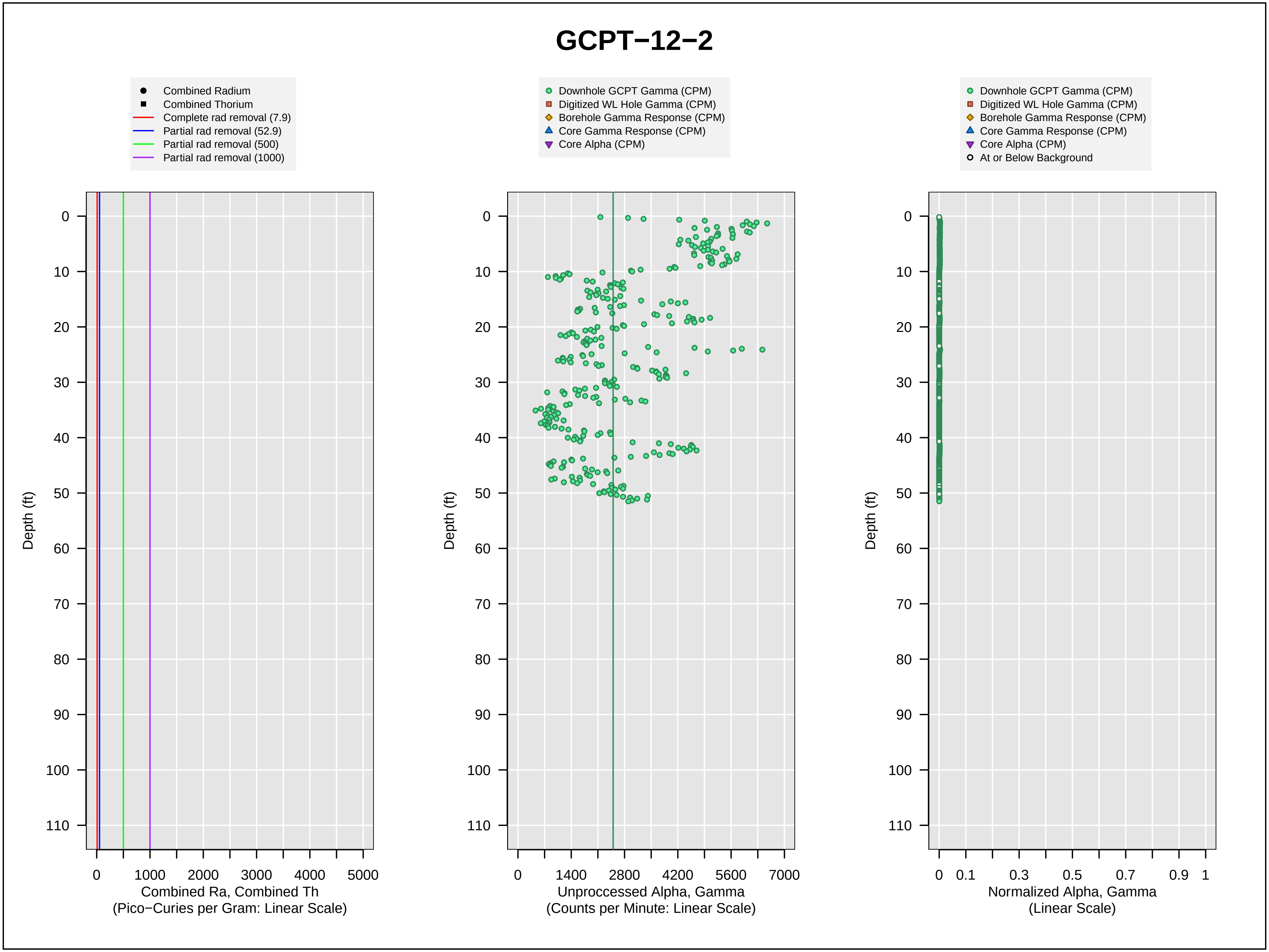

Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
2000
4000
6000
8000
10000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

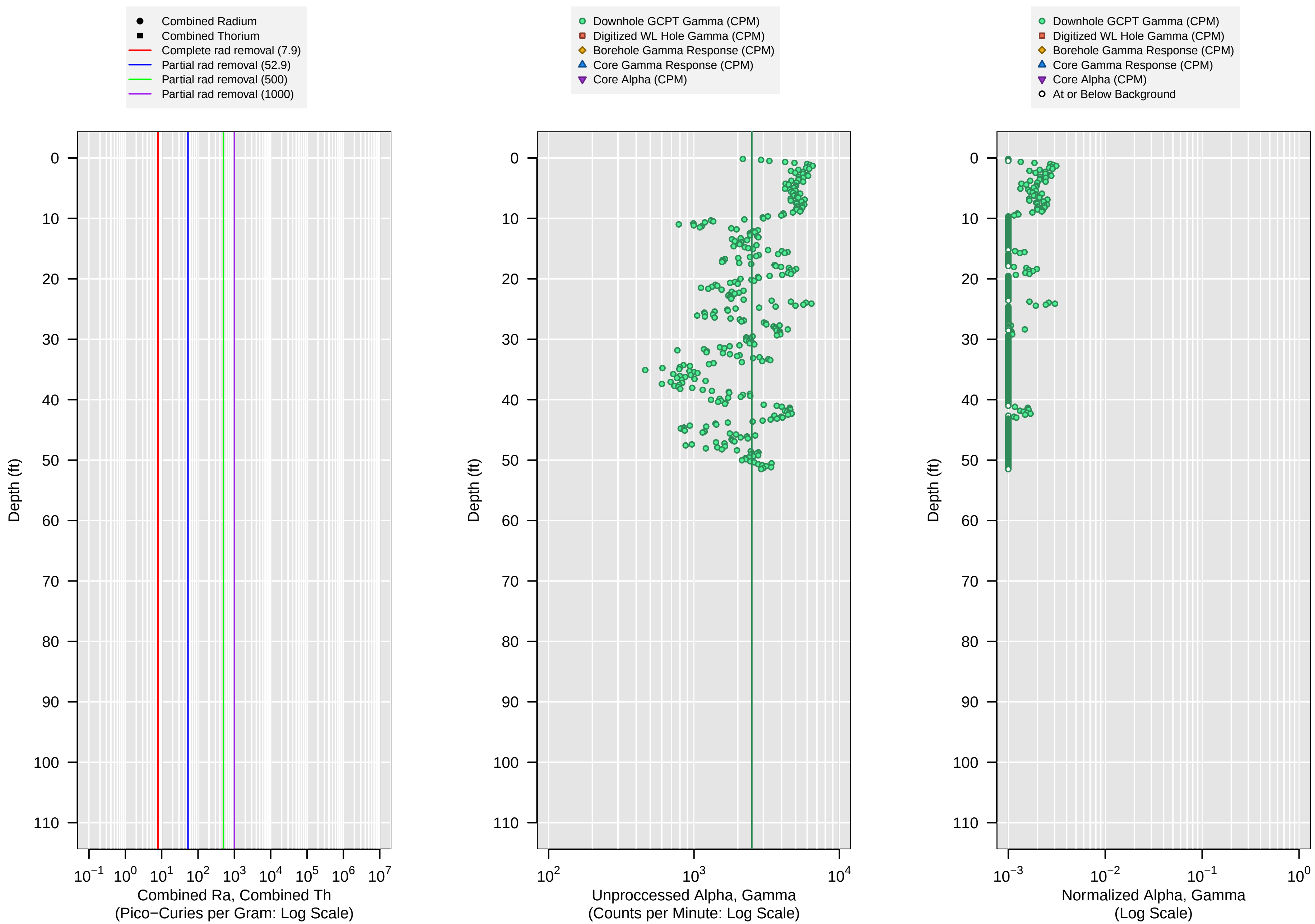
GCPT−111A



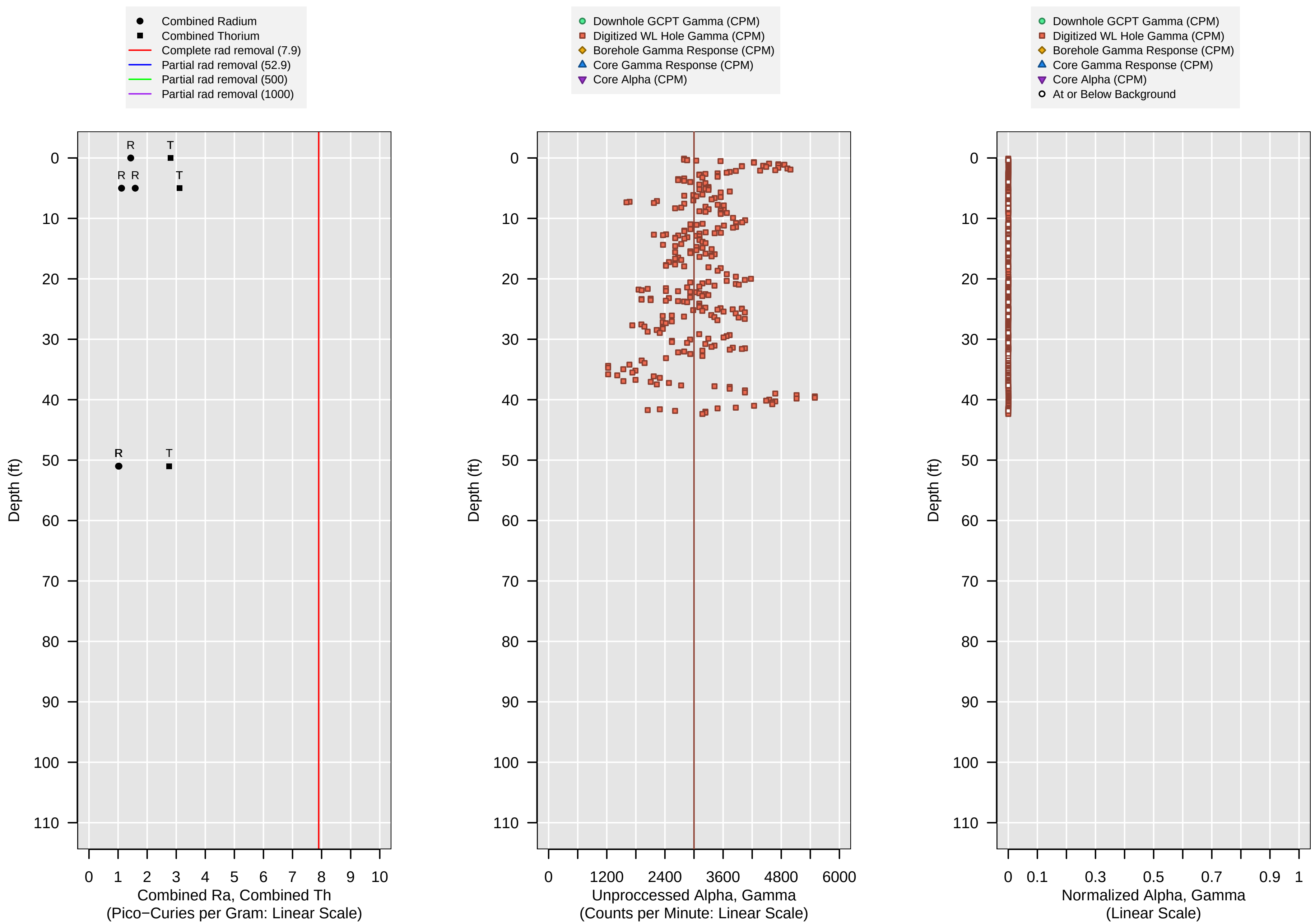
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)


GCPT−12−2
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

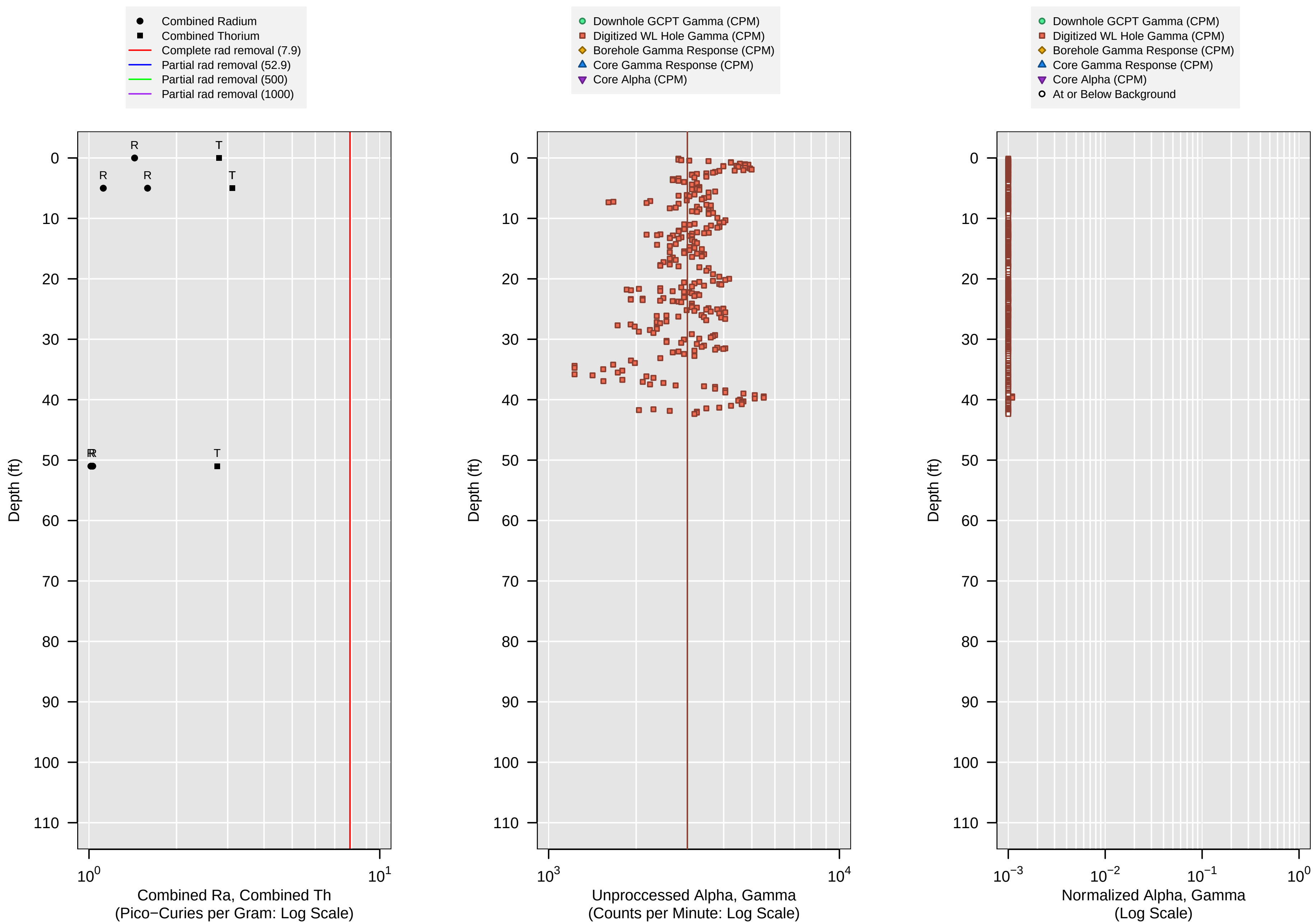
GCPT−12−2


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−111−MH

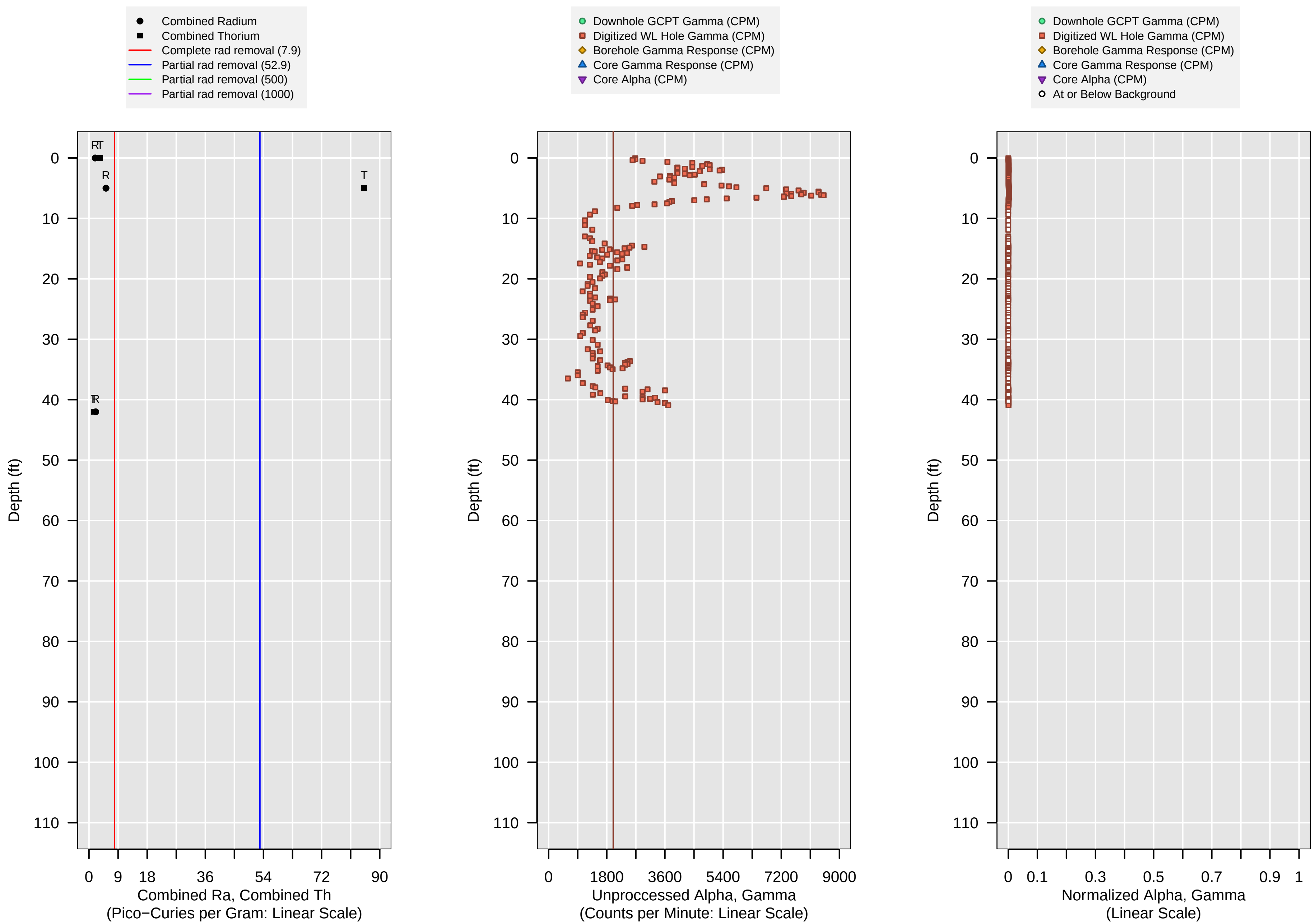

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−111−MH

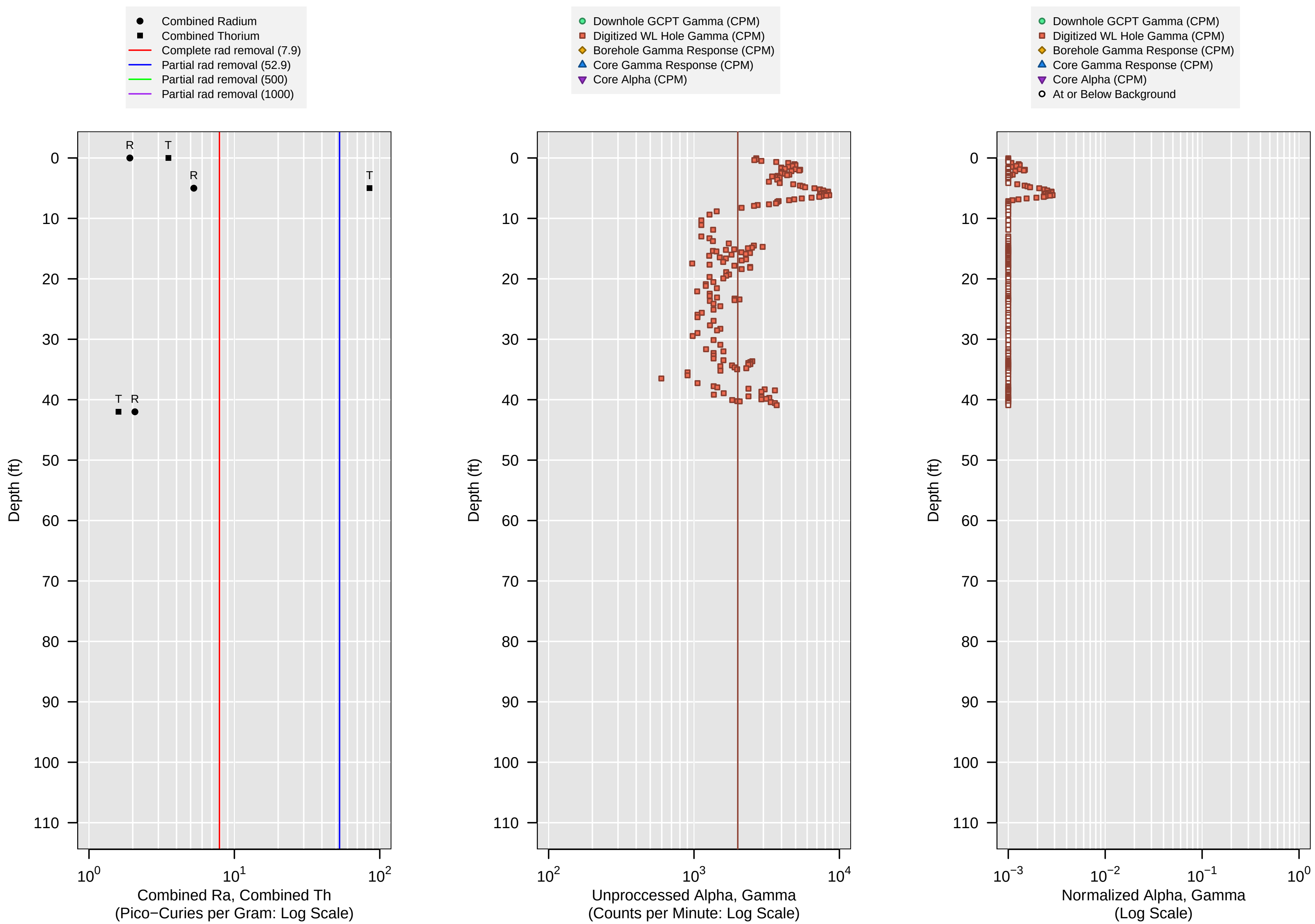


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

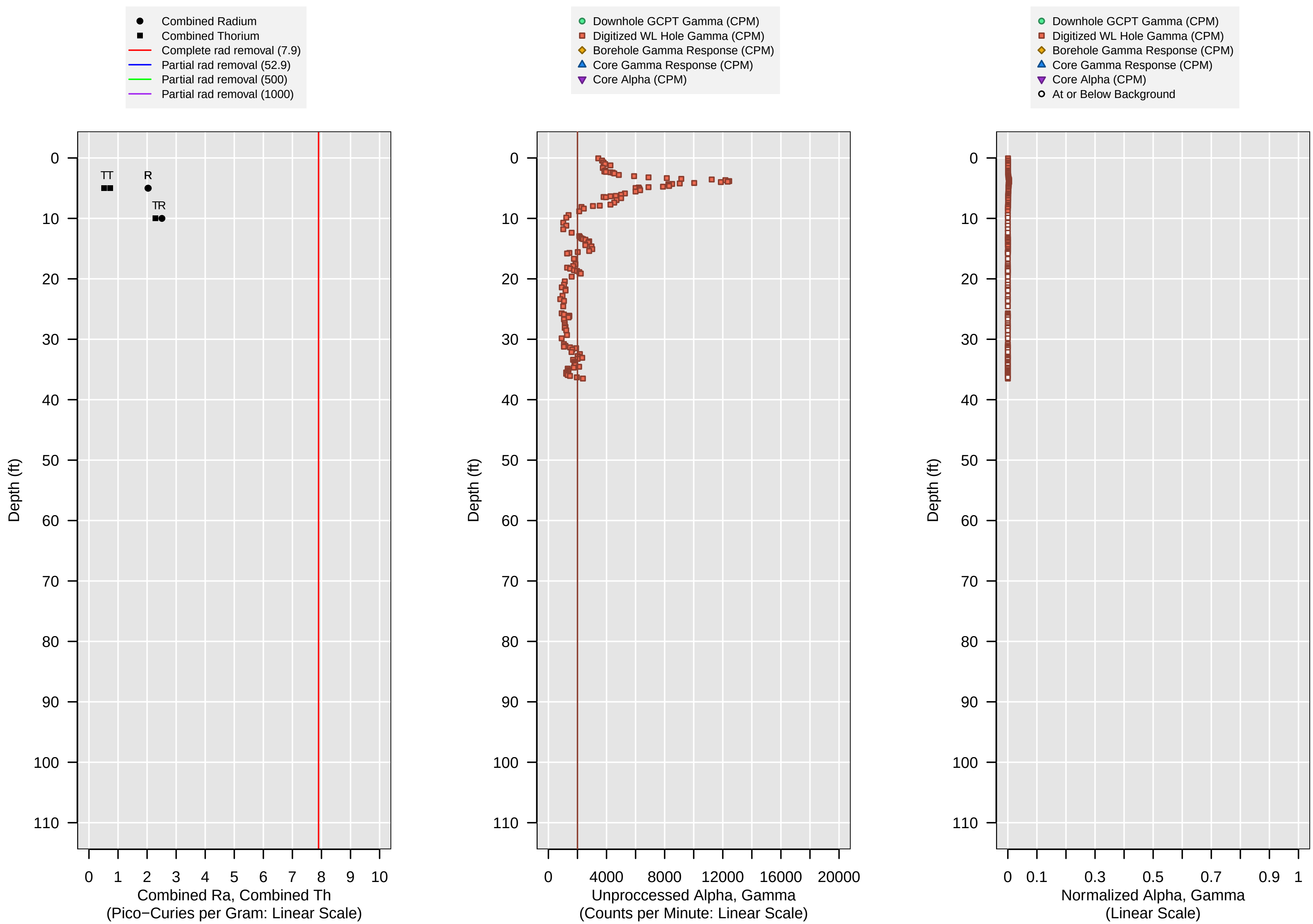
WL−112−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

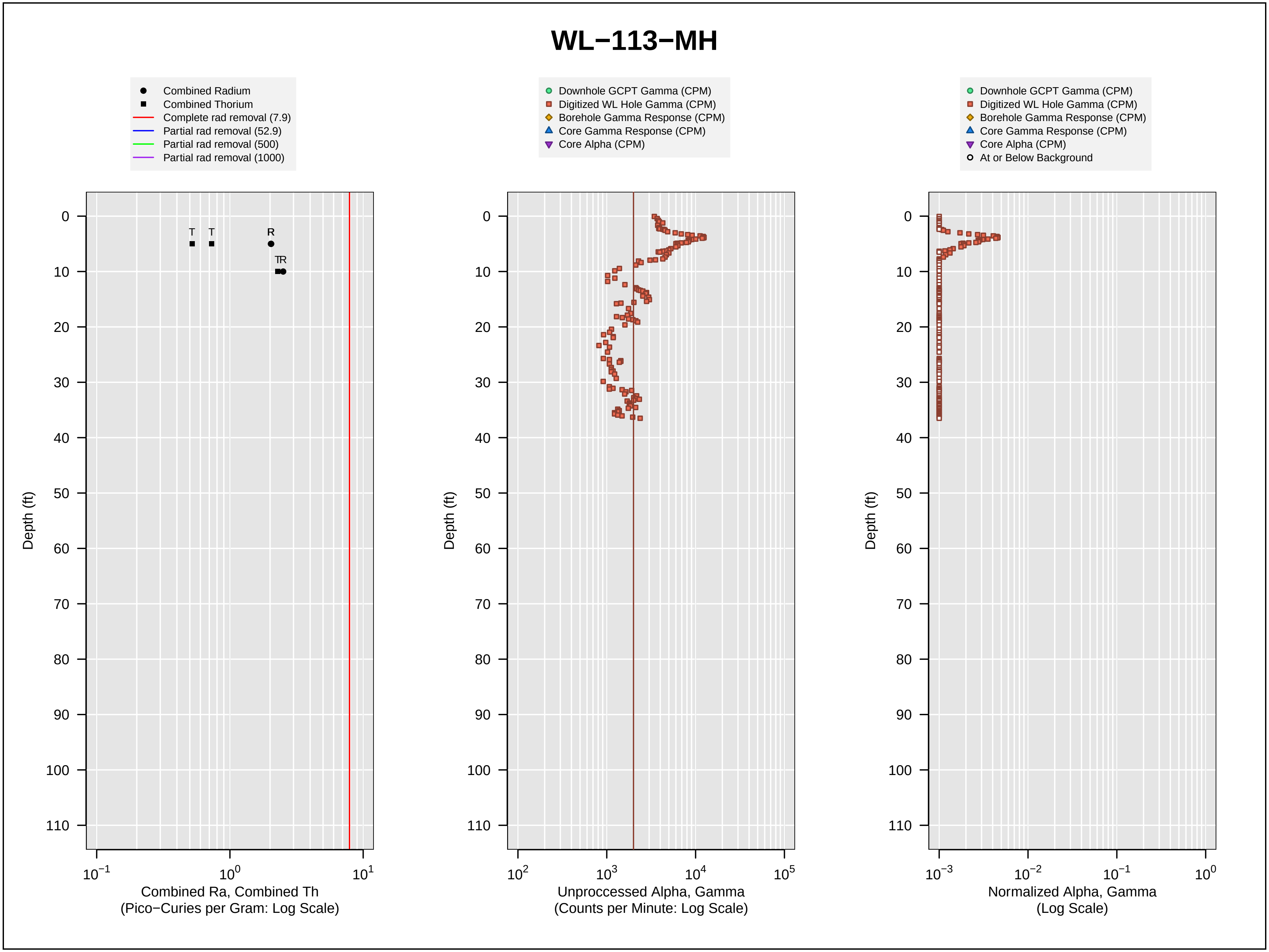
WL−112−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

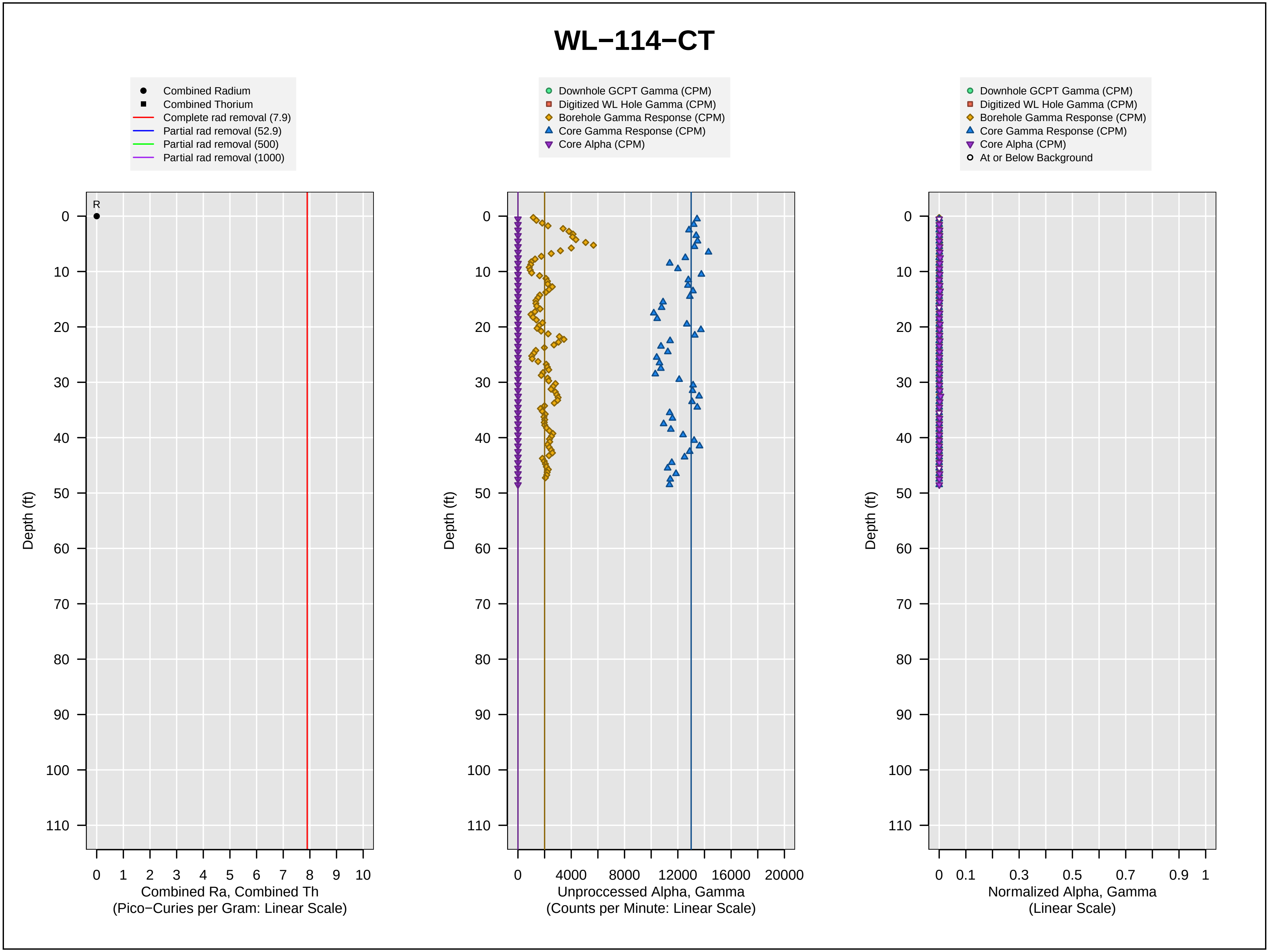
WL−113−MH



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
TT
R
TR
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

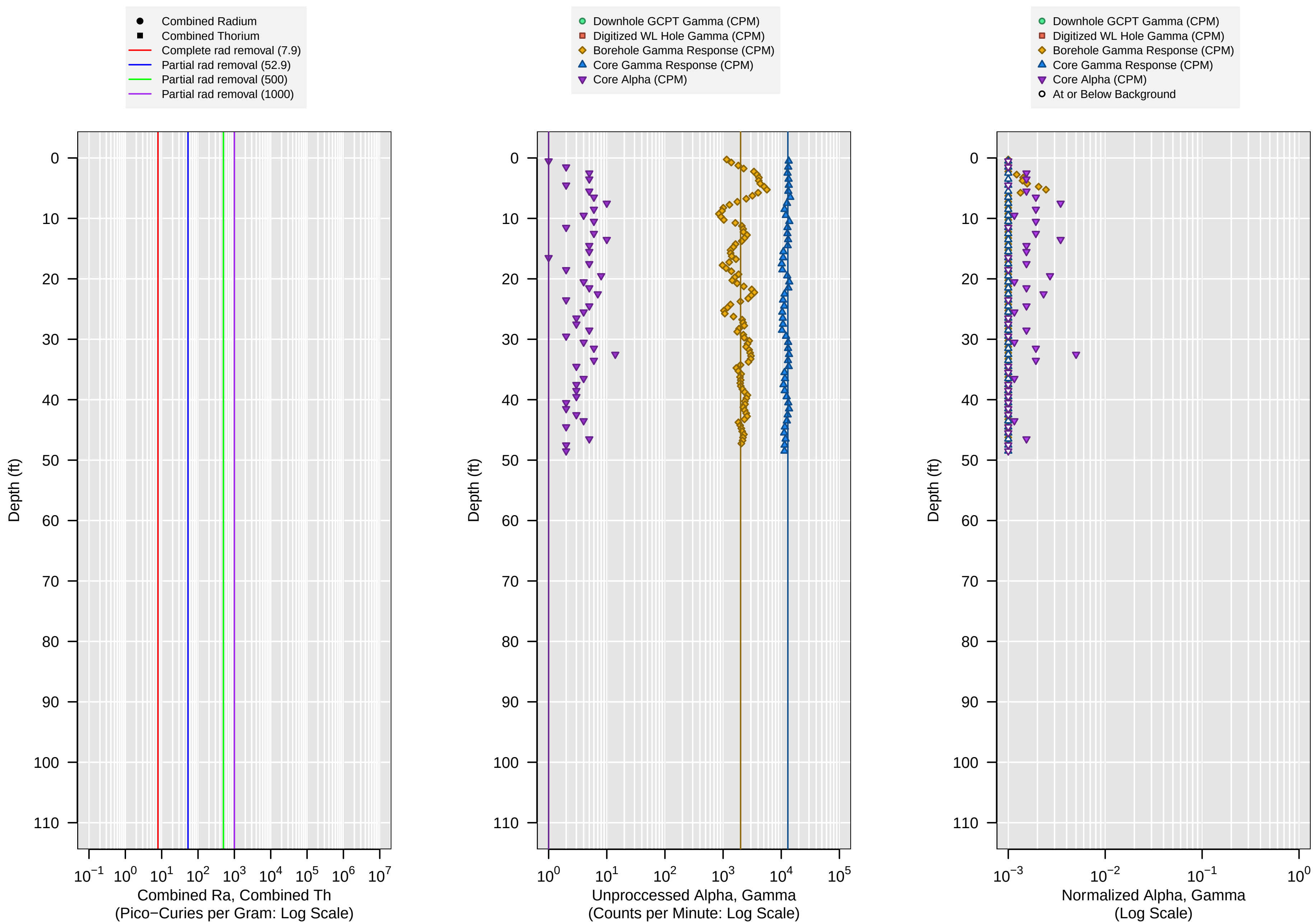


WL−113−MH
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
T
T
R
TR
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{-1}
10^{0}
10^{1}
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
10^{2}
10^{3}
10^{4}
10^{5}
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
10^{-3}
10^{-2}
10^{-1}
10^{0}
Normalized Alpha, Gamma
(Log Scale)

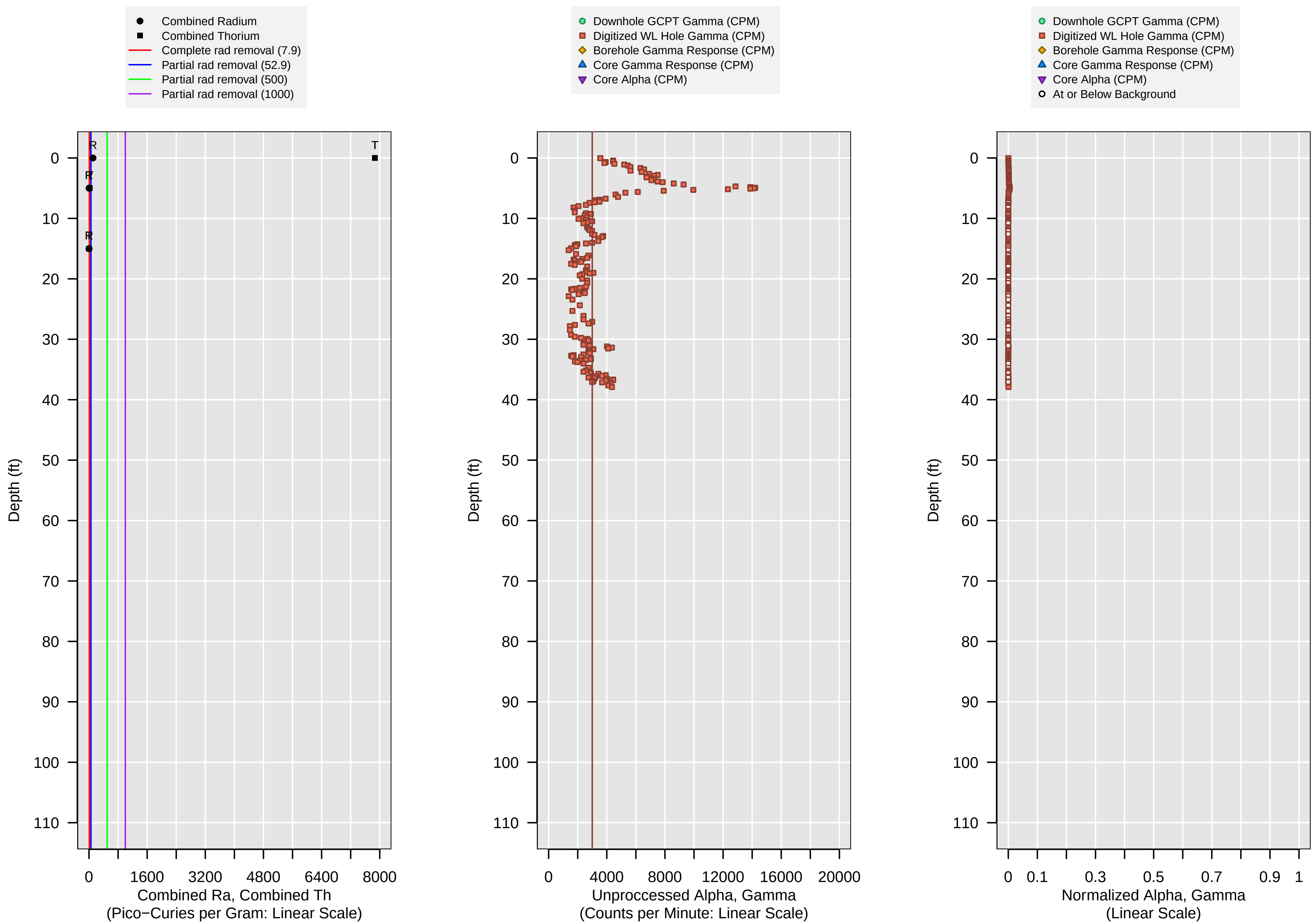


WL−114−CT
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−114−CT

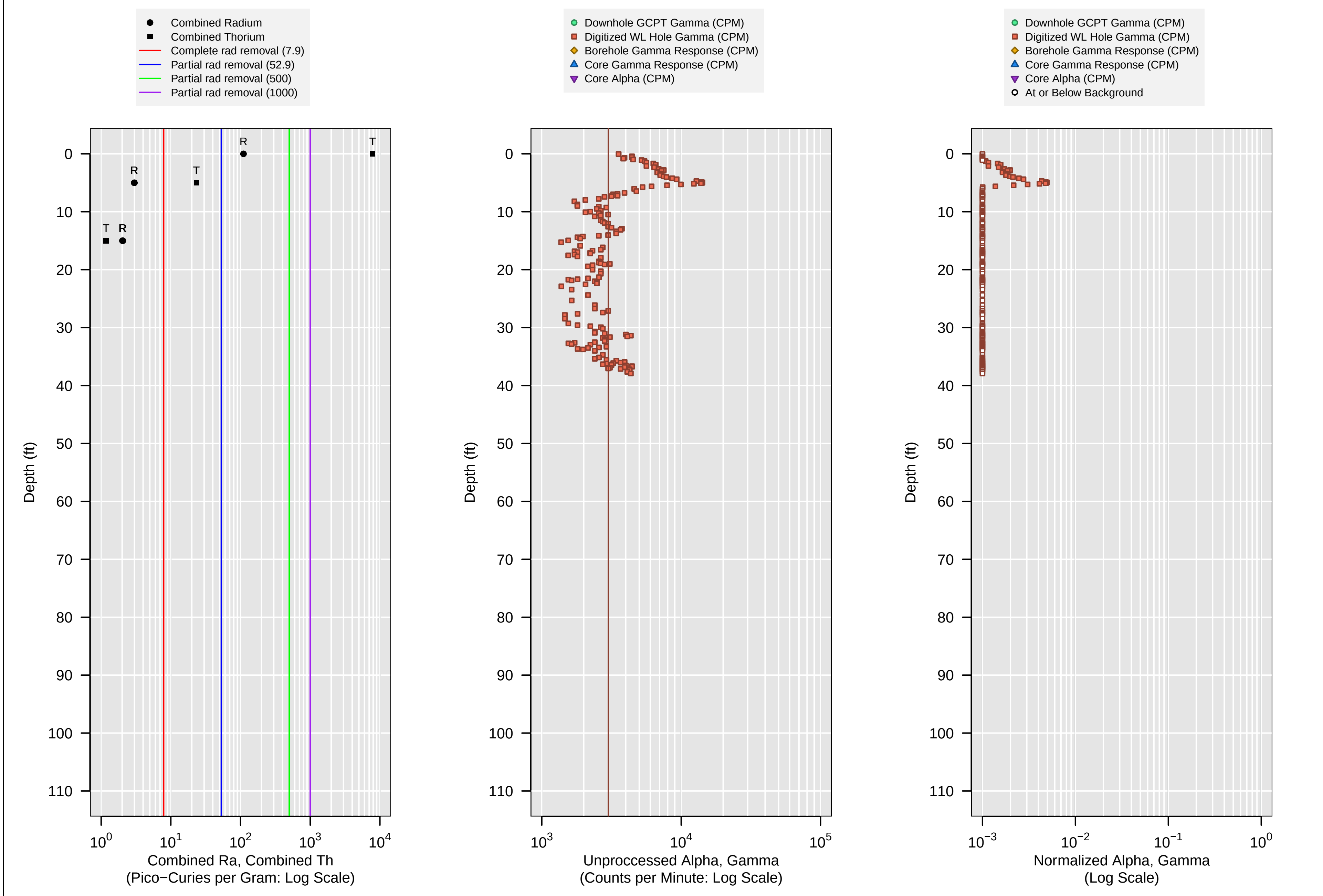

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

WL−114−MH

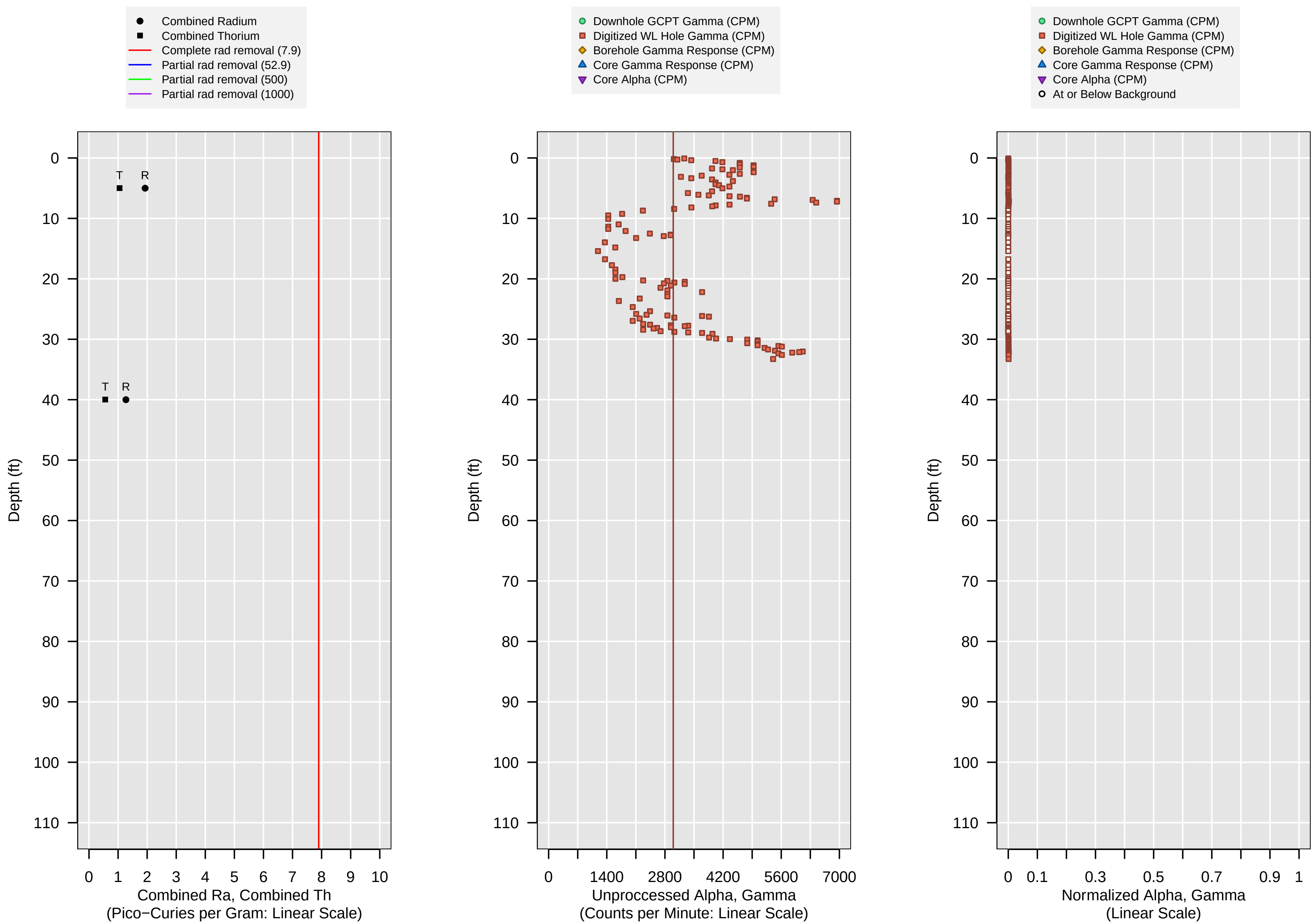


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

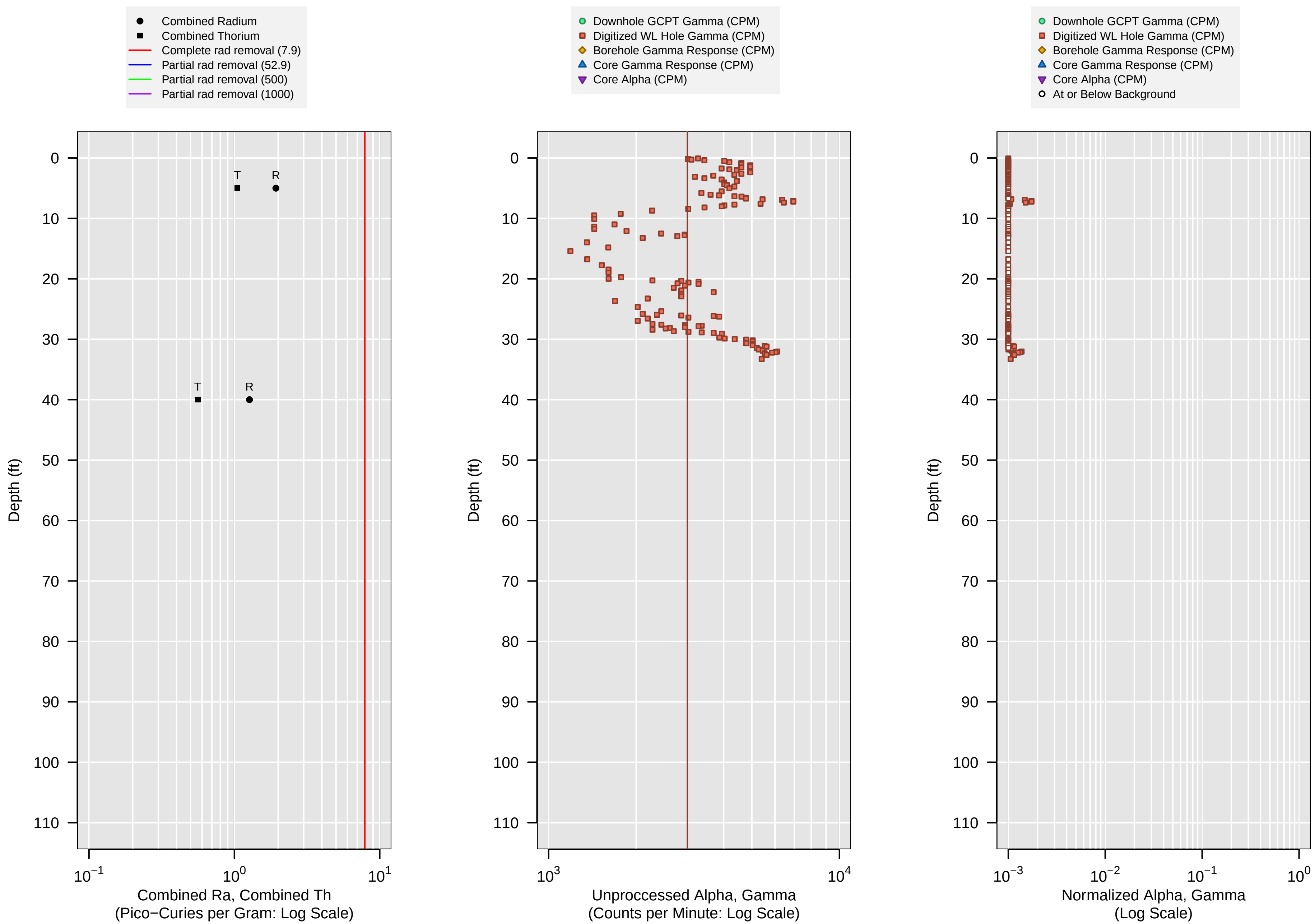
WL−114−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−115−MH

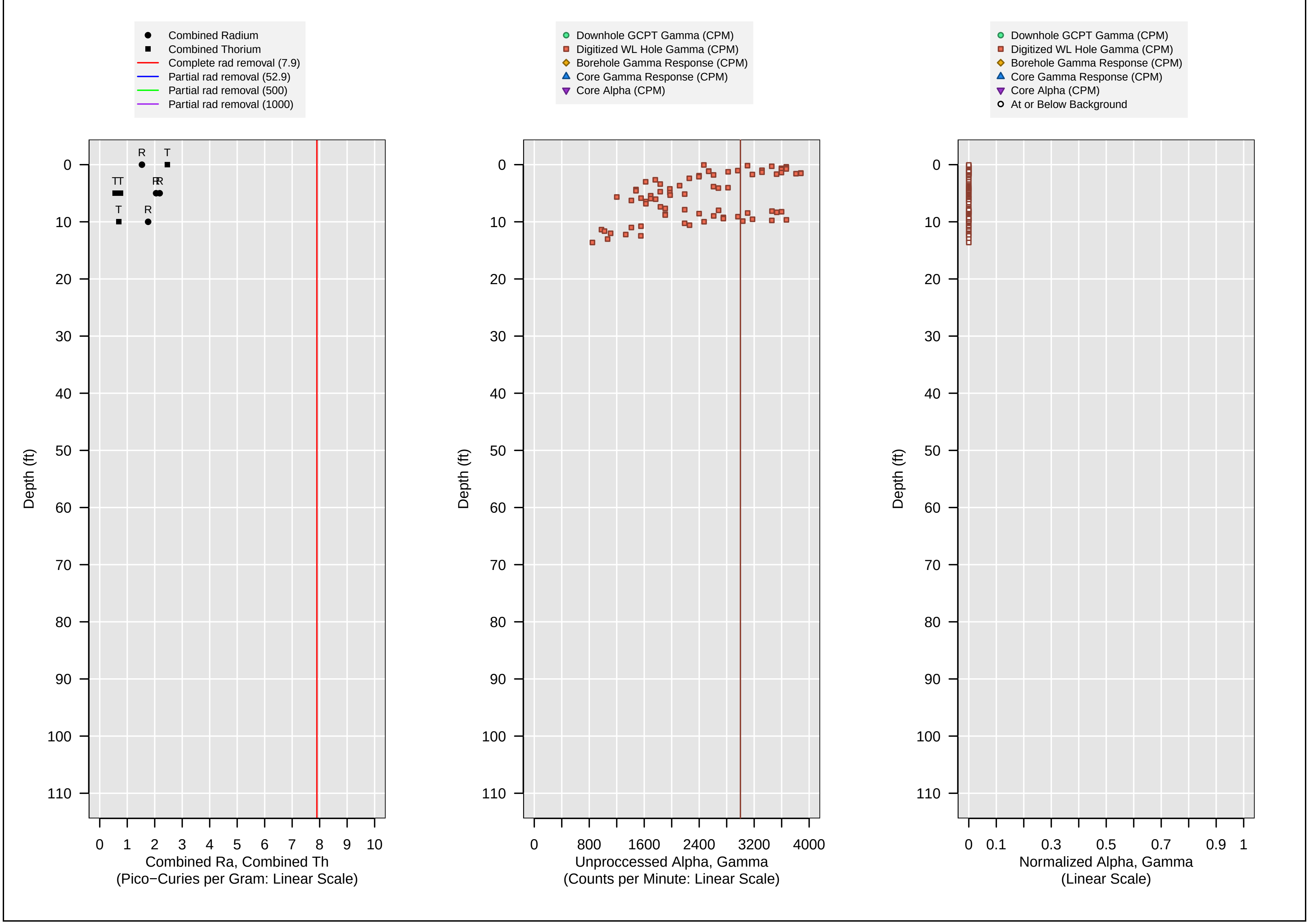

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
T R
T R
Depth (ft)
0 10 20 30 40 50 60 70 80 90 100 110
0 1 2 3 4 5 6 7 8 9 10
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0 1400 2800 4200 5600 7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

WL−115−MH



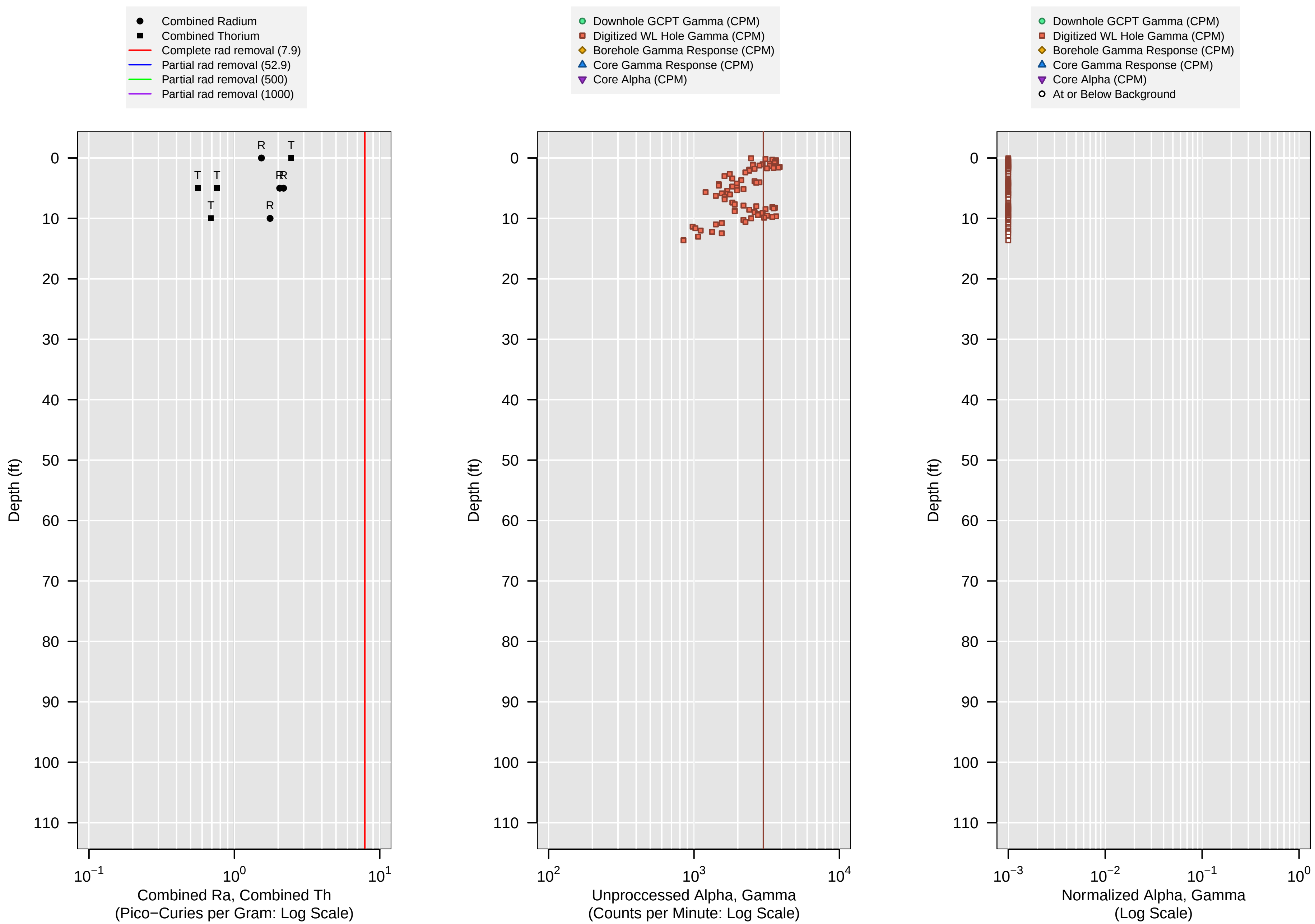
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
T
R
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−116−MH



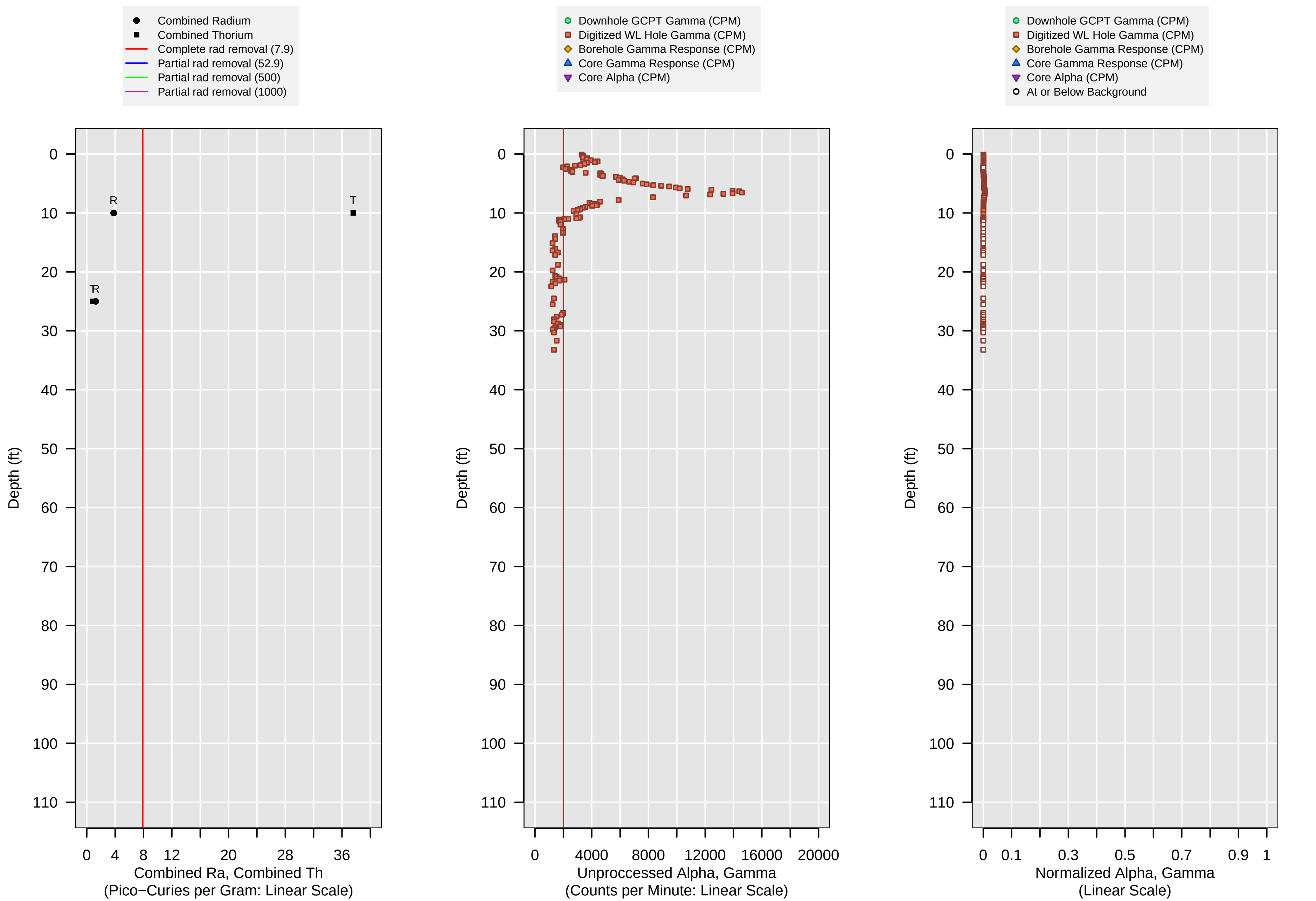
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−116−MH



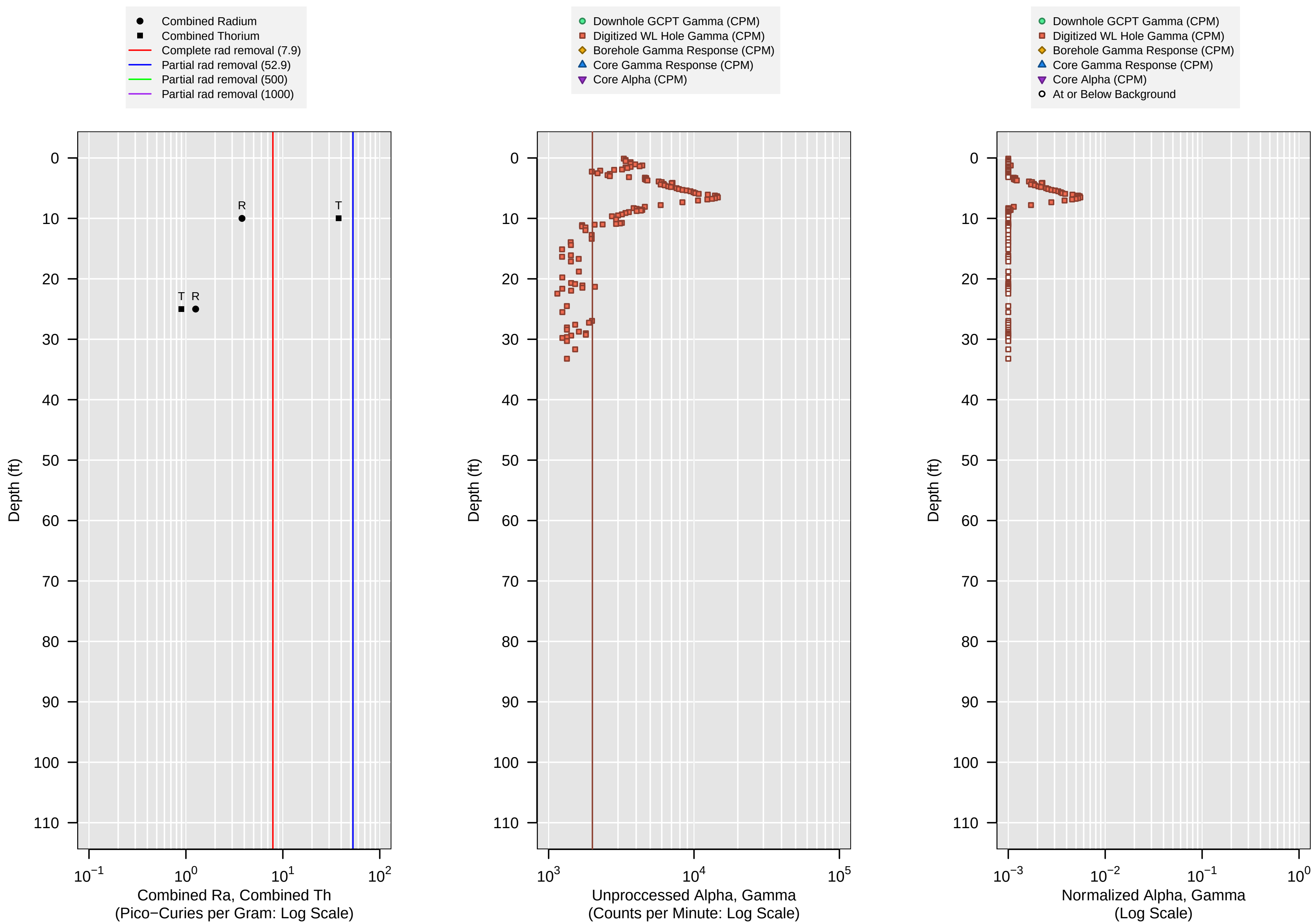
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−117−MH



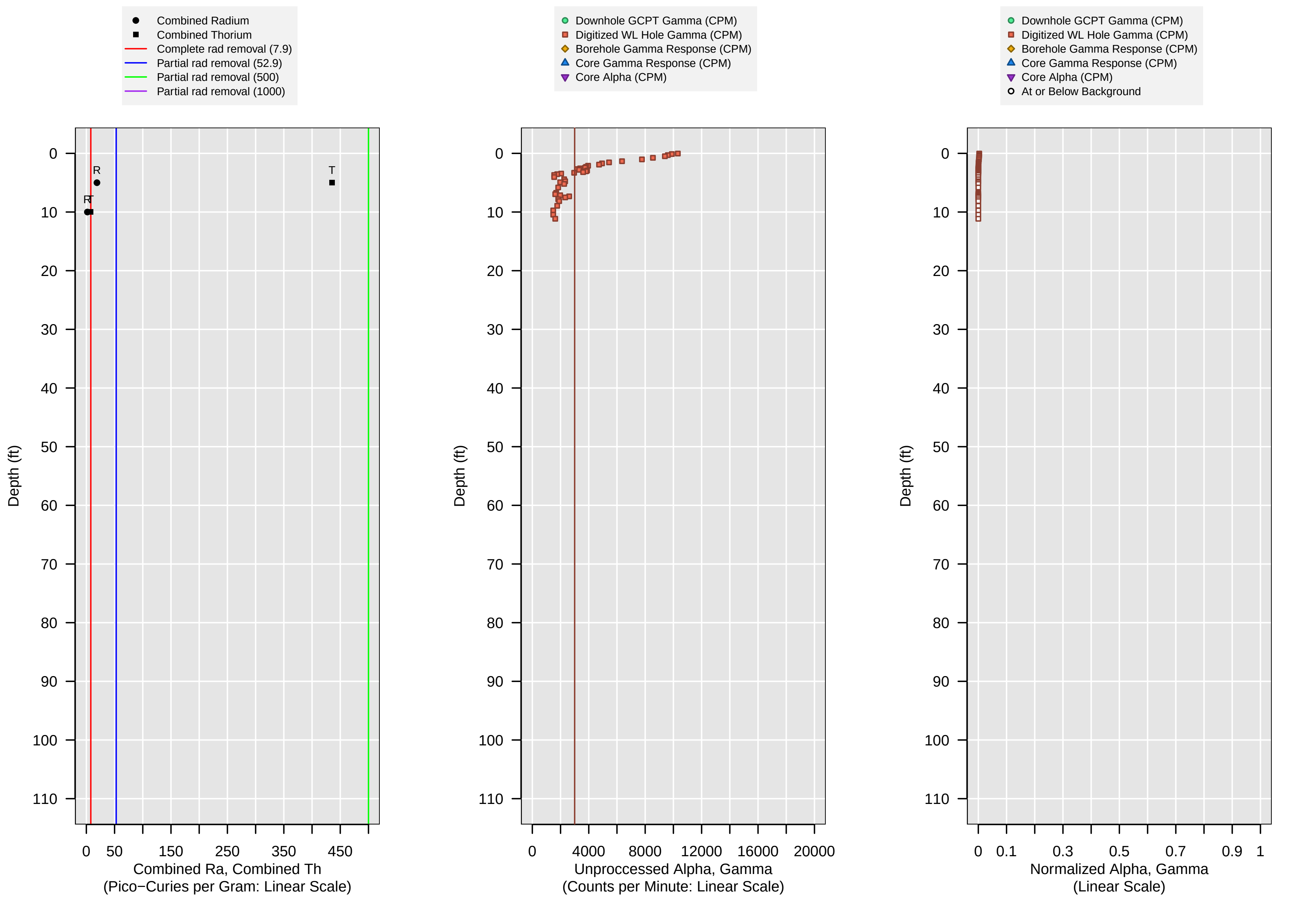
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 4 8 12 20 28 36
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0 4000 8000 12000 16000 20000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

WL−117−MH



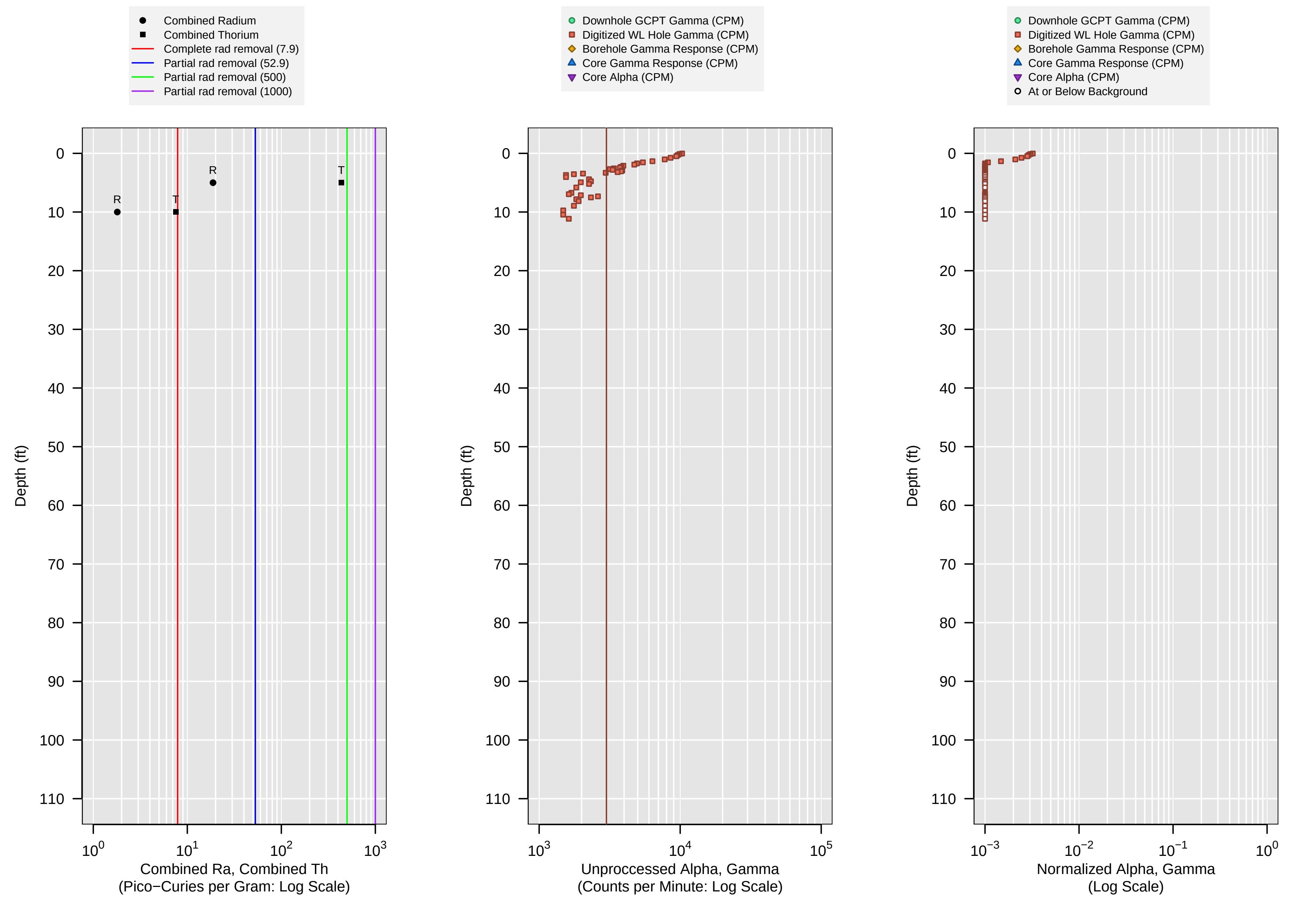
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
T R
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−118−MH

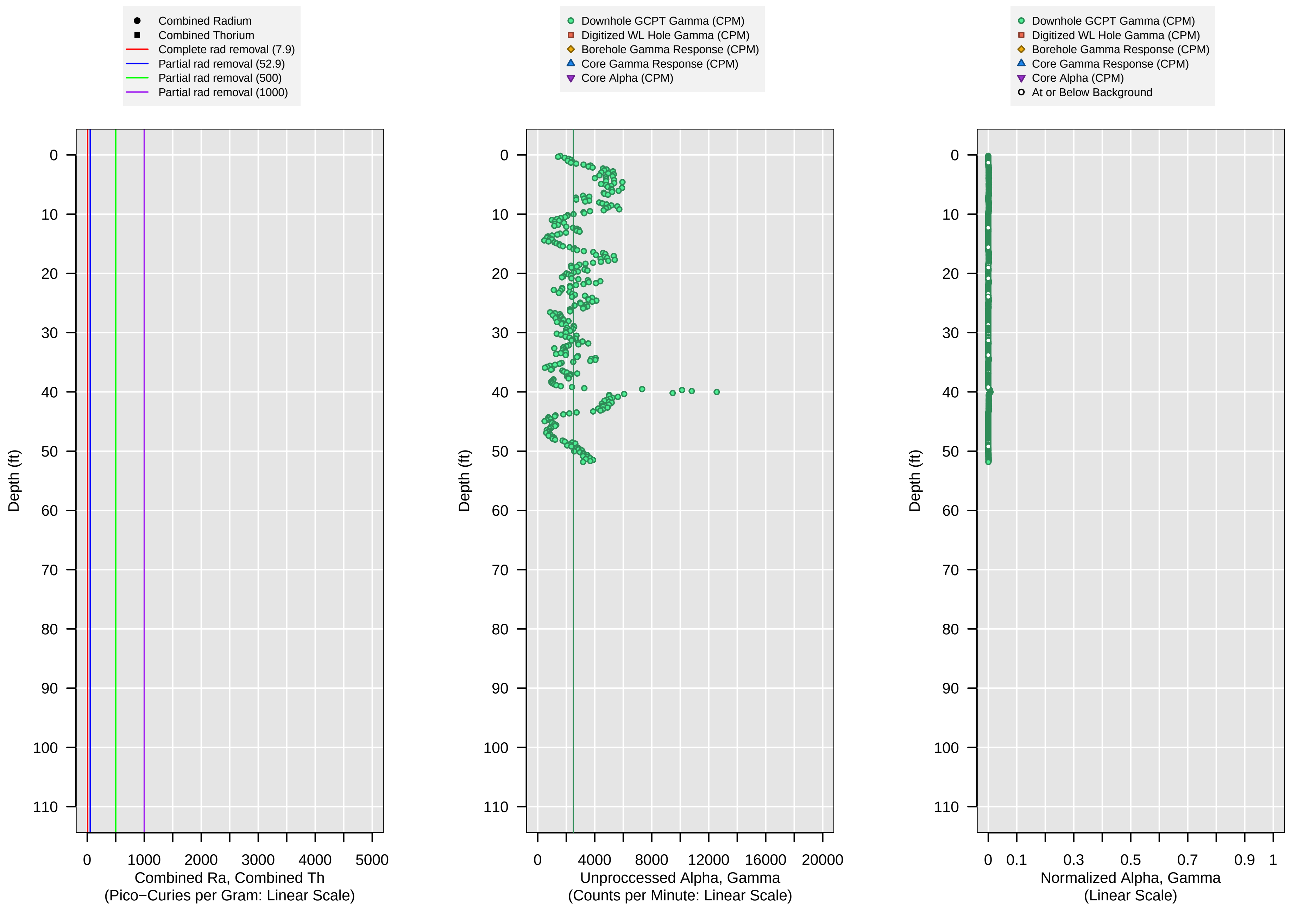


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
R
T
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
50
150
250
350
450
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
4000
8000
12000
16000
20000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

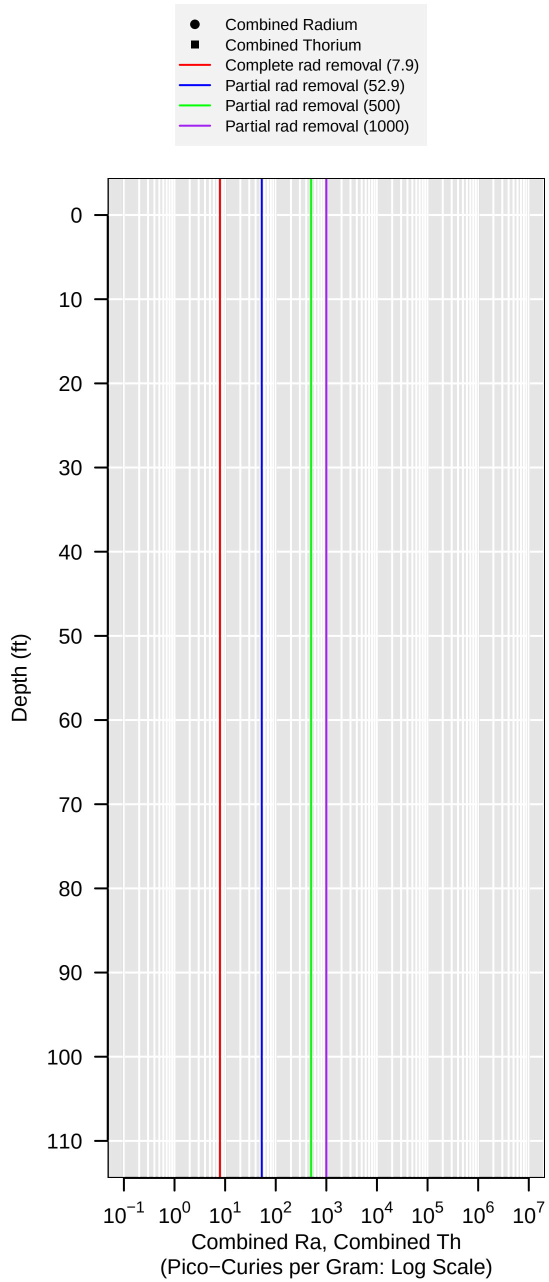
WL−118−MH

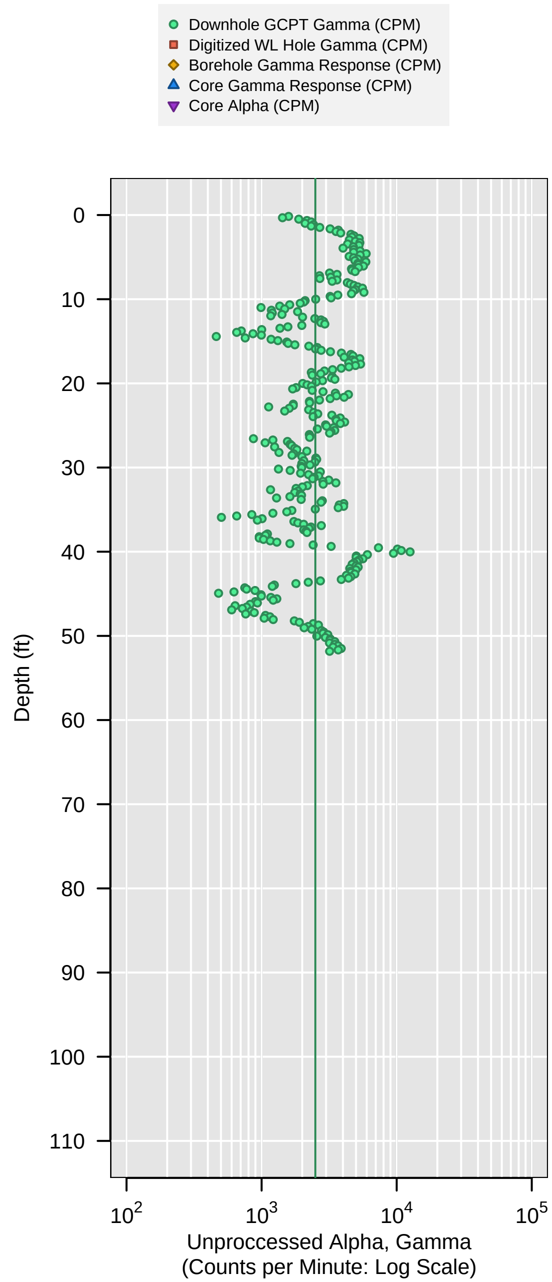

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

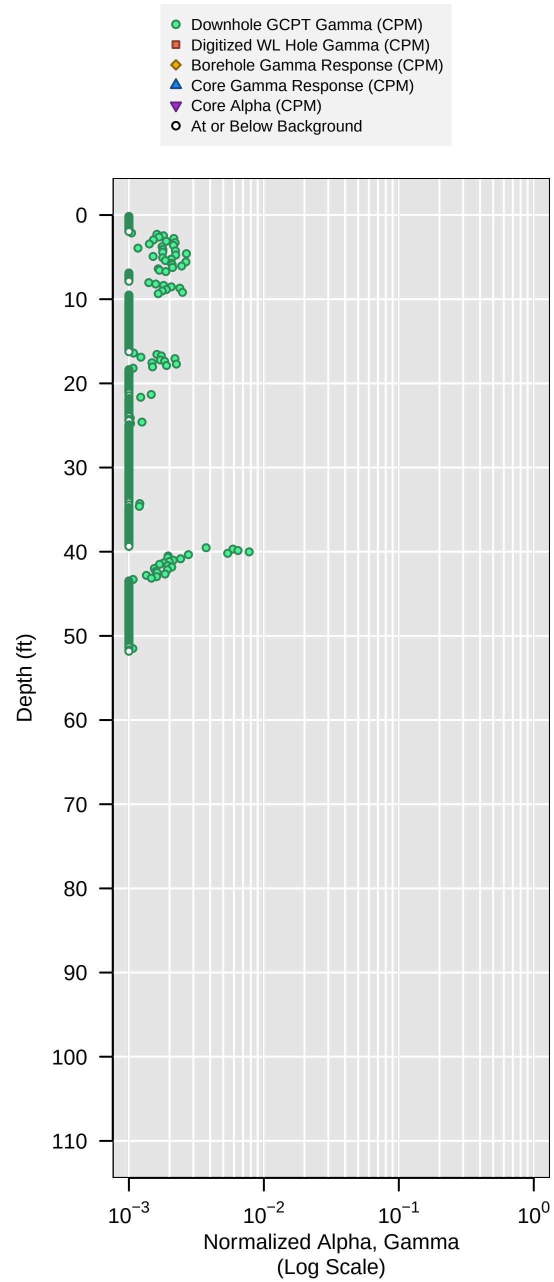
GCPT−7−3


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

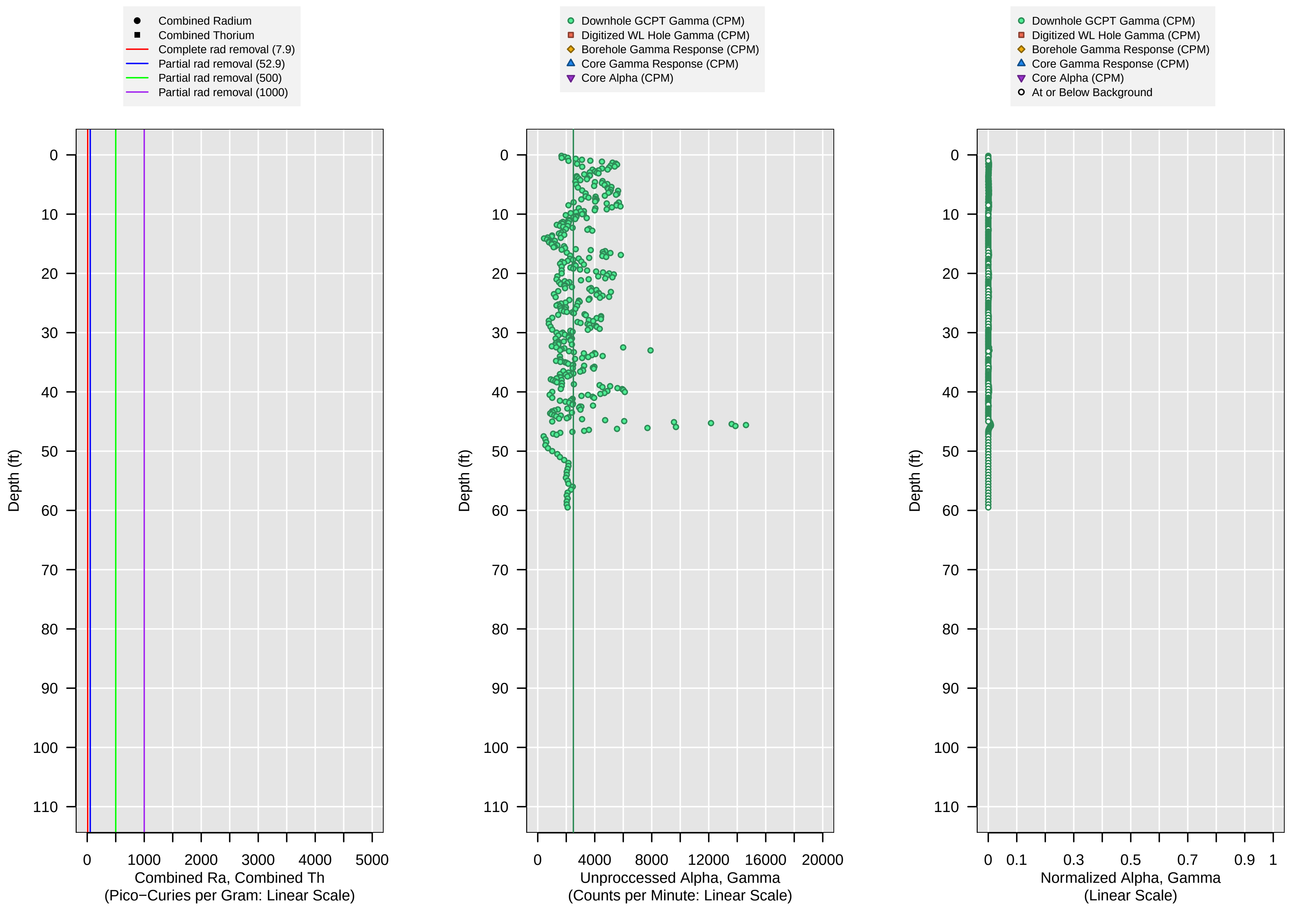
GCPT−7−3


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^{-1} 10^{0} 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6} 10^{7}
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)

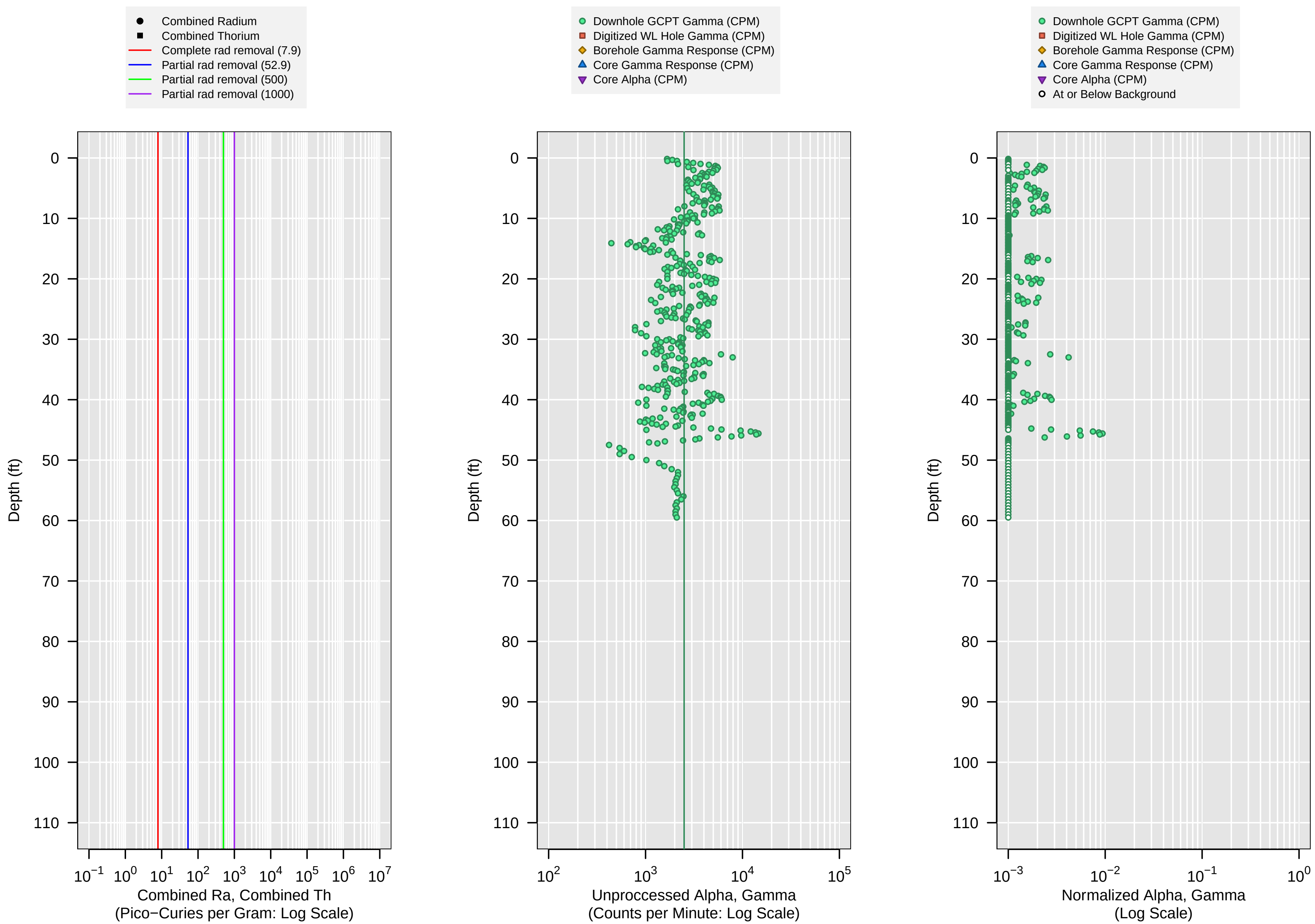

Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
10^{2} 10^{3} 10^{4} 10^{5}
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)

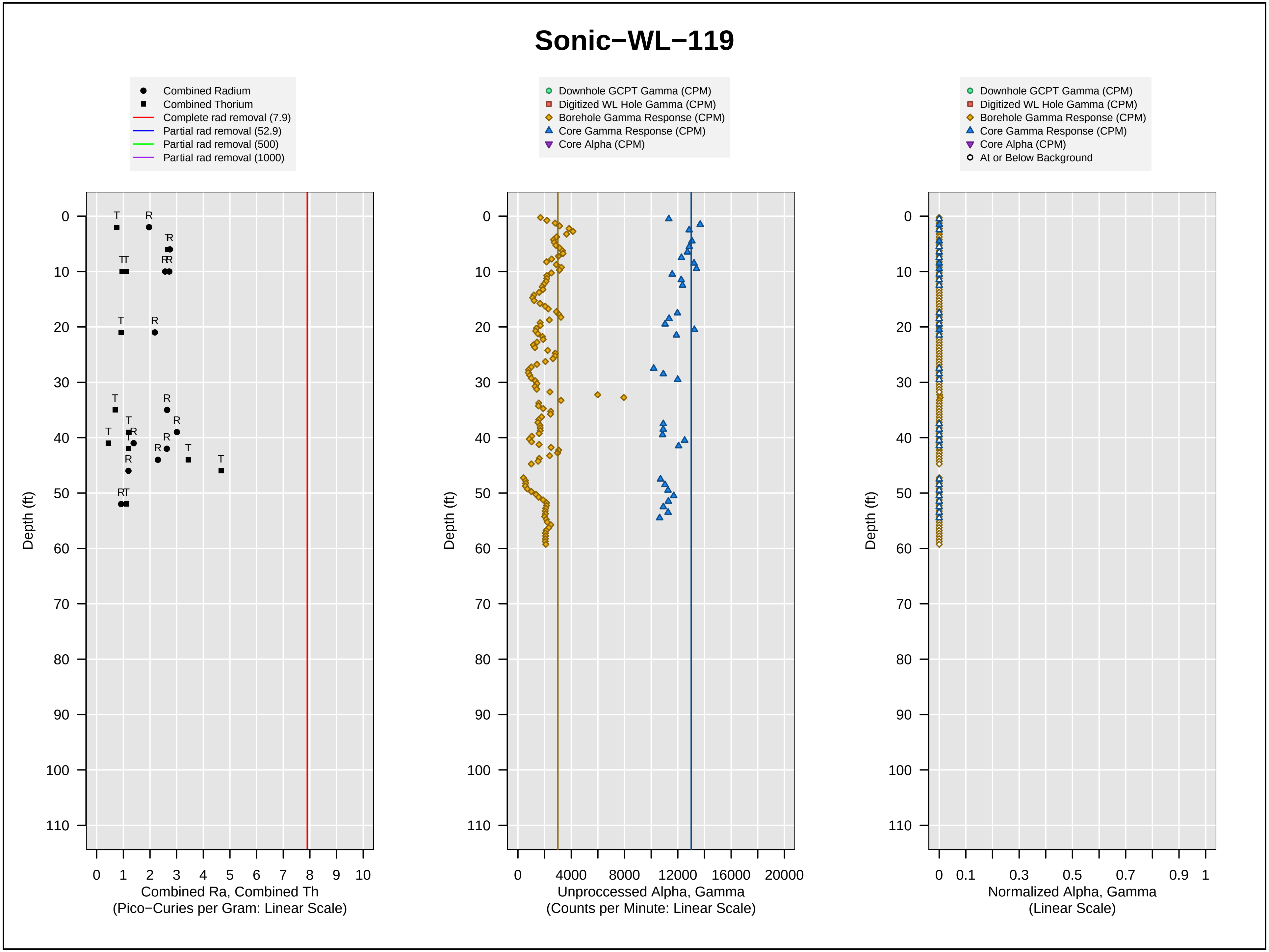

Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
10^{-3} 10^{-2} 10^{-1} 10^{0}
Normalized Alpha, Gamma
(Log Scale)

GCPT−WL−119

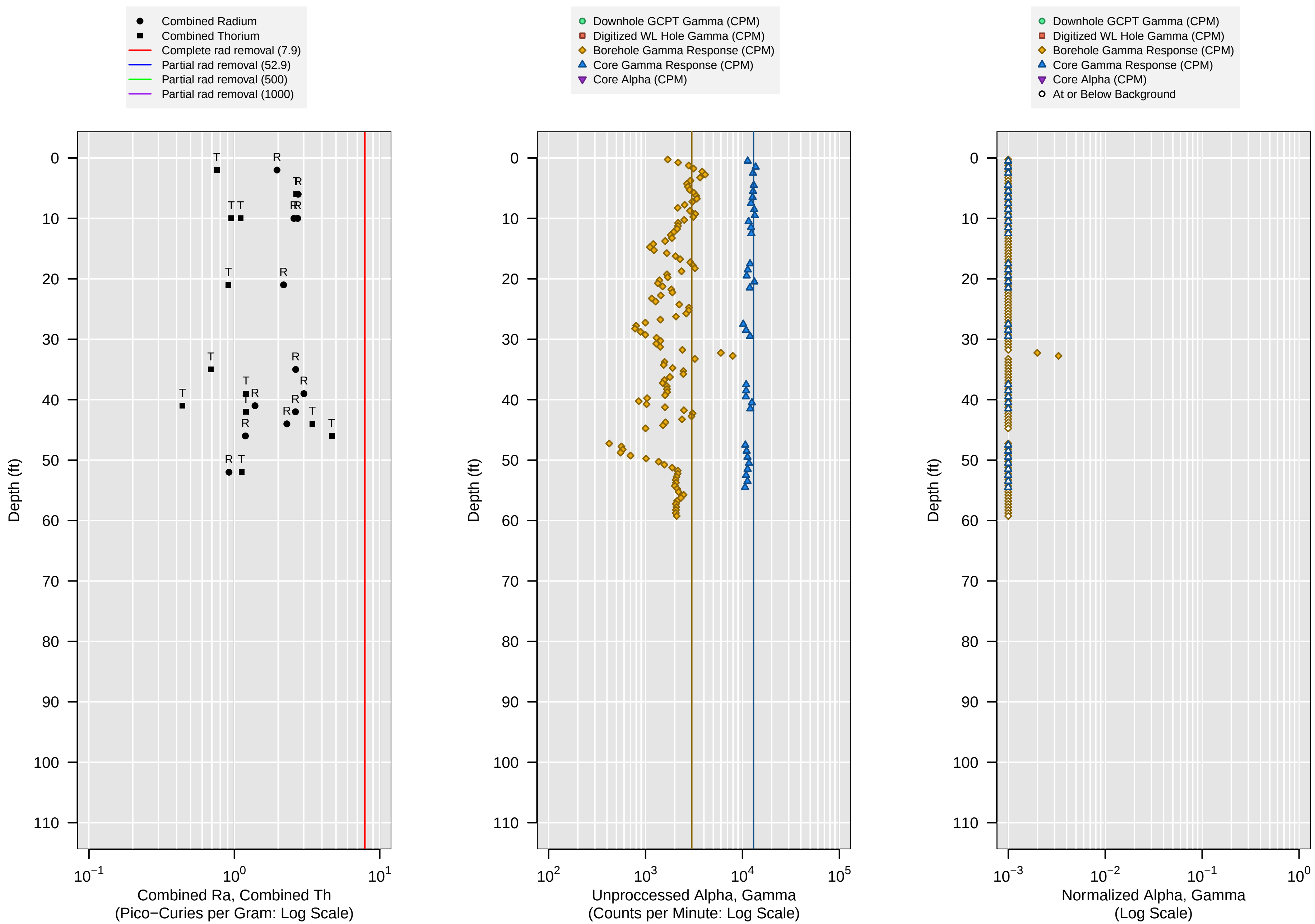

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

GCPT−WL−119

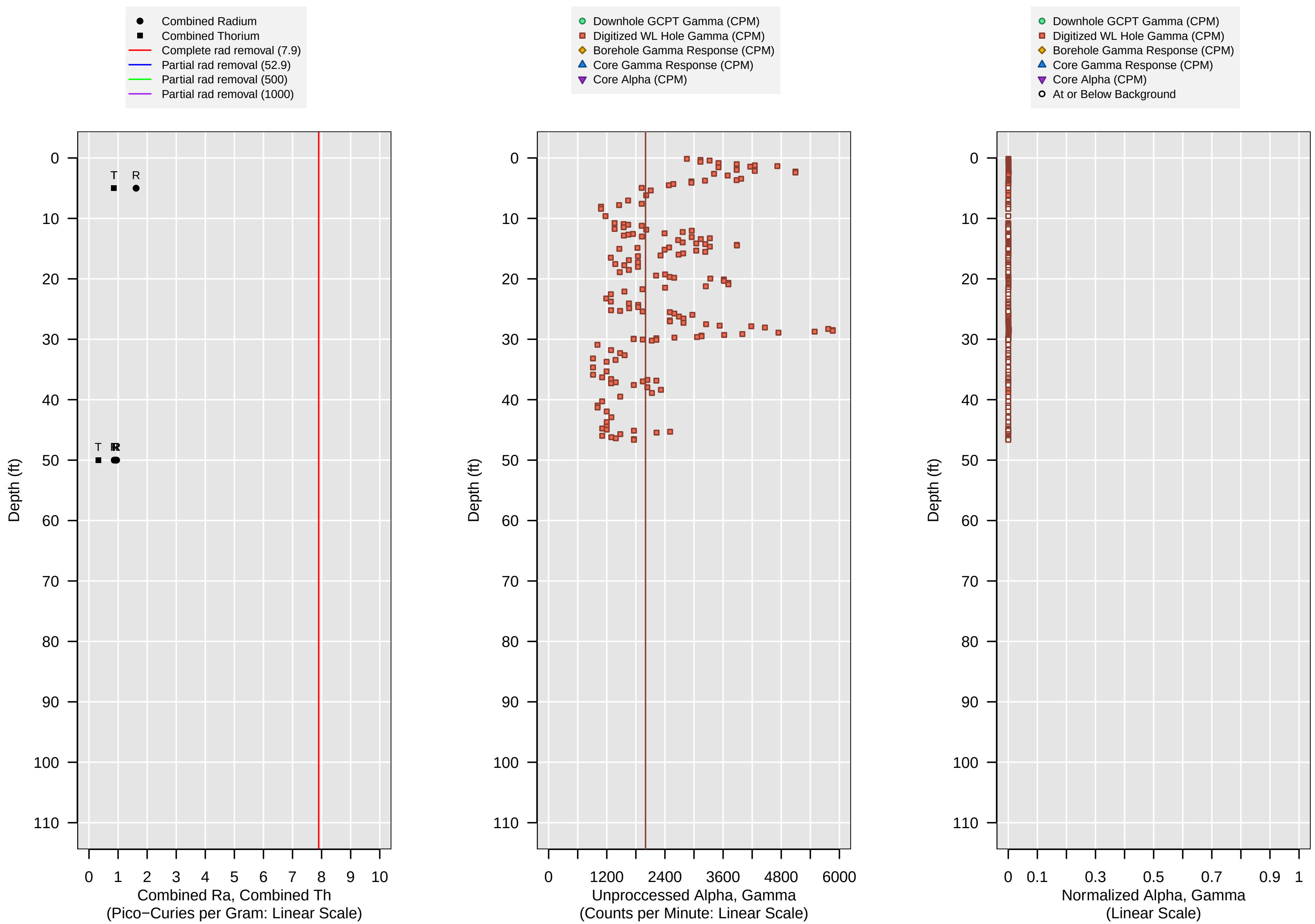

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)


Sonic−WL−119
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

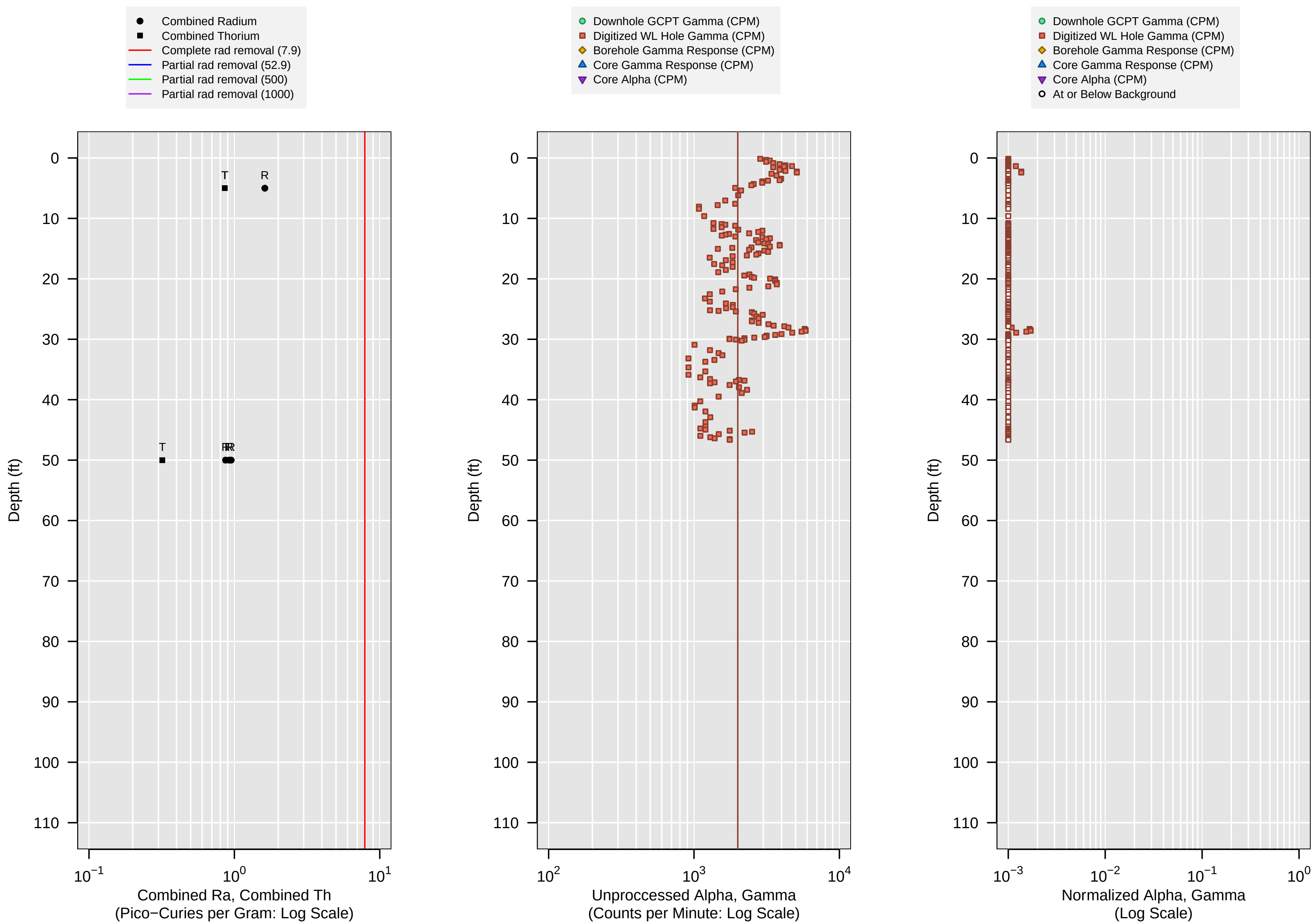
Sonic−WL−119


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−119−MH

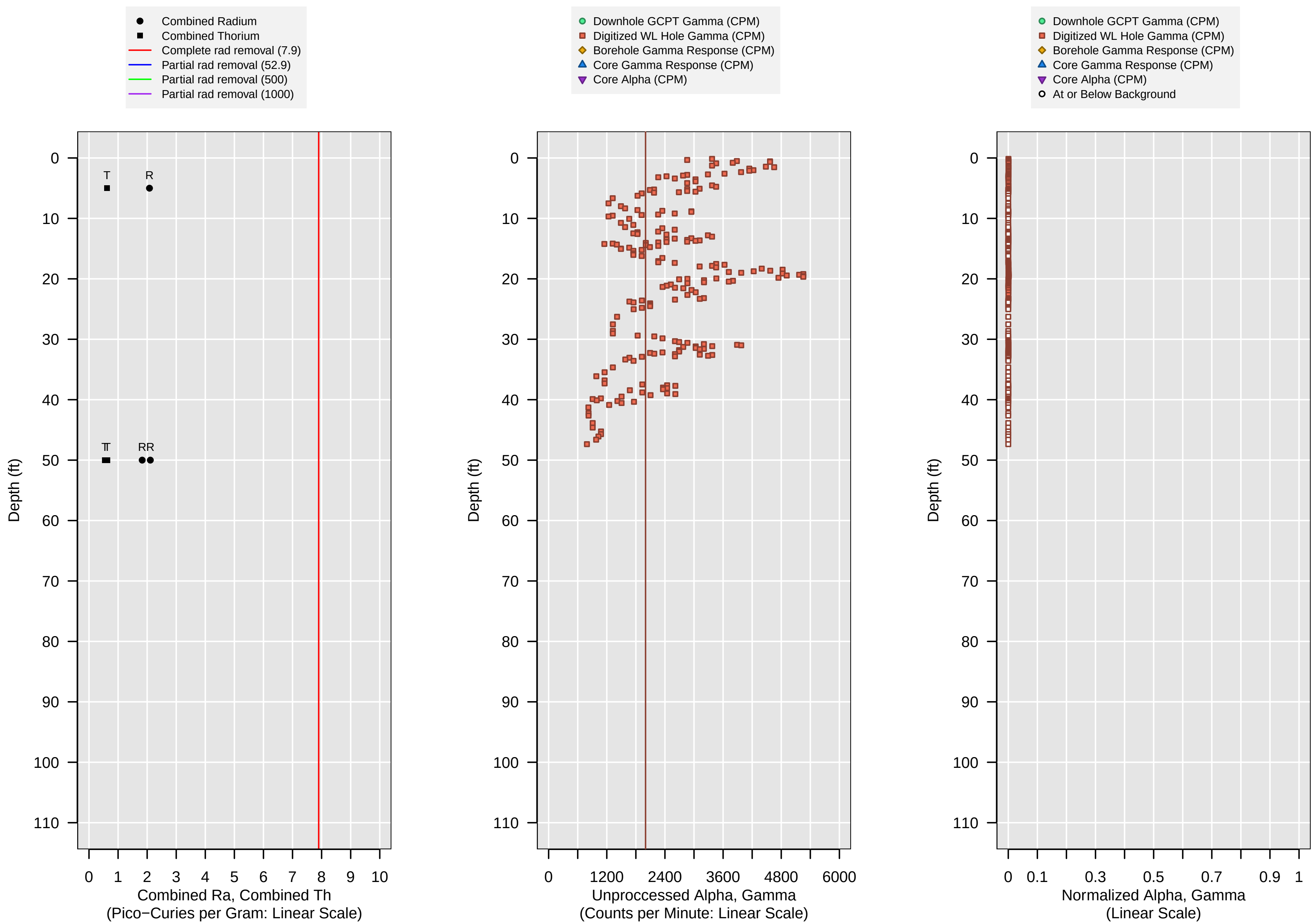

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
T R
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−119−MH

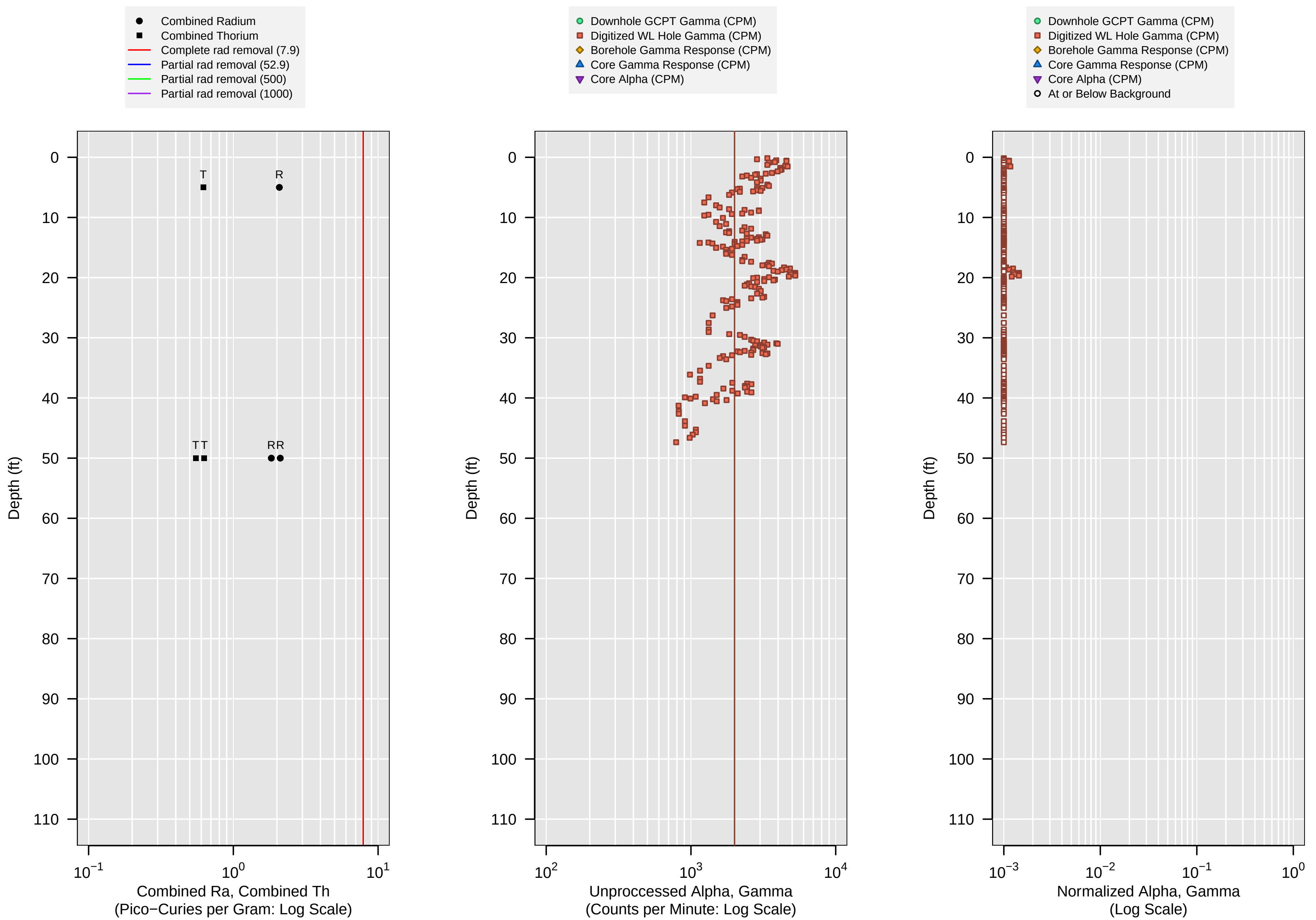


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
T
R
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

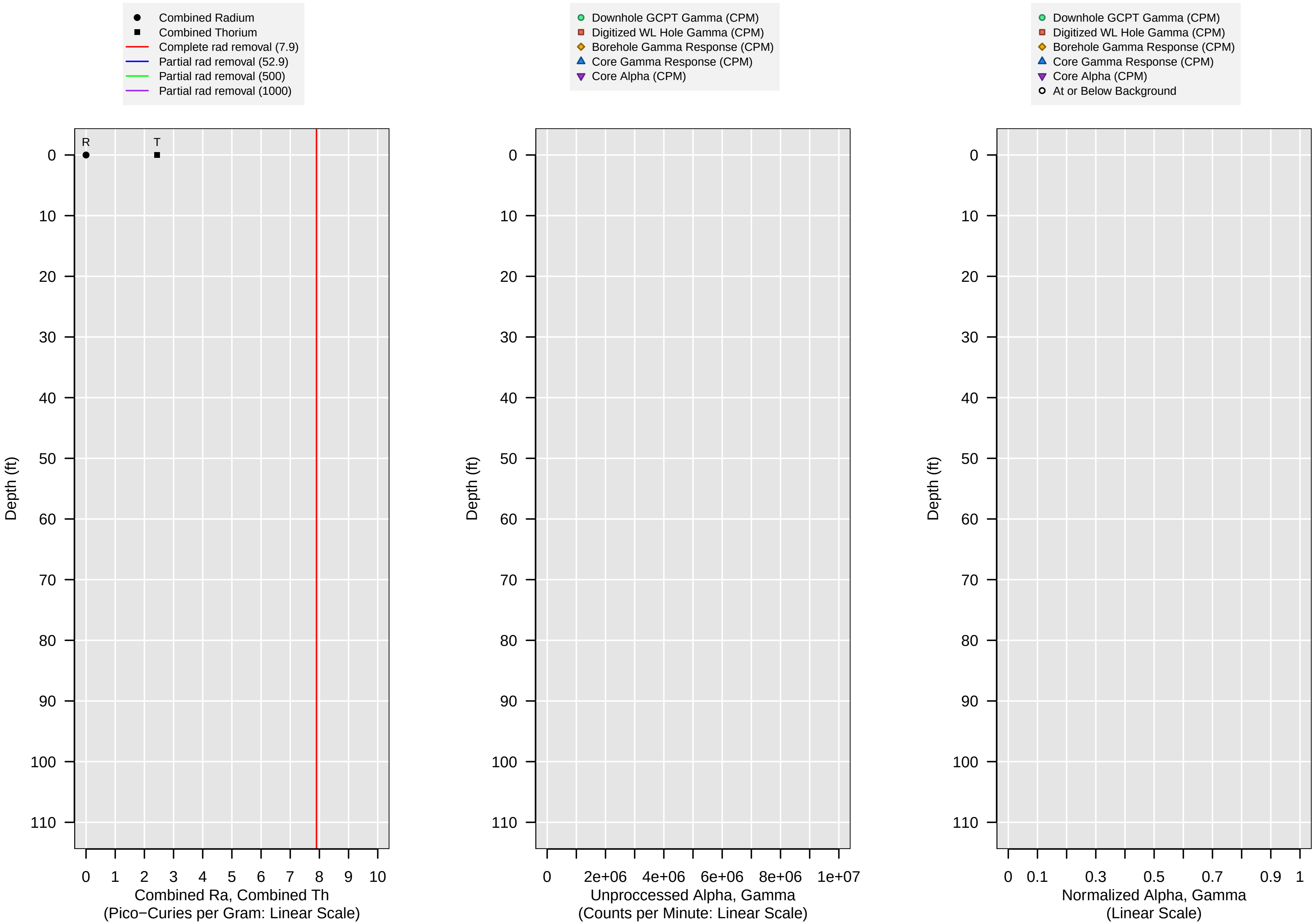
WL−120−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
T
R
TT
RR
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

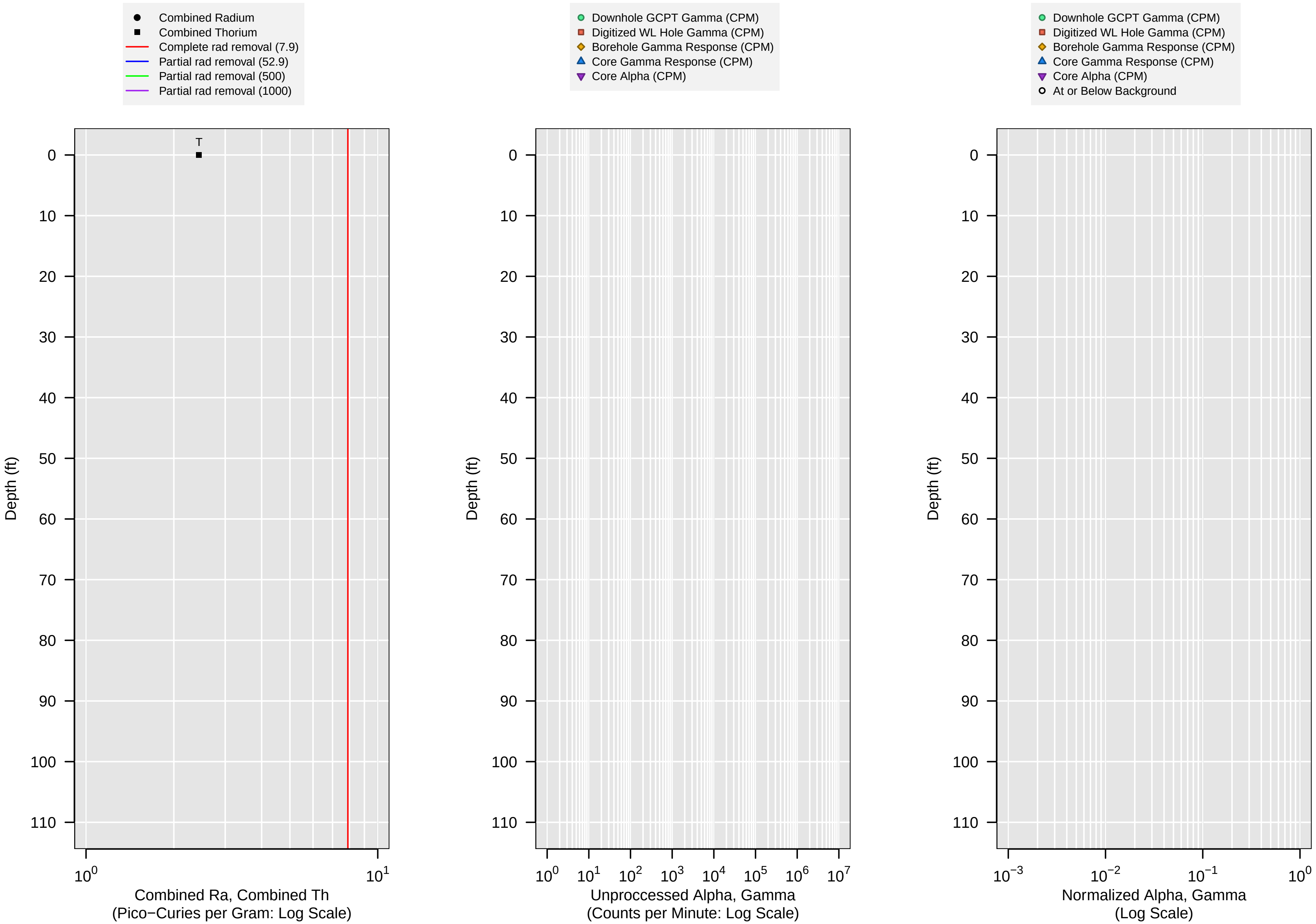
WL−120−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
T
R
TT
RR
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

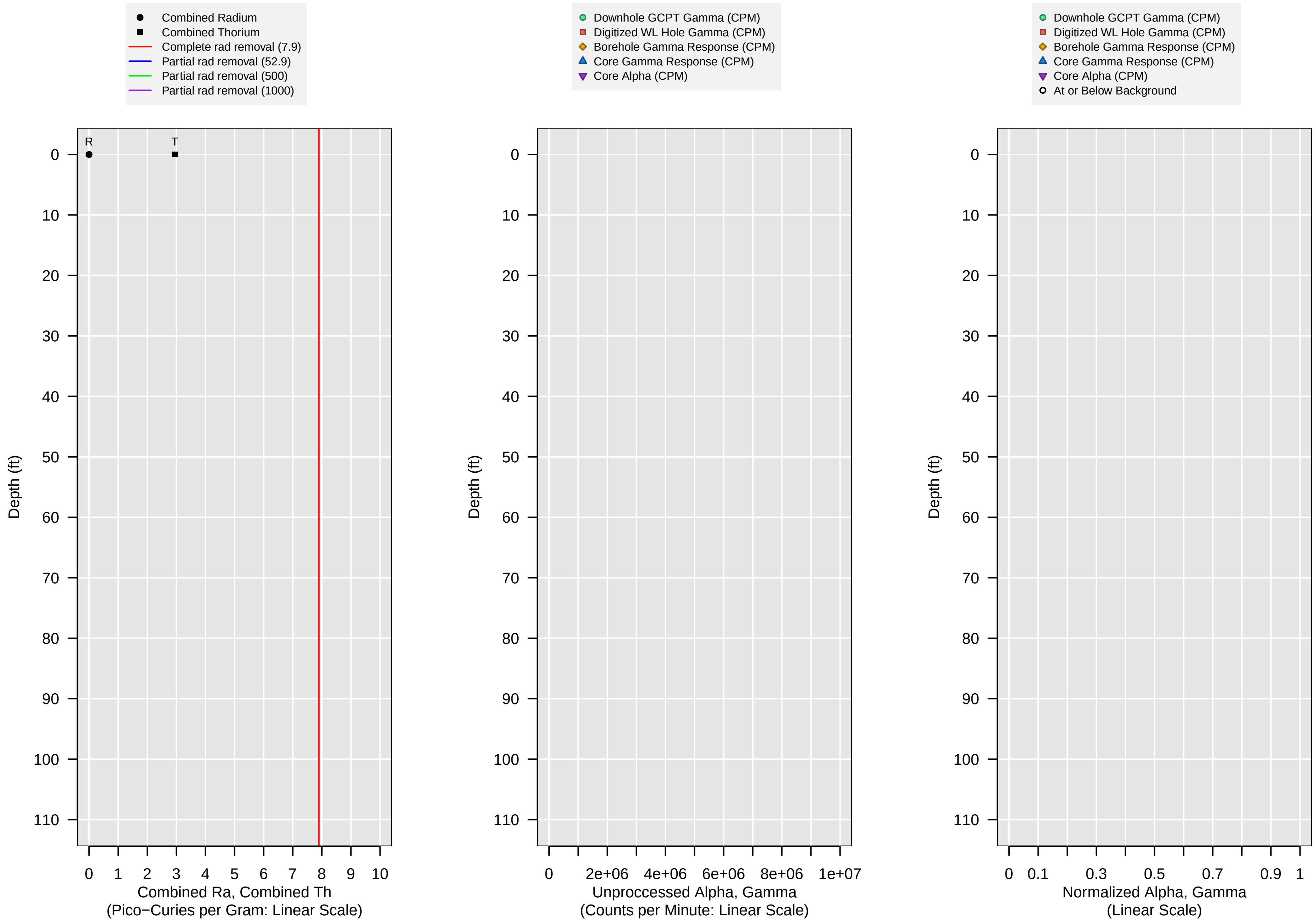
WL−121−MH

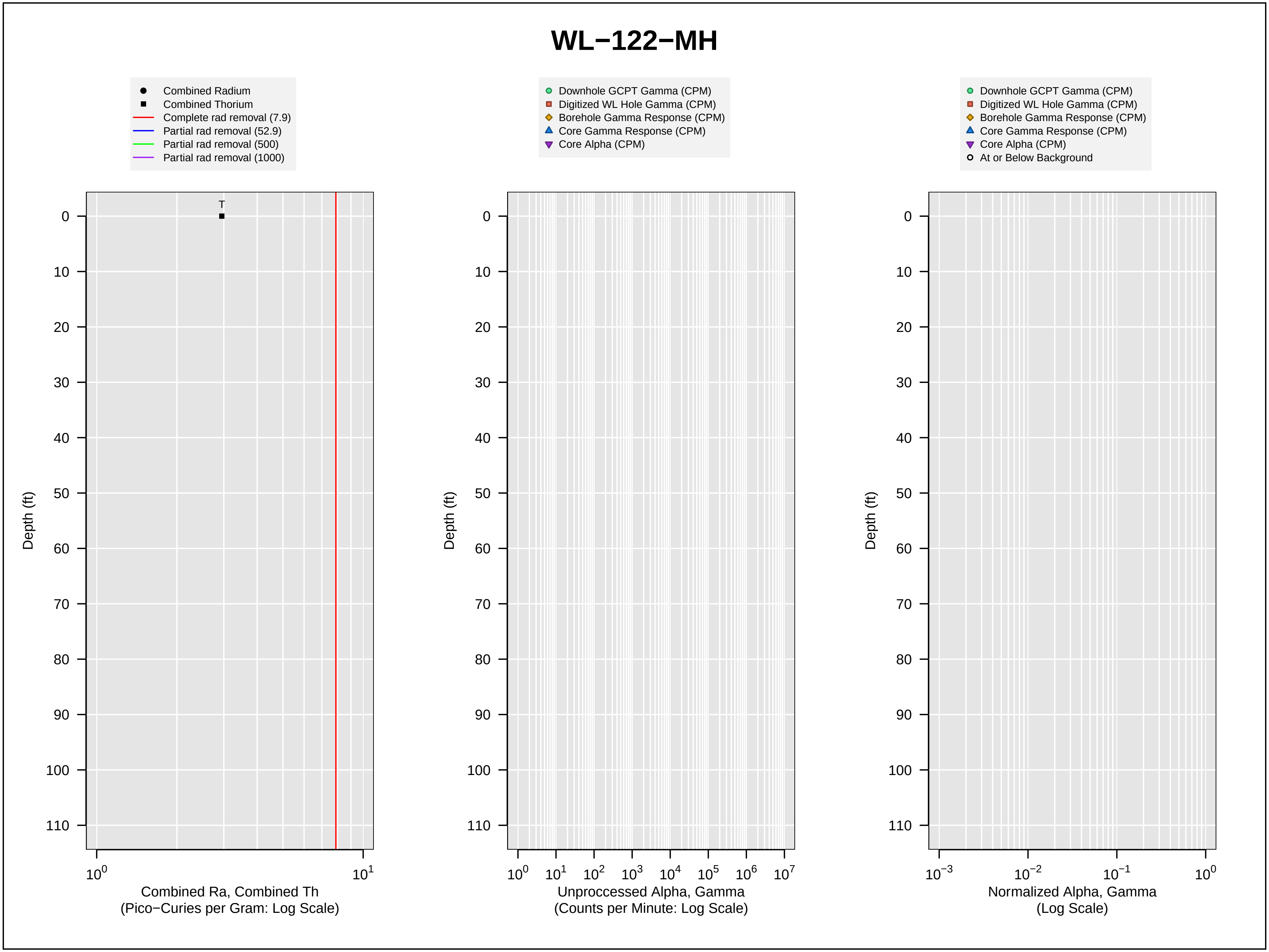

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 1 2 3 4 5 6 7 8 9 10
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0 2e+06 4e+06 6e+06 8e+06 1e+07
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

WL−121−MH

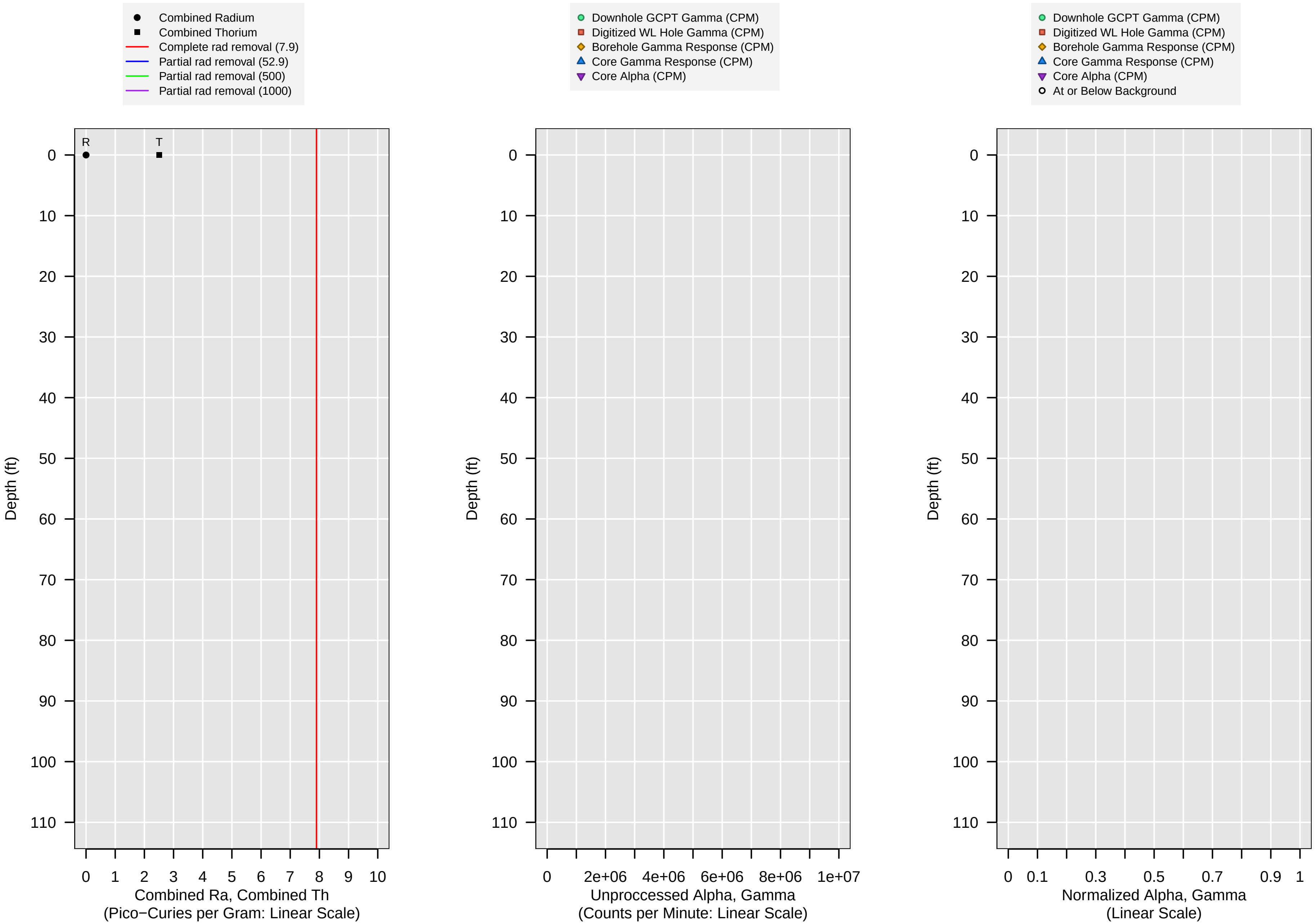

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−122−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 1 2 3 4 5 6 7 8 9 10
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0 2e+06 4e+06 6e+06 8e+06 1e+07
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

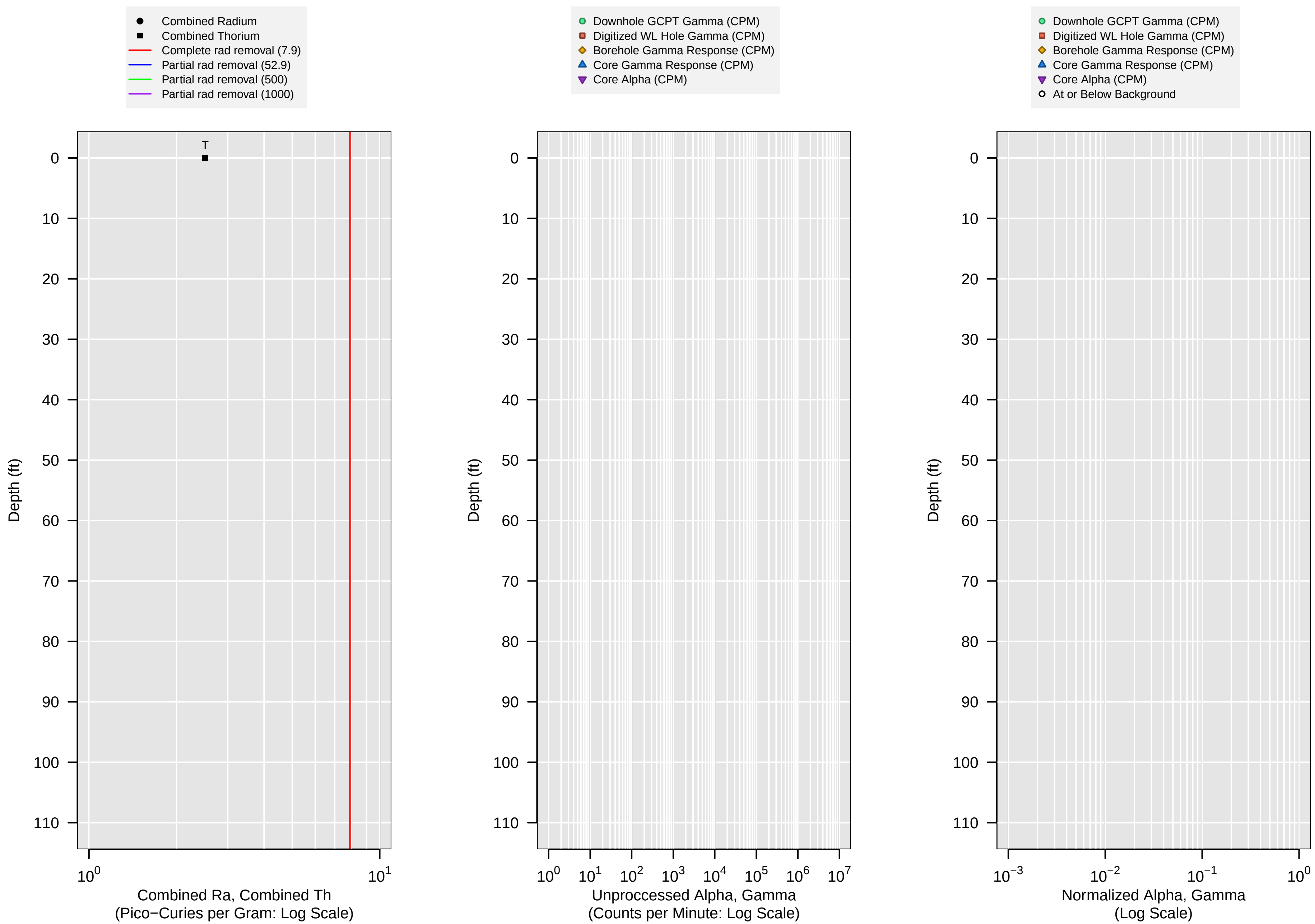

WL−122−MH
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−123−MH

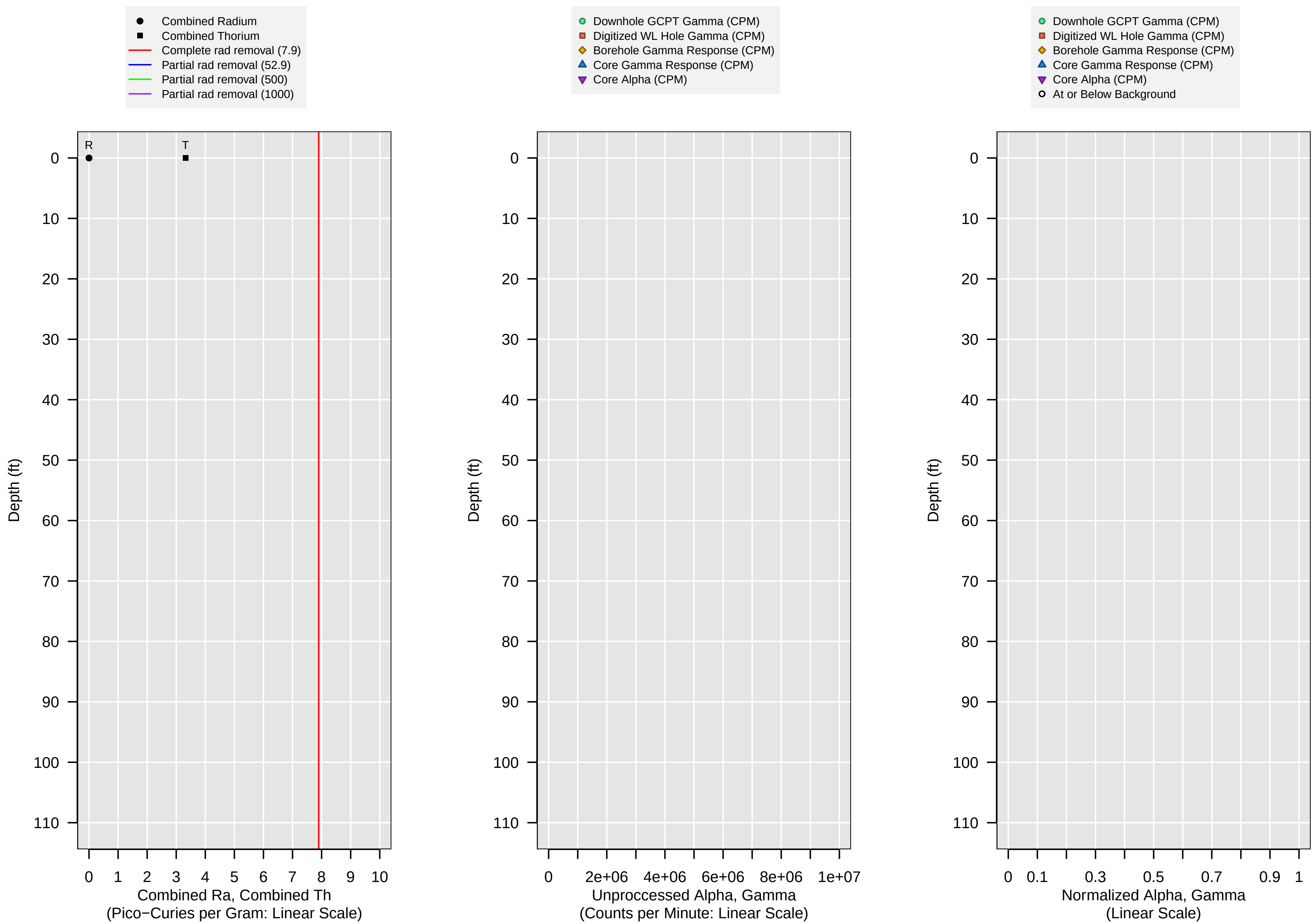


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 1 2 3 4 5 6 7 8 9 10
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0 2e+06 4e+06 6e+06 8e+06 1e+07
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

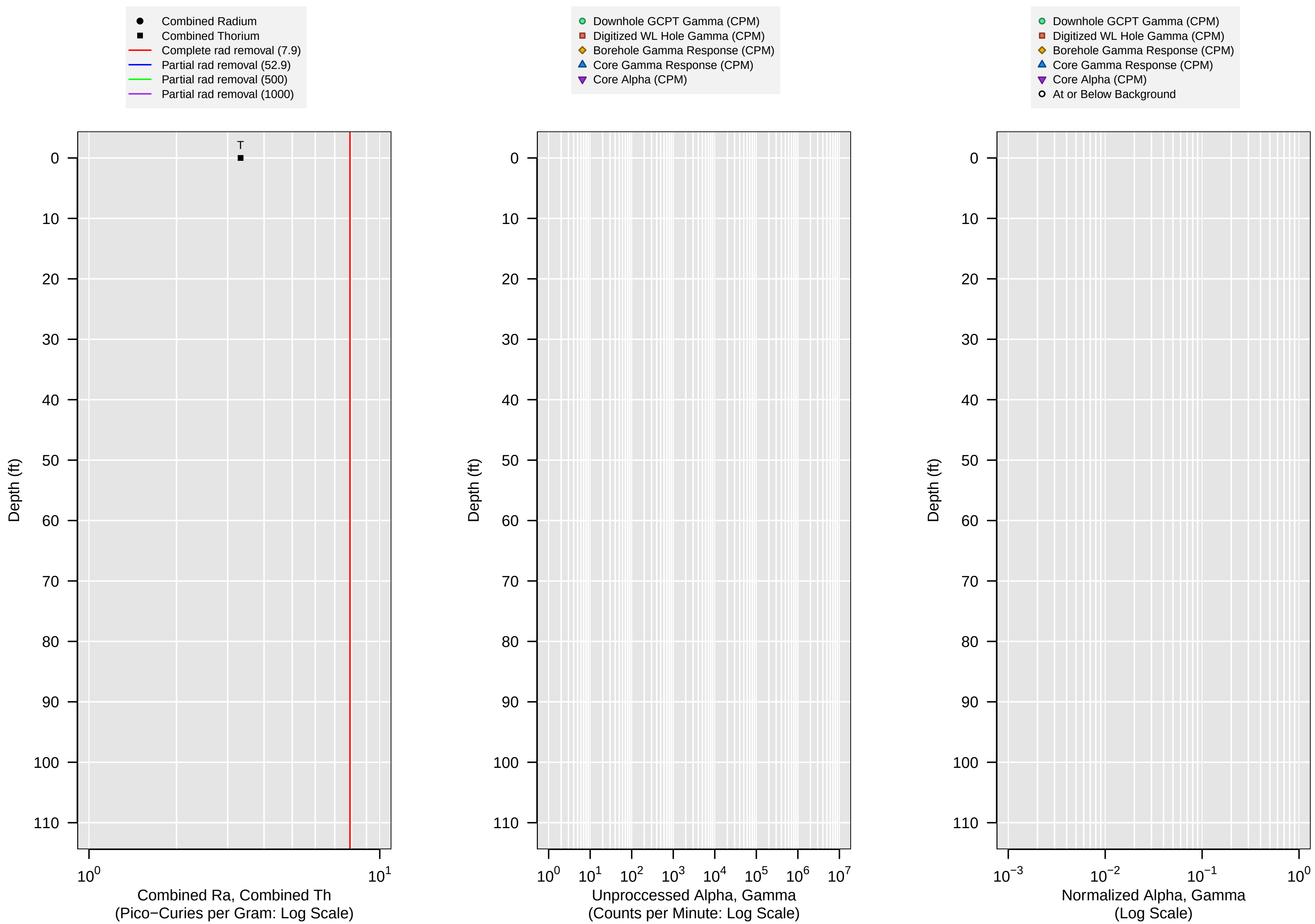
WL−123−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−124−MH

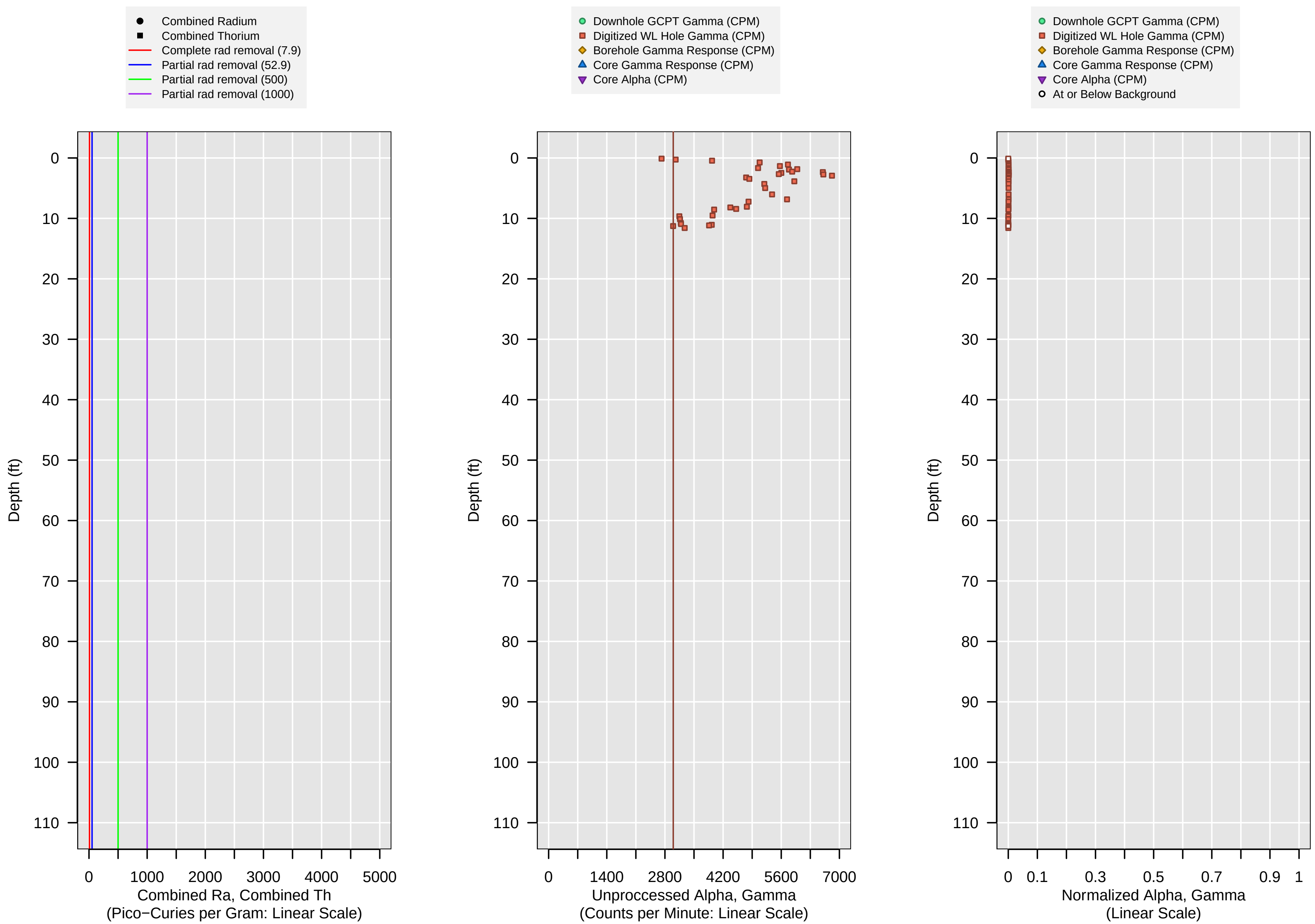

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 1 2 3 4 5 6 7 8 9 10
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0 2e+06 4e+06 6e+06 8e+06 1e+07
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

WL−124−MH



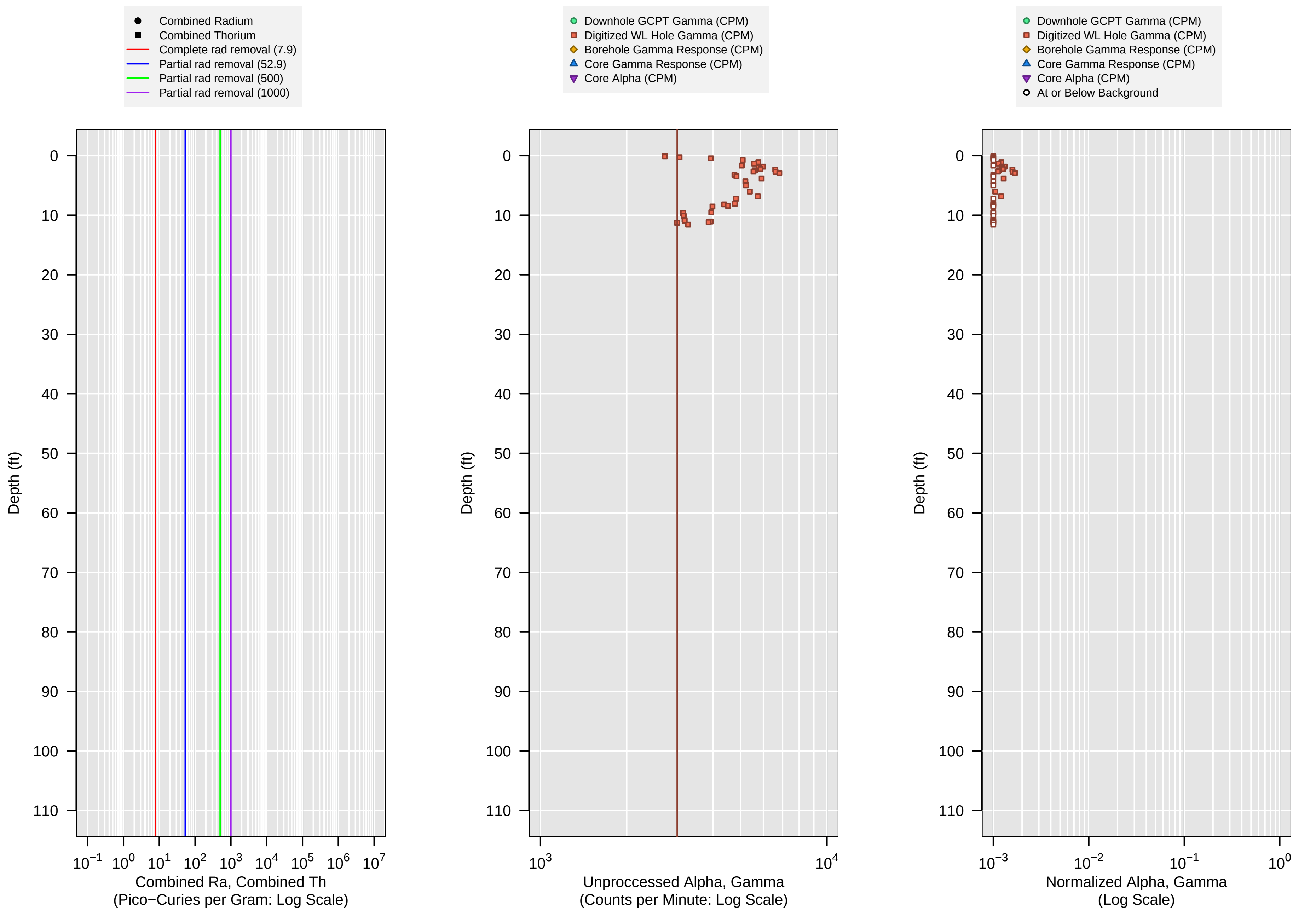
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

WL−201−MH



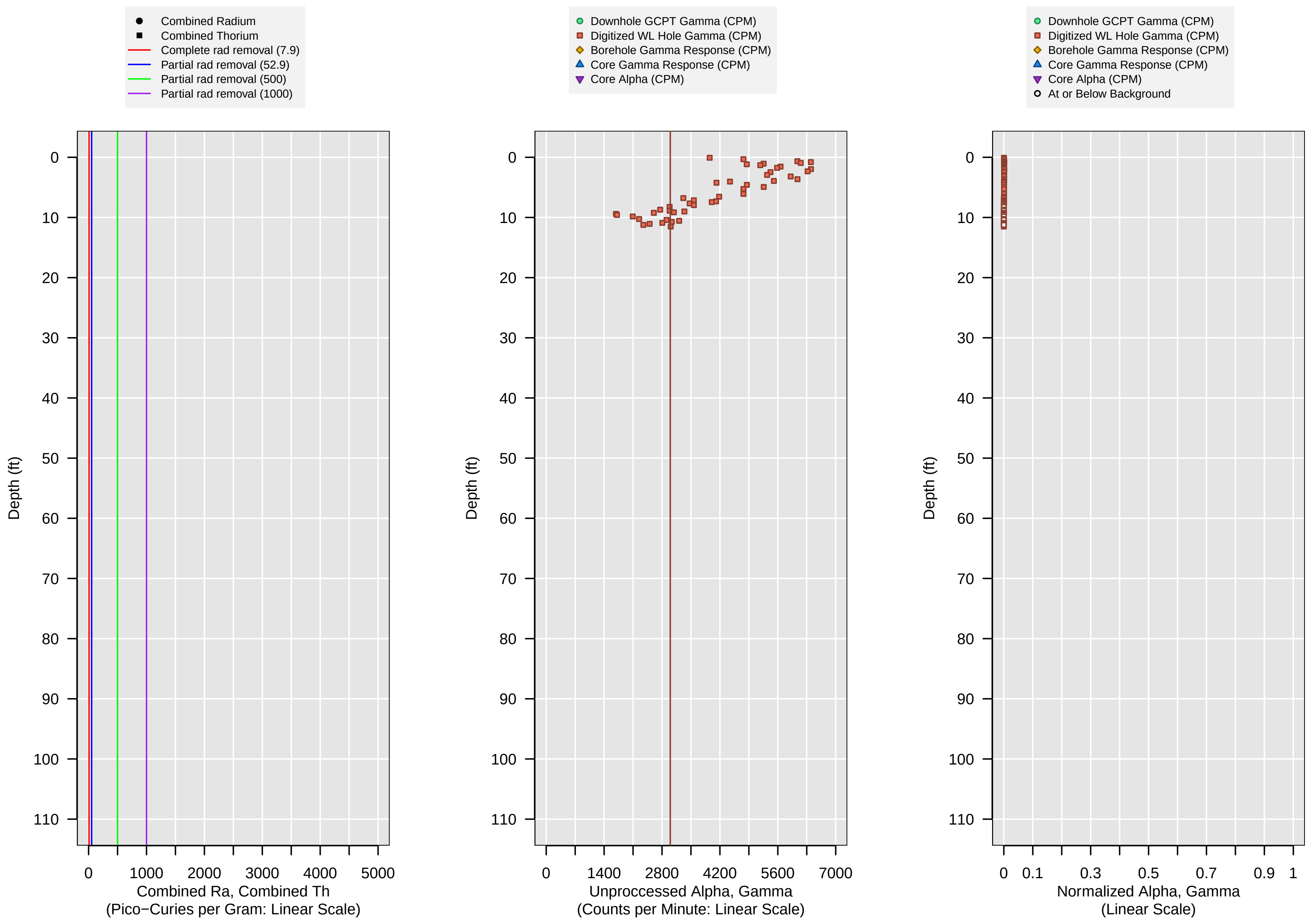
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
1400
2800
4200
5600
7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

WL−201−MH



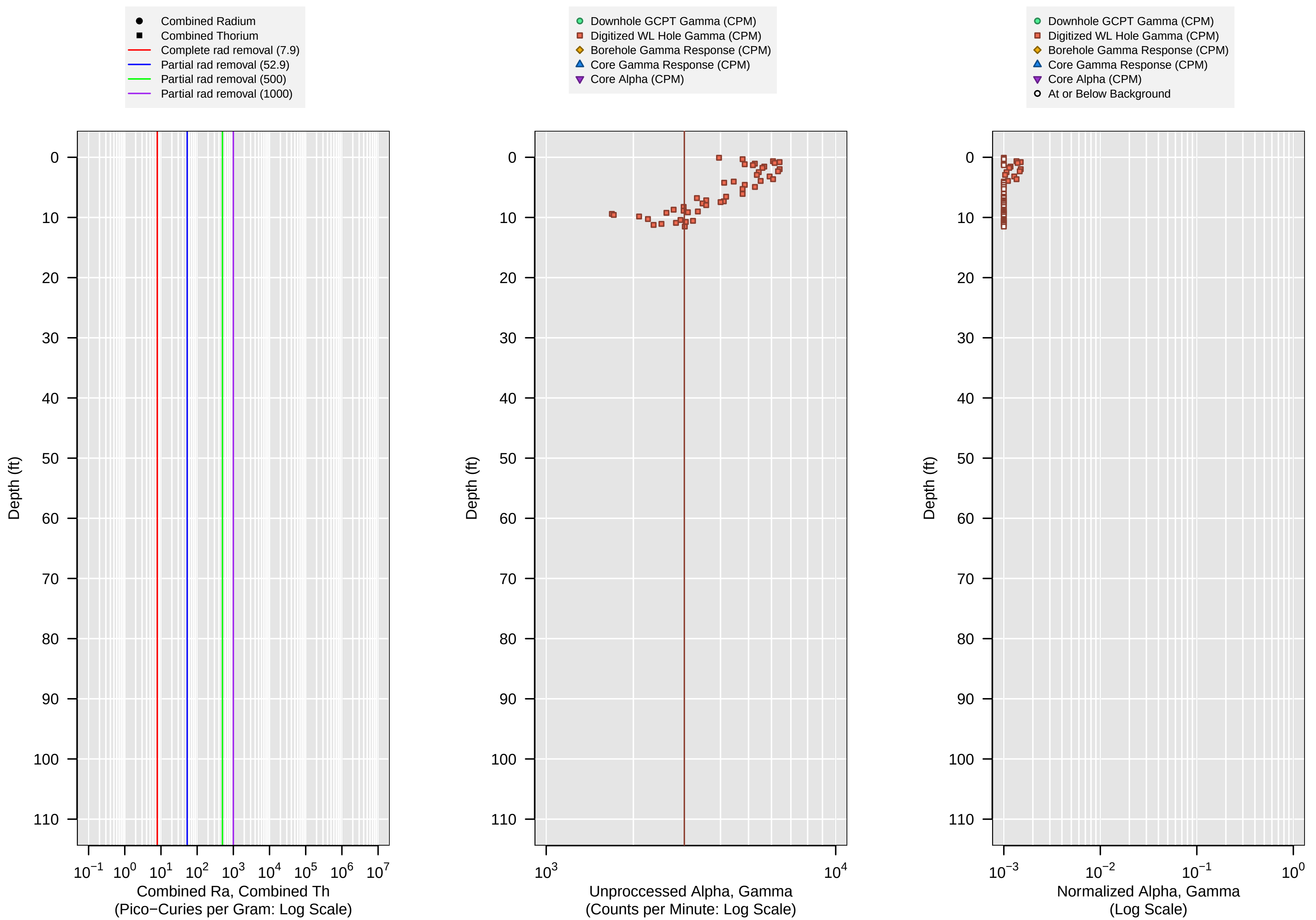
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−202−MH

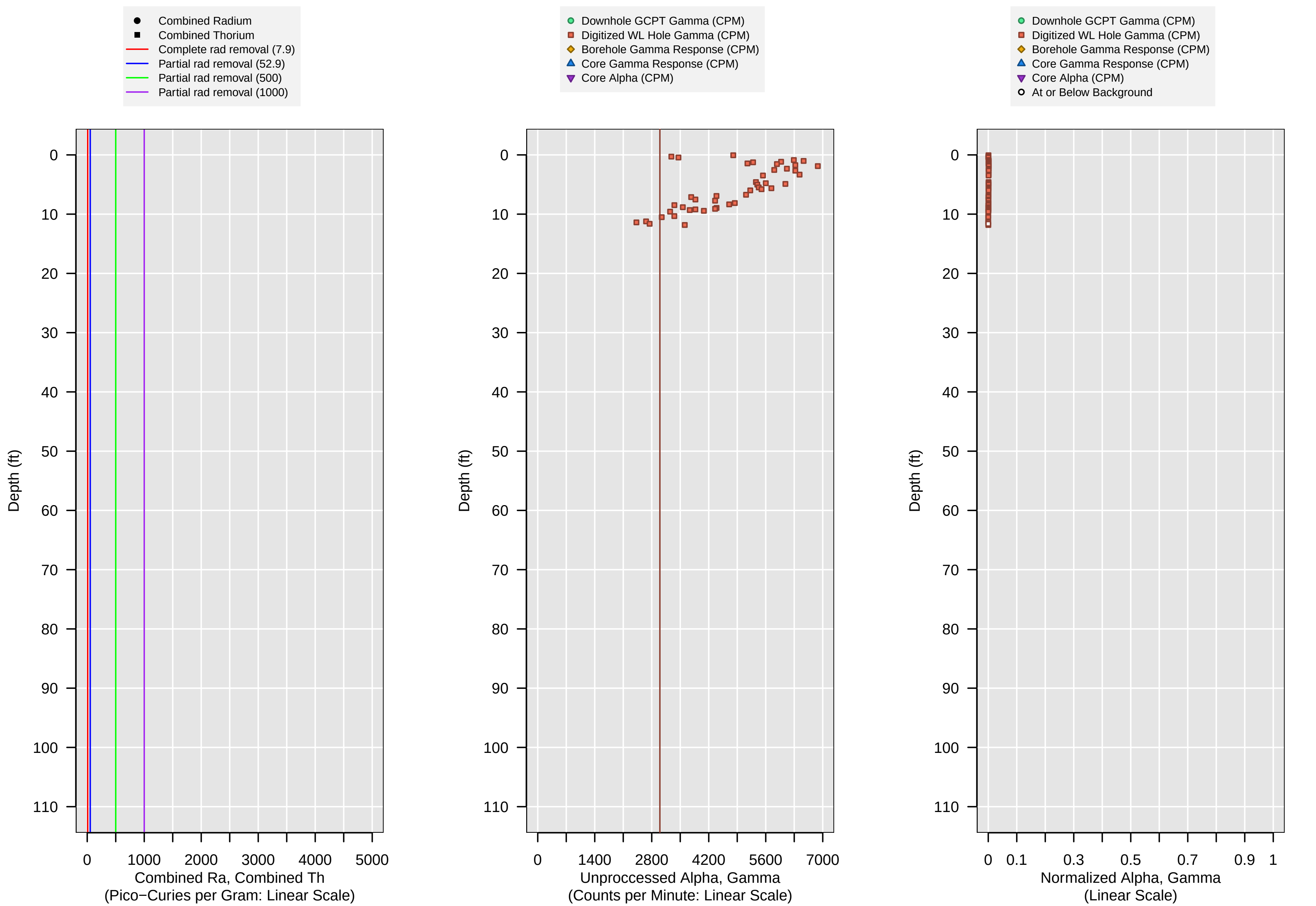


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
1400
2800
4200
5600
7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

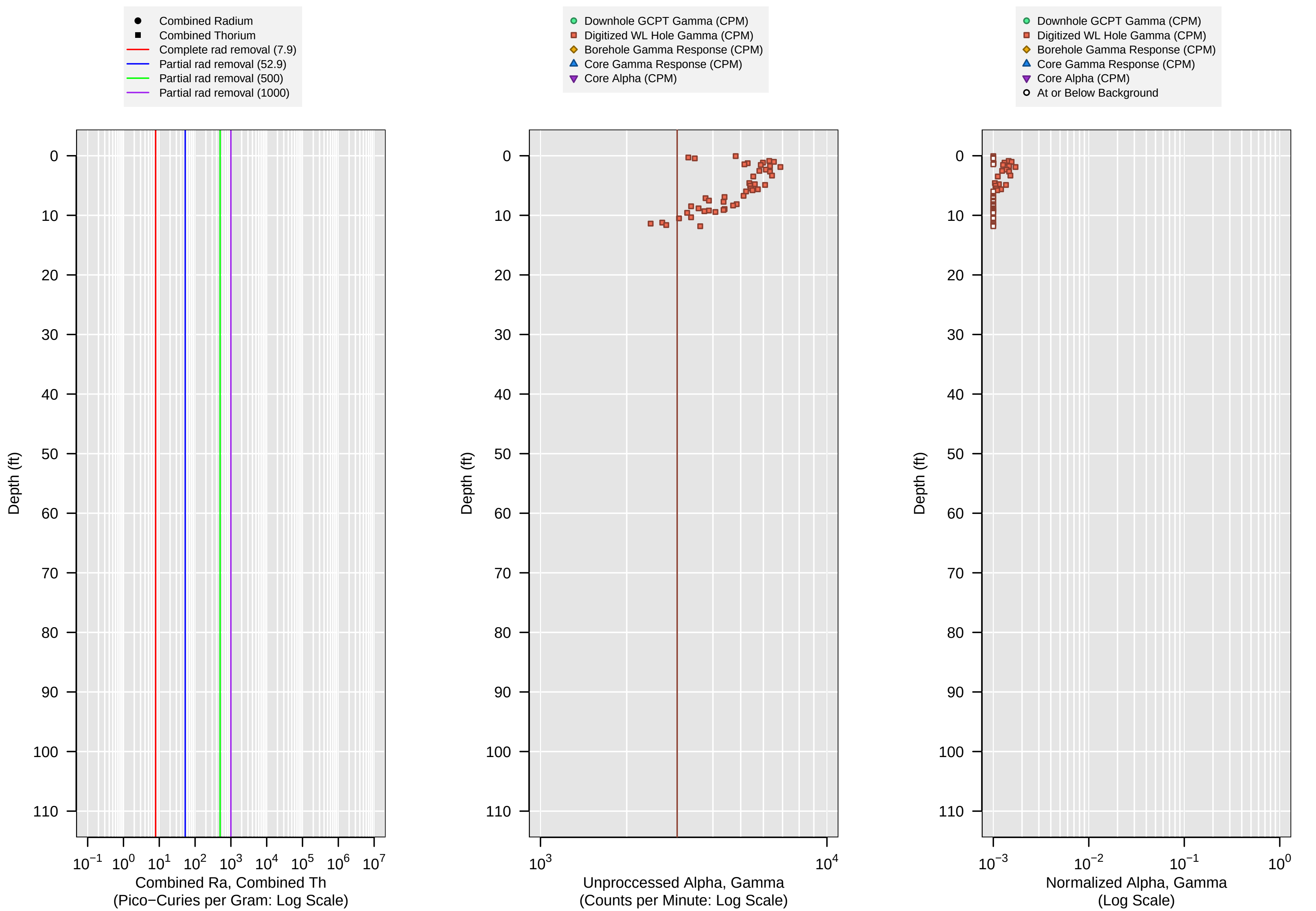
WL−202−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

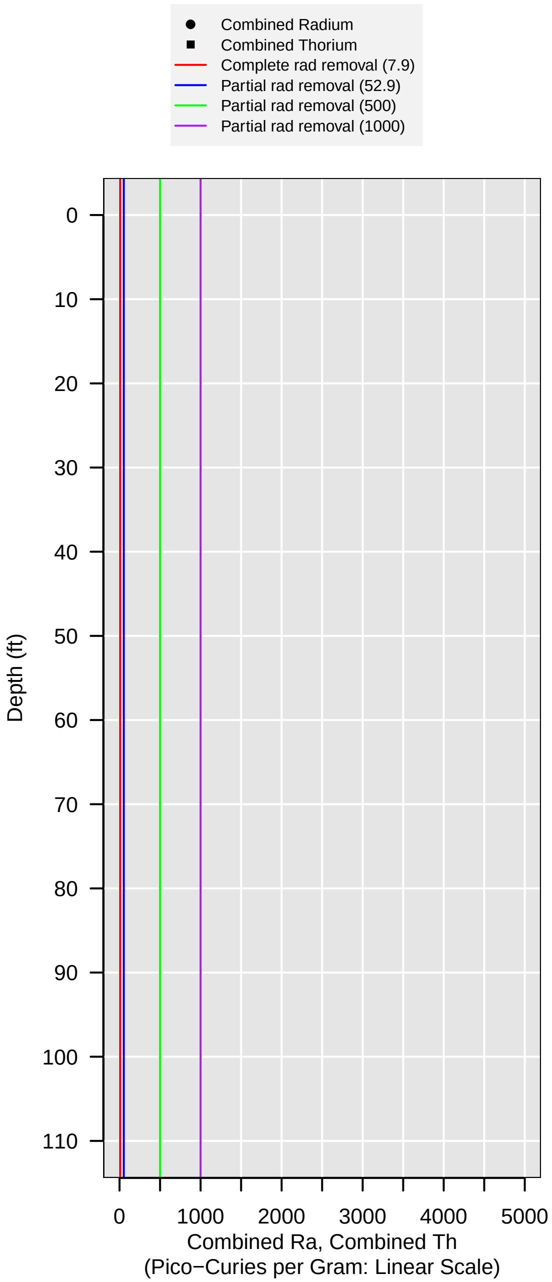
WL−203−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

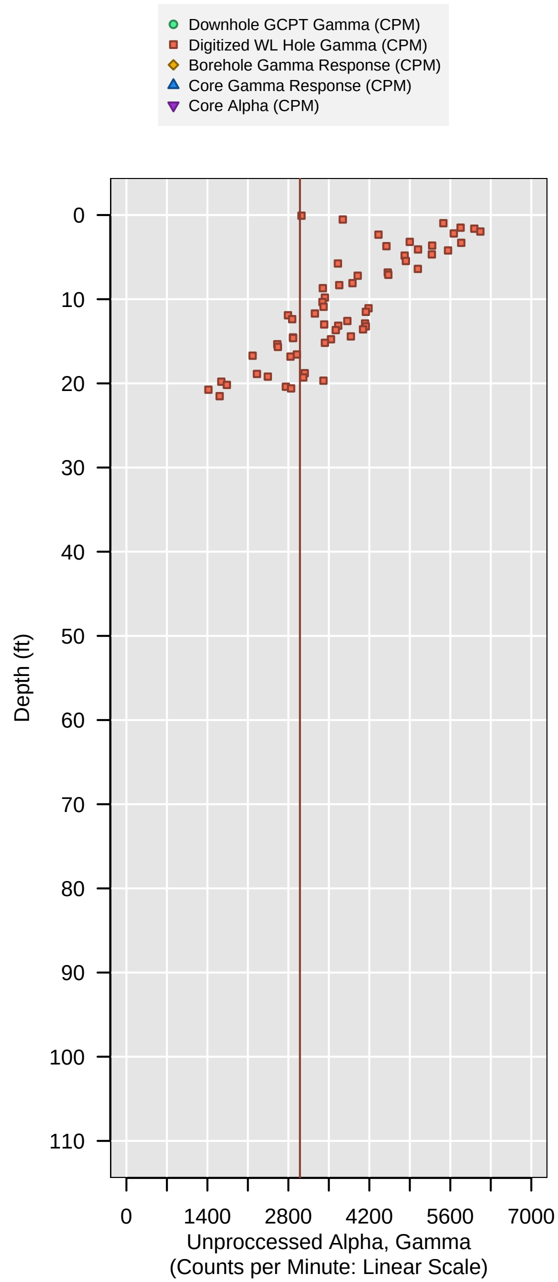
WL−203−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

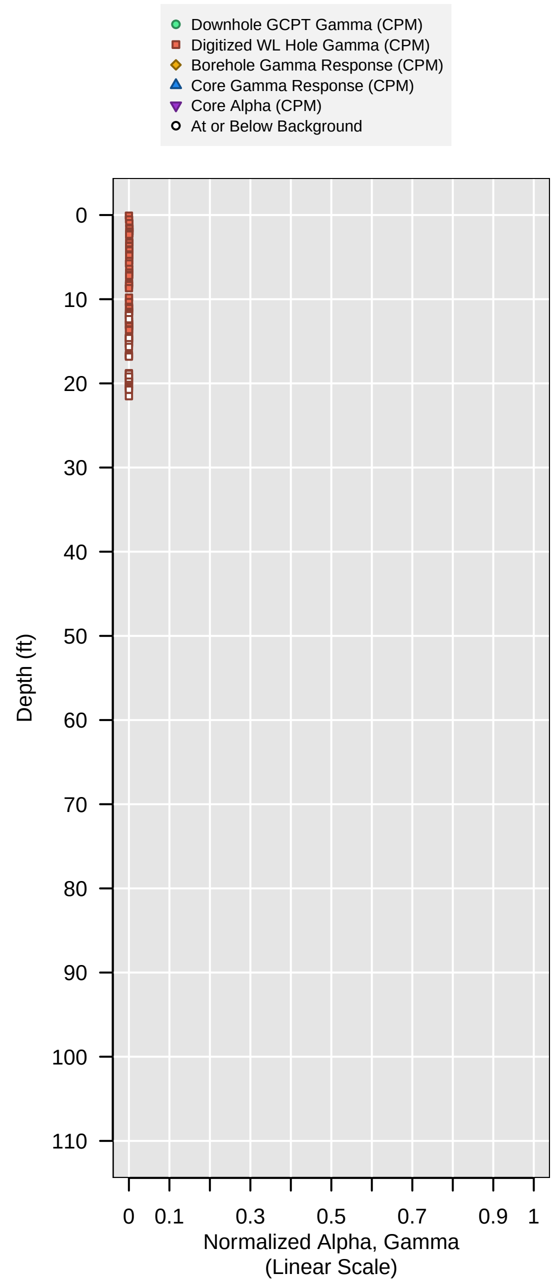
WL−204−MH



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)

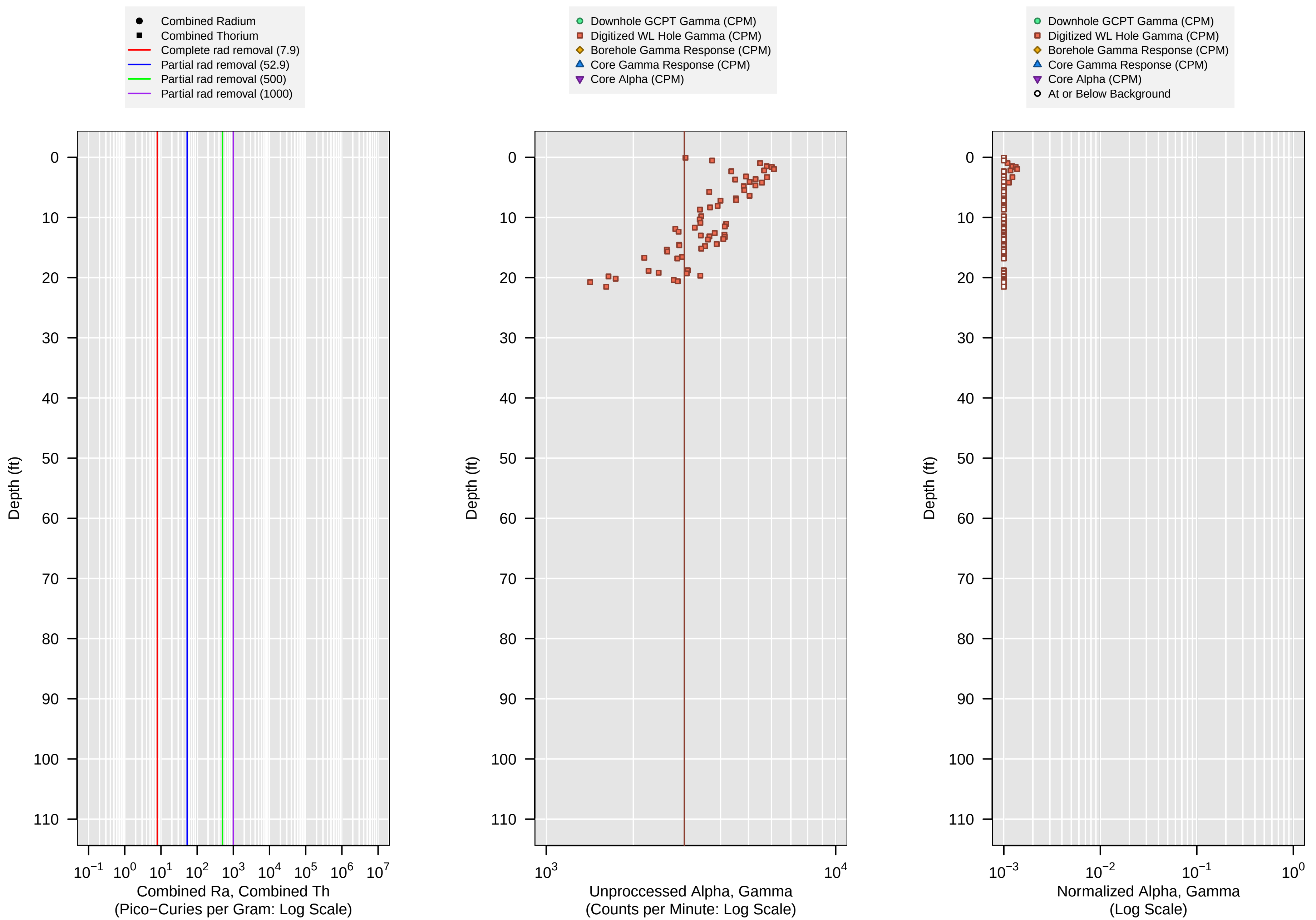


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1400
2800
4200
5600
7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)

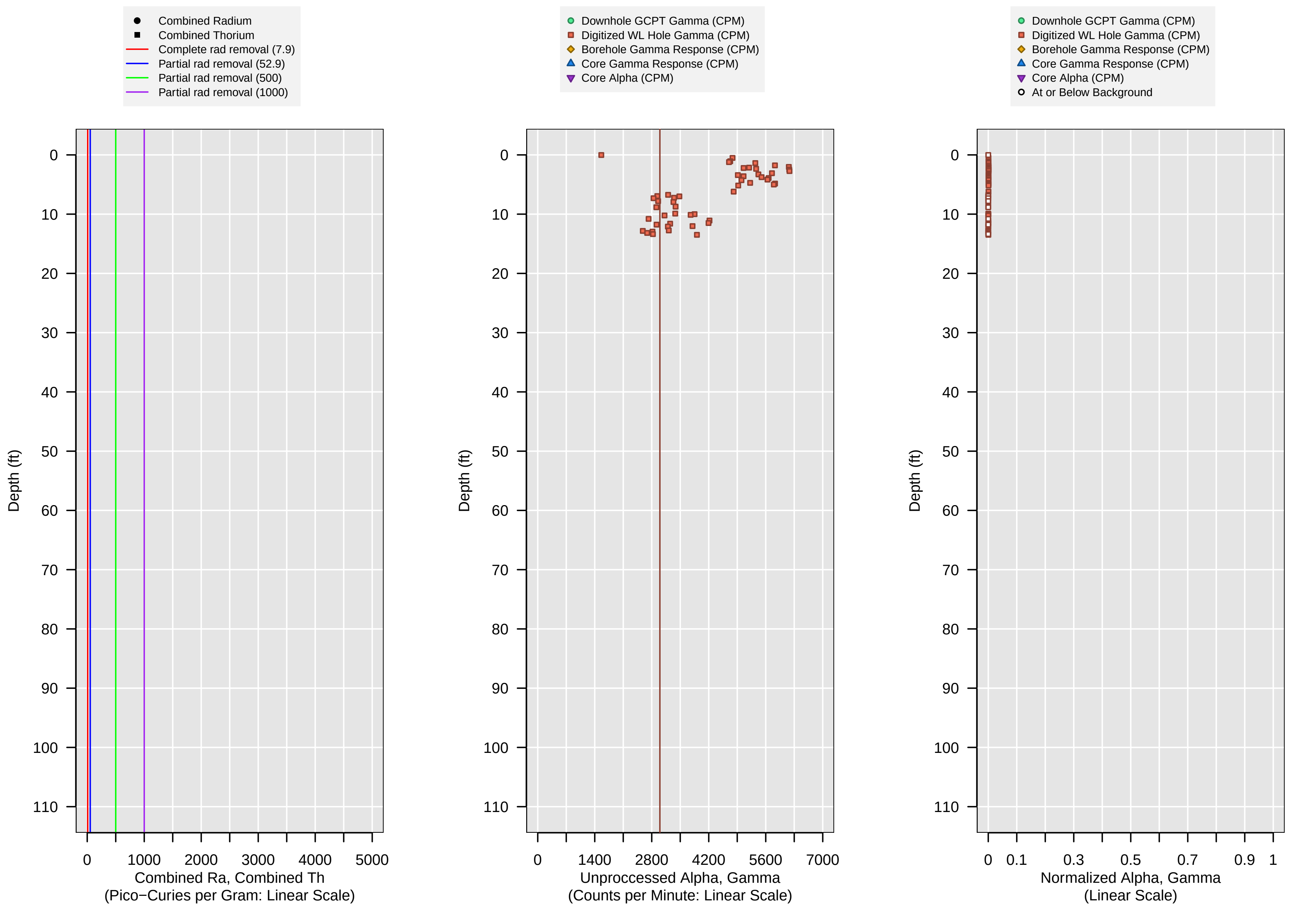


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

WL−204−MH

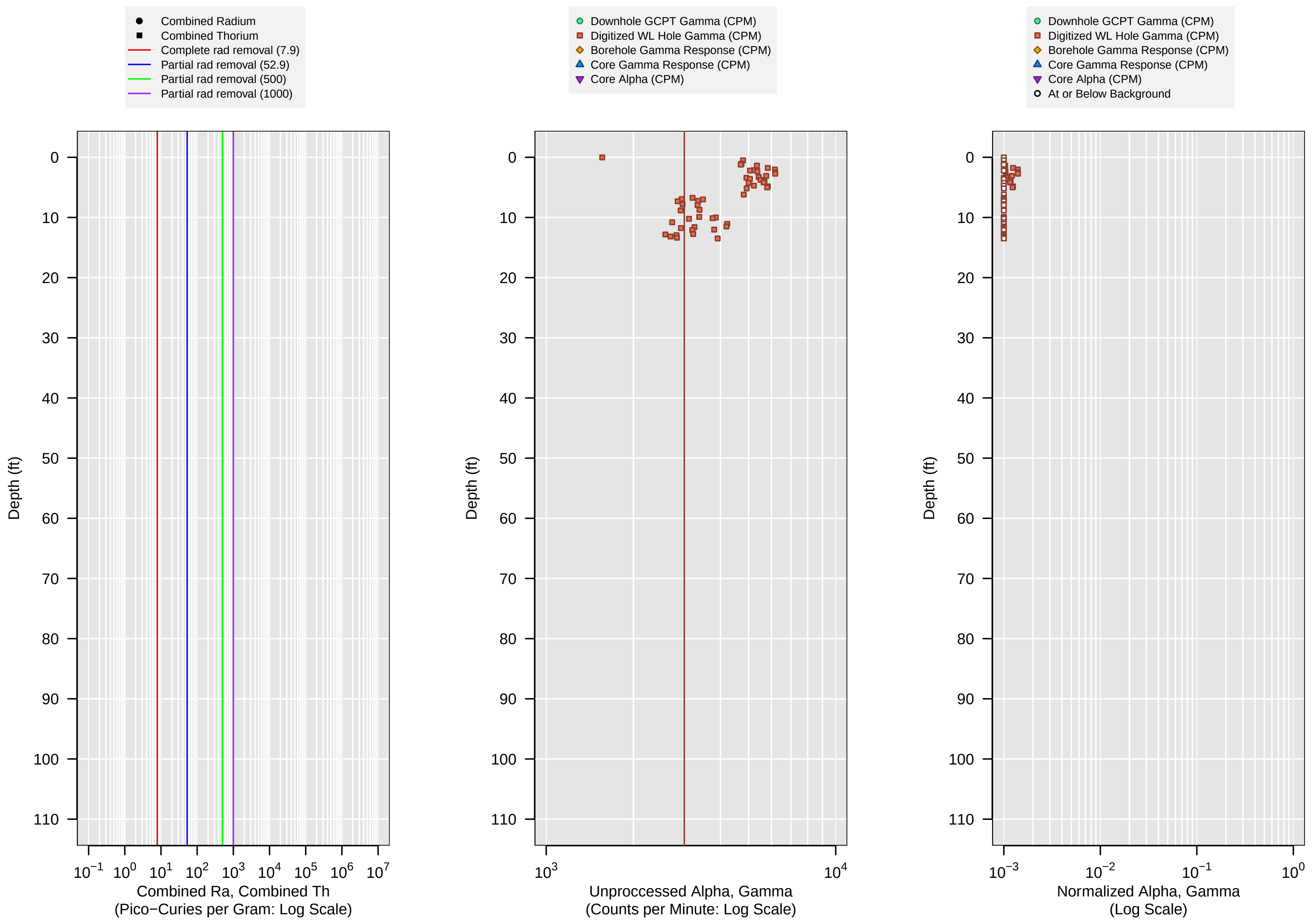

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

WL−205−MH



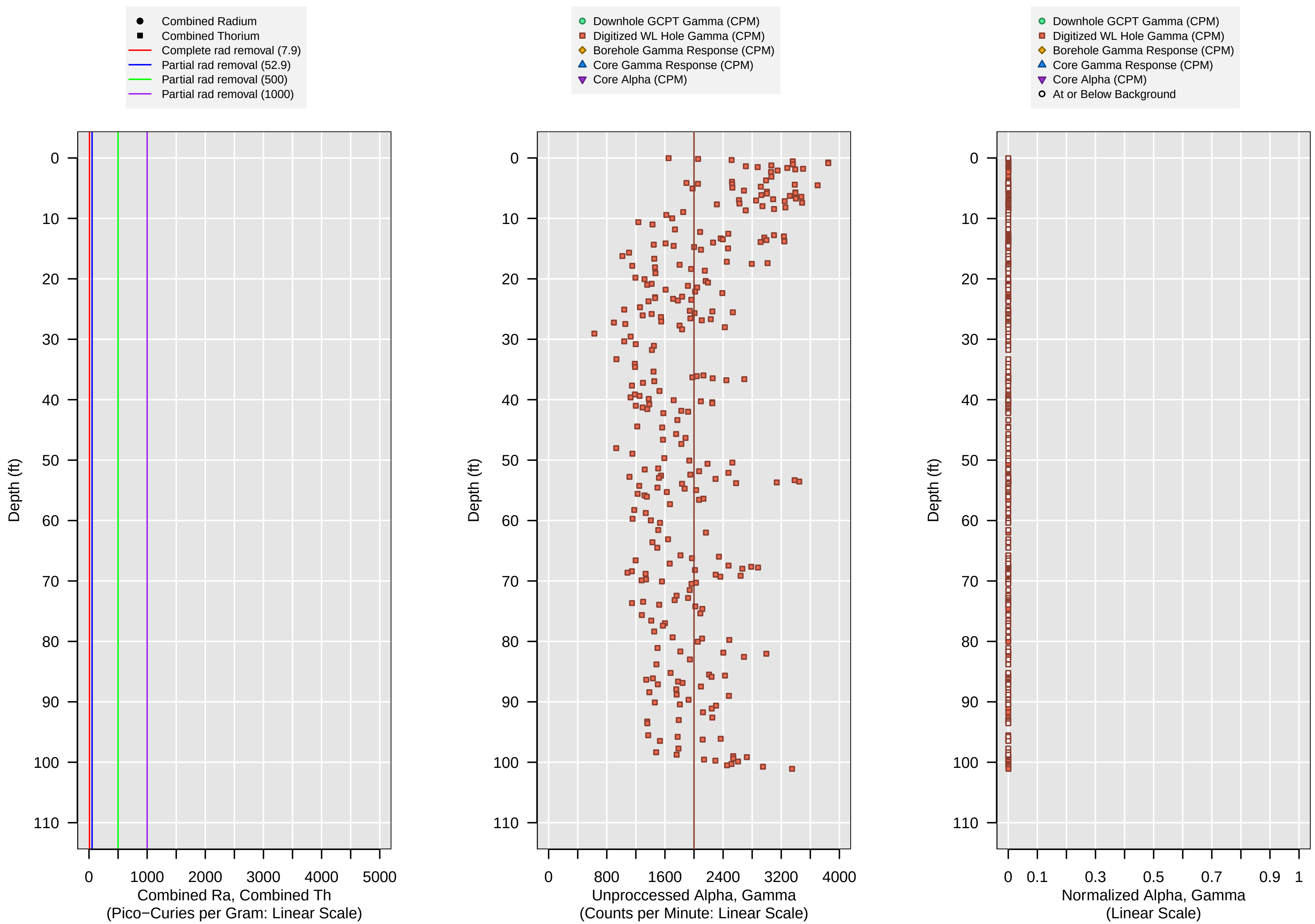
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0 10 20 30 40 50 60 70 80 90 100 110
0 1000 2000 3000 4000 5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0 1400 2800 4200 5600 7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

WL−205−MH

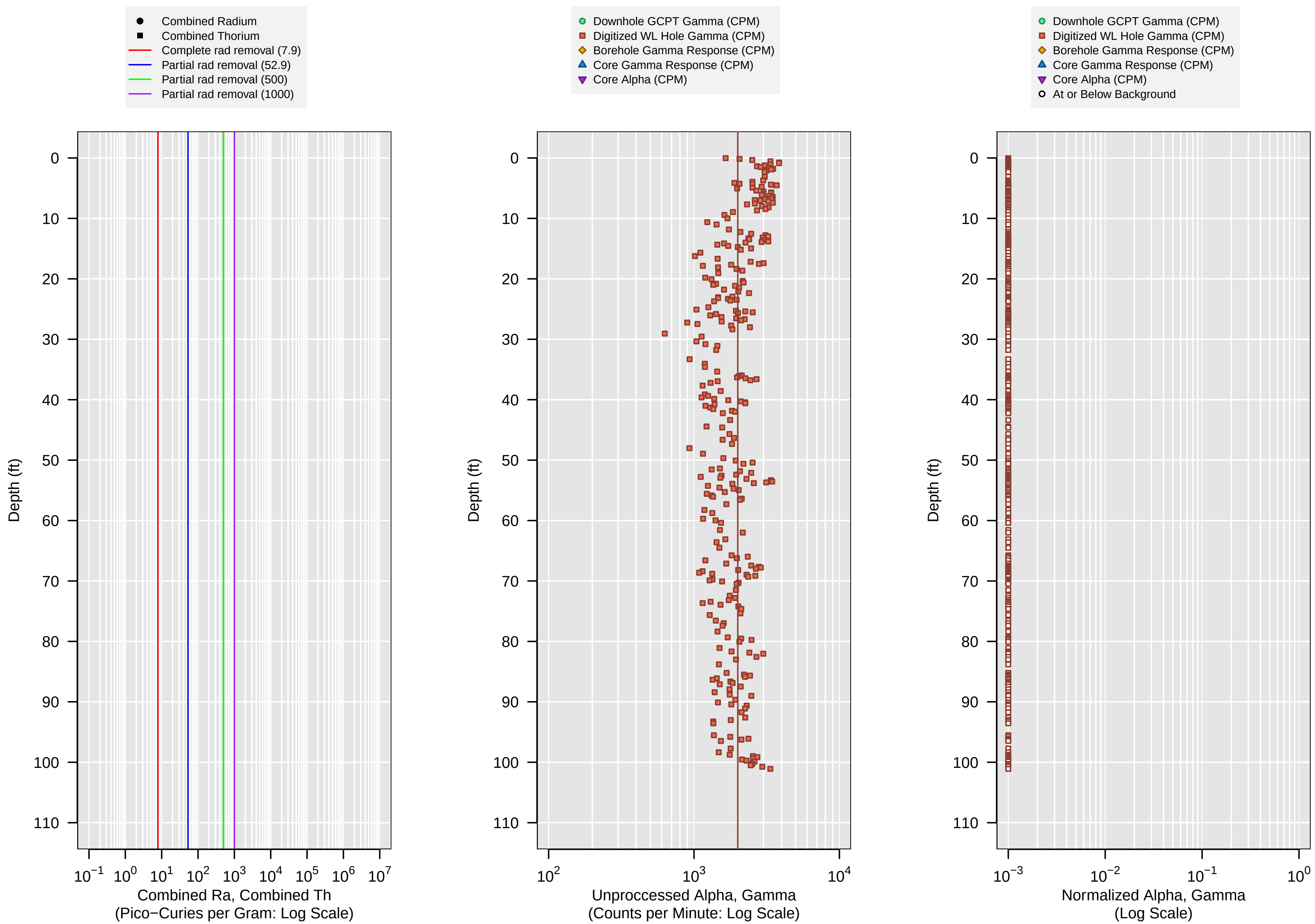


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−206−MH

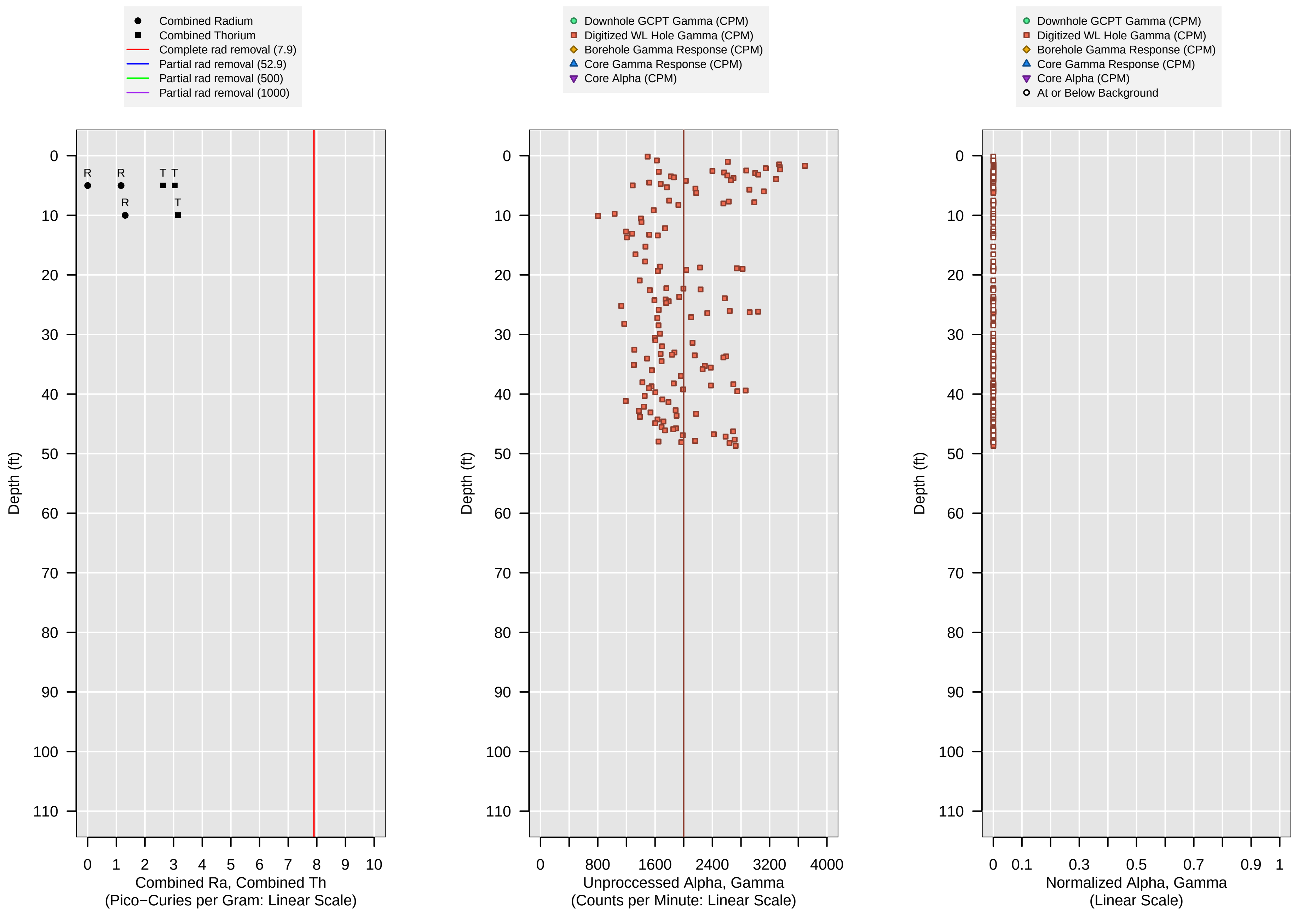

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−206−MH



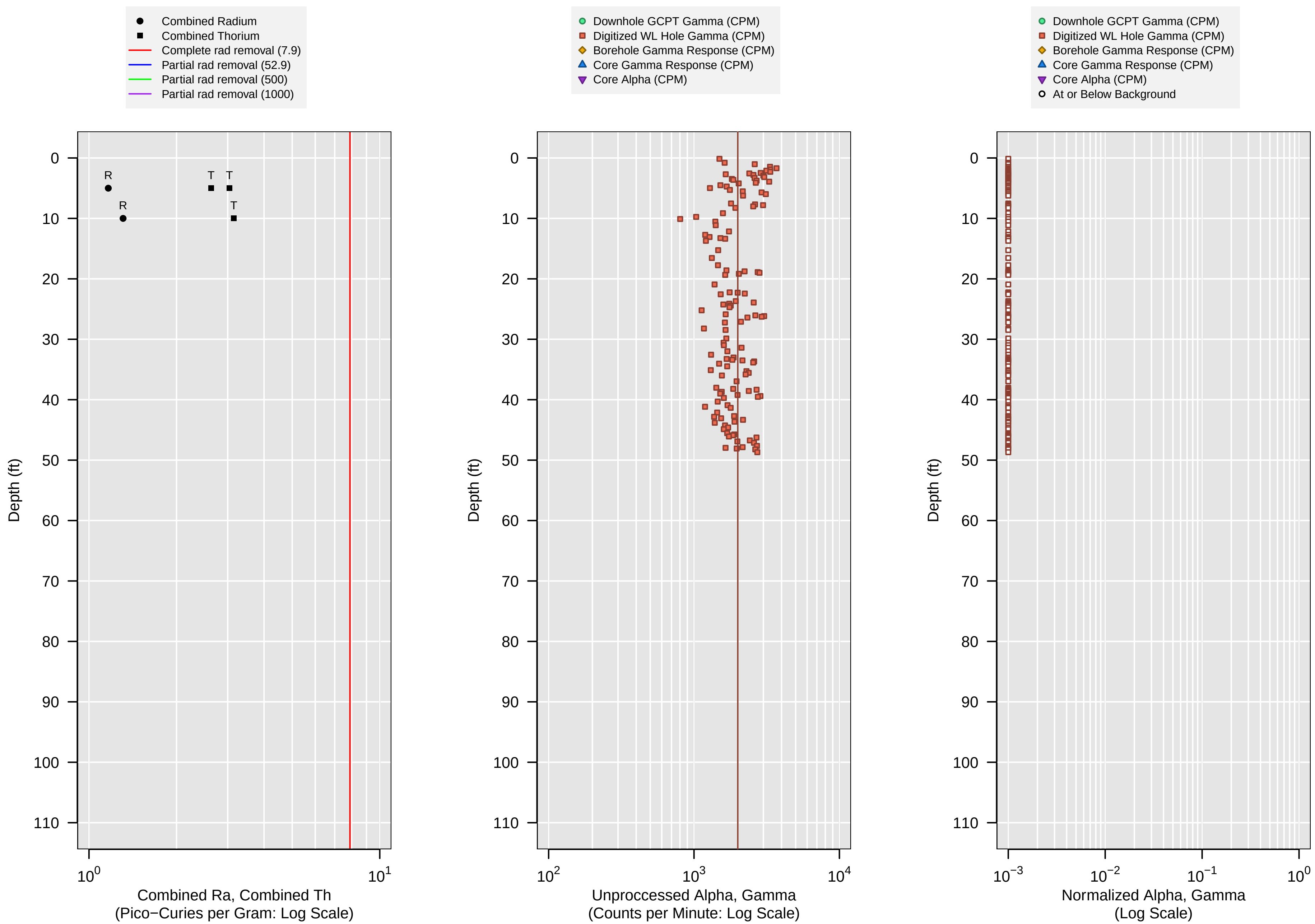
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

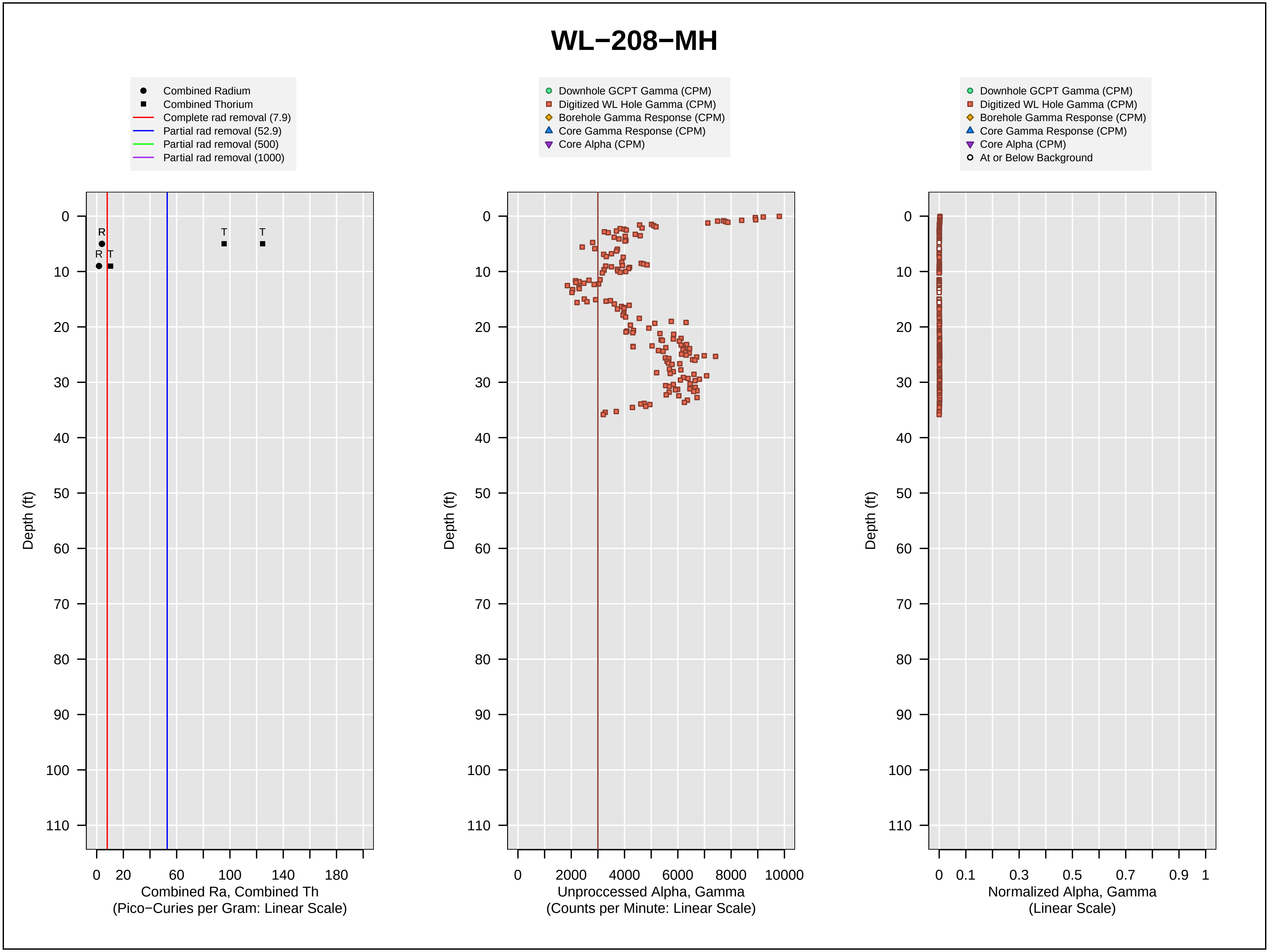
WL−207−MH



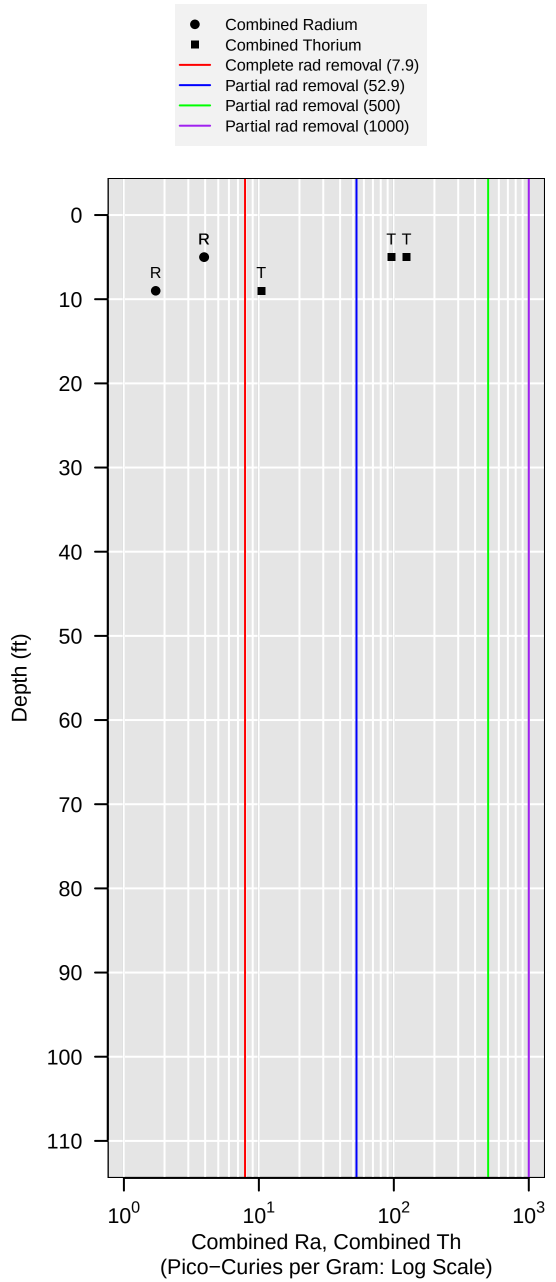
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−207−MH

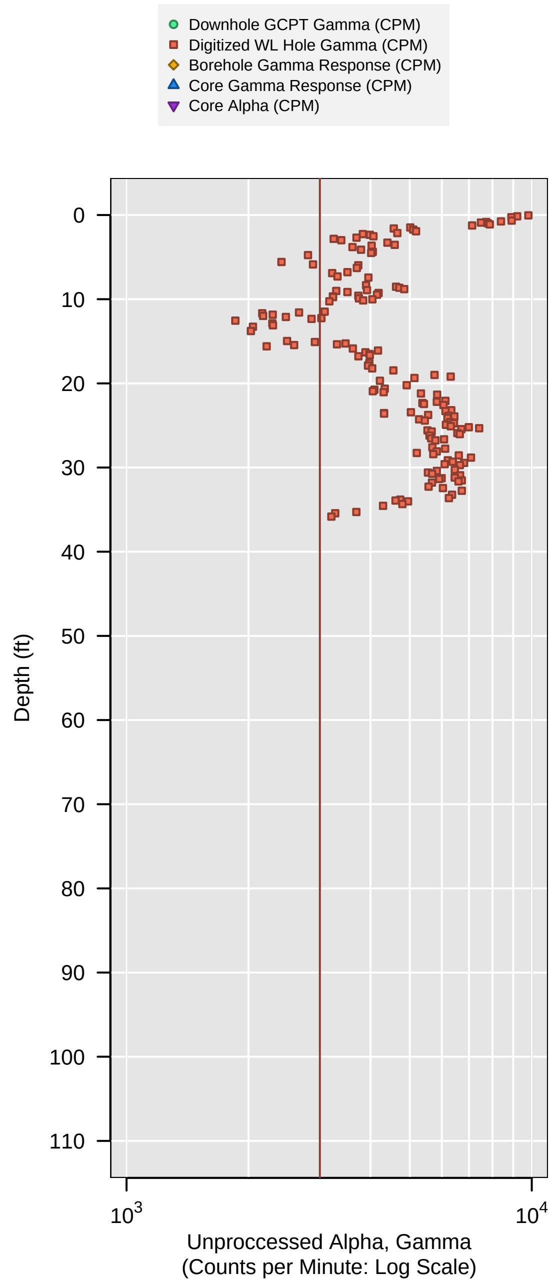

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)


WL−208−MH
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

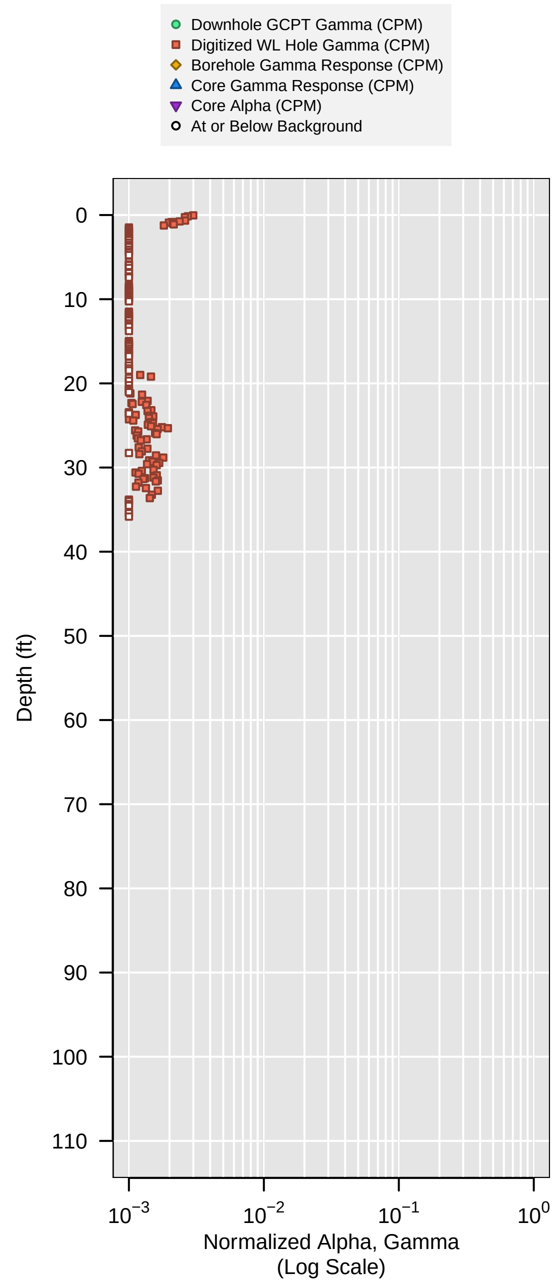
WL−208−MH



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
R
T
T T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)

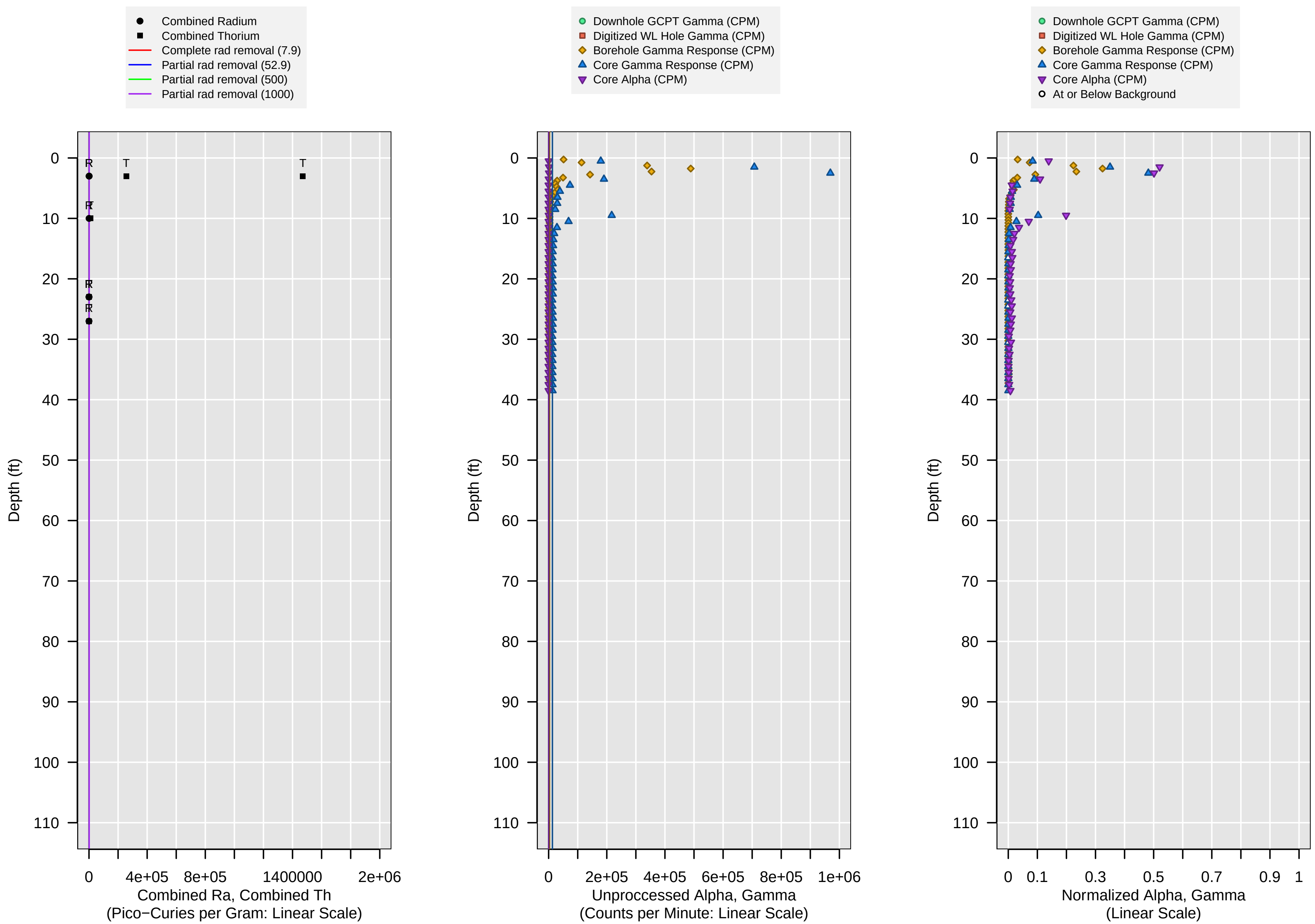


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)



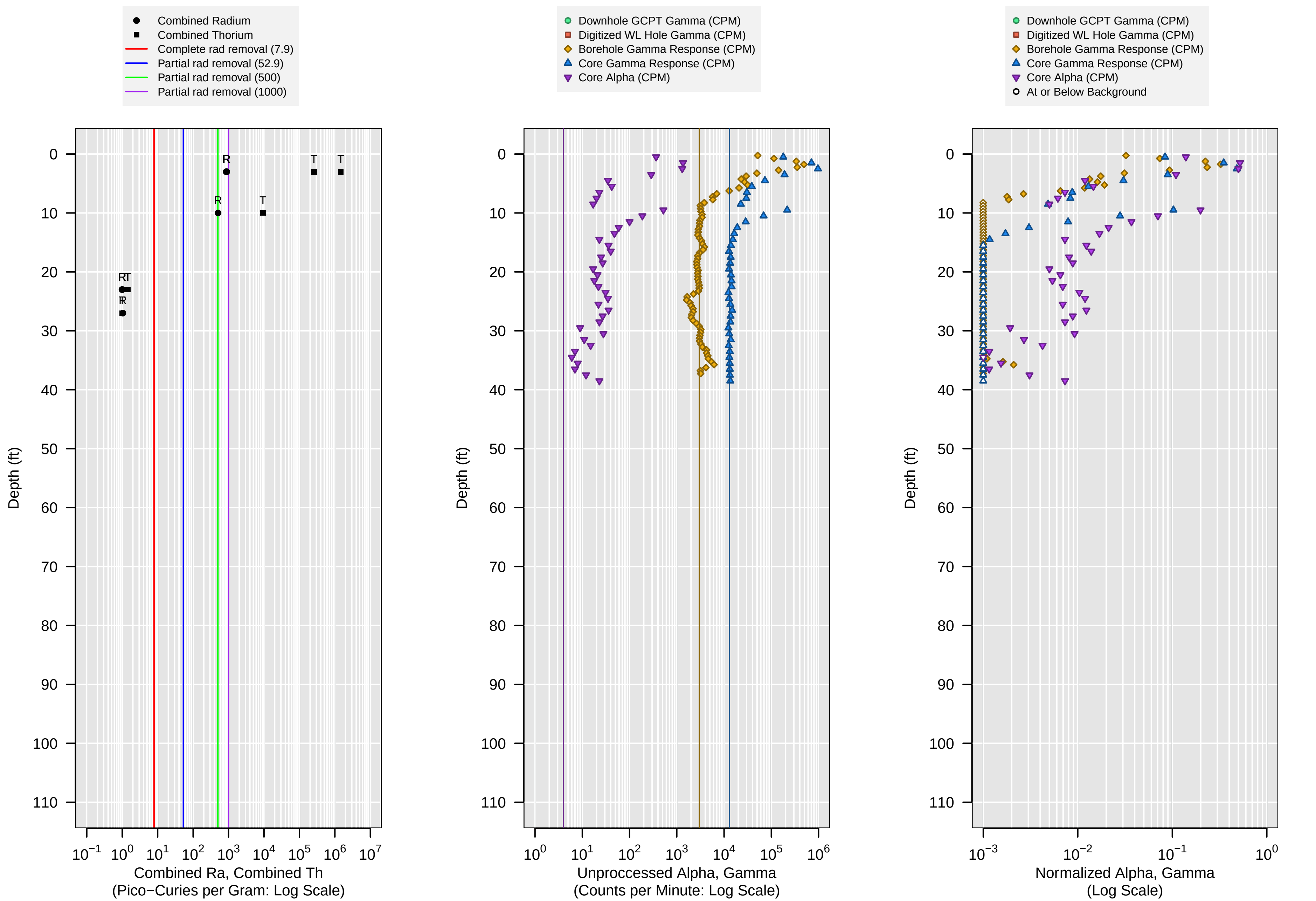
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

WL−209−CT

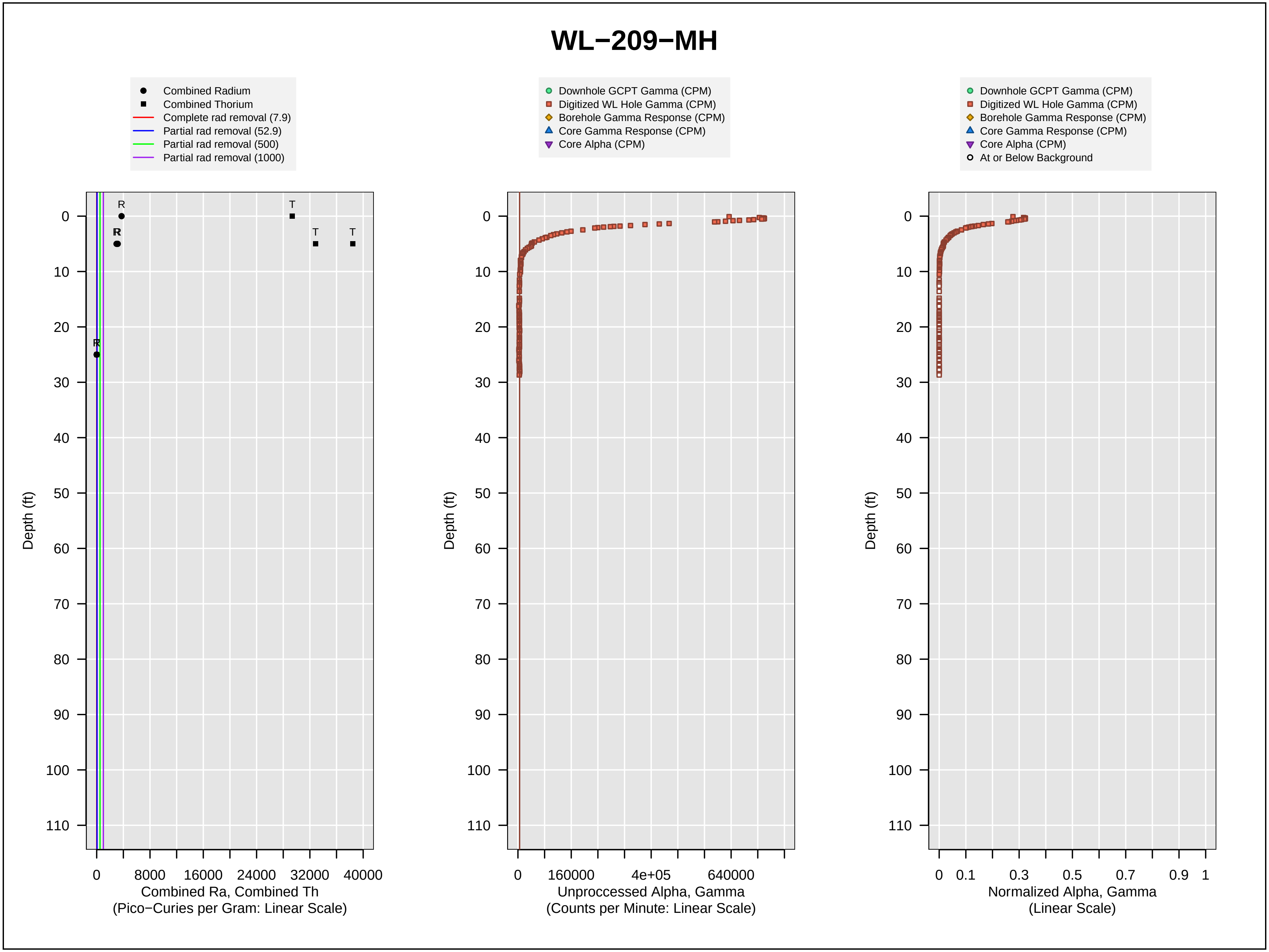


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
0
4e+05
8e+05
1400000
2e+06
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
0
2e+05
4e+05
6e+05
8e+05
1e+06
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)
0
0.1
0.3
0.5
0.7
0.9
1

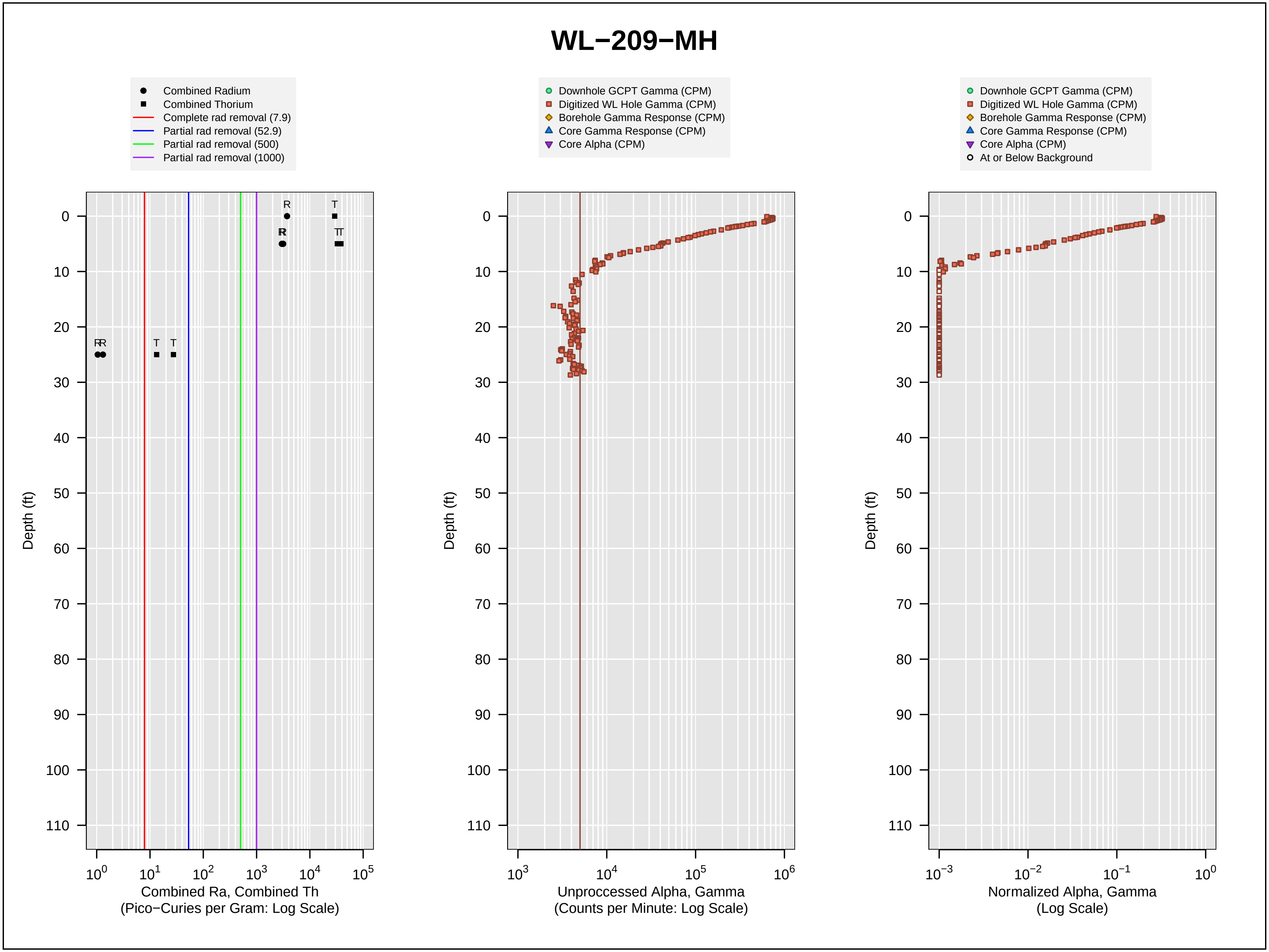
WL−209−CT



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

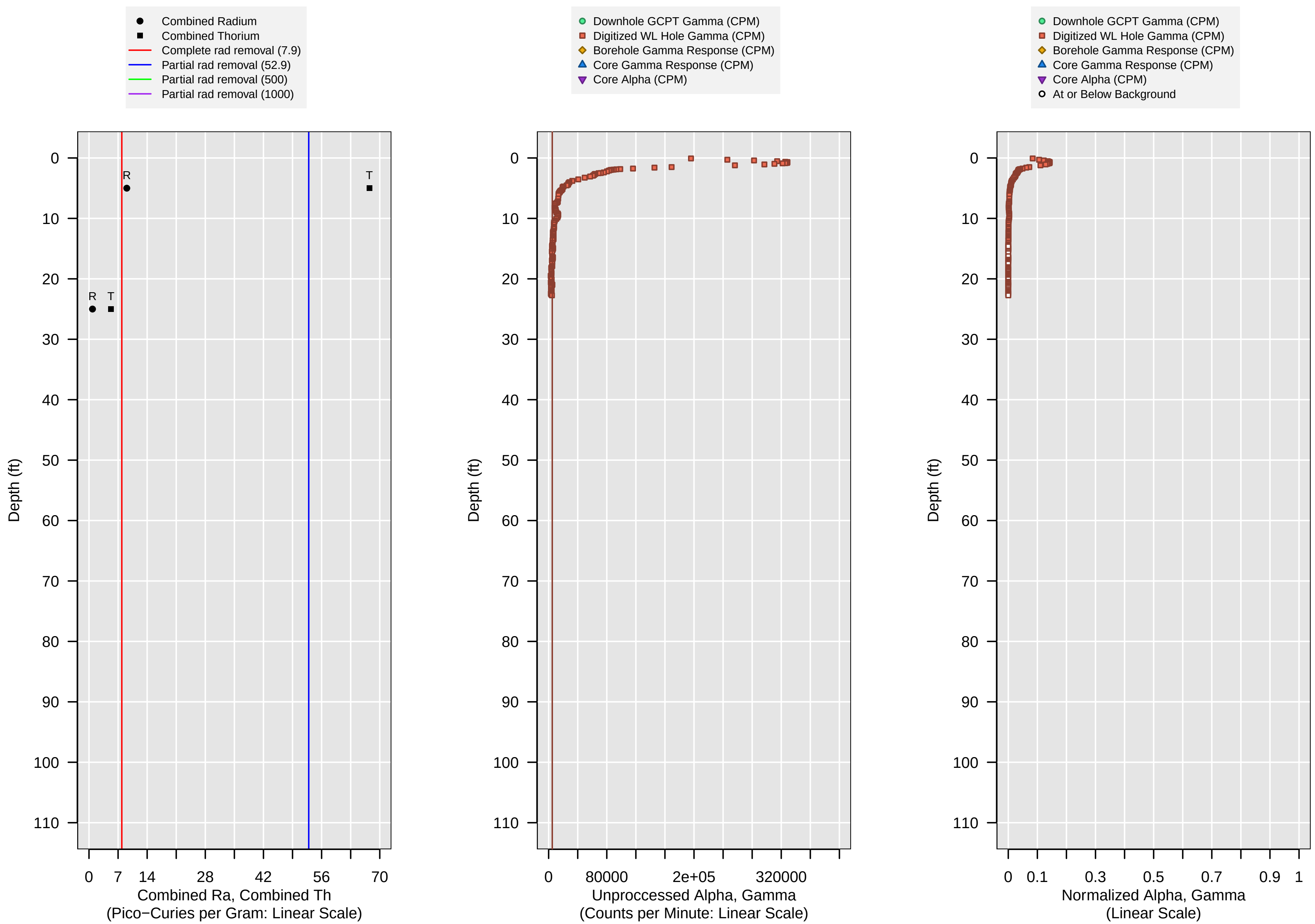


WL−209−MH
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Normalized Alpha, Gamma
(Linear Scale)



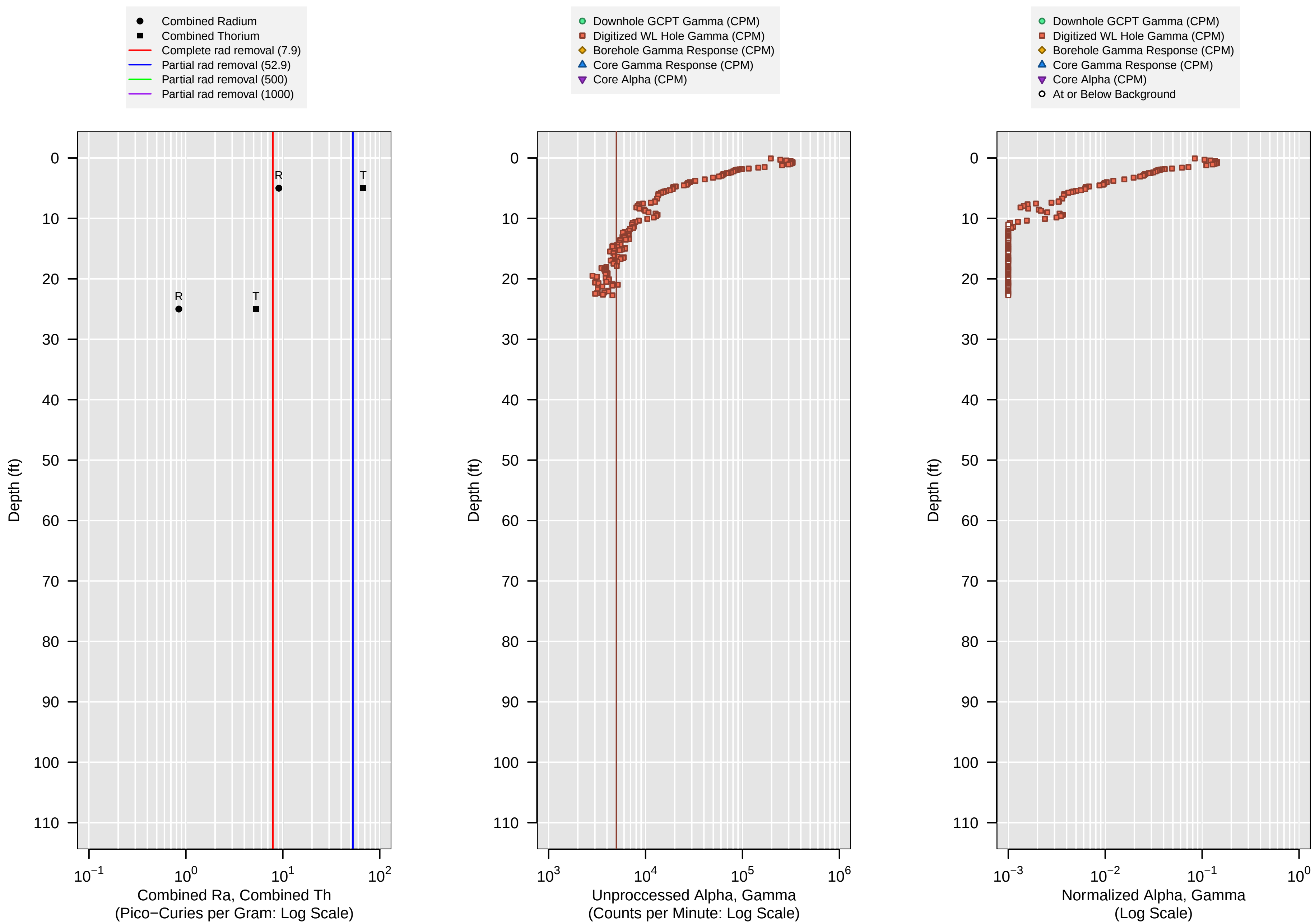
WL−209−MH
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−211−MH

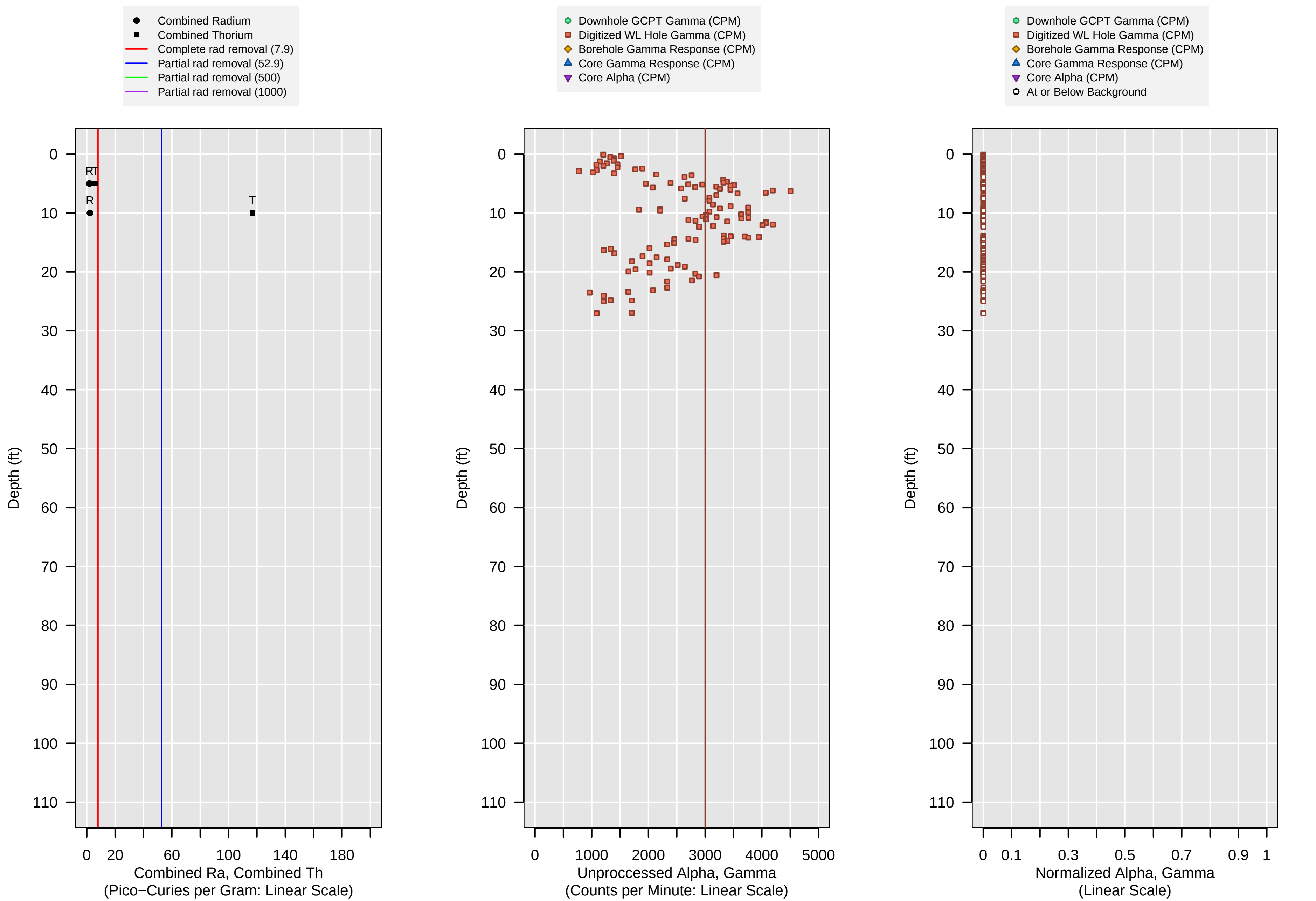


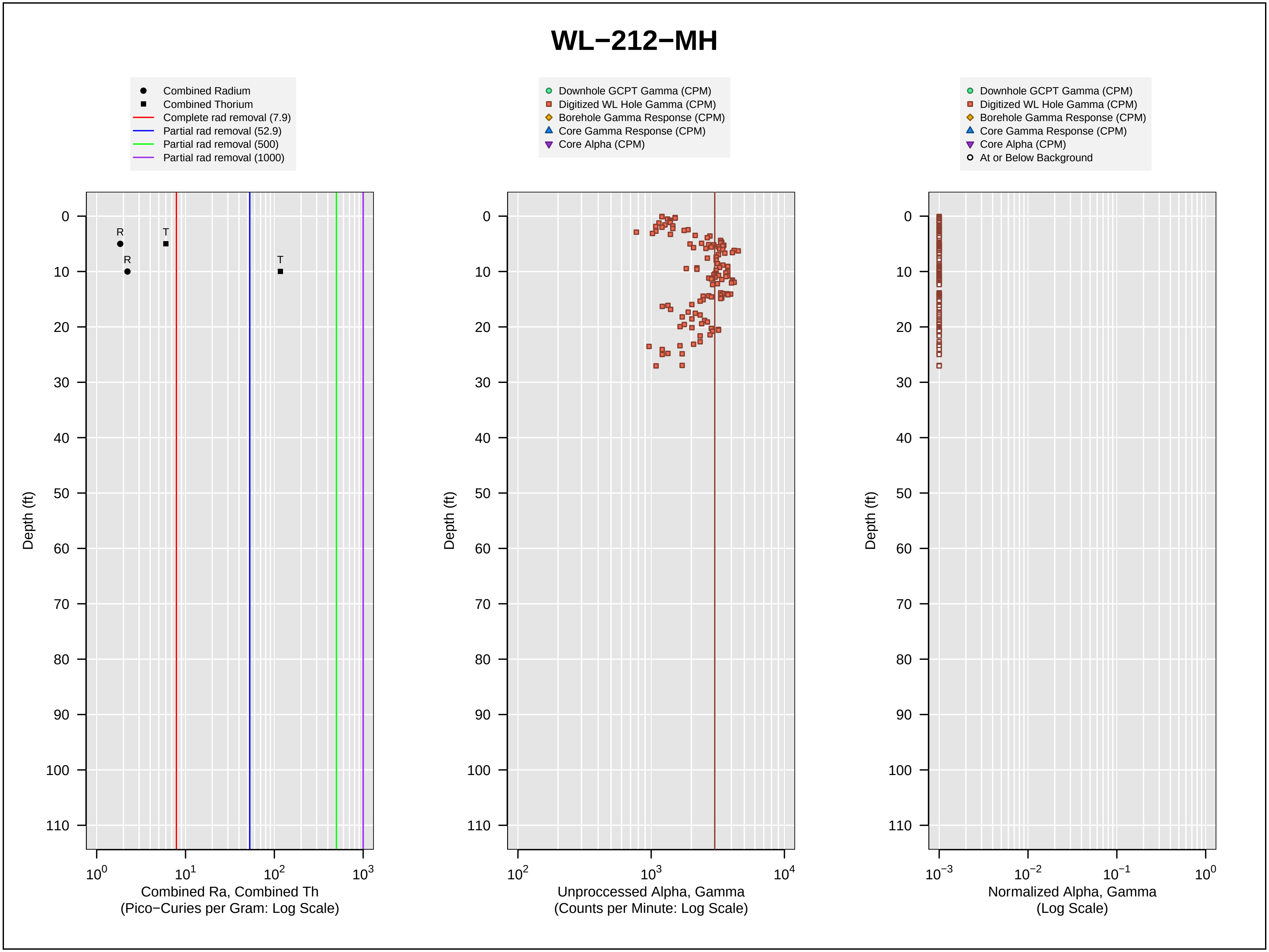
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 7 14 28 42 56 70
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0 80000 2e+05 320000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

WL−211−MH

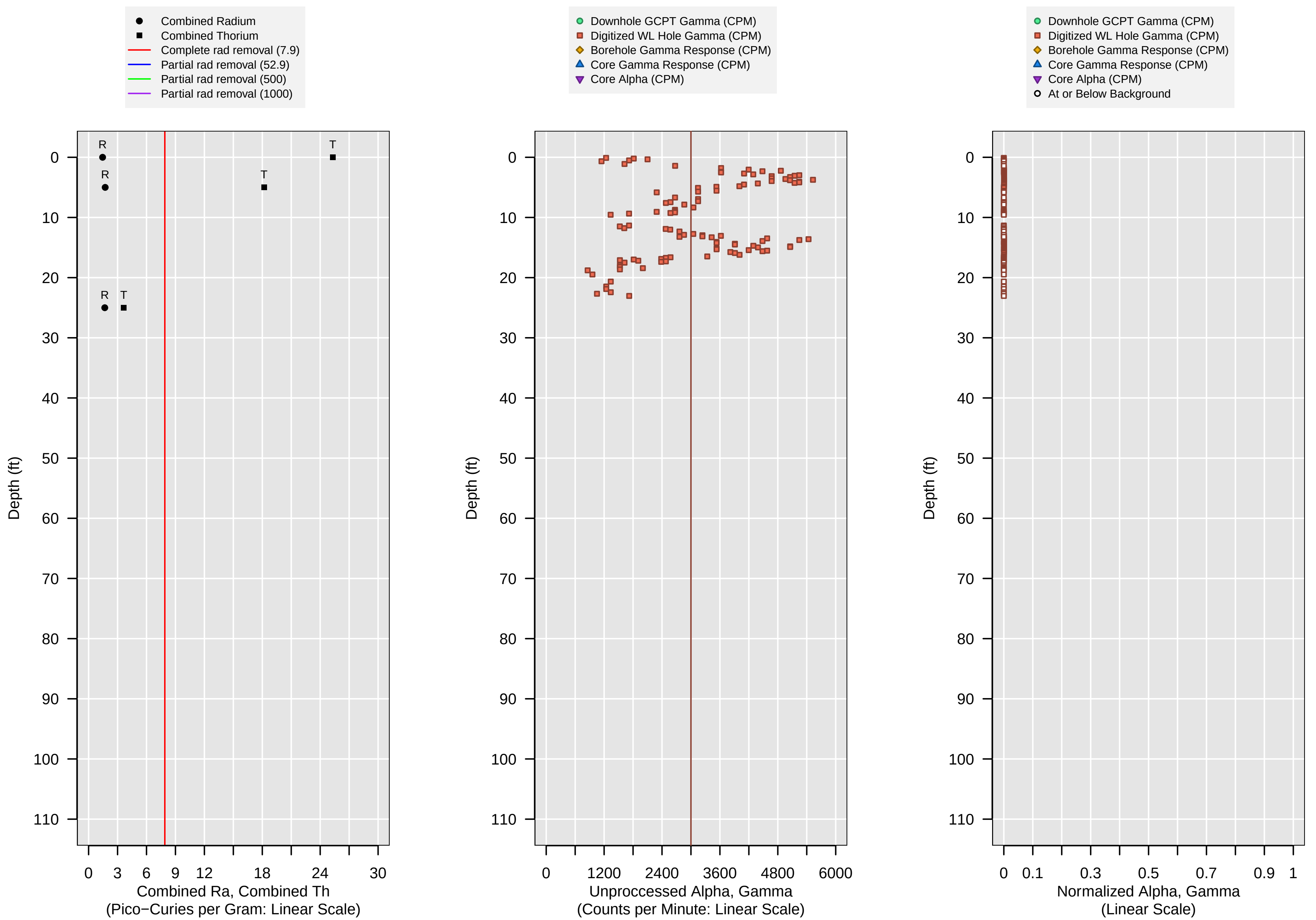

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−212−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
RT
R
T
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)


WL−212−MH
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

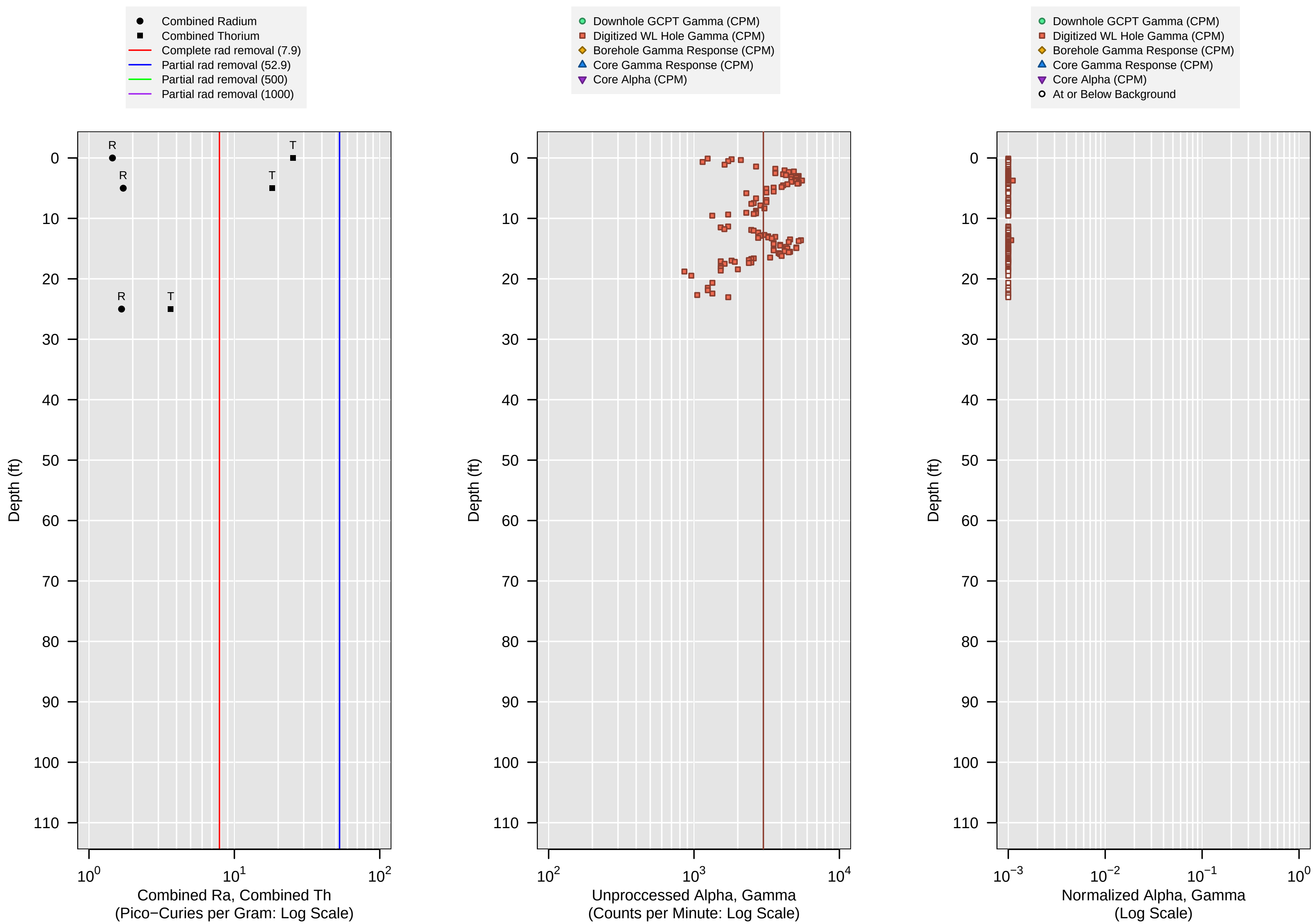
WL−213−MH

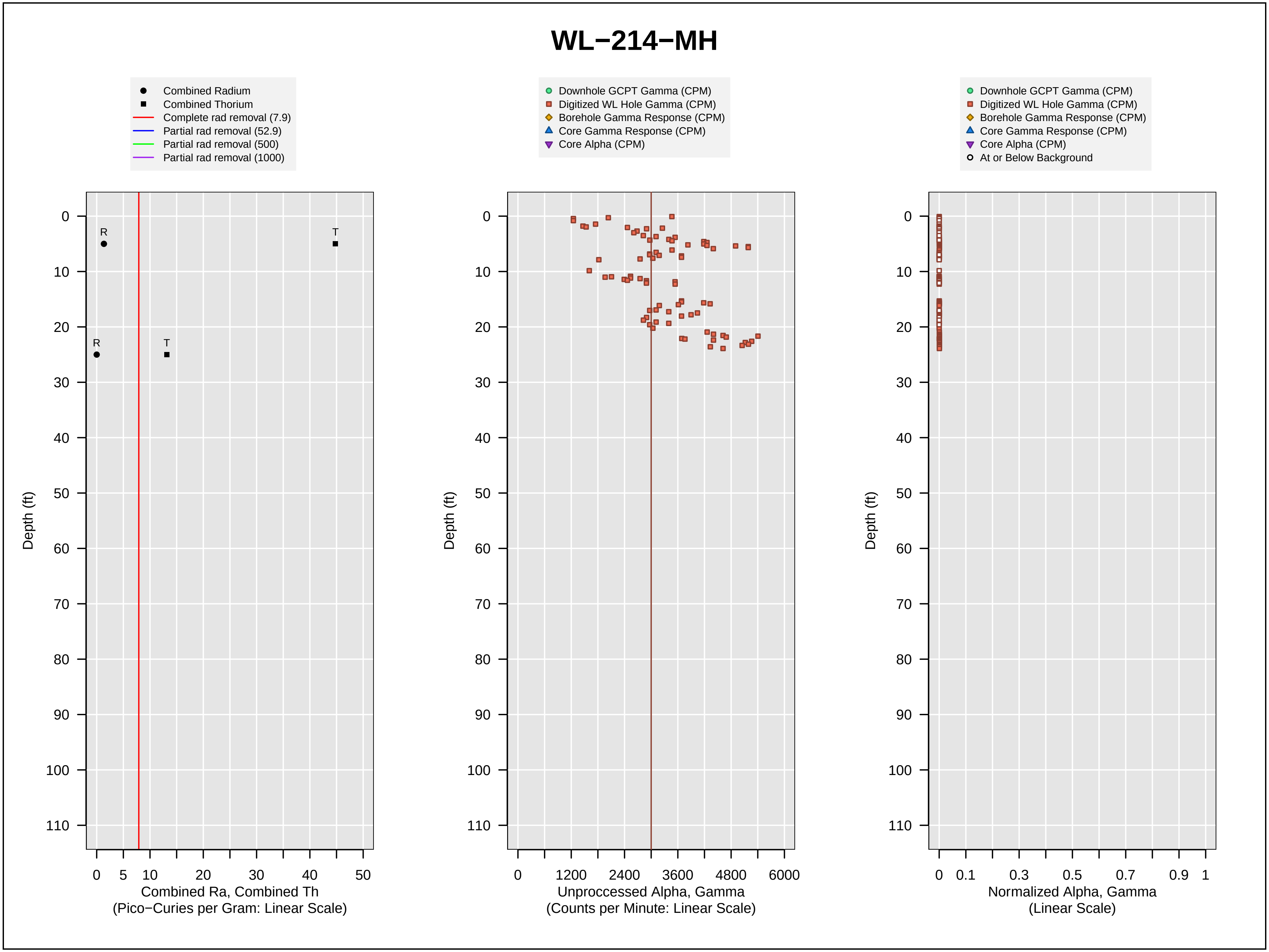


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

S.S. PAPADOPULOS & ASSOCIATES, INC.

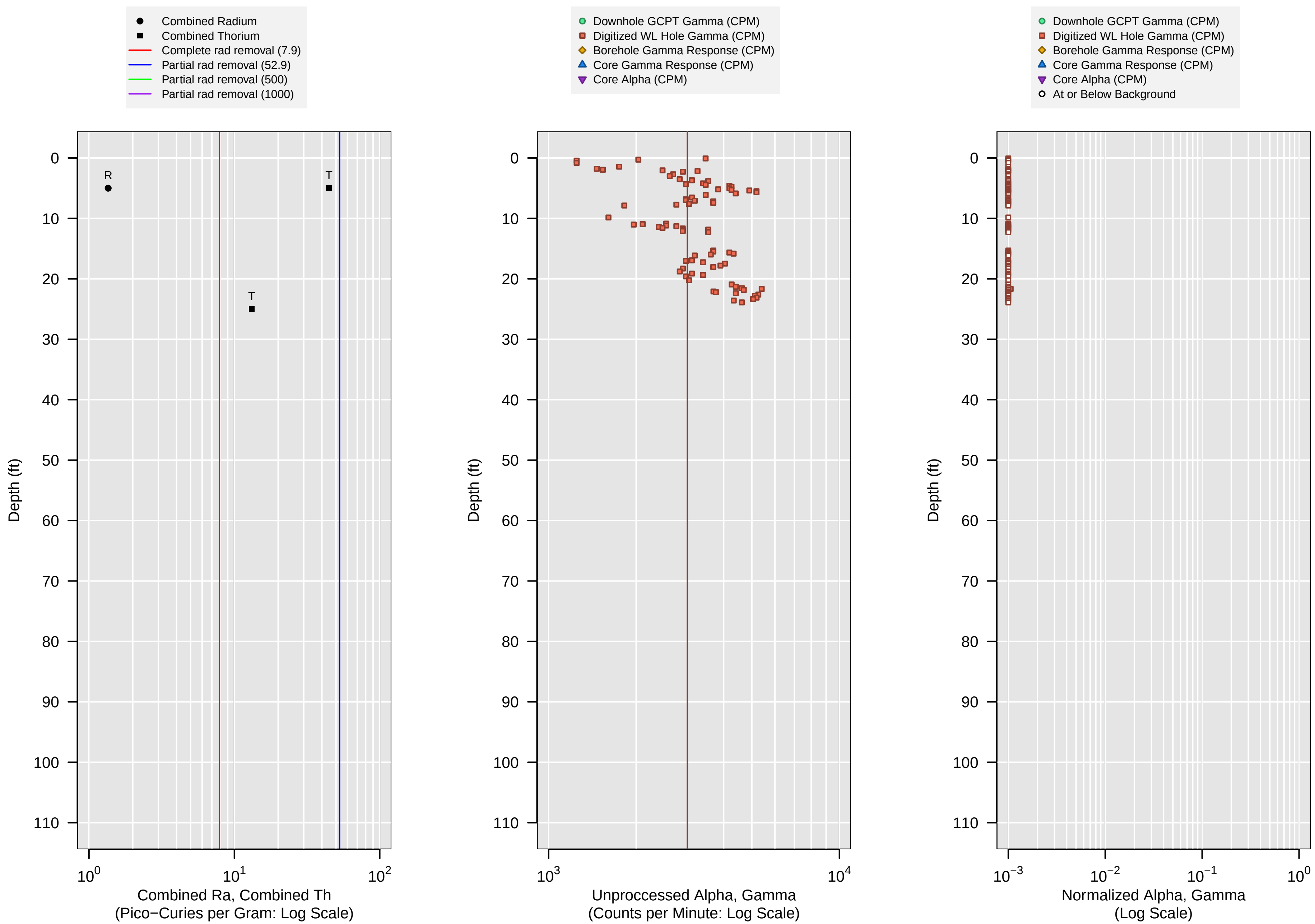
WL−213−MH





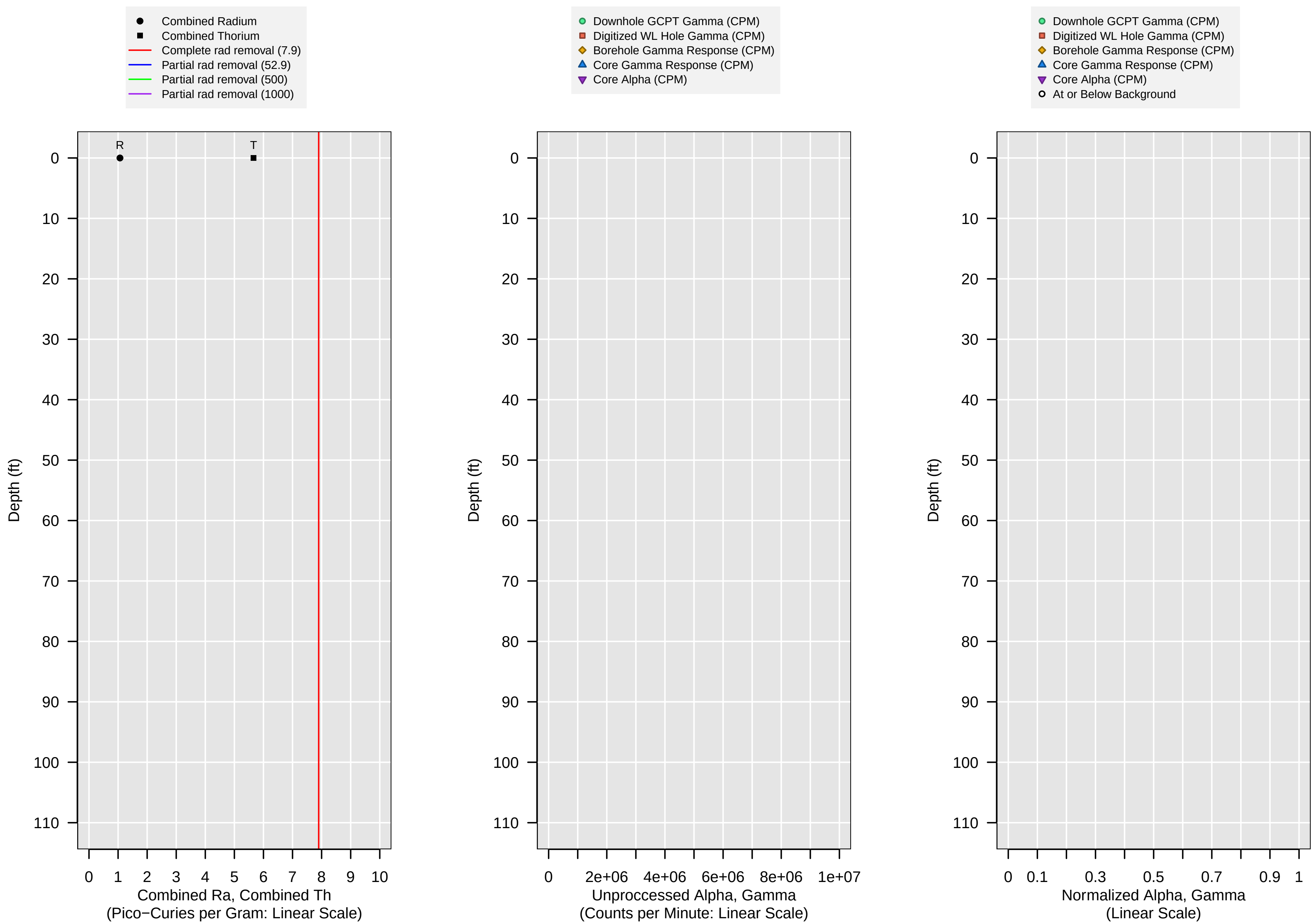
WL−214−MH
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−214−MH

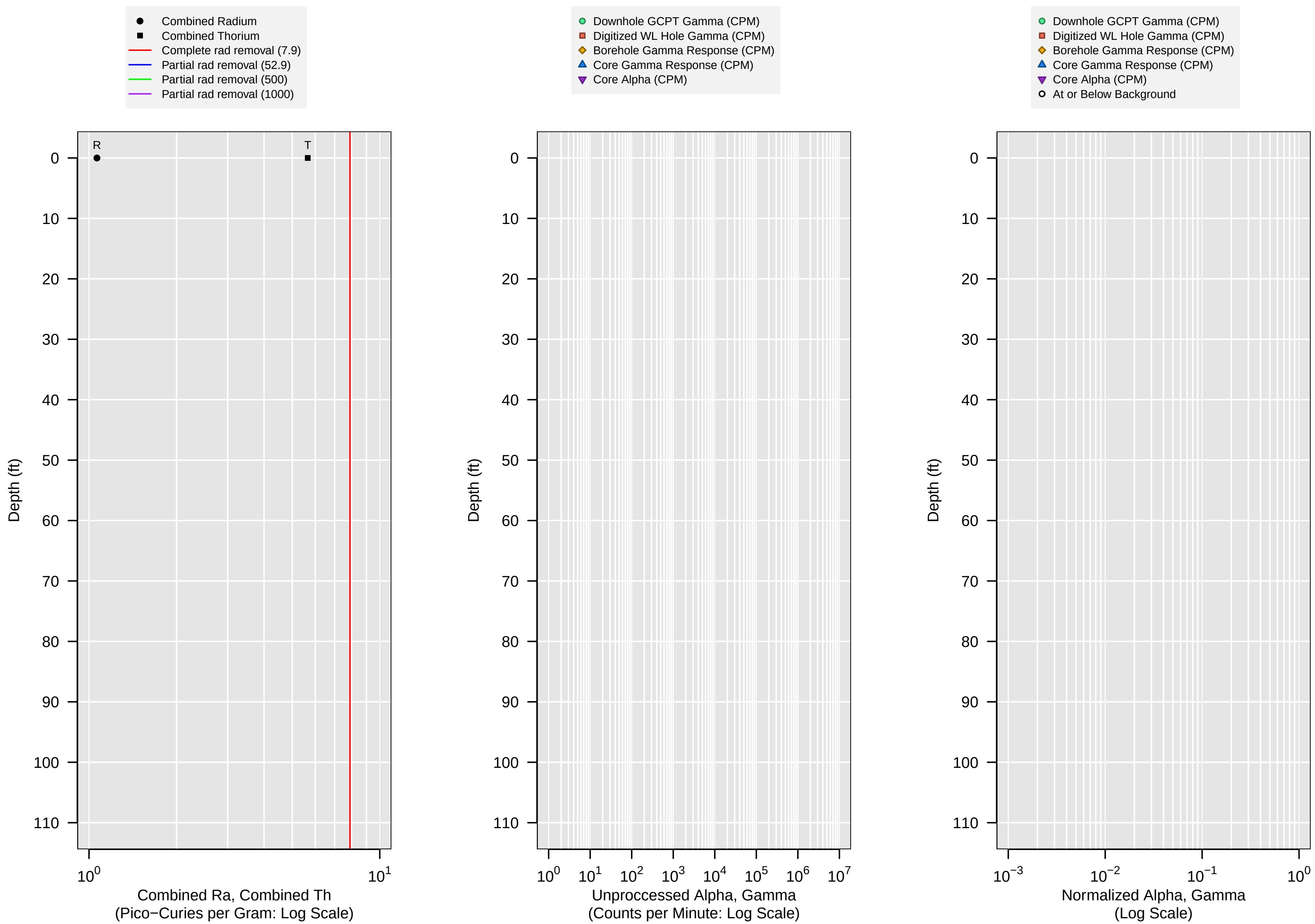


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

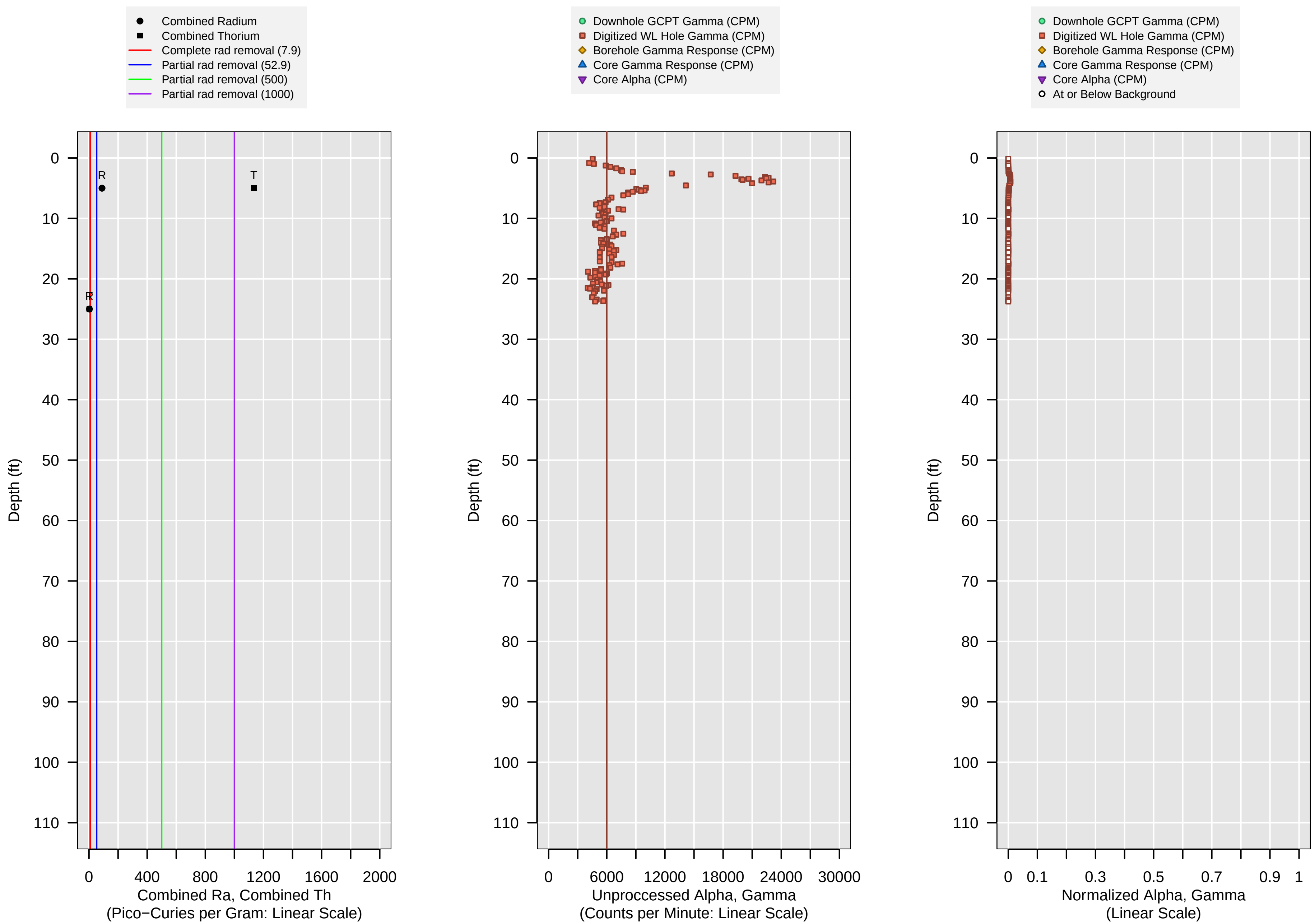
WL−215


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 1 2 3 4 5 6 7 8 9 10
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0 2e+06 4e+06 6e+06 8e+06 1e+07
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

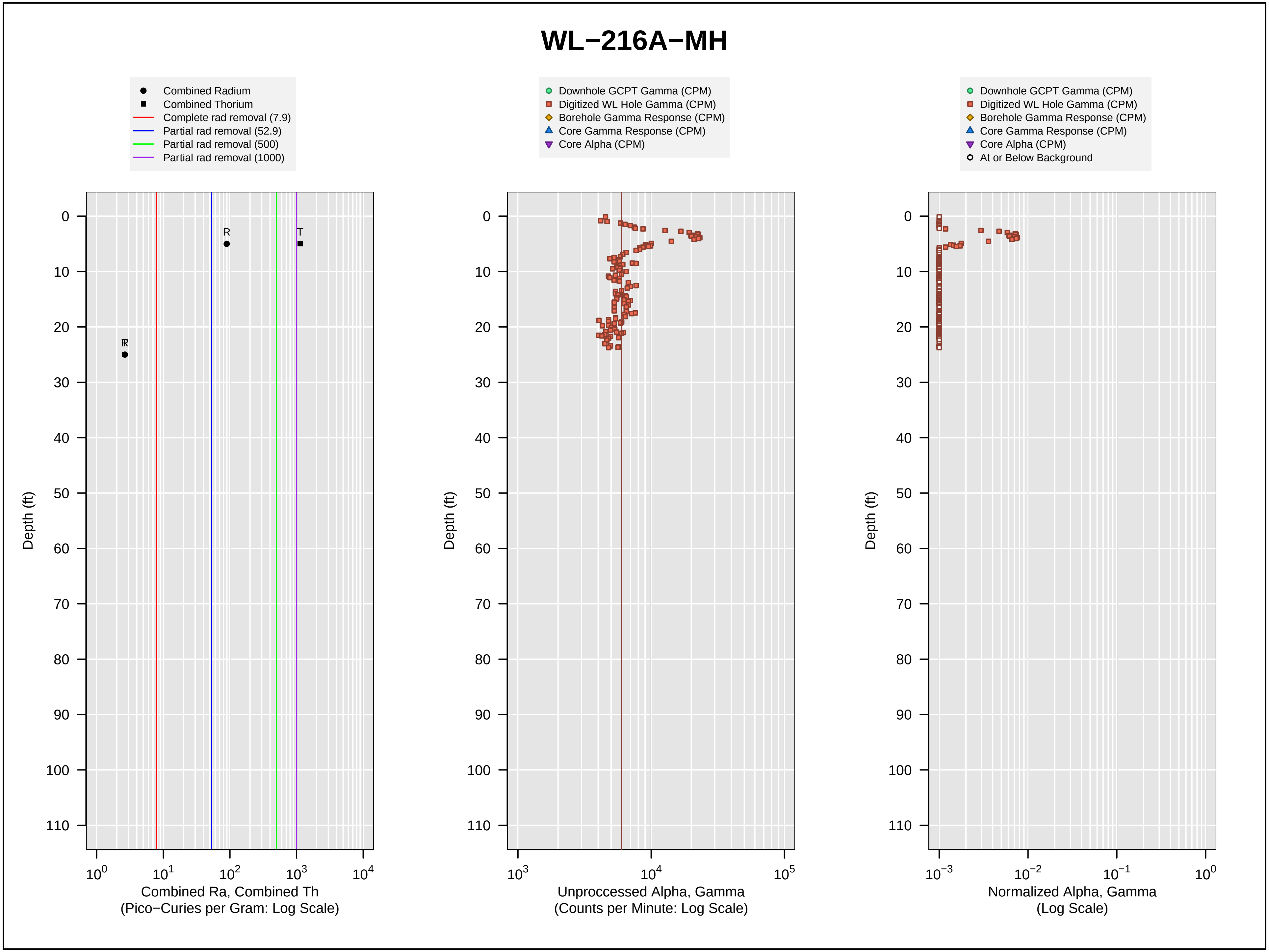
WL−215


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^0
10^1
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
10^0 10^1 10^2 10^3 10^4 10^5 10^6 10^7
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
10^{-3} 10^{-2} 10^{-1} 10^0
Normalized Alpha, Gamma
(Log Scale)

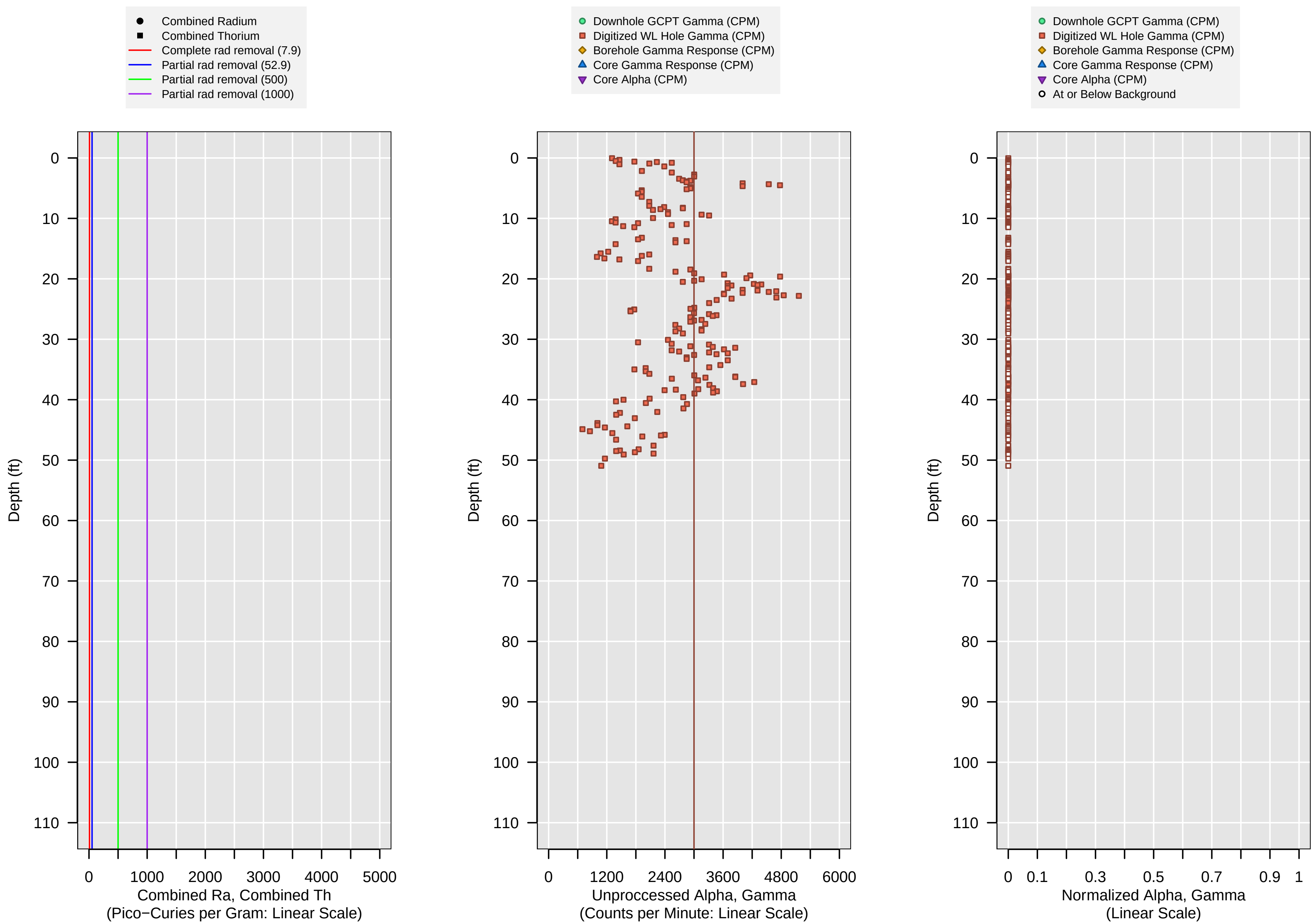
WL−216A−MH



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
R
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

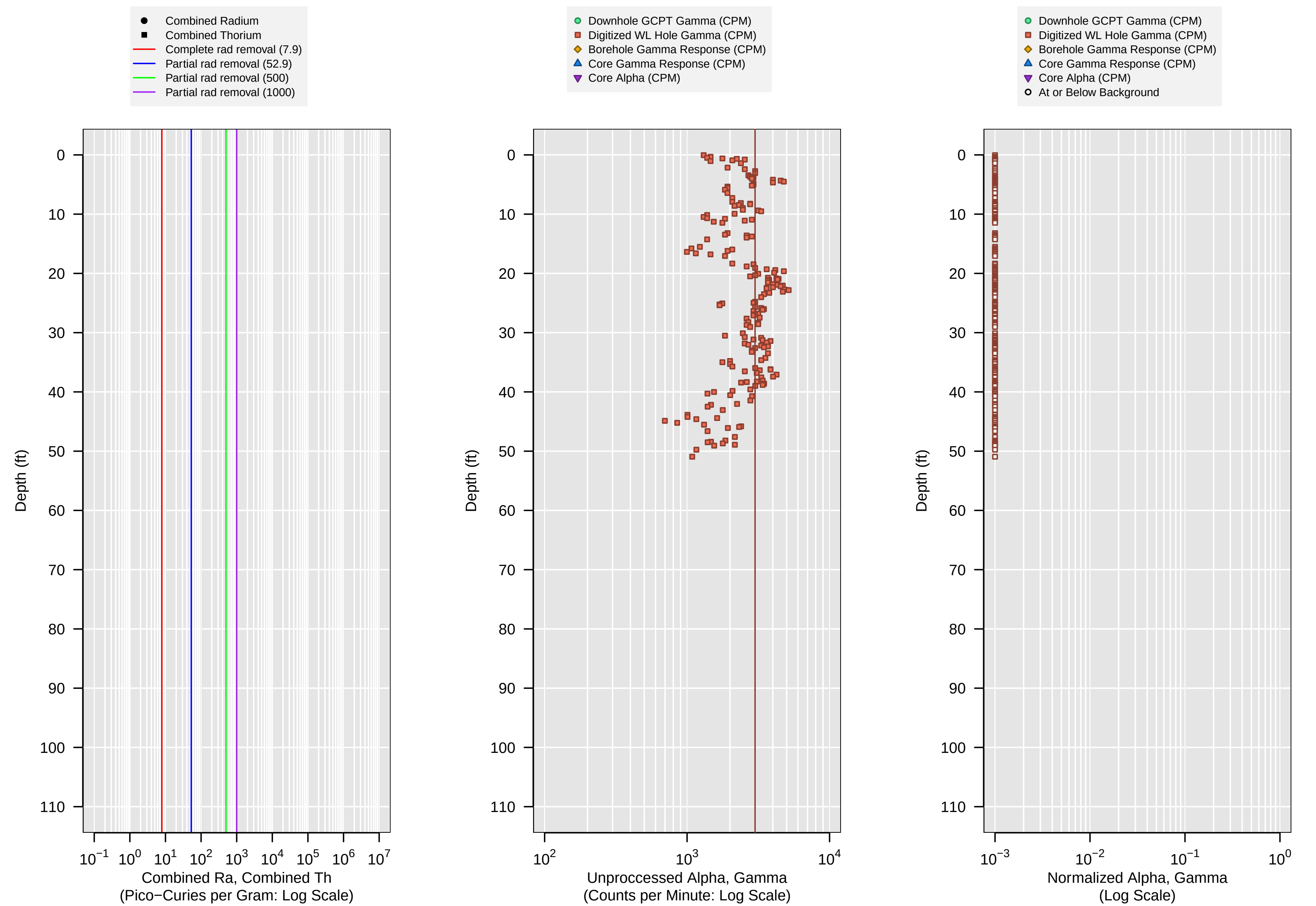

WL−216A−MH
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−216B−MH



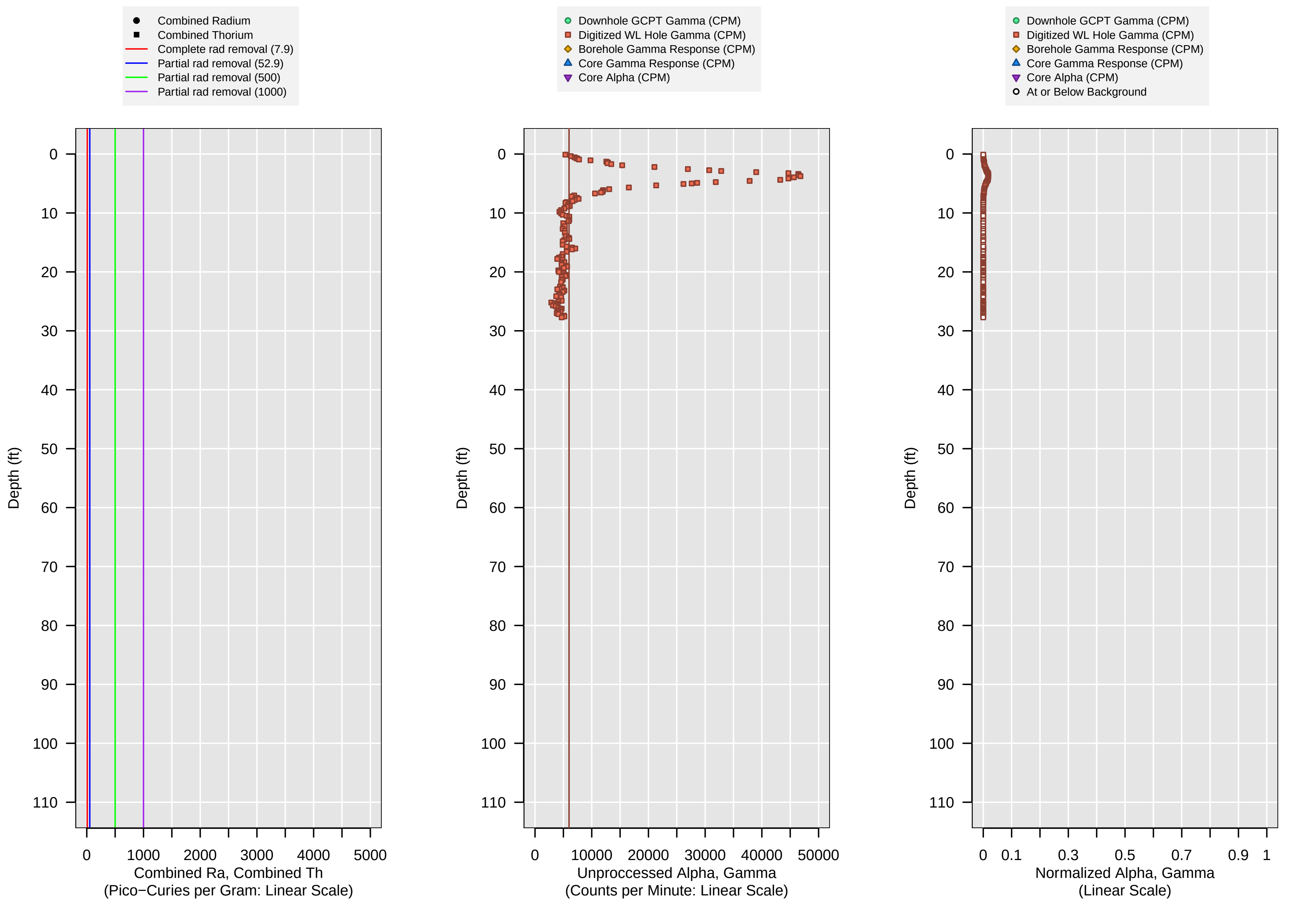
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0
1200
2400
3600
4800
6000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

WL−216B−MH

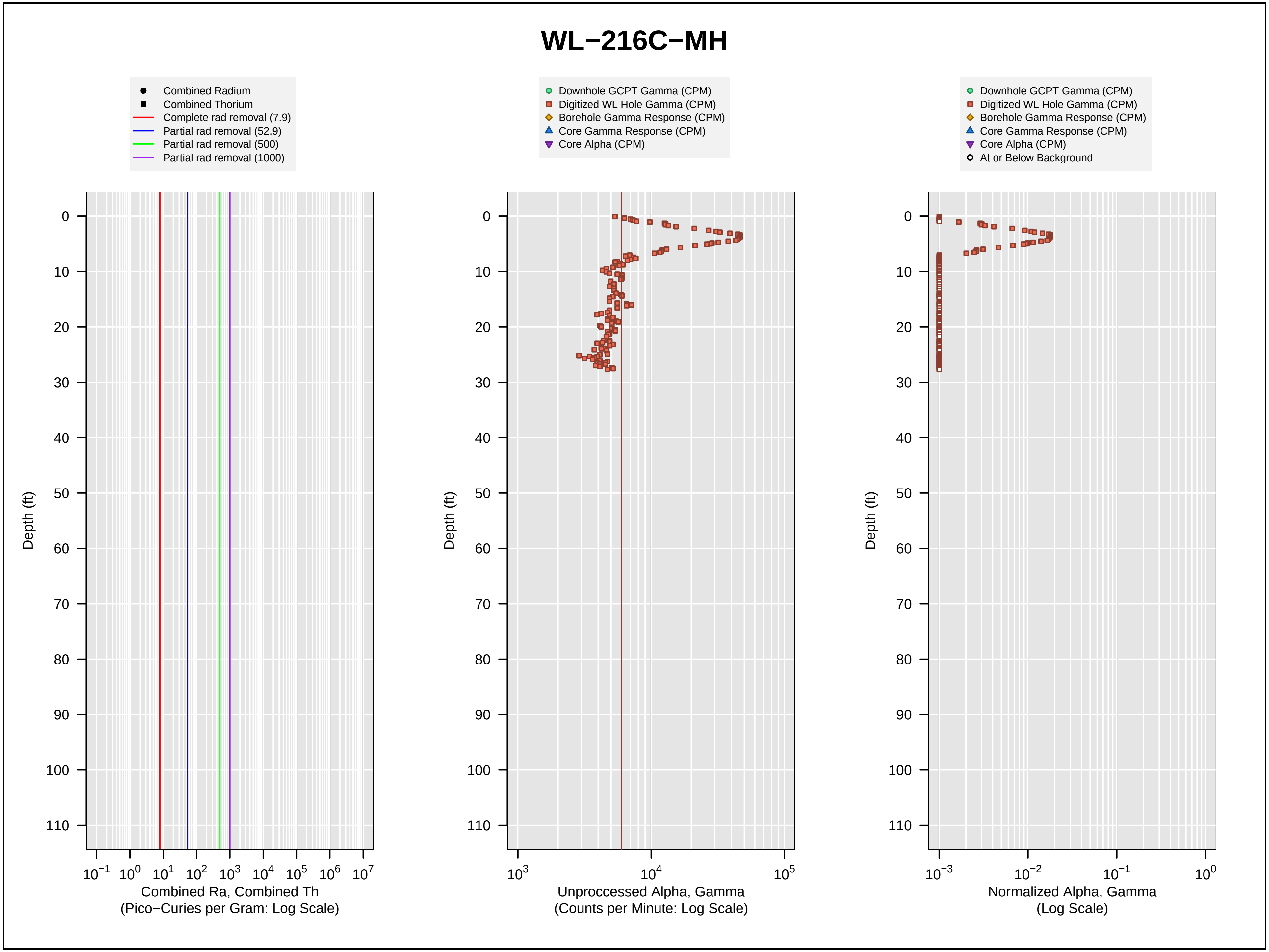


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

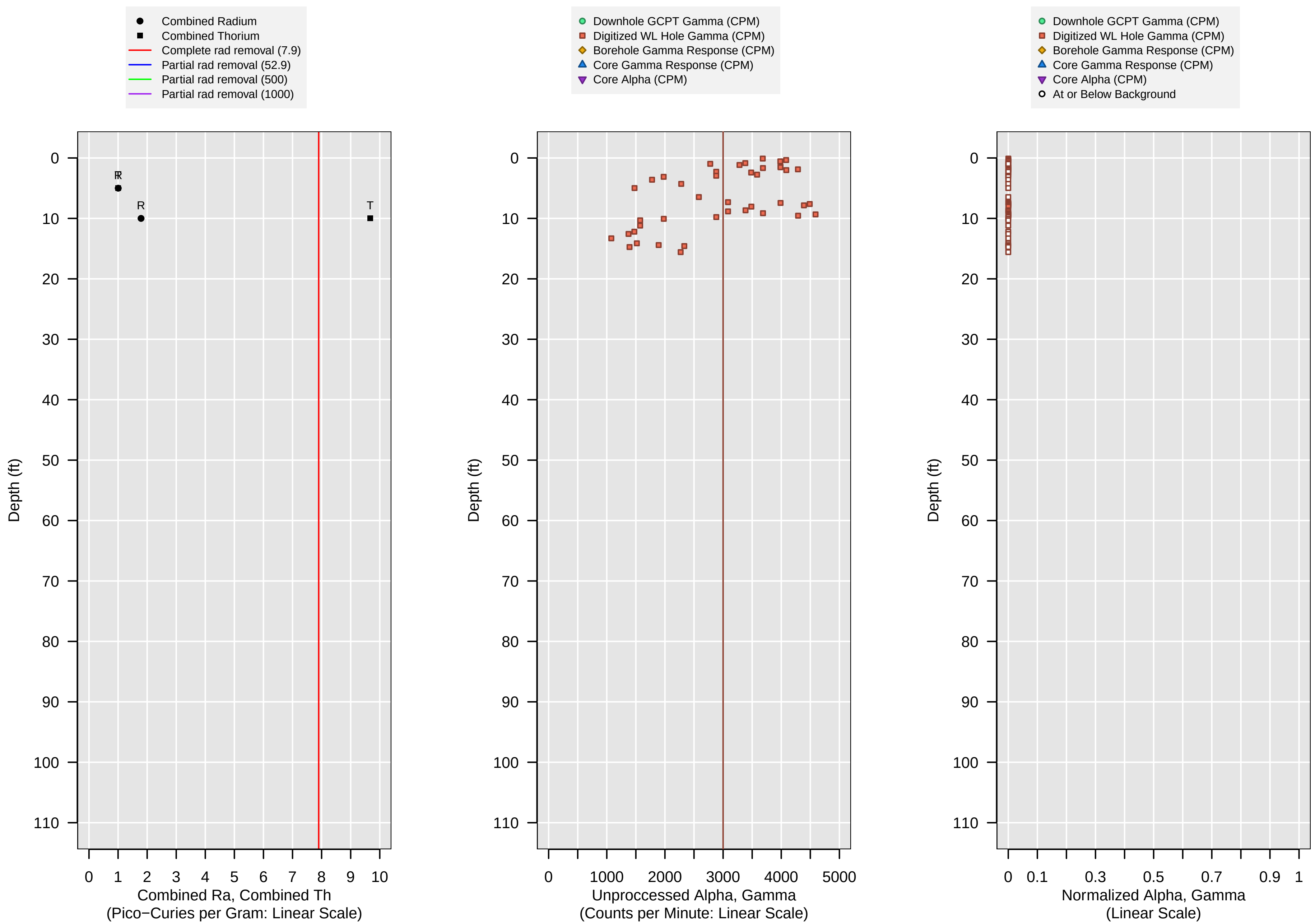
WL−216C−MH



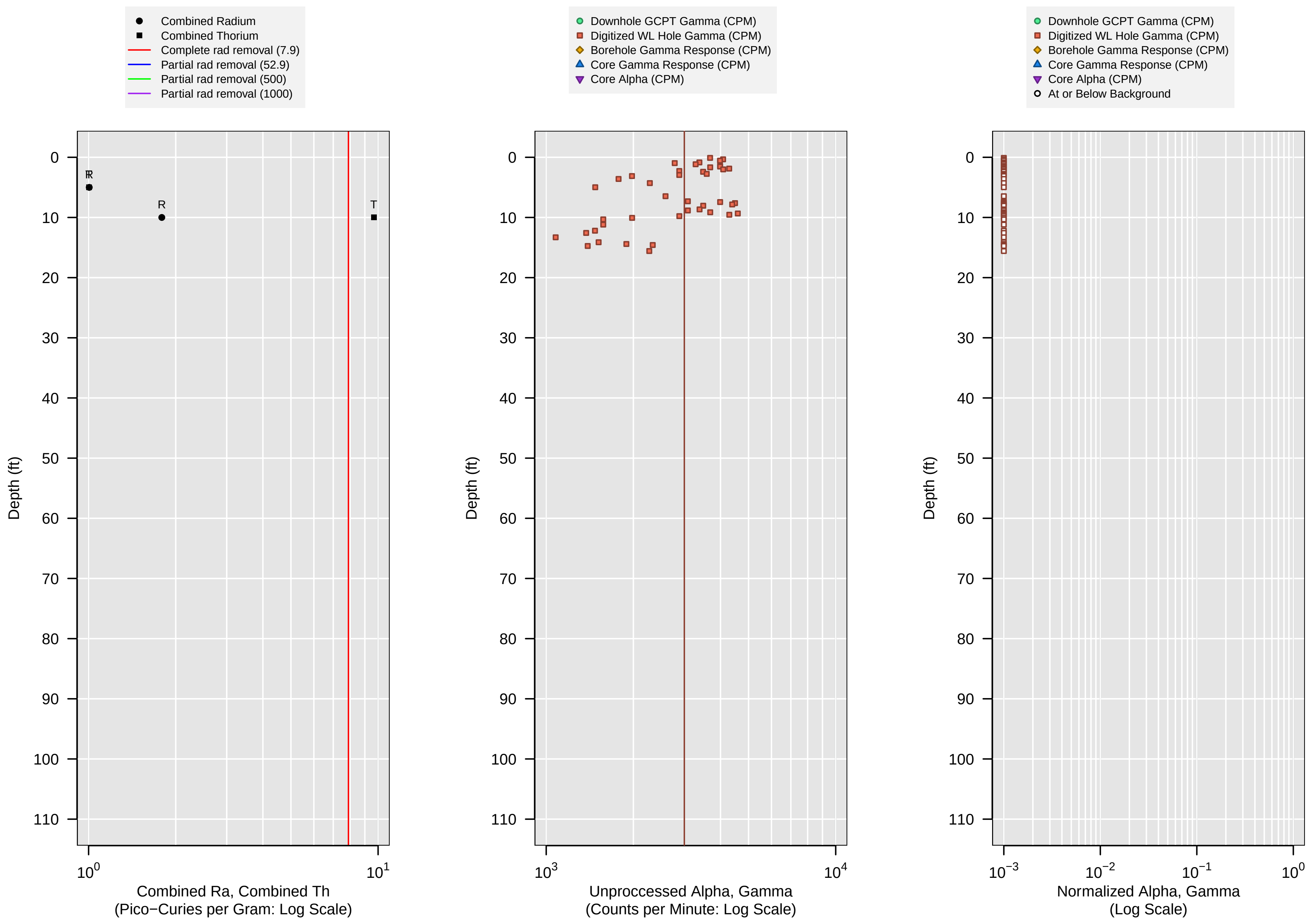
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Linear Scale)


WL−216C−MH
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

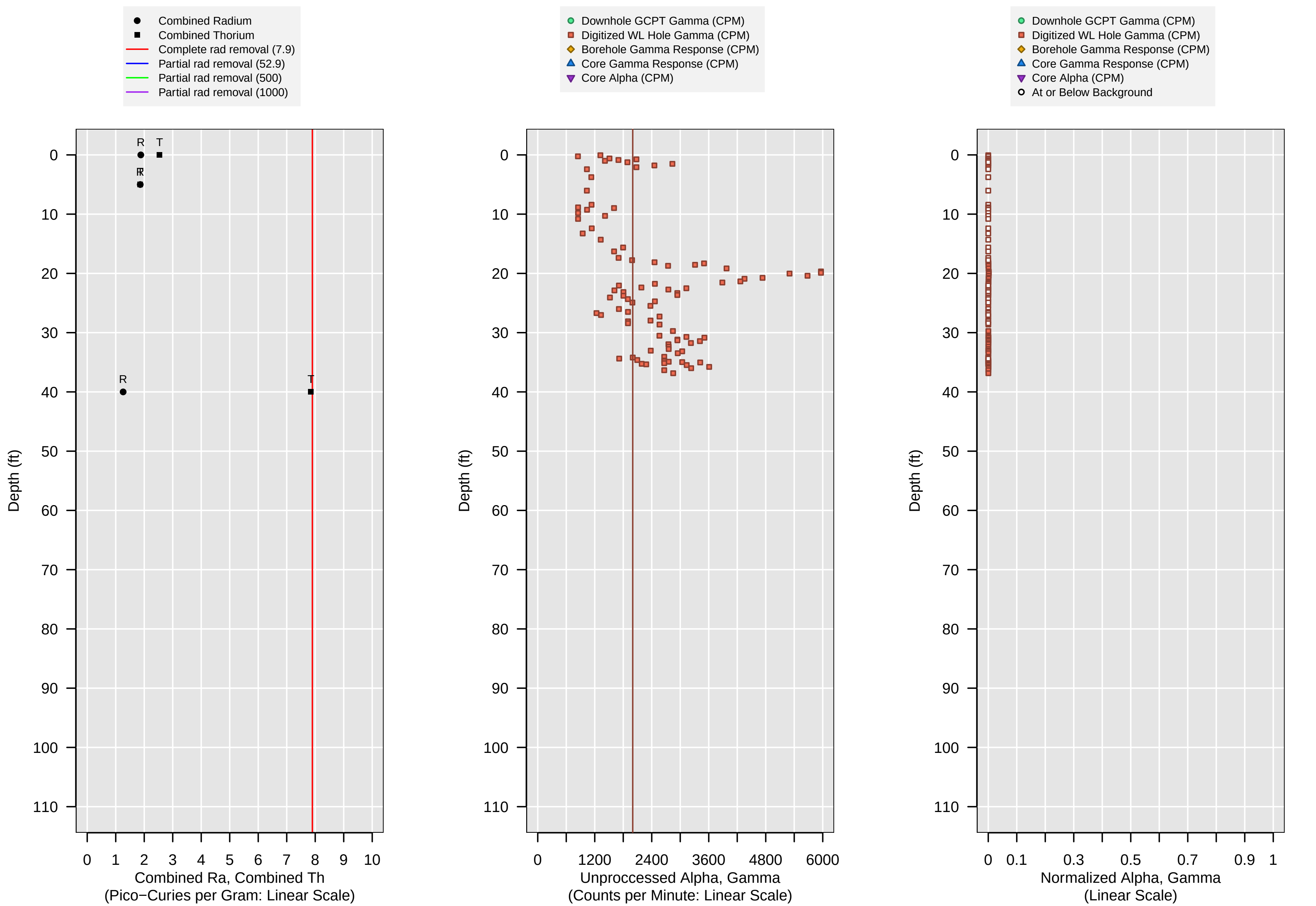
WL−217−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−217−MH

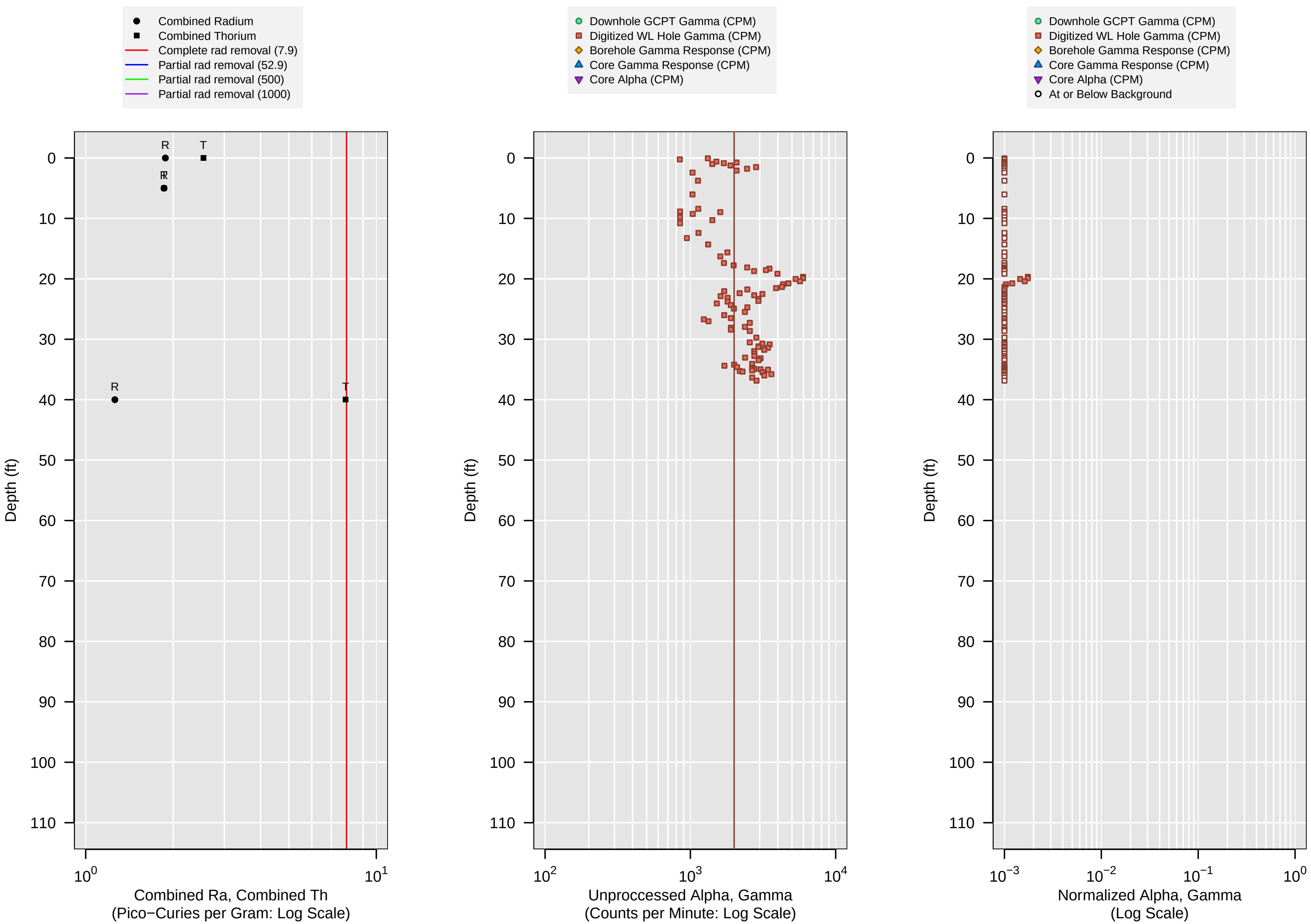

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−218−MH

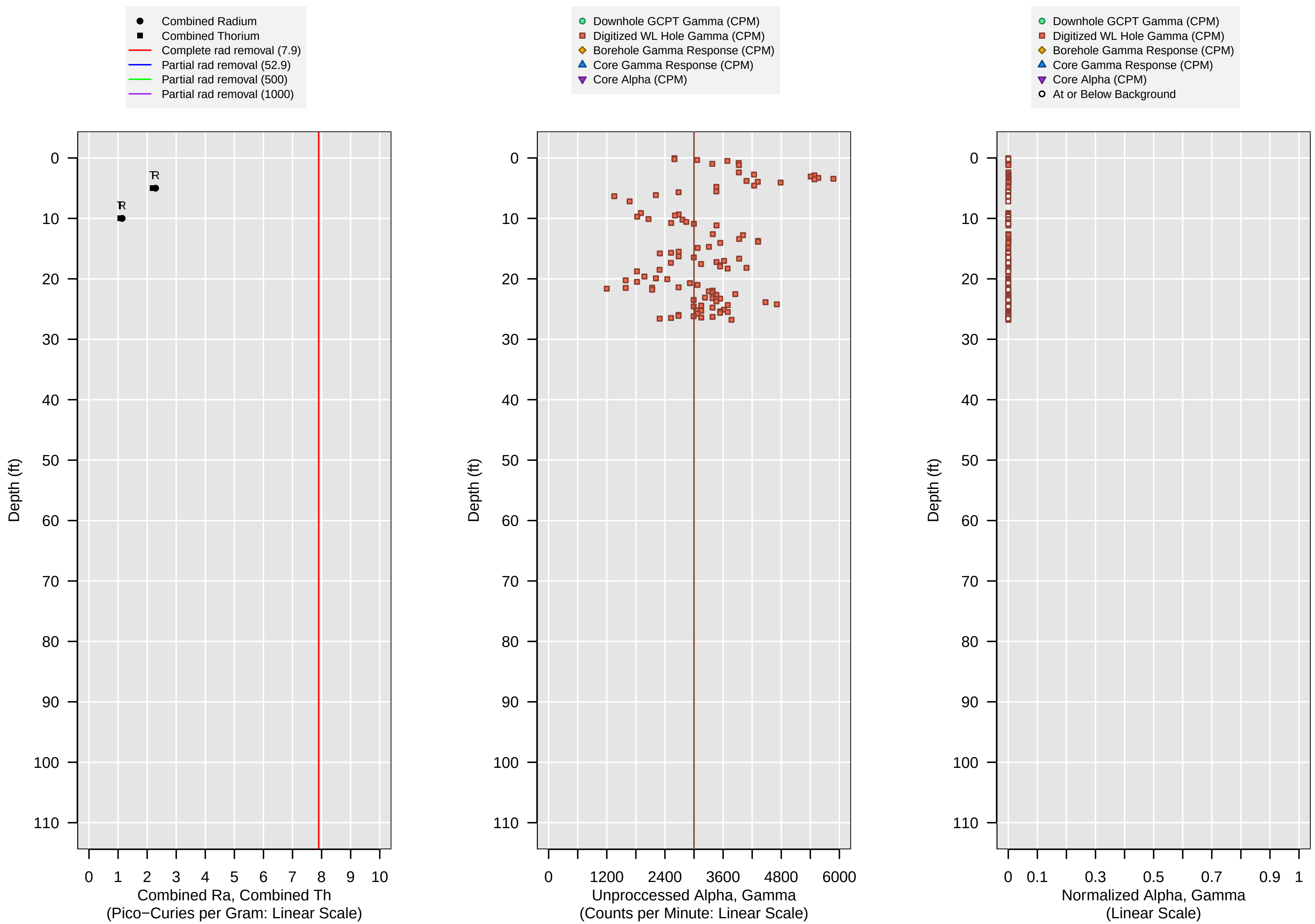


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

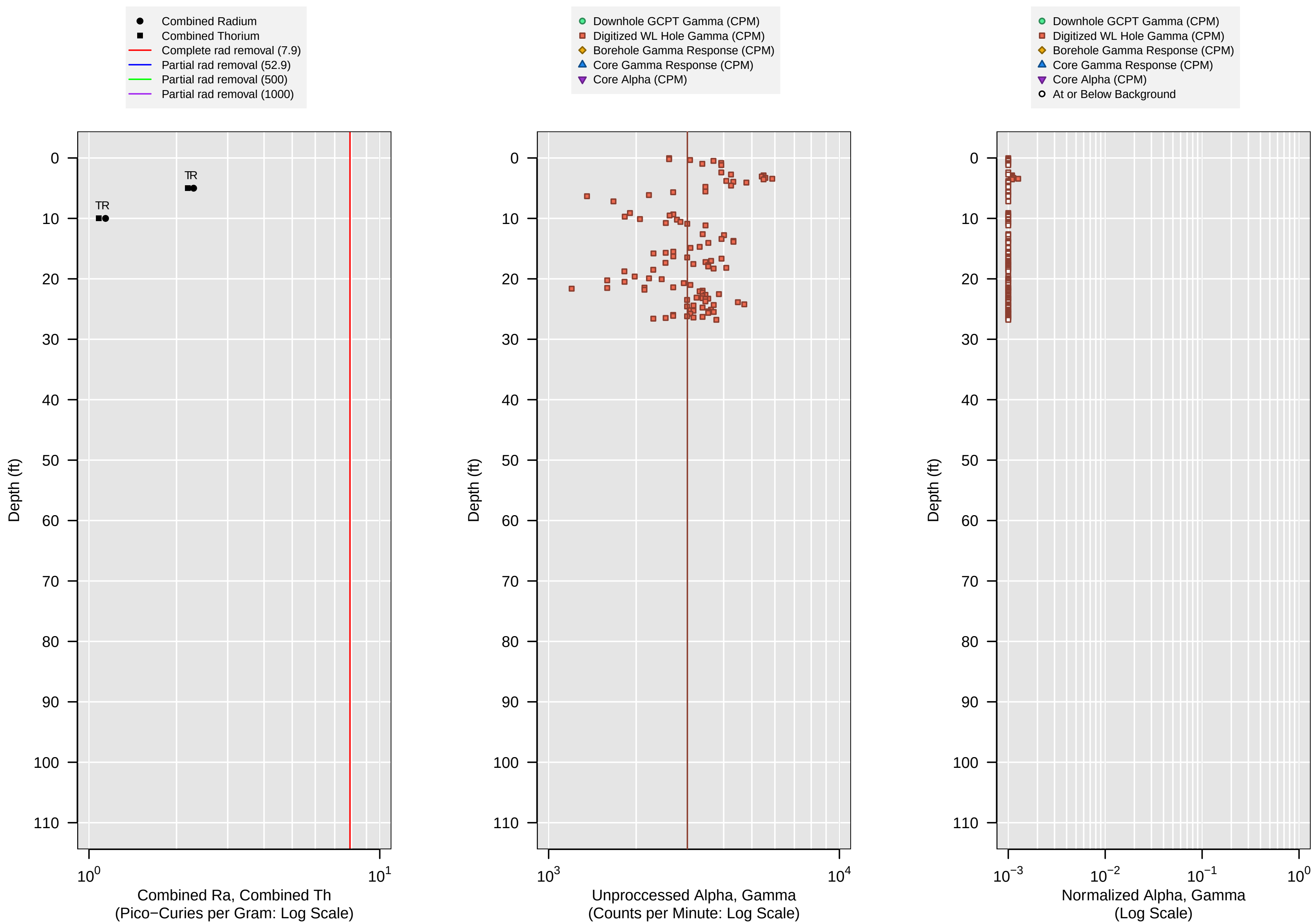
WL−218−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−219A−MH

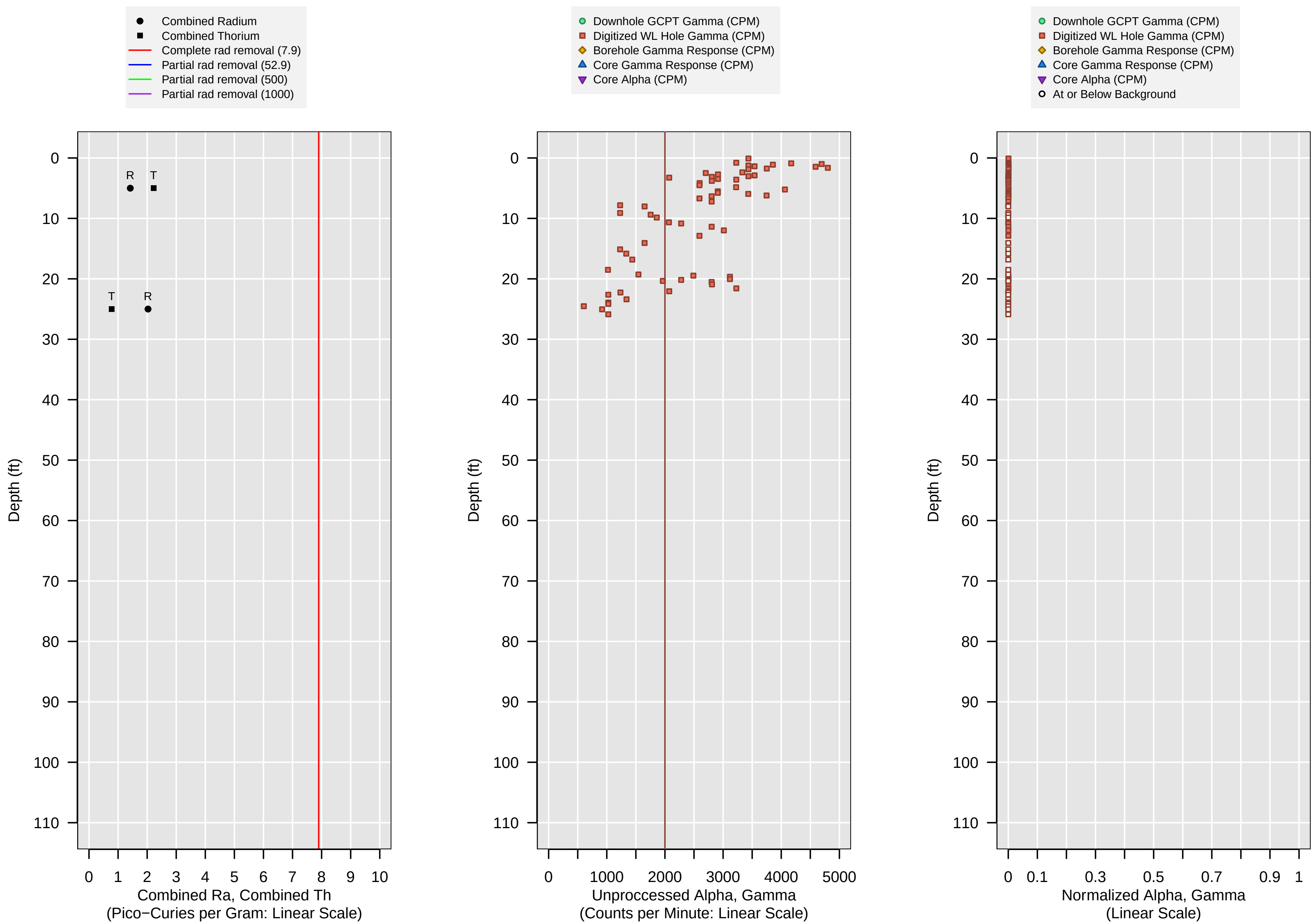

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−219A−MH



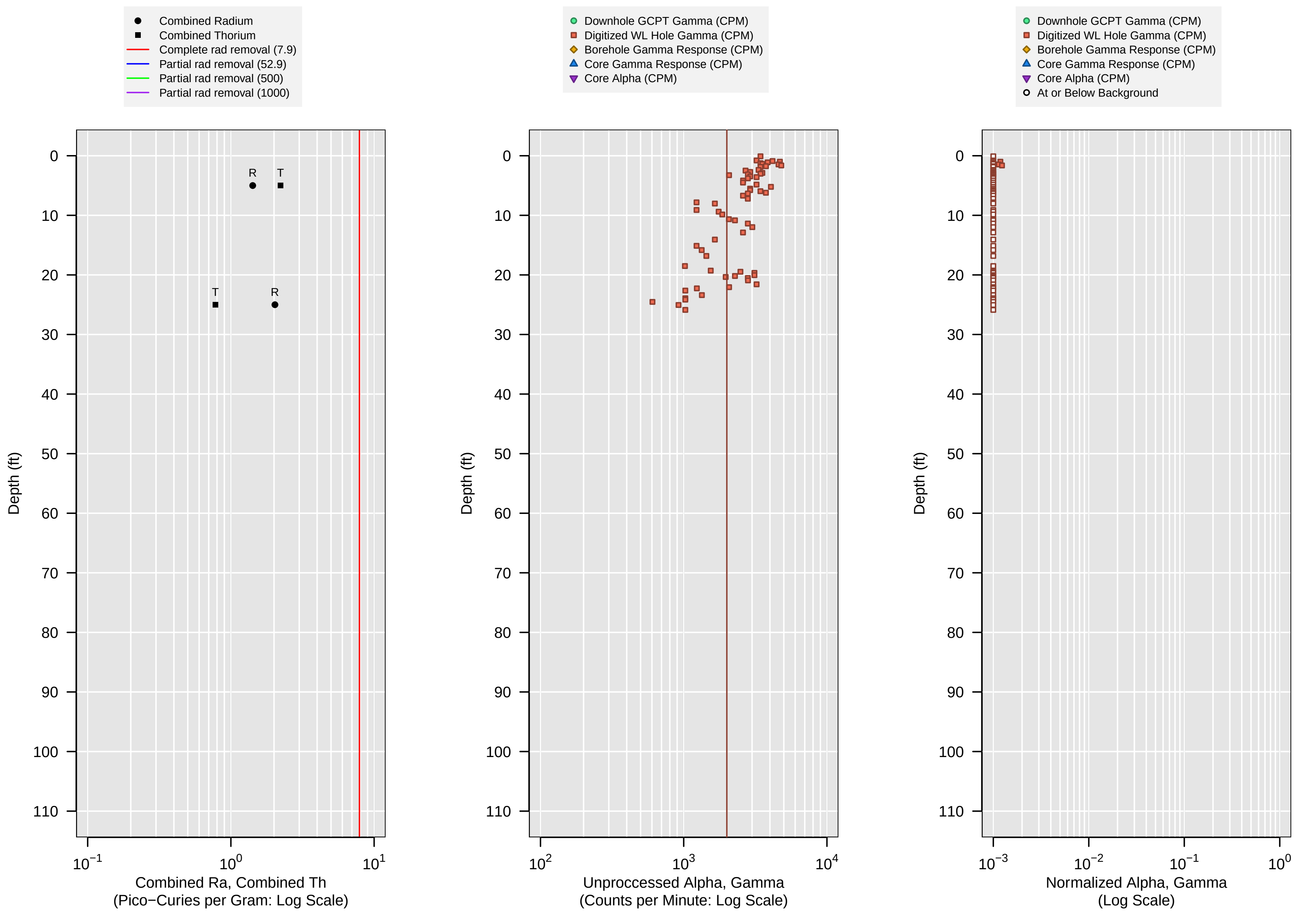
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
TR
TR
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−220−MH

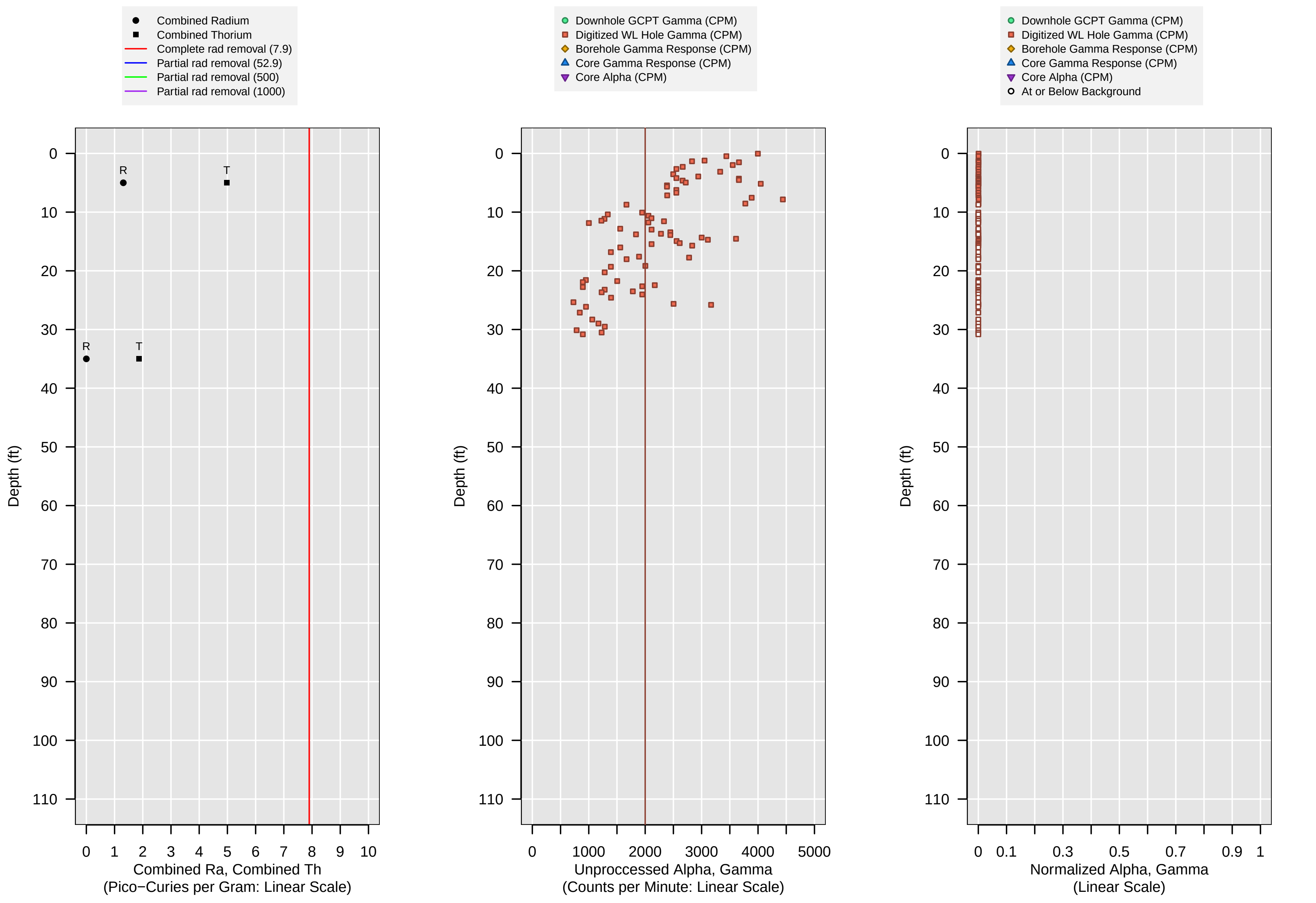


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−220−MH

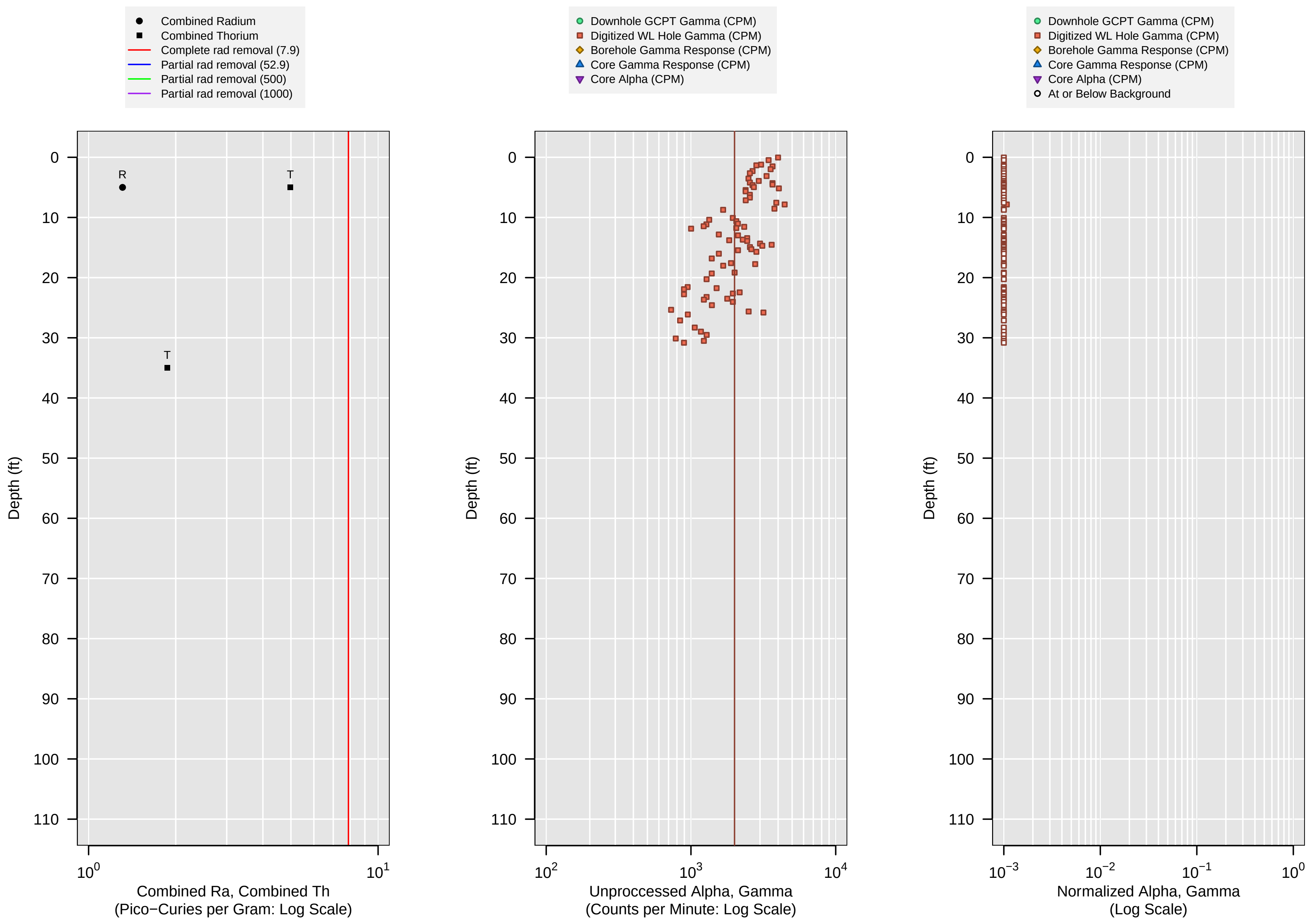

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−221−MH



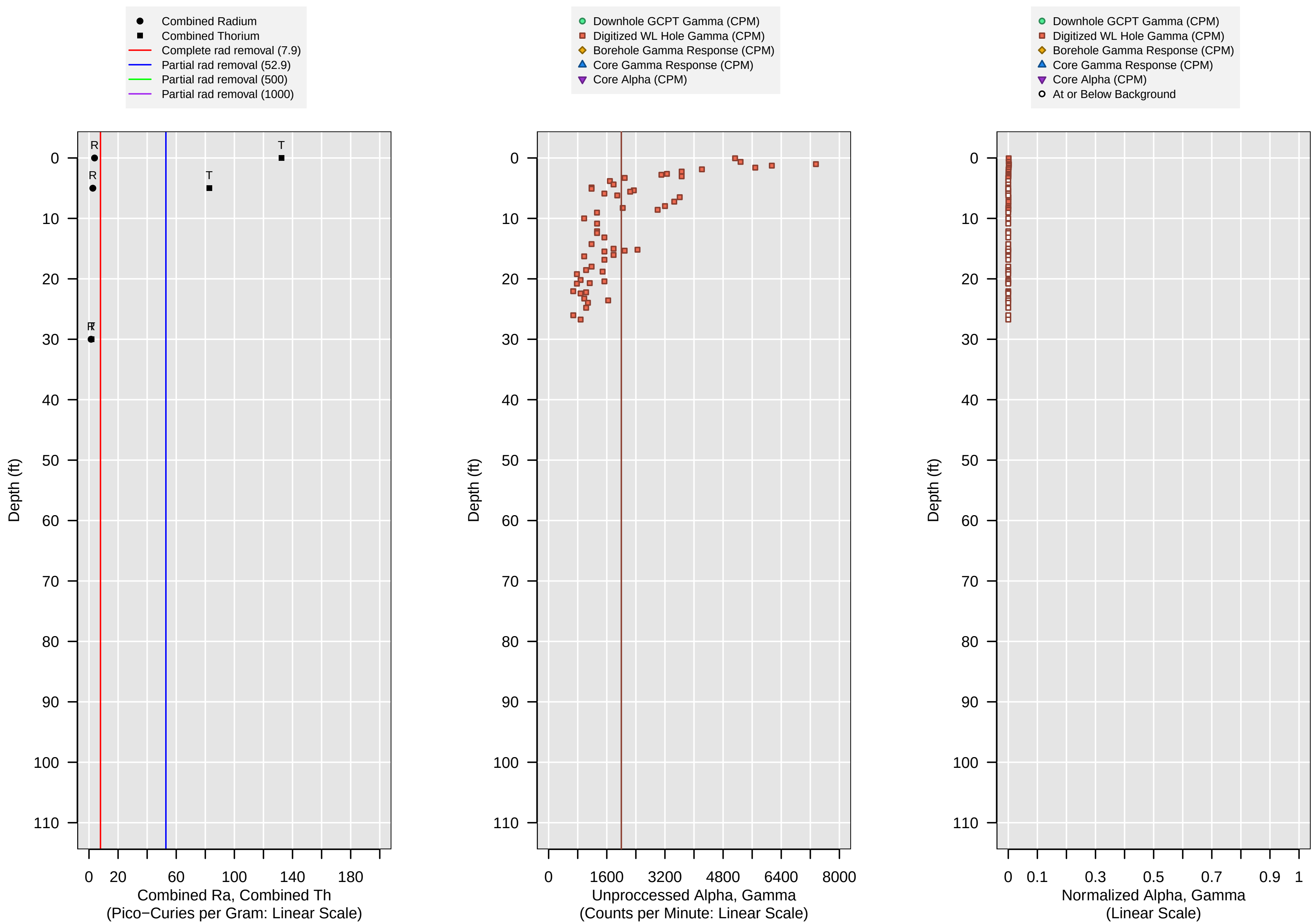
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−221−MH

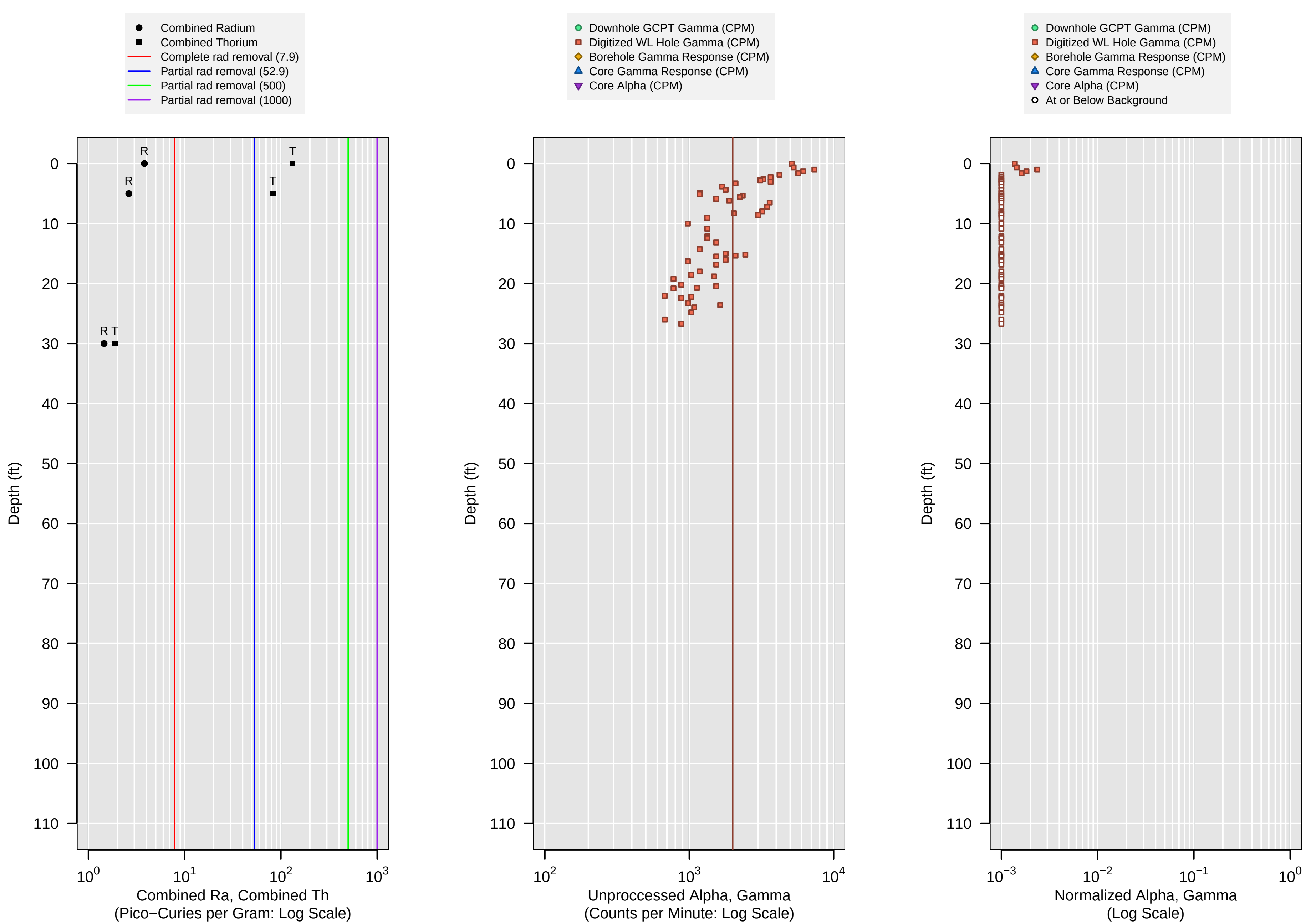


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

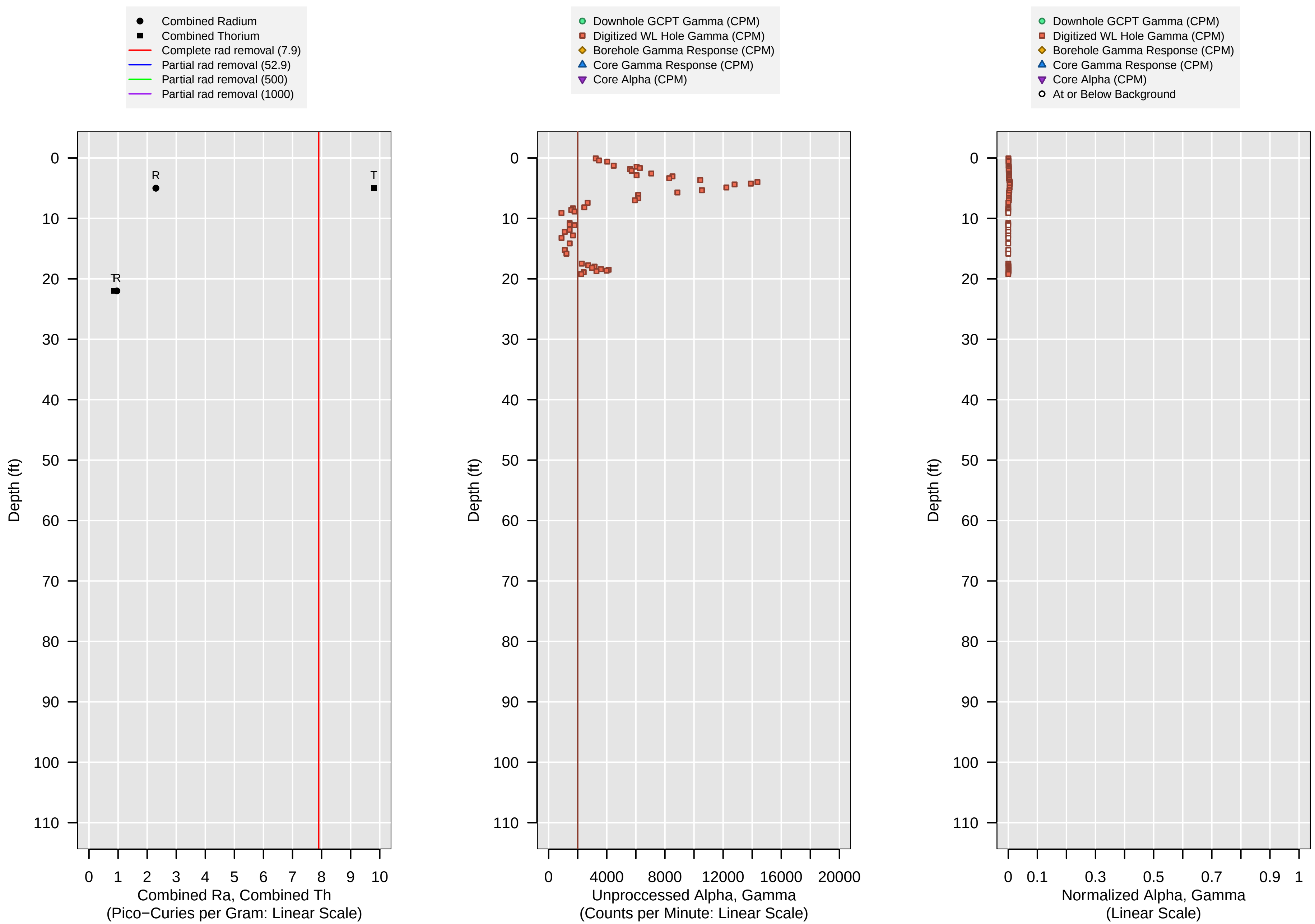
WL−222−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

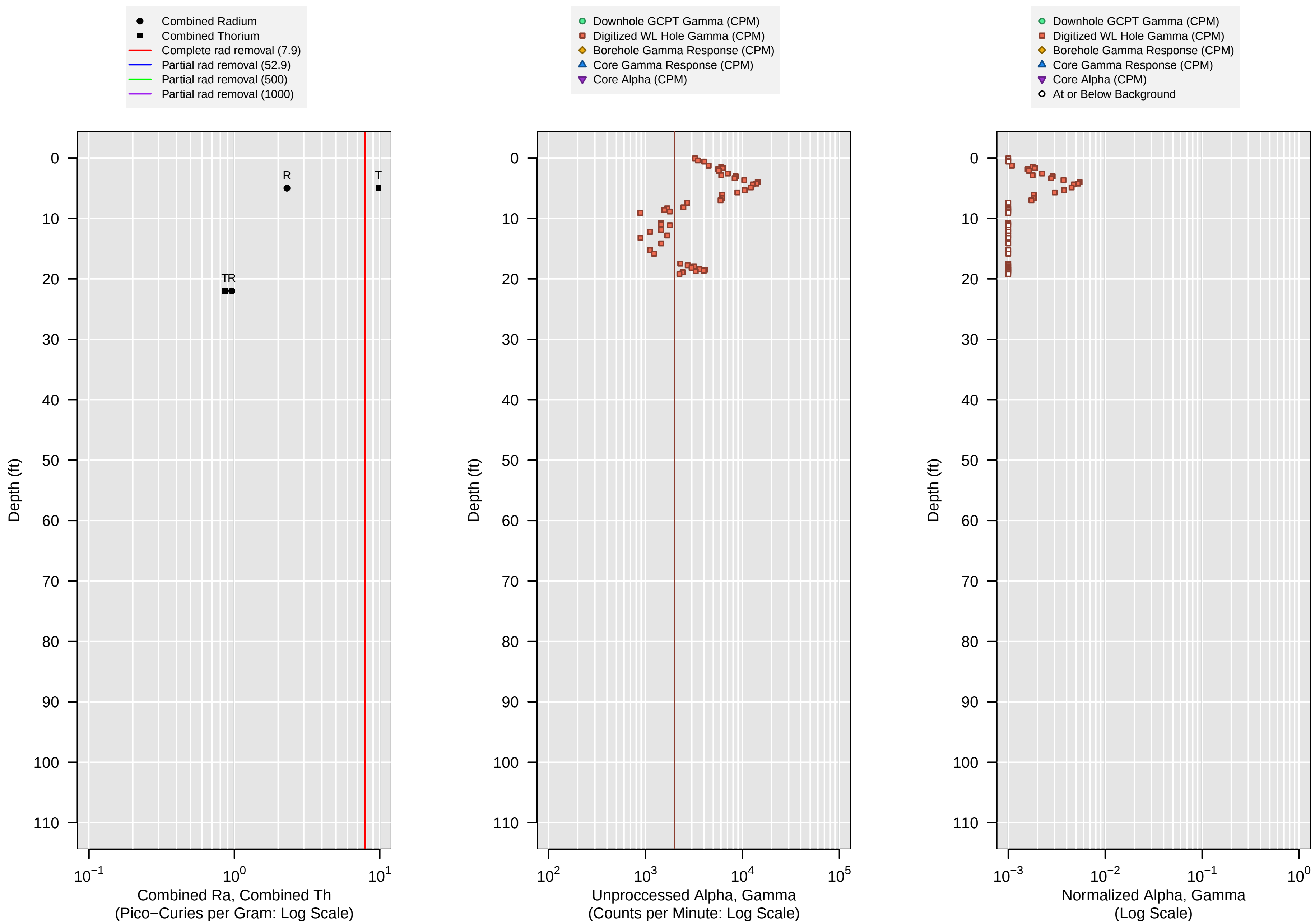
WL−222−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
R T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

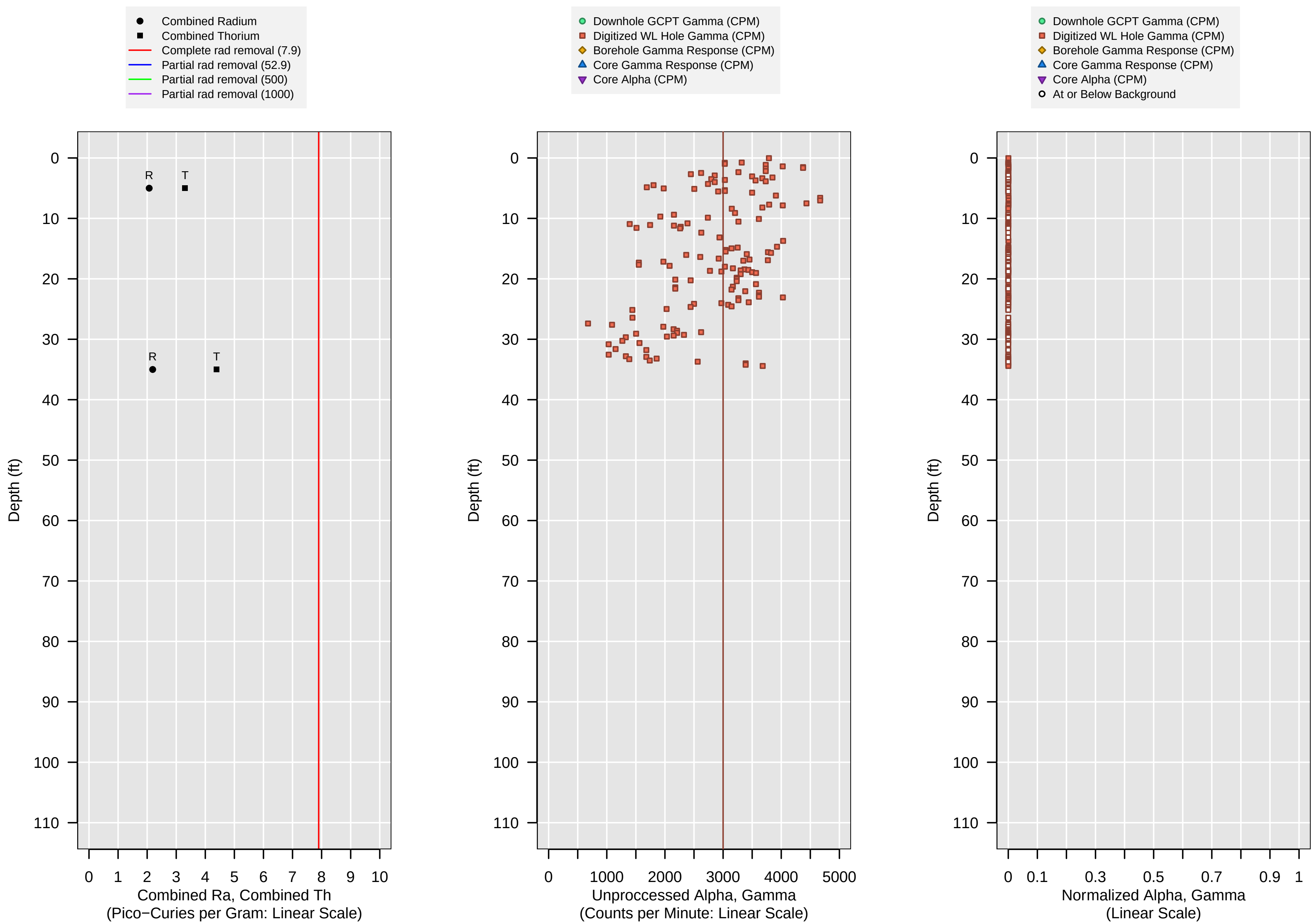
WL−223−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
R
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−223−MH

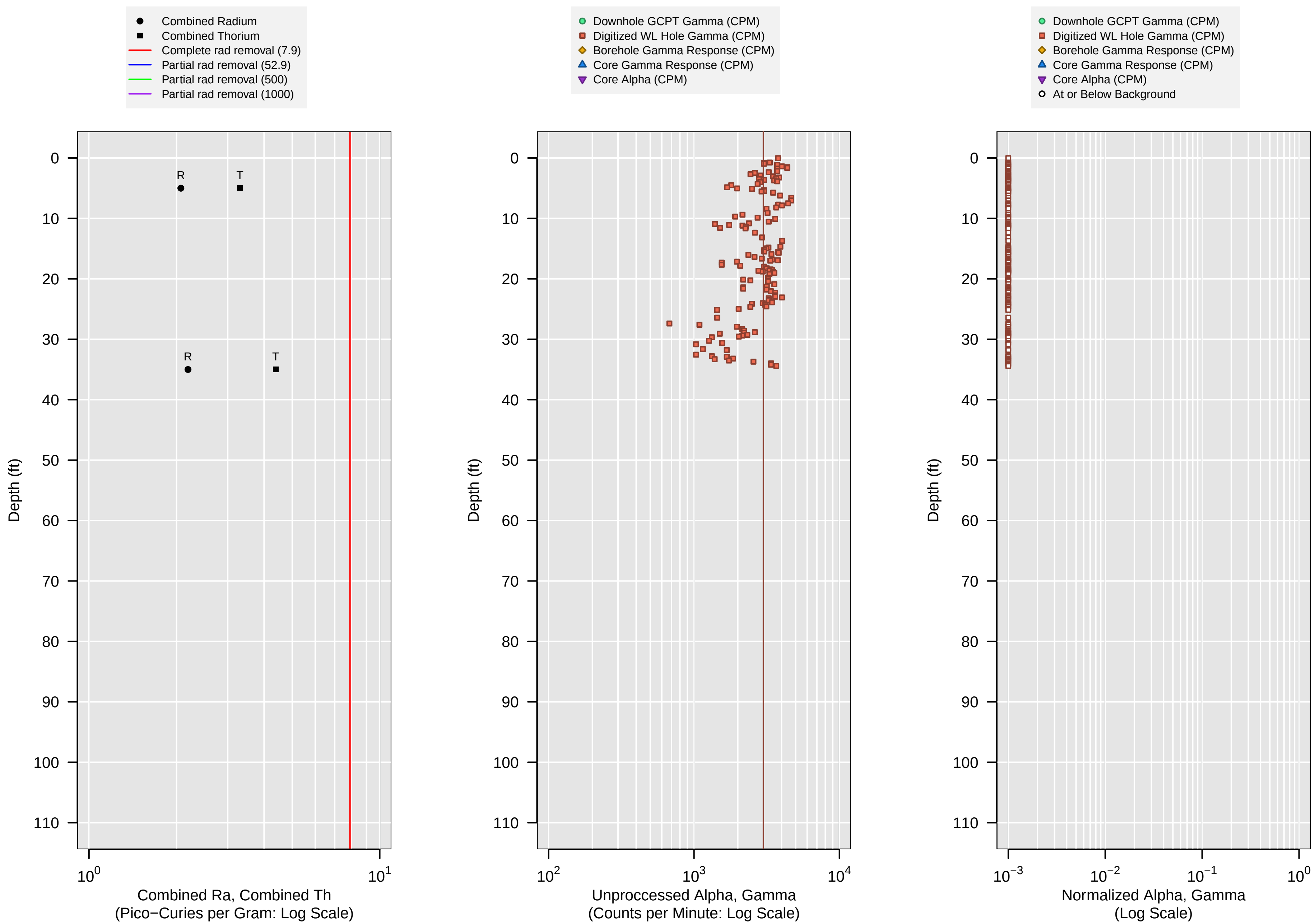

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
TR
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−224−MH

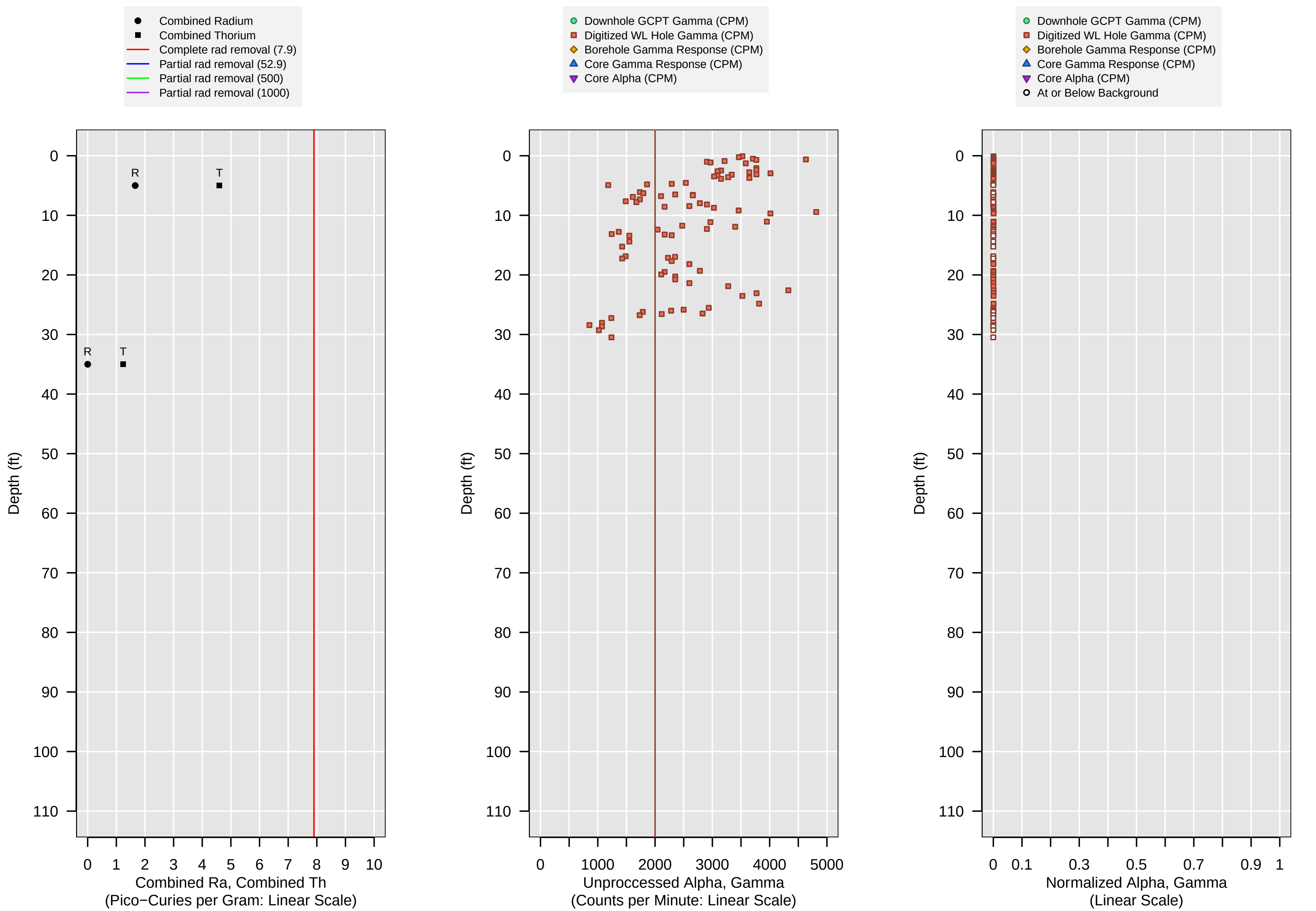


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−224−MH

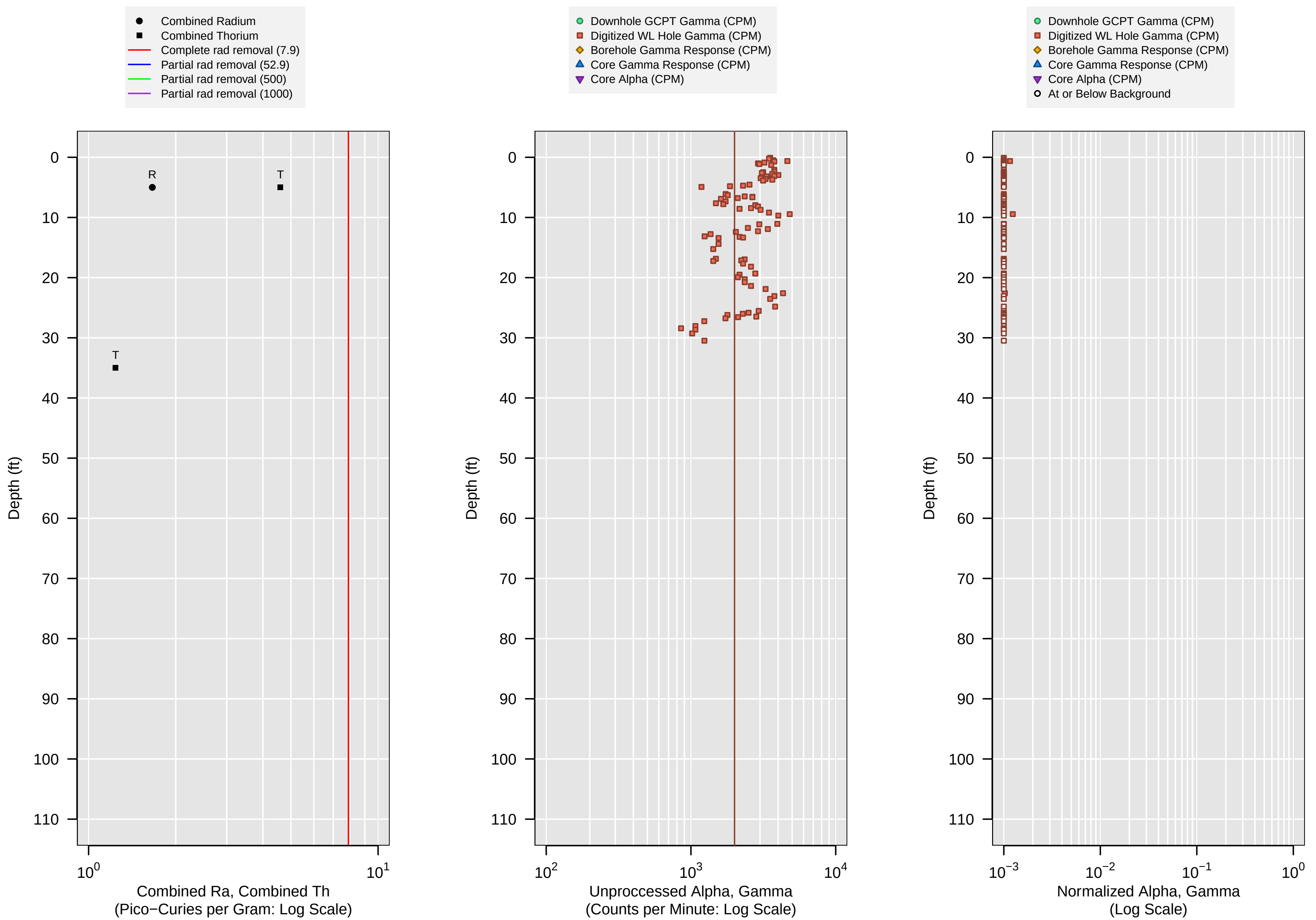

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

WL−225−MH



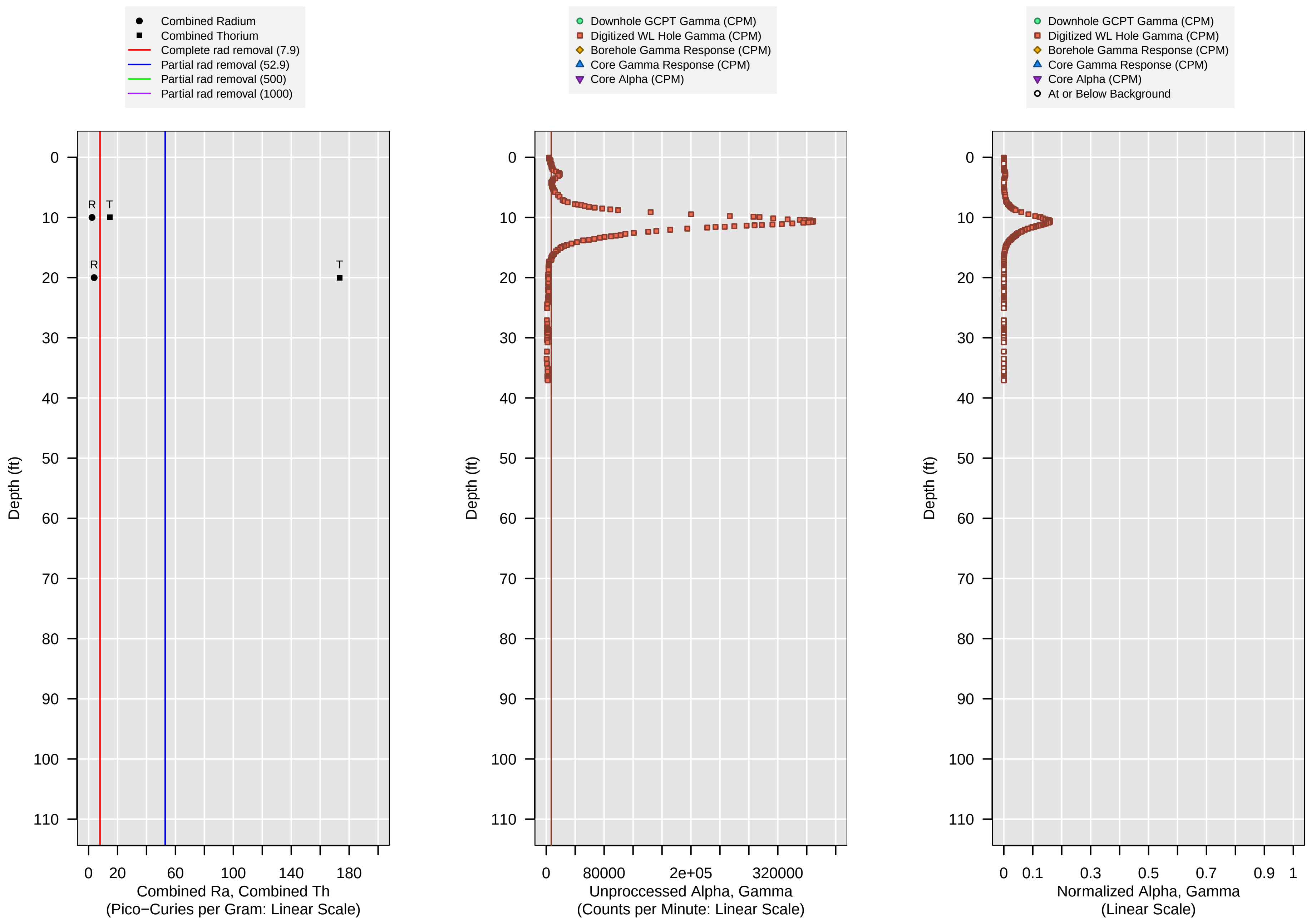
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−225−MH



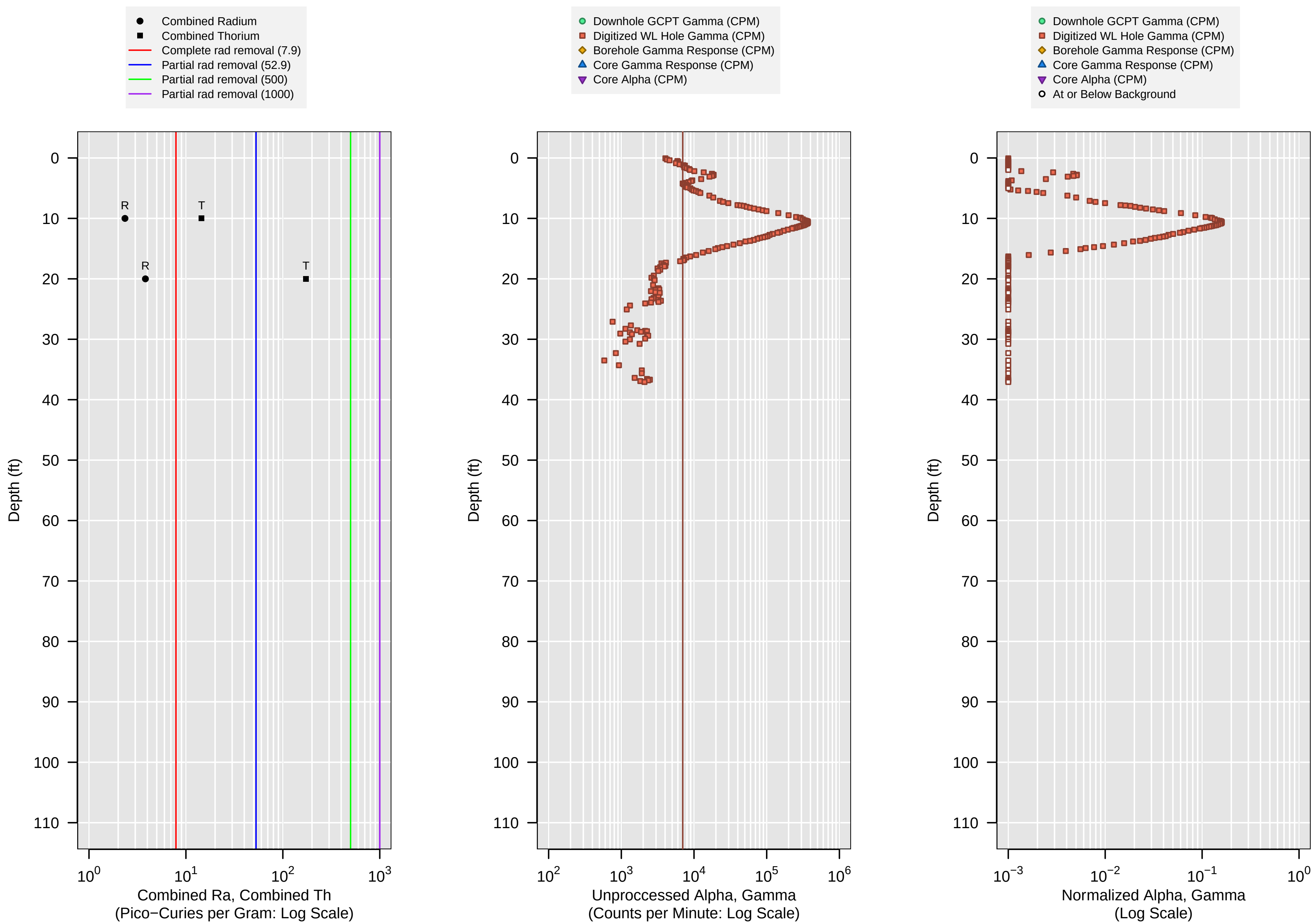
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−226−MH

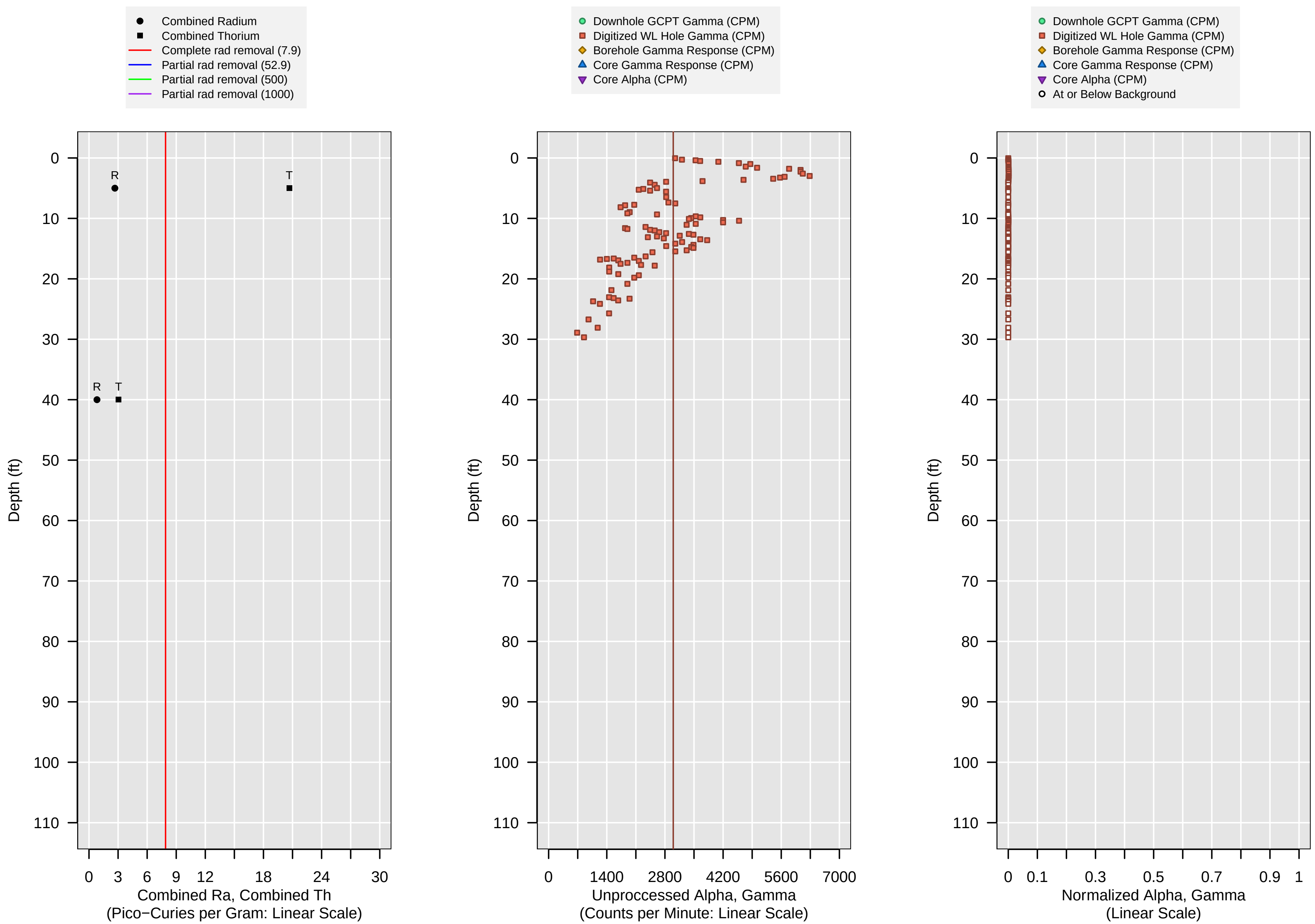


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
R
T
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 20 60 100 140 180
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0 80000 2e+05 320000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

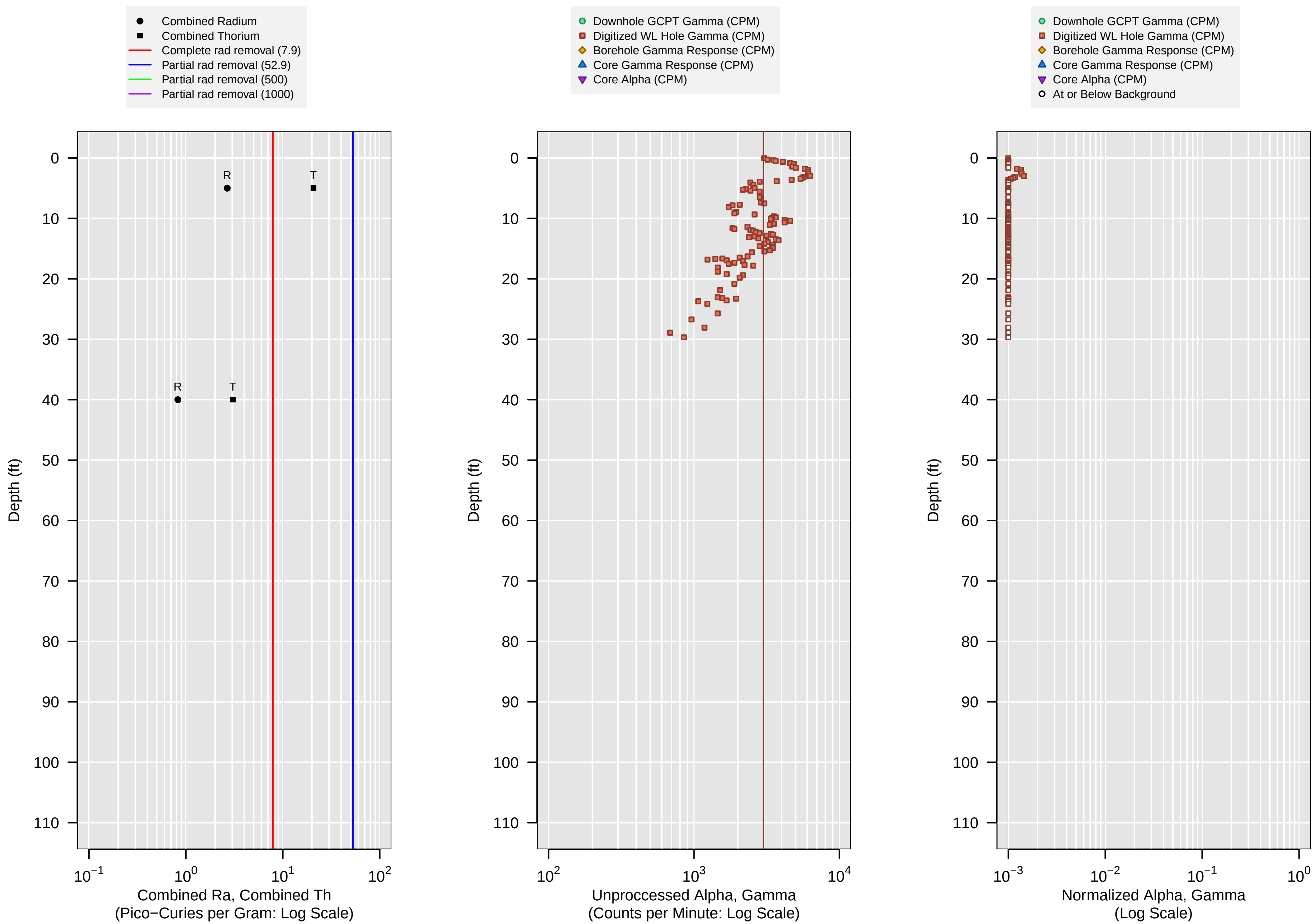
WL−226−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

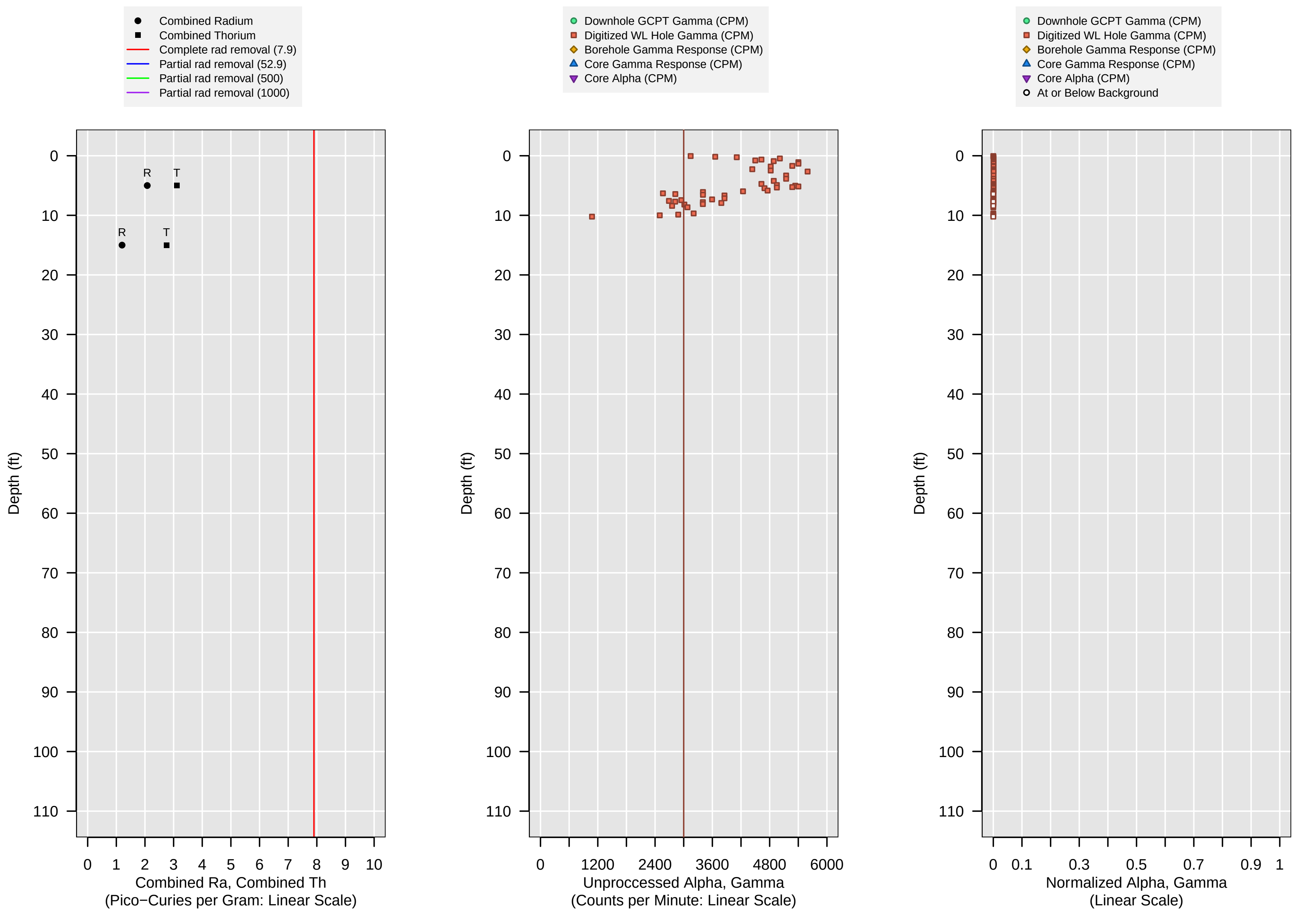
WL−227−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
0 3 6 9 12 18 24 30
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0 1400 2800 4200 5600 7000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)
0 10 20 30 40 50 60 70 80 90 100 110

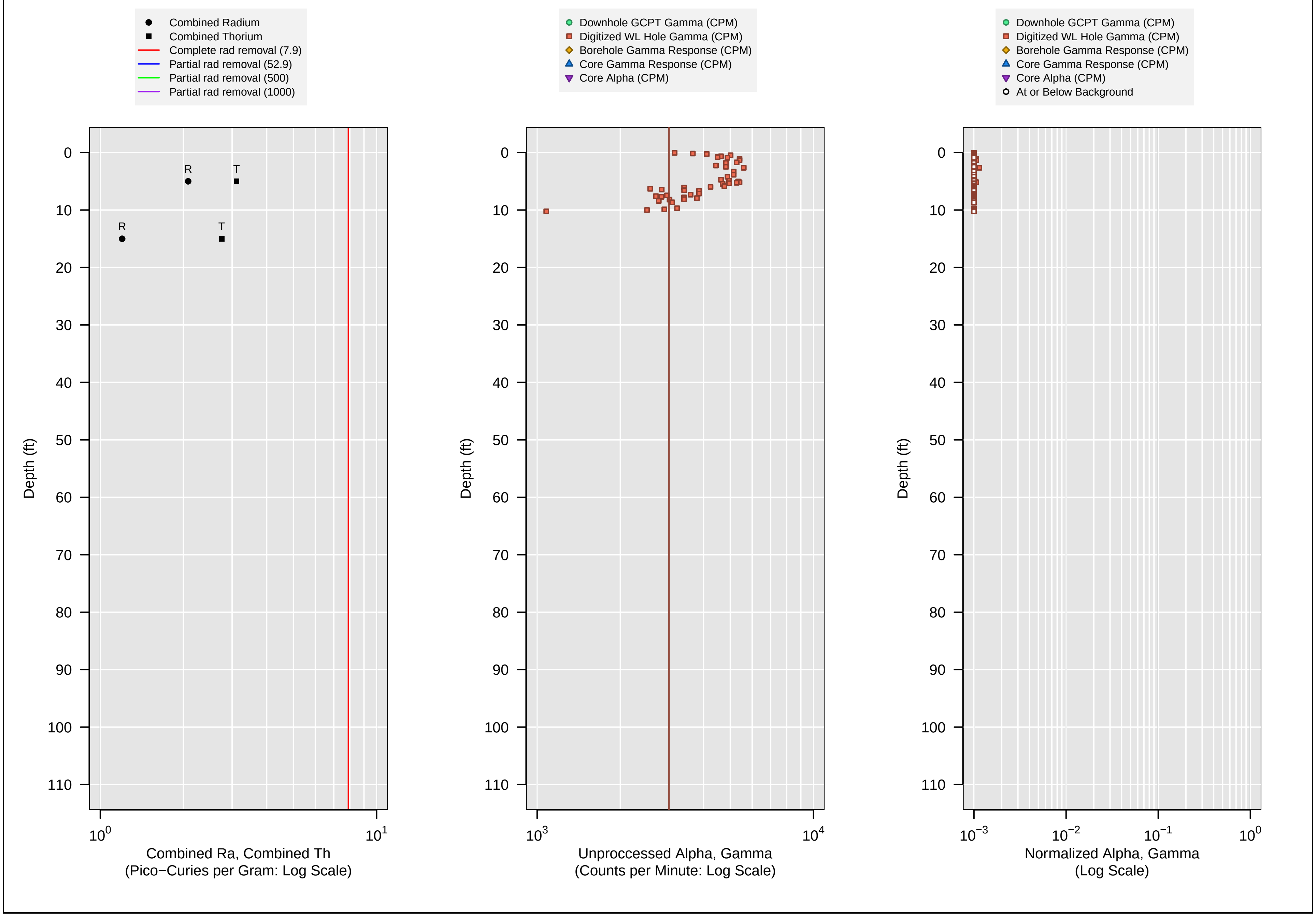
WL−227−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

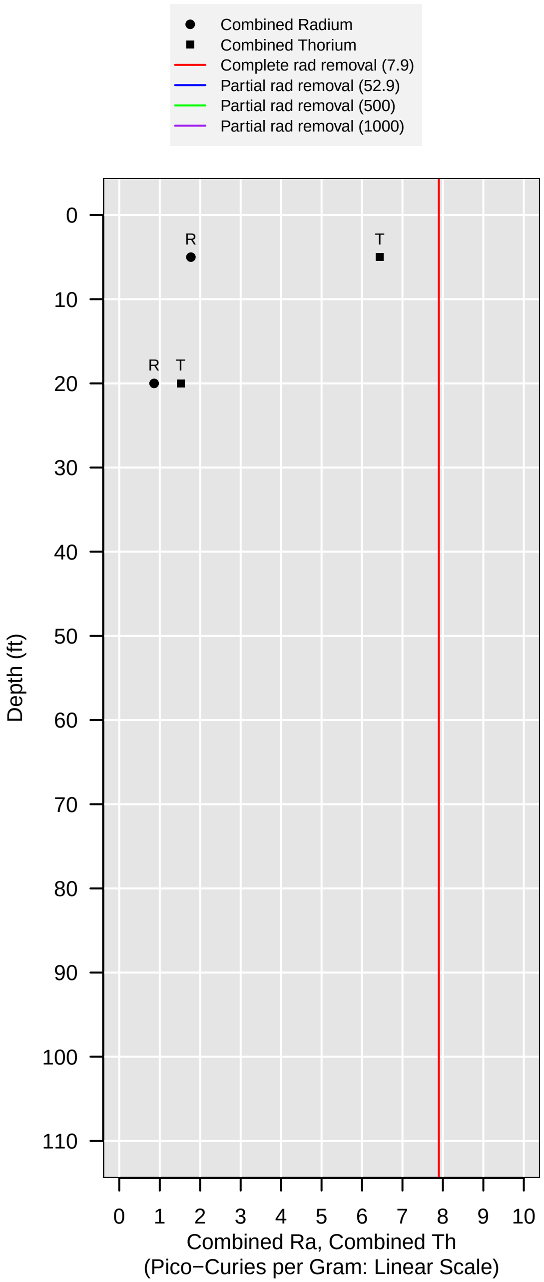
WL−228−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

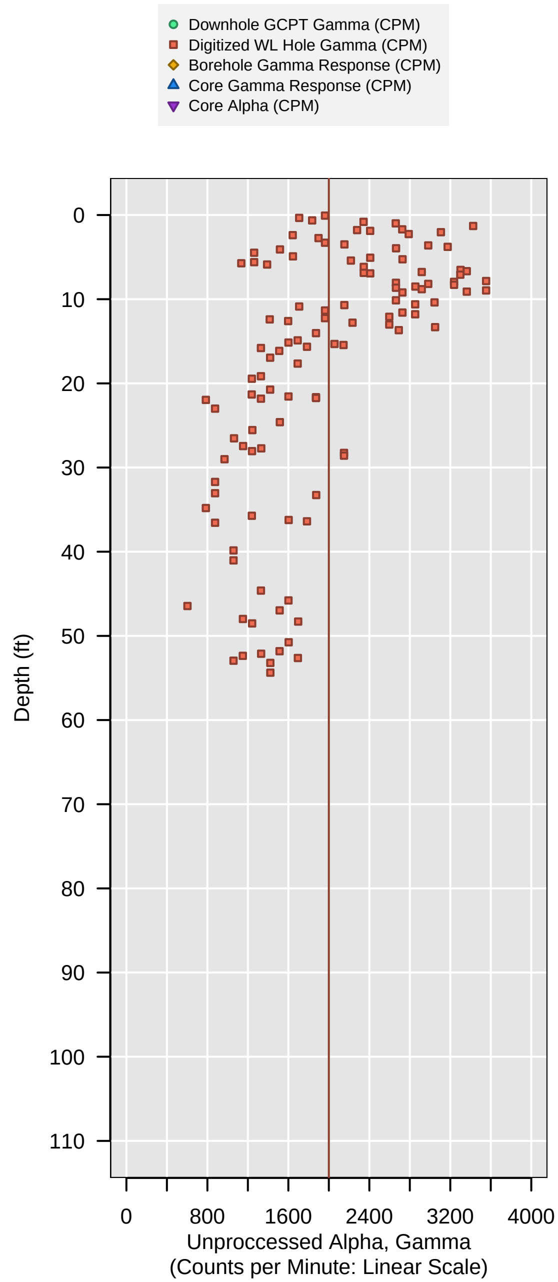
WL−228−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

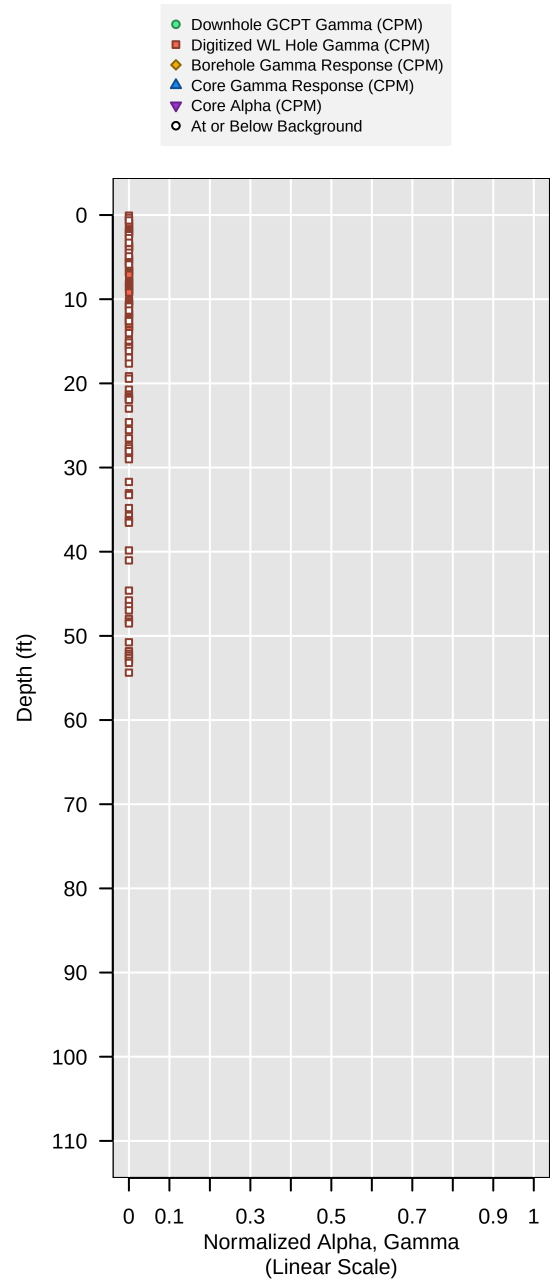
WL−229−MH



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
0 10 20 30 40 50 60 70 80 90 100 110
0 1 2 3 4 5 6 7 8 9 10
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)

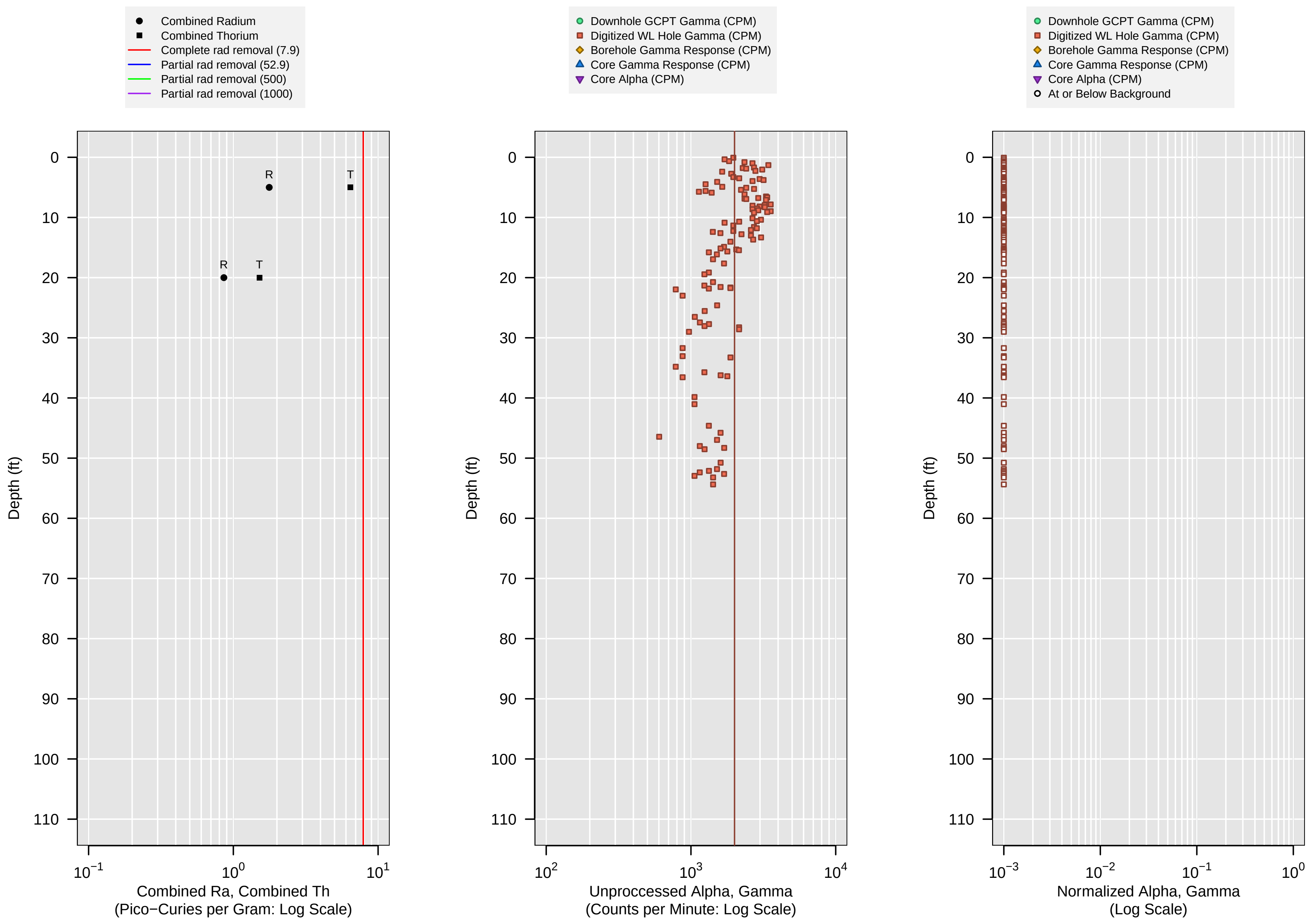


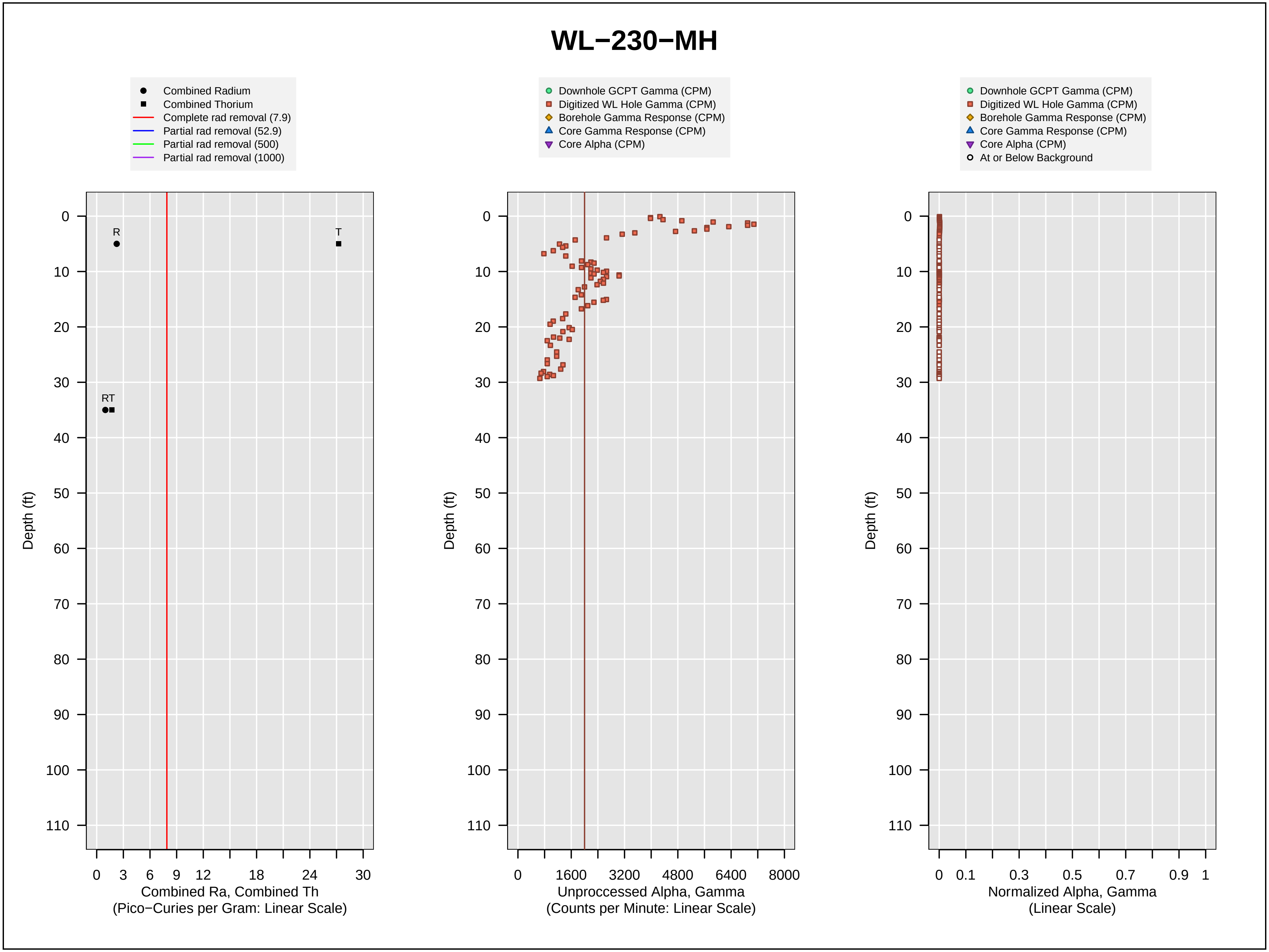
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0 10 20 30 40 50 60 70 80 90 100 110
0 800 1600 2400 3200 4000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)



Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0 10 20 30 40 50 60 70 80 90 100 110
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

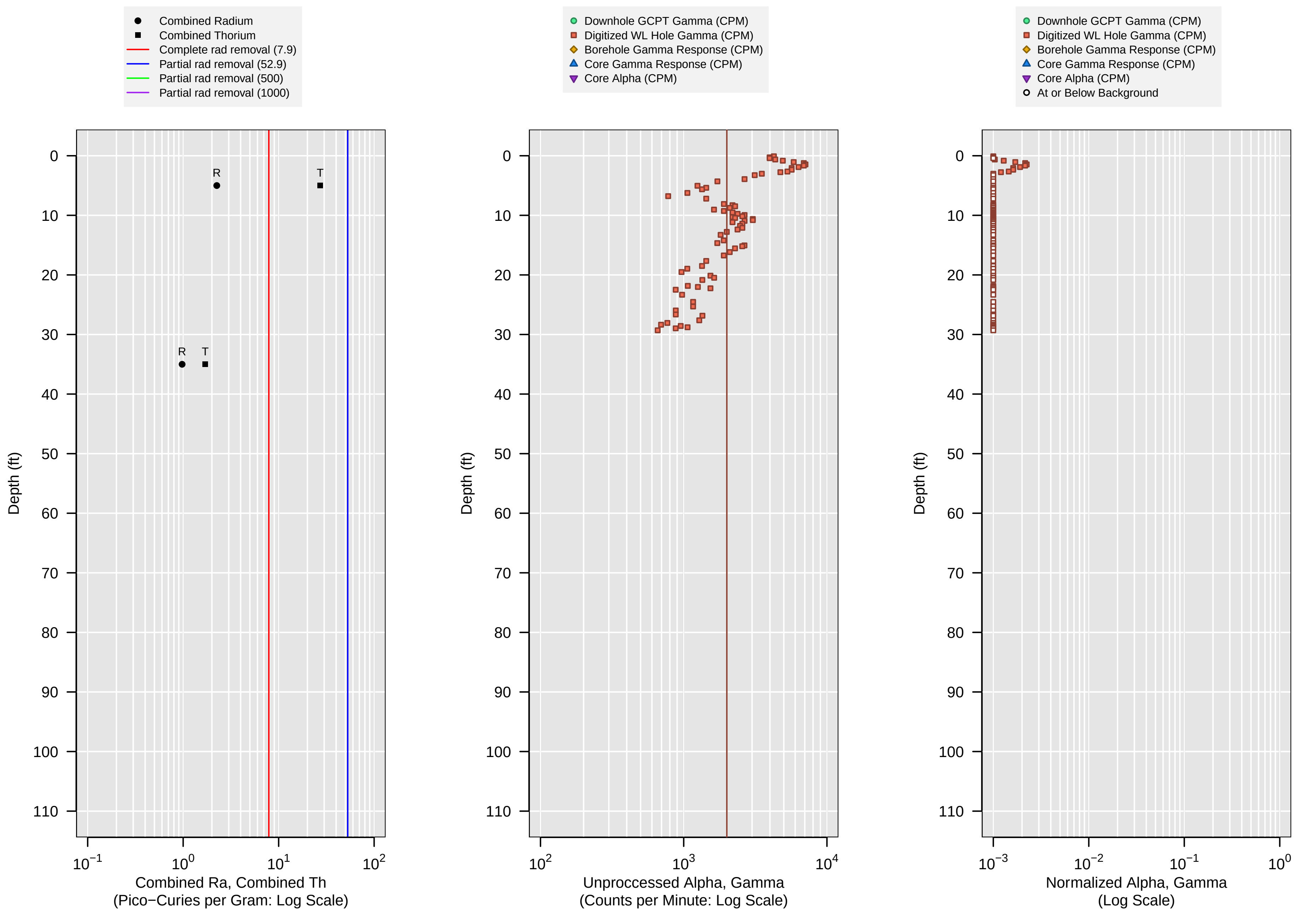
WL−229−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
R
T
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

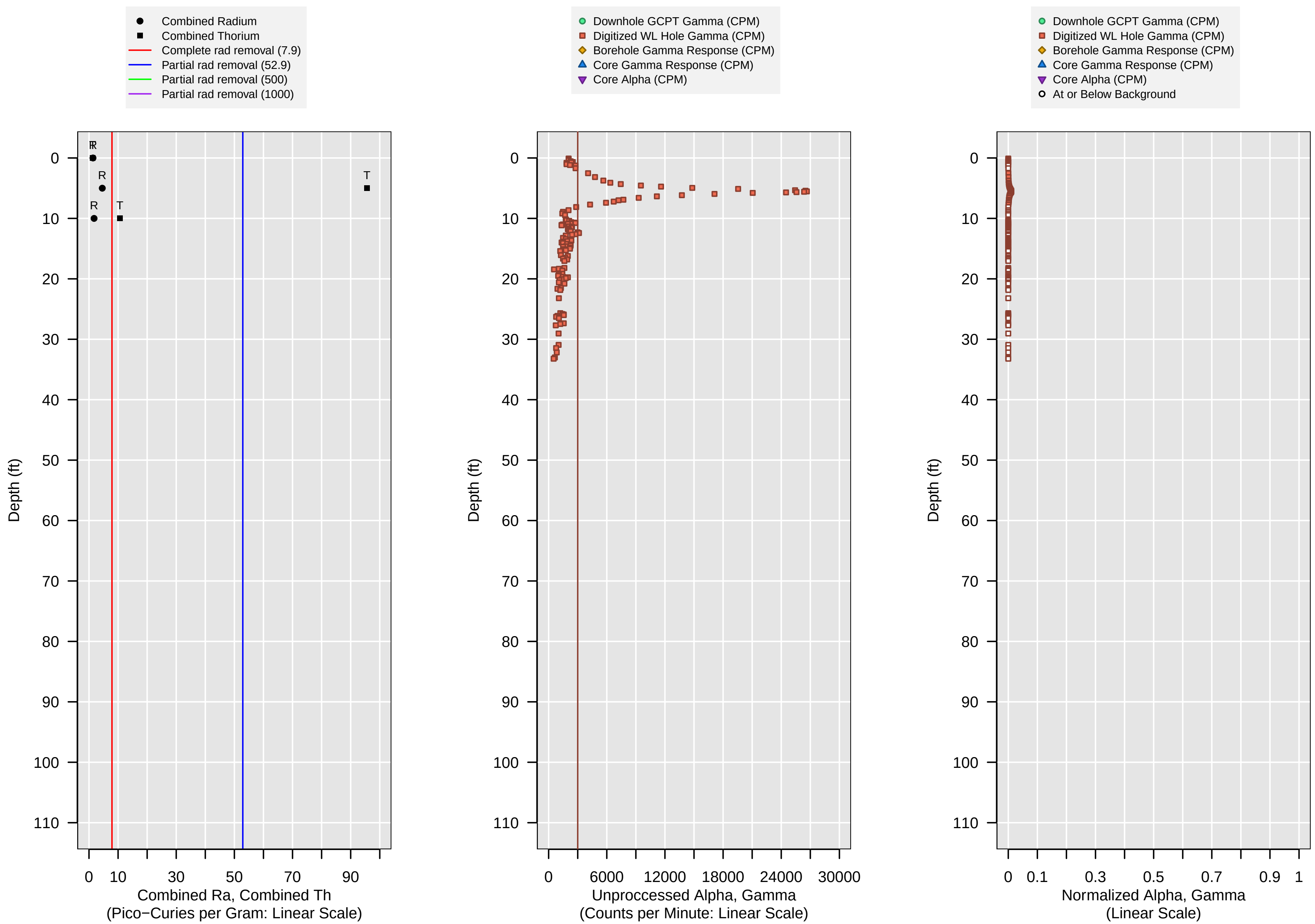


WL−230−MH
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
RT
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−230−MH

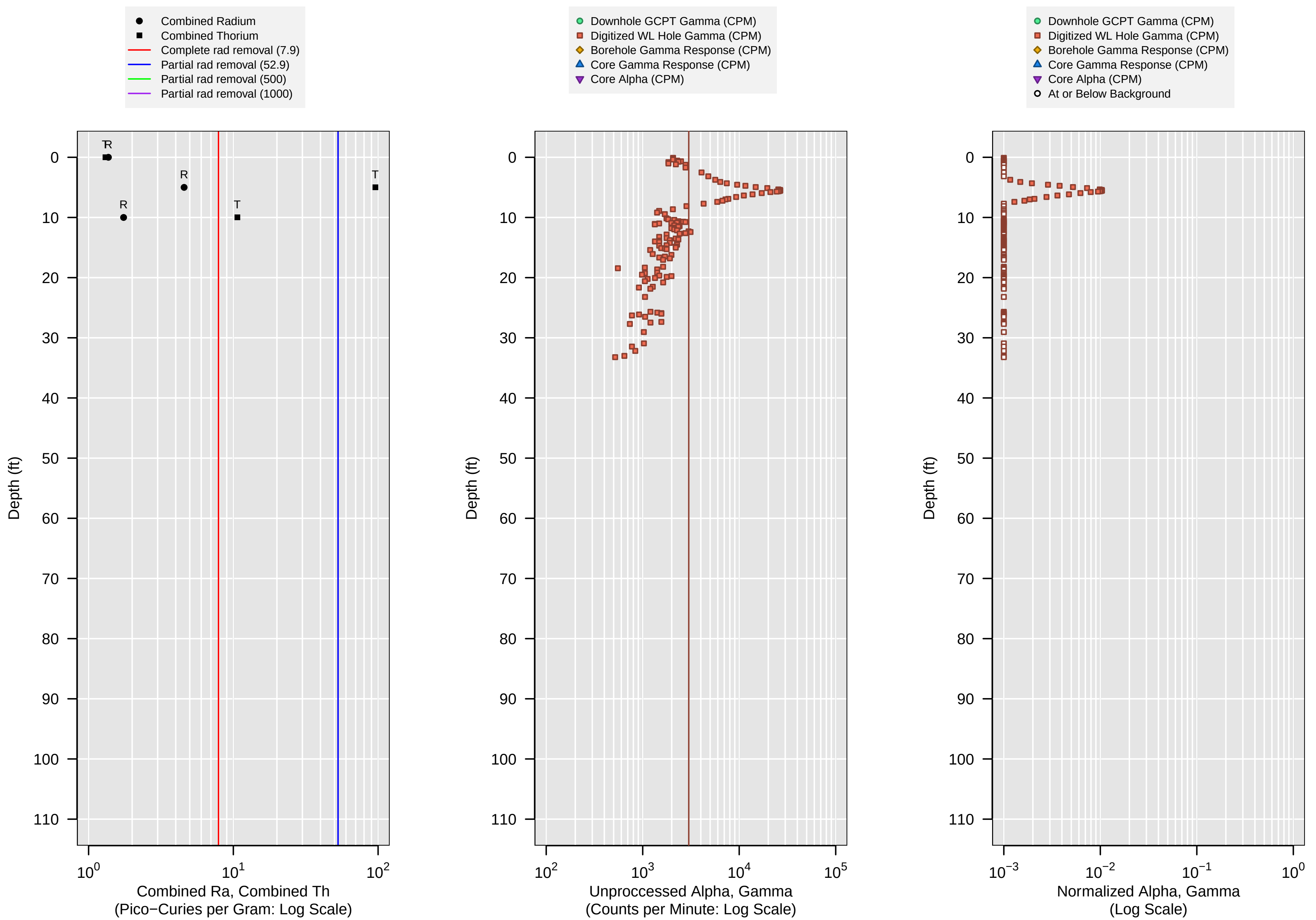

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−231−MH



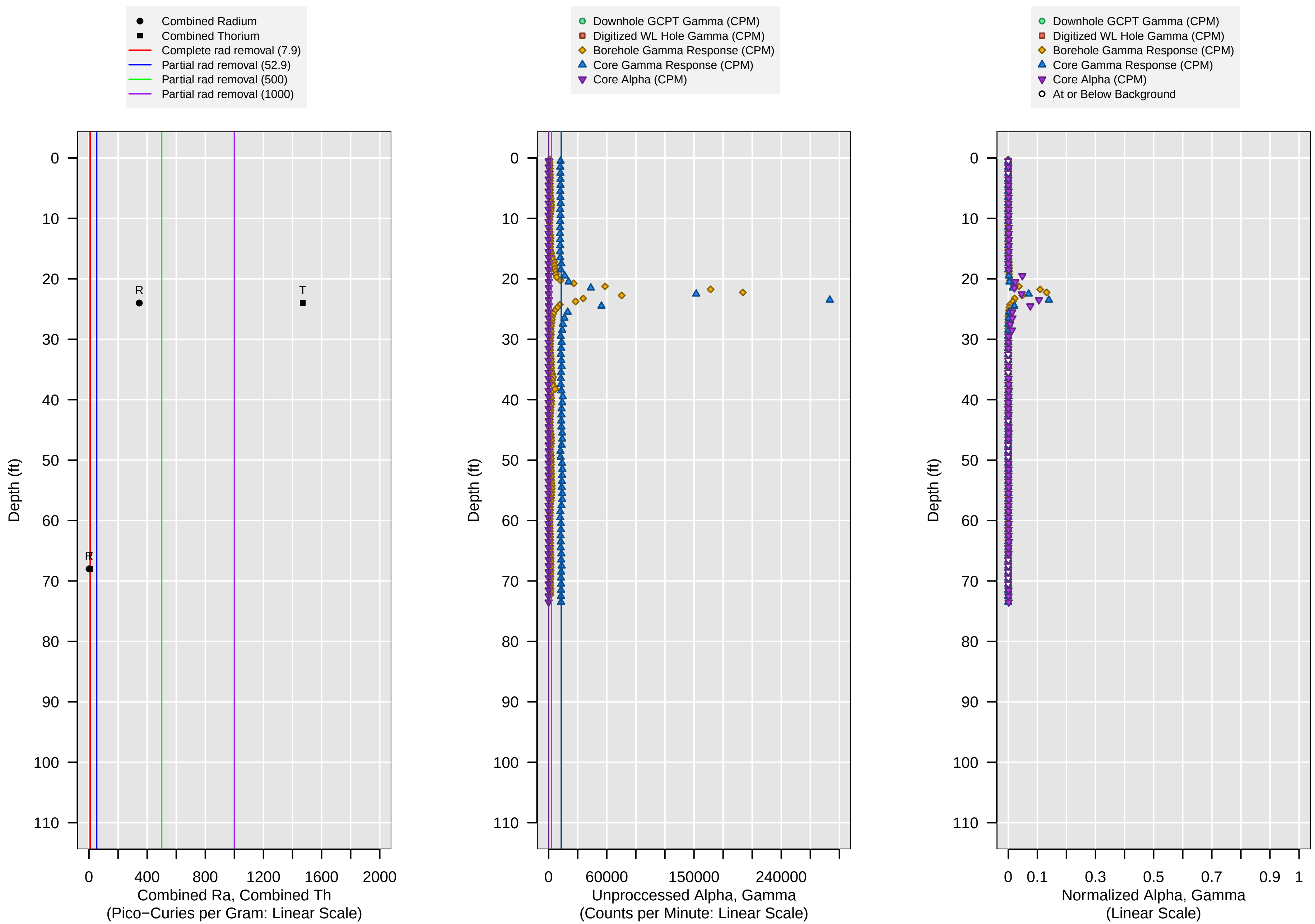
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−231−MH



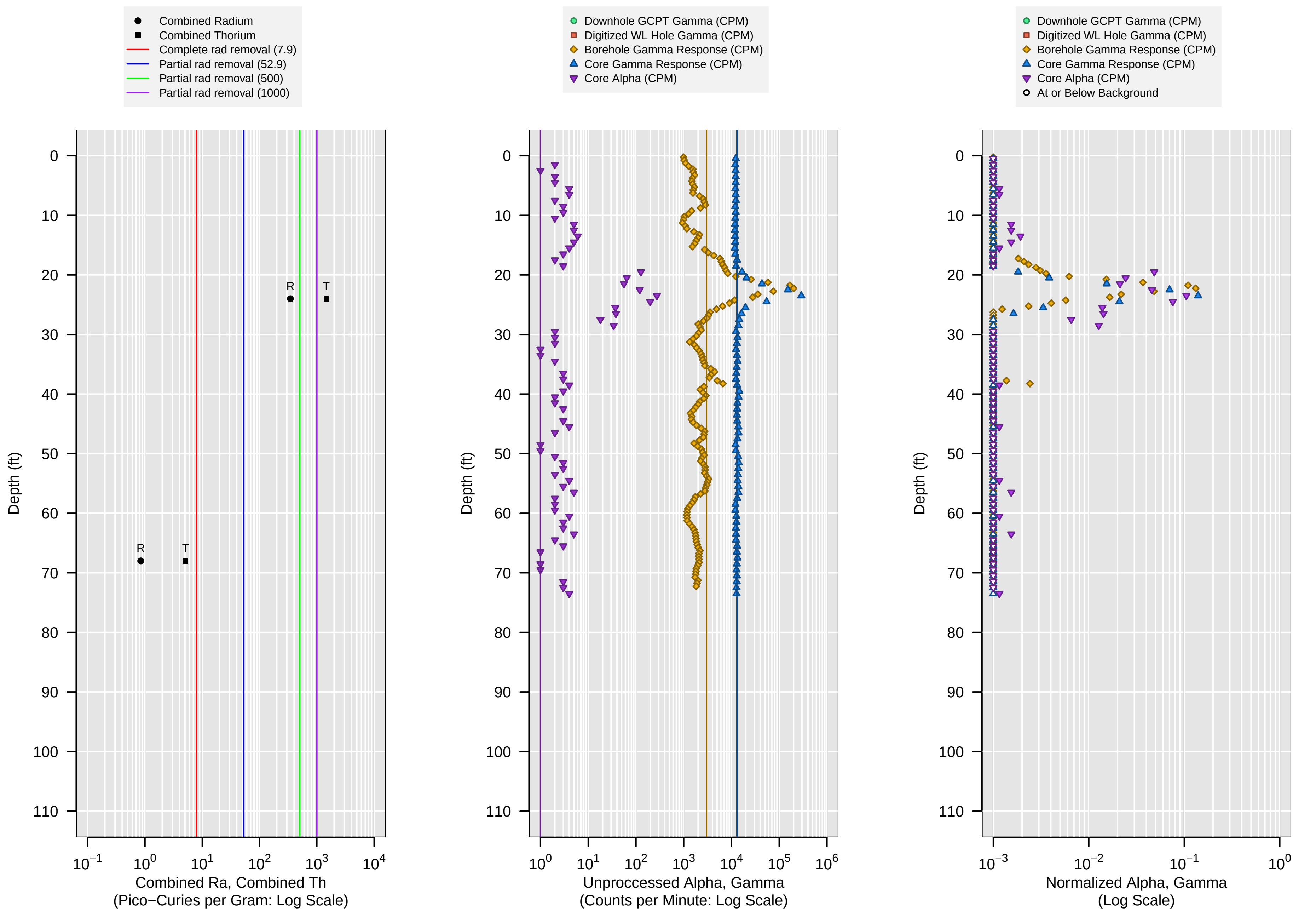
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

AC−23



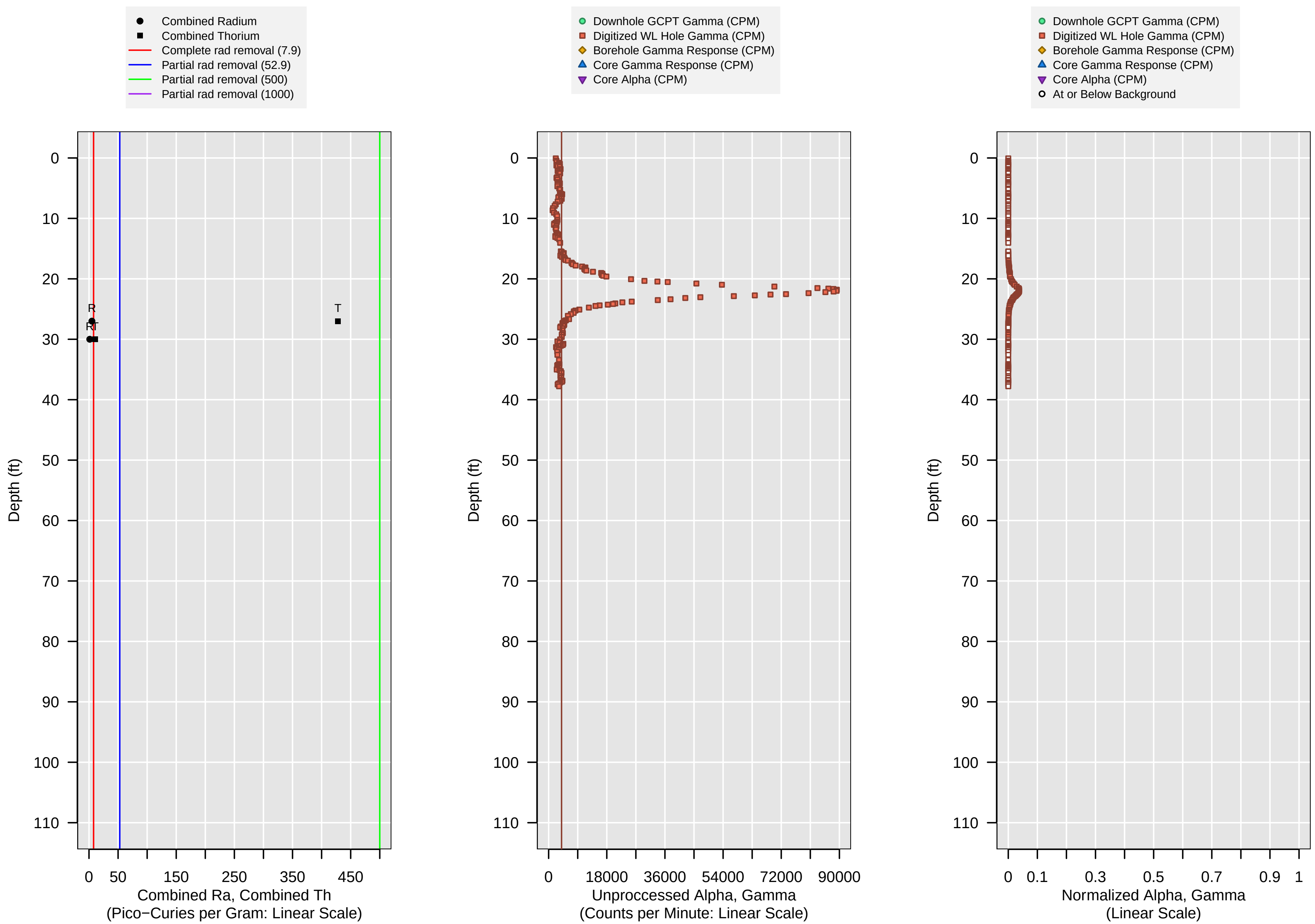
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

AC−23

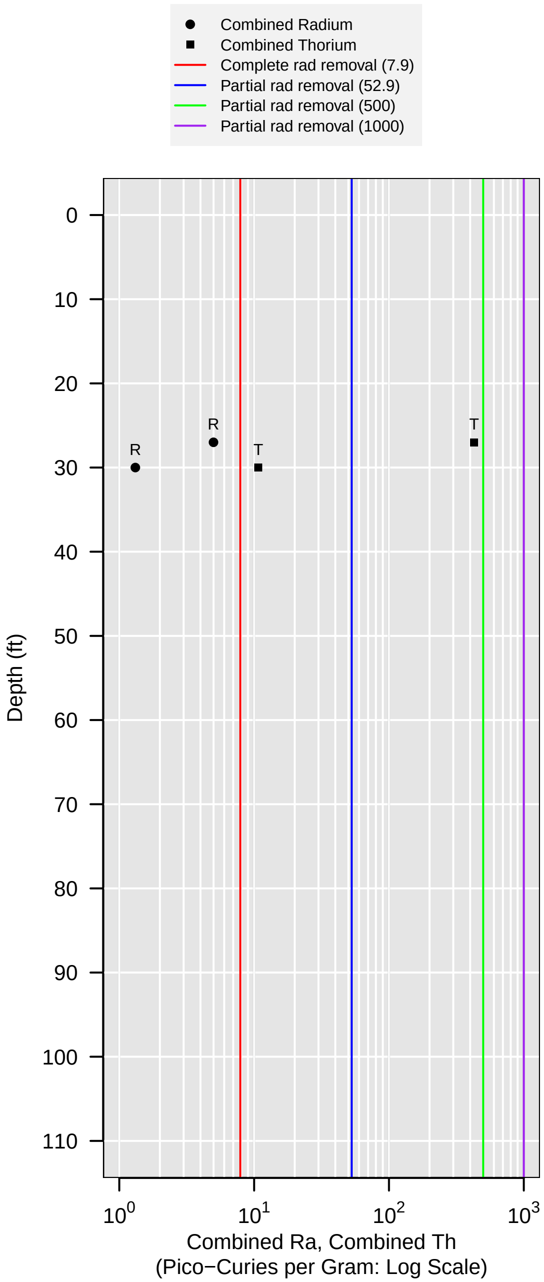


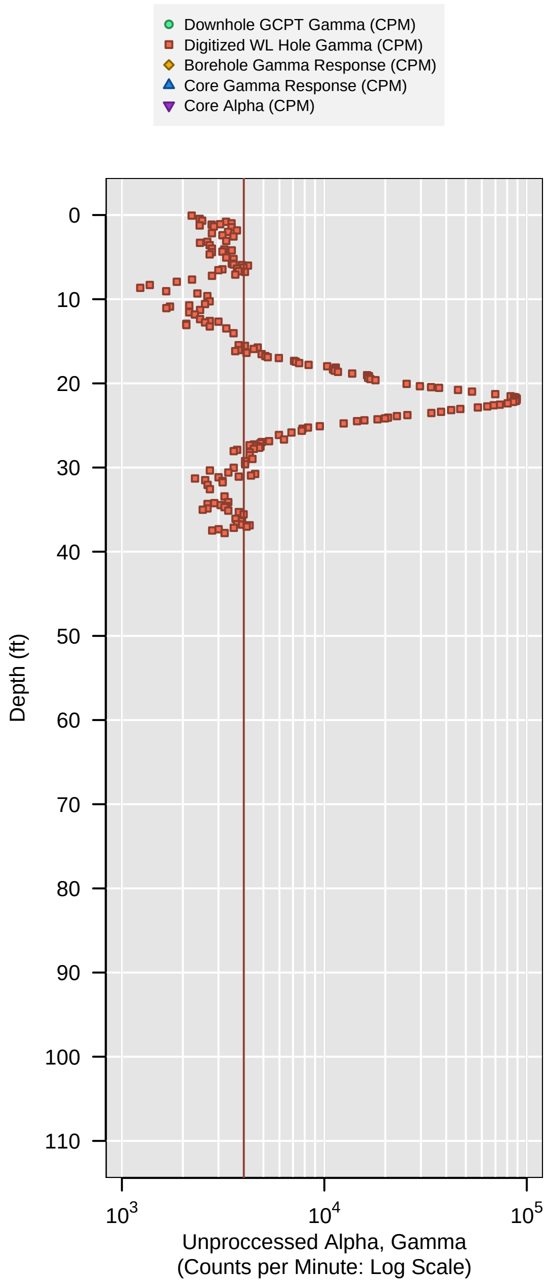
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
R
T
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

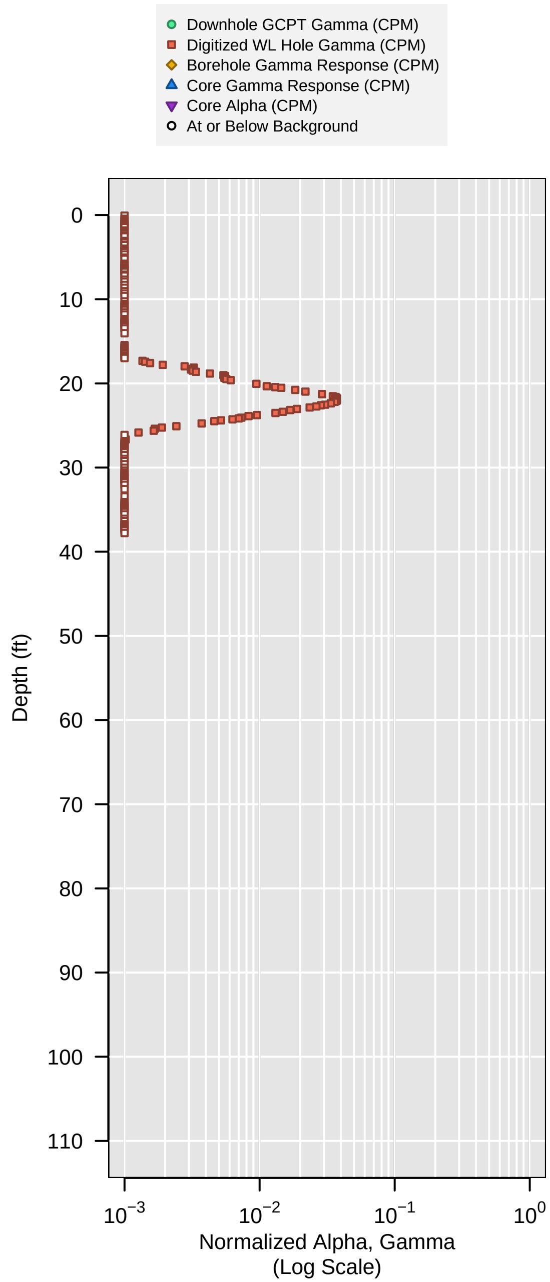
WL−233−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

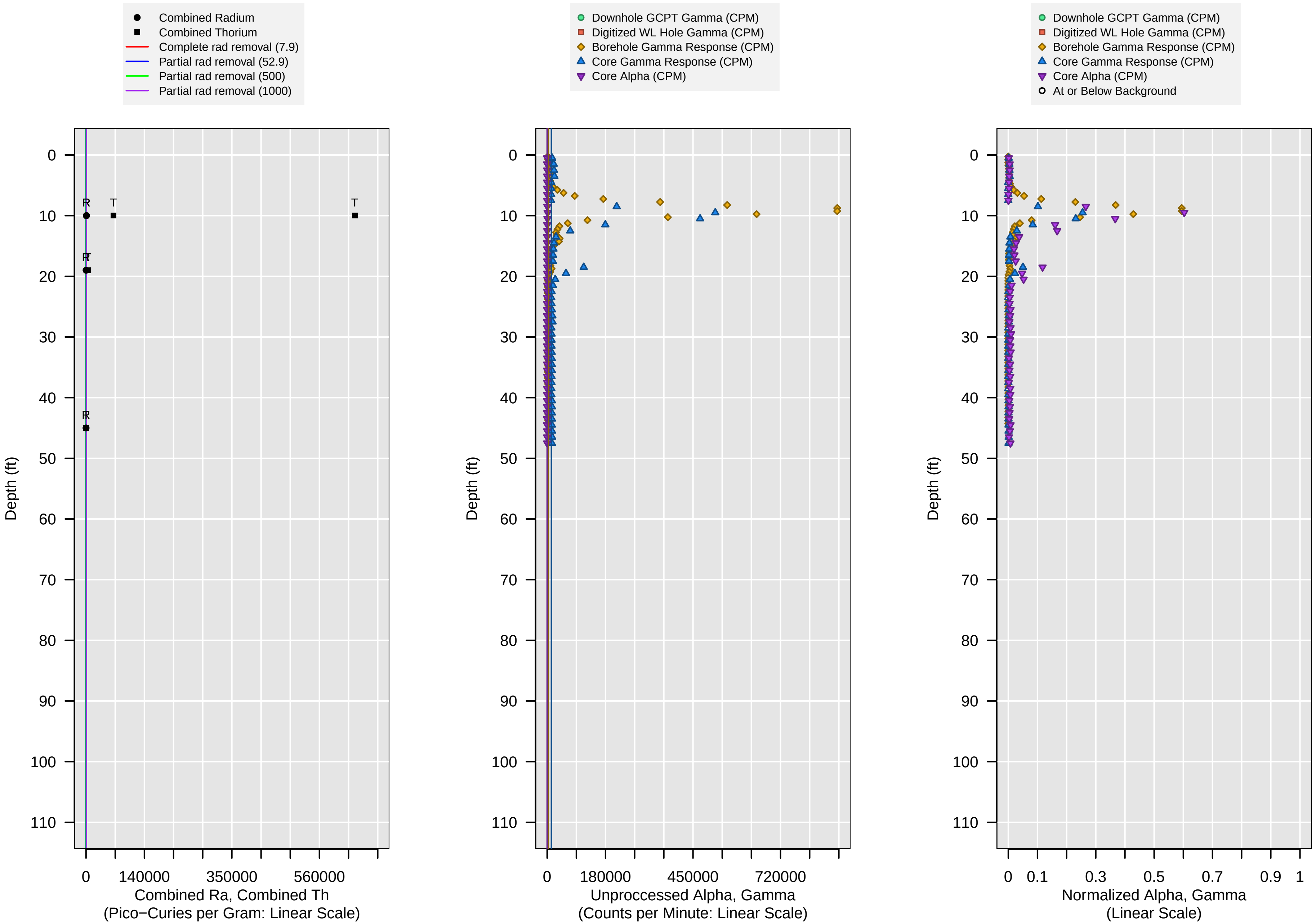
WL−233−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)

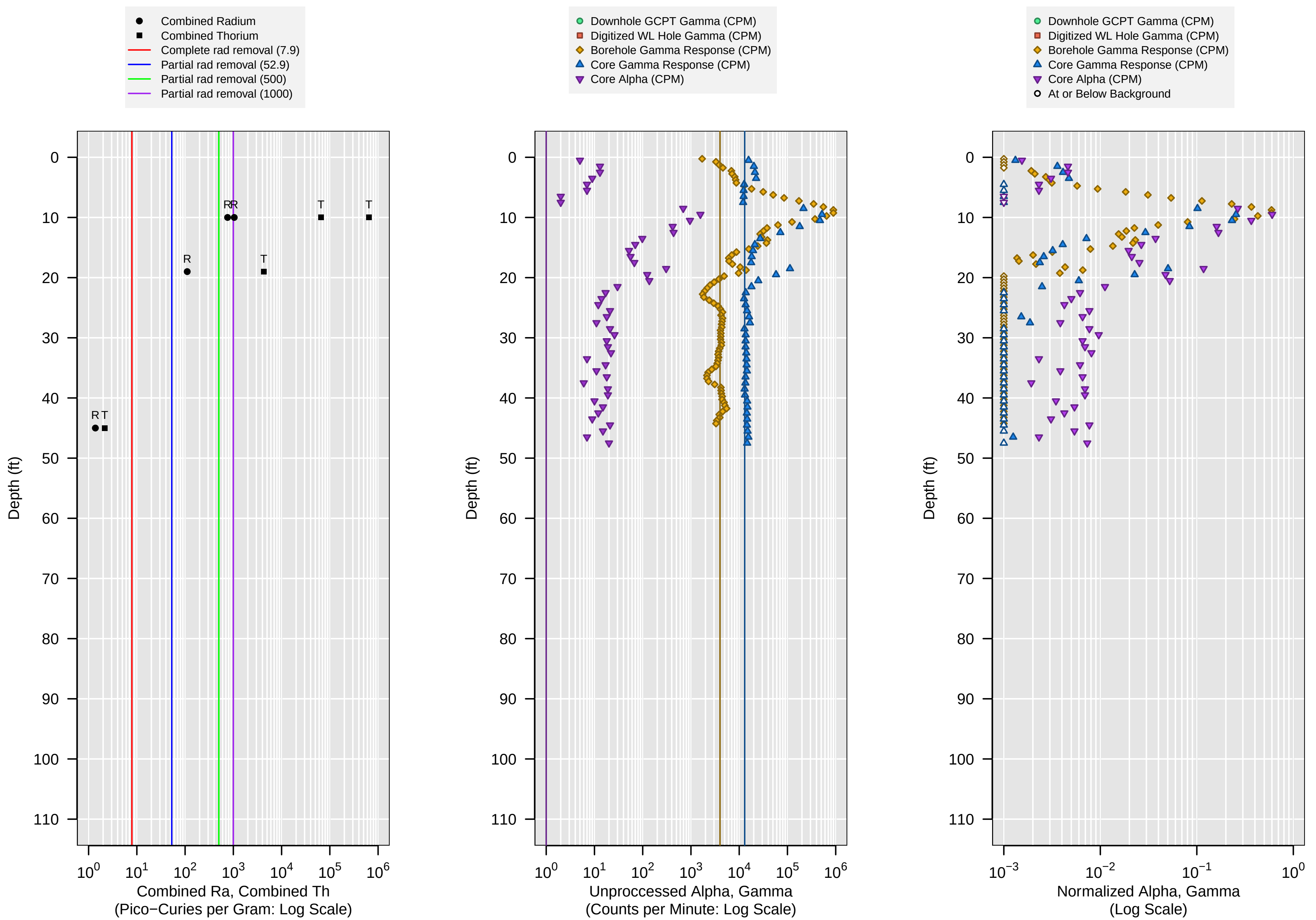

Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

WL−234−CT

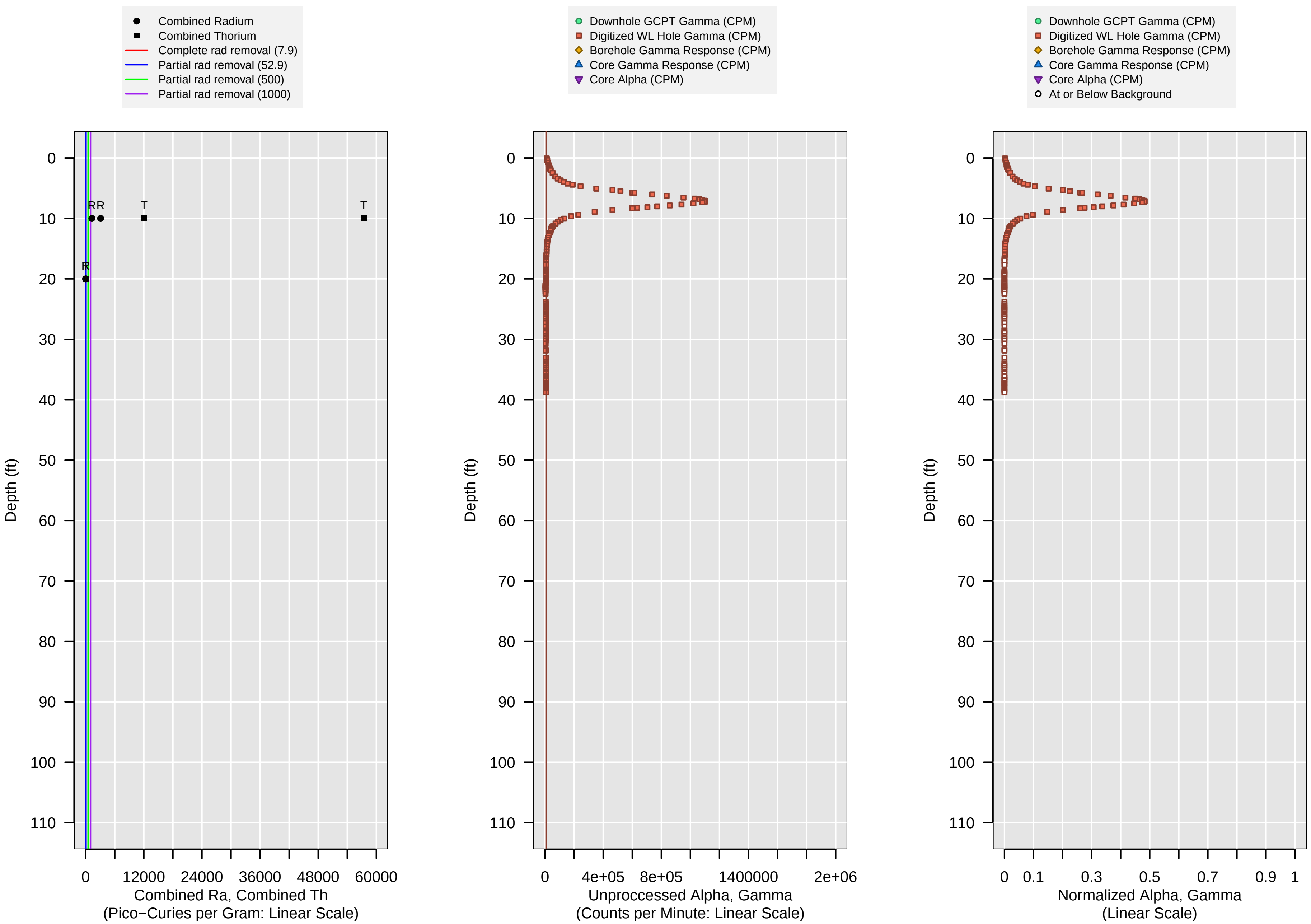


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

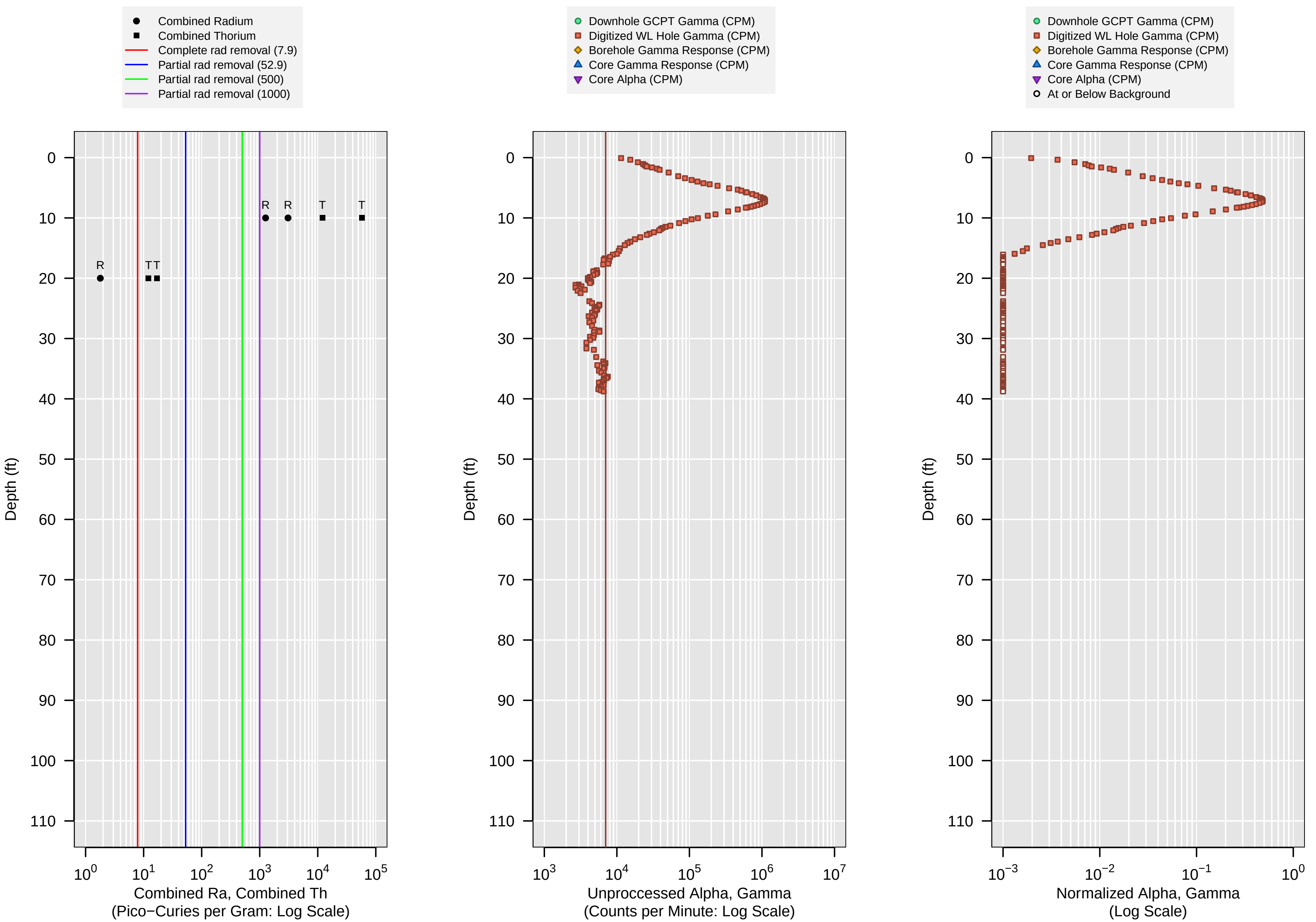
WL−234−CT


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

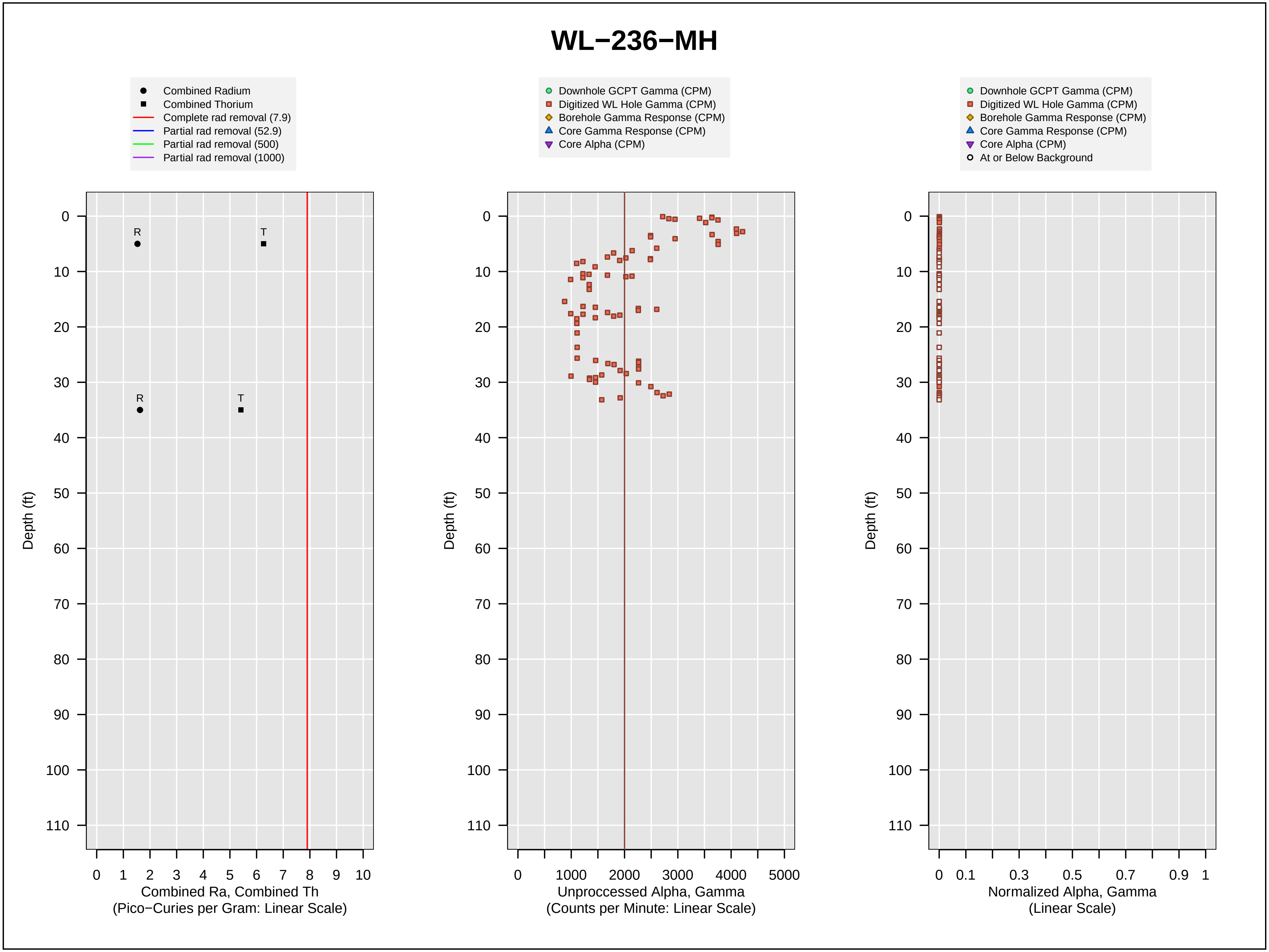
WL−234−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
RR
T
T
R
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
12000
24000
36000
48000
60000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
4e+05
8e+05
1400000
2e+06
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

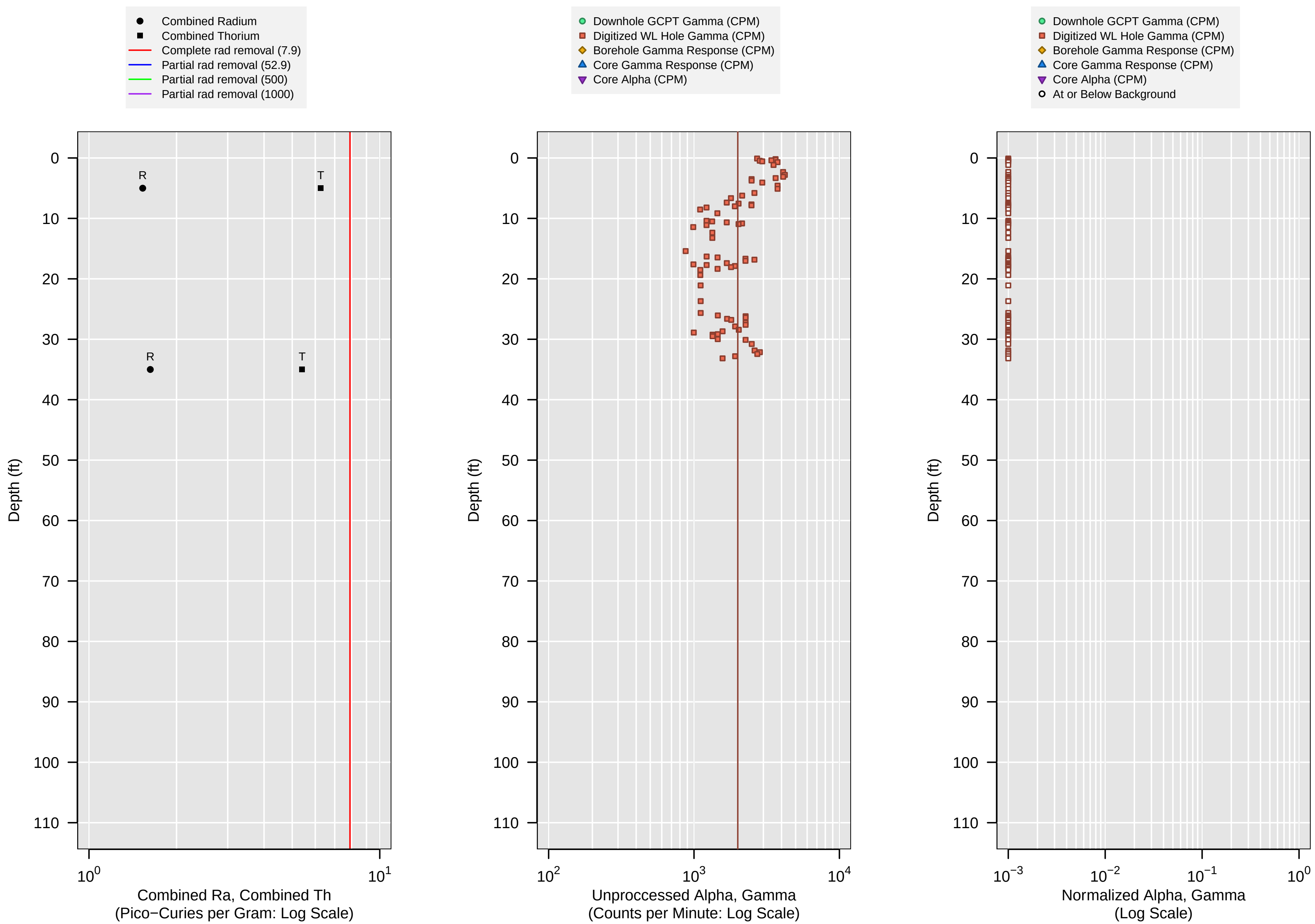
WL−234−MH



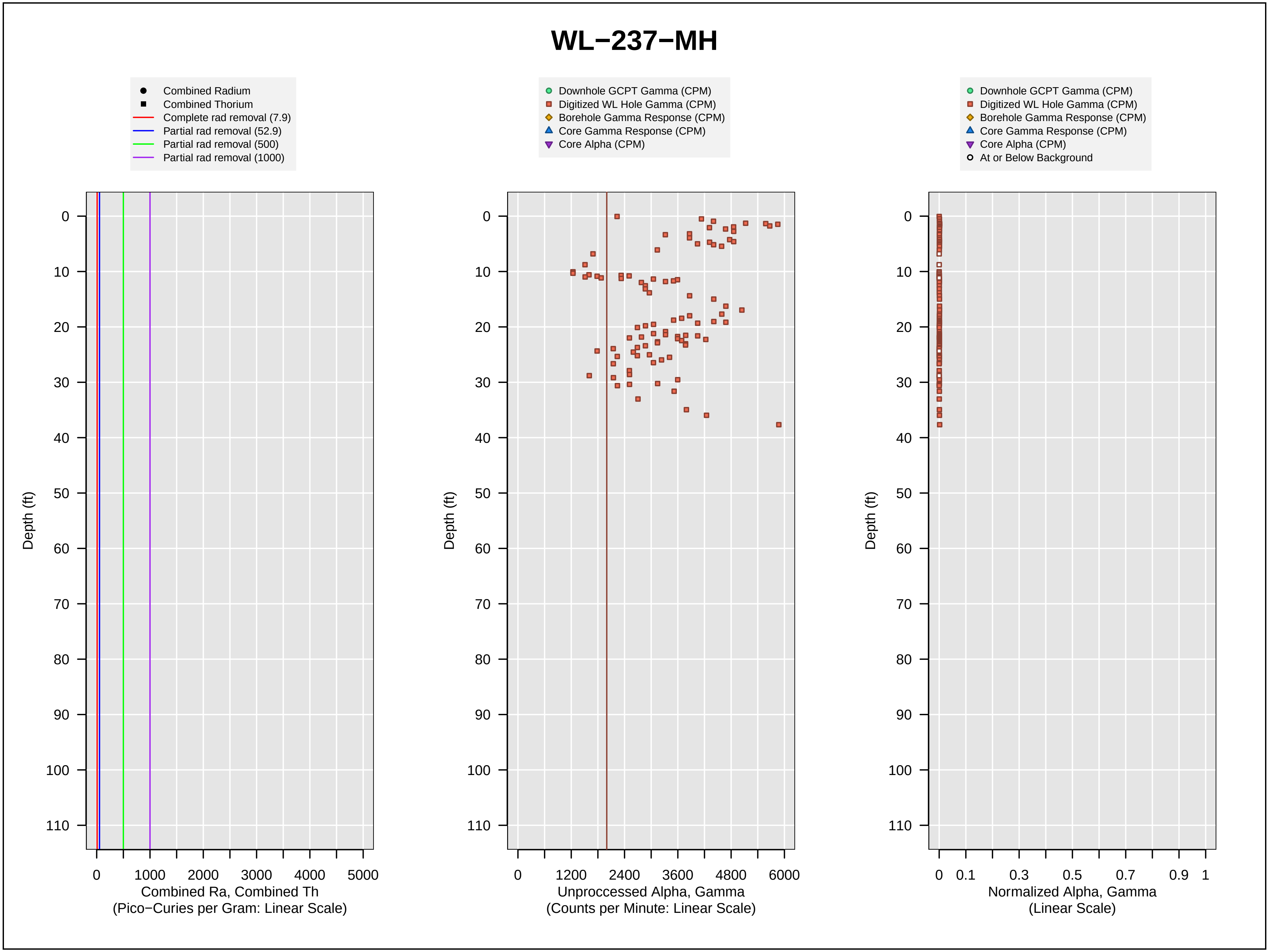
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)


WL−236−MH
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

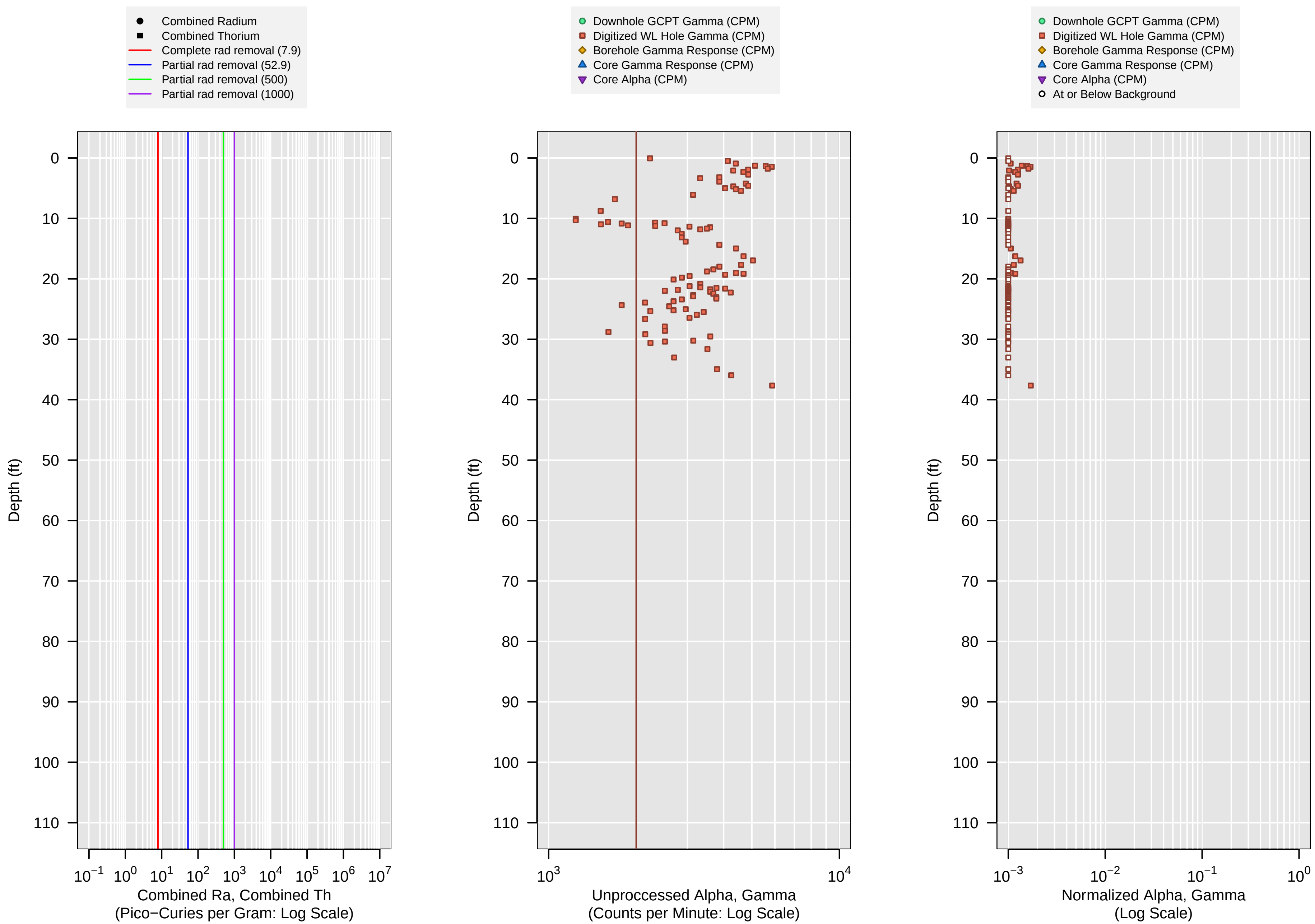
WL−236−MH



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

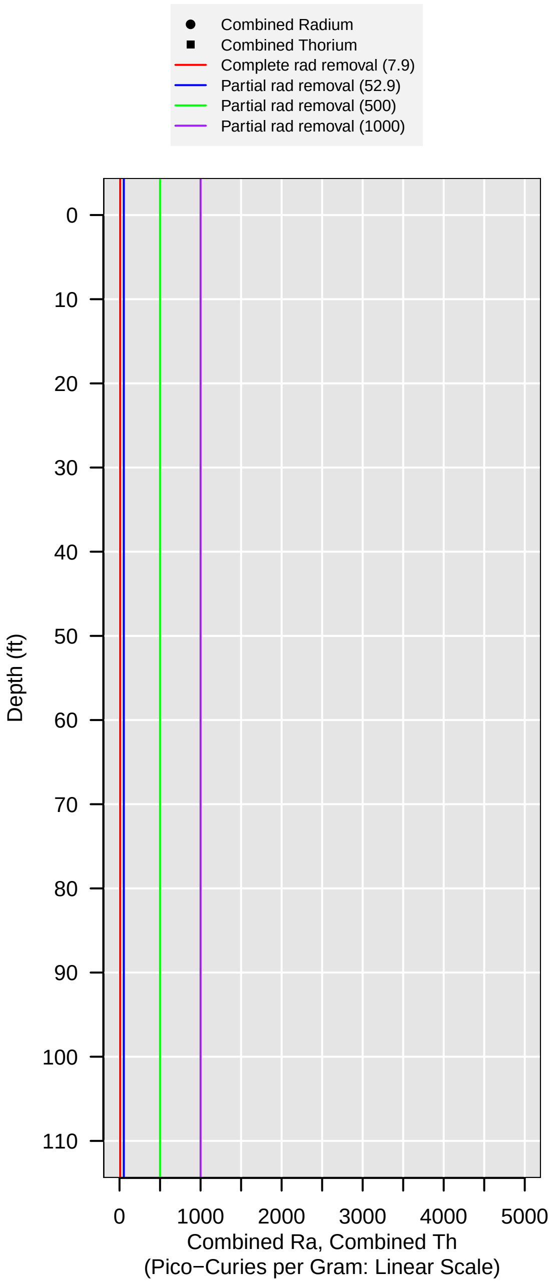

WL−237−MH
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

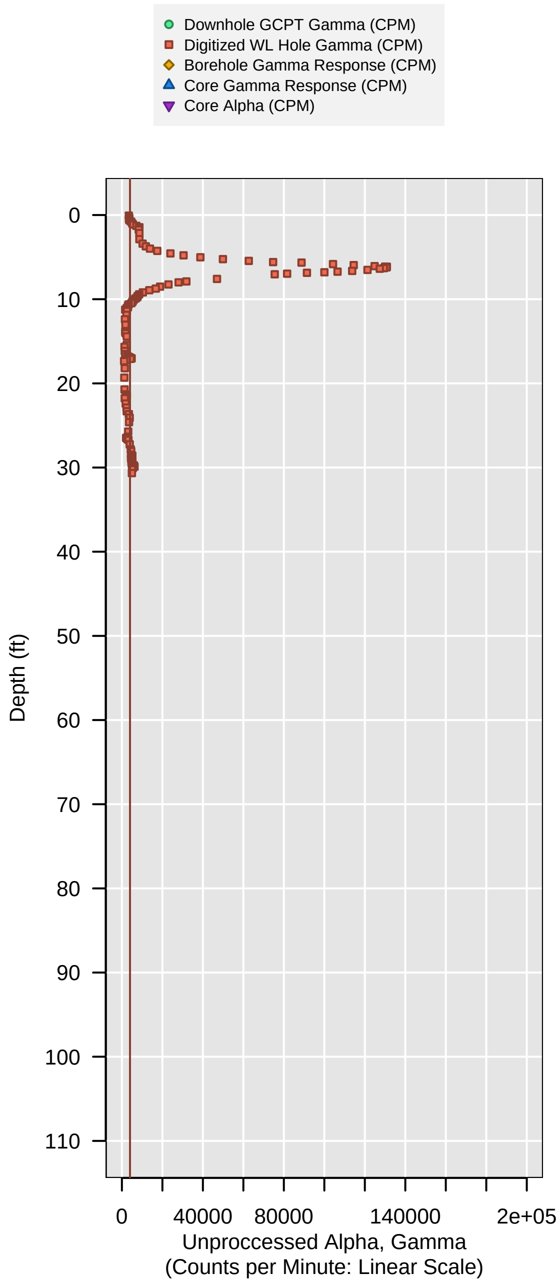
WL−237−MH

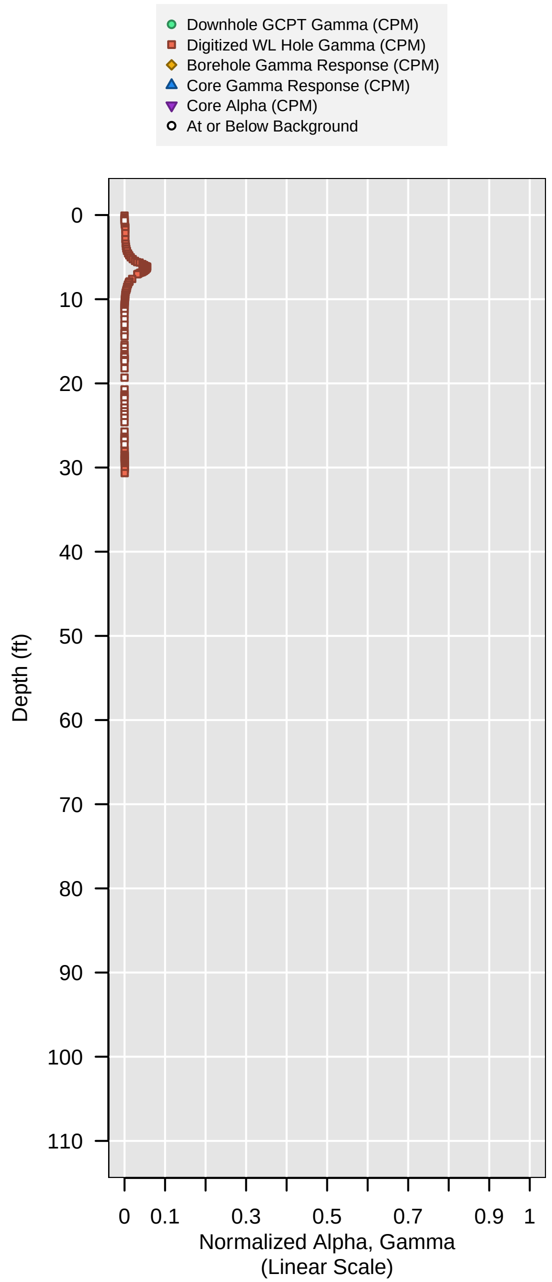


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

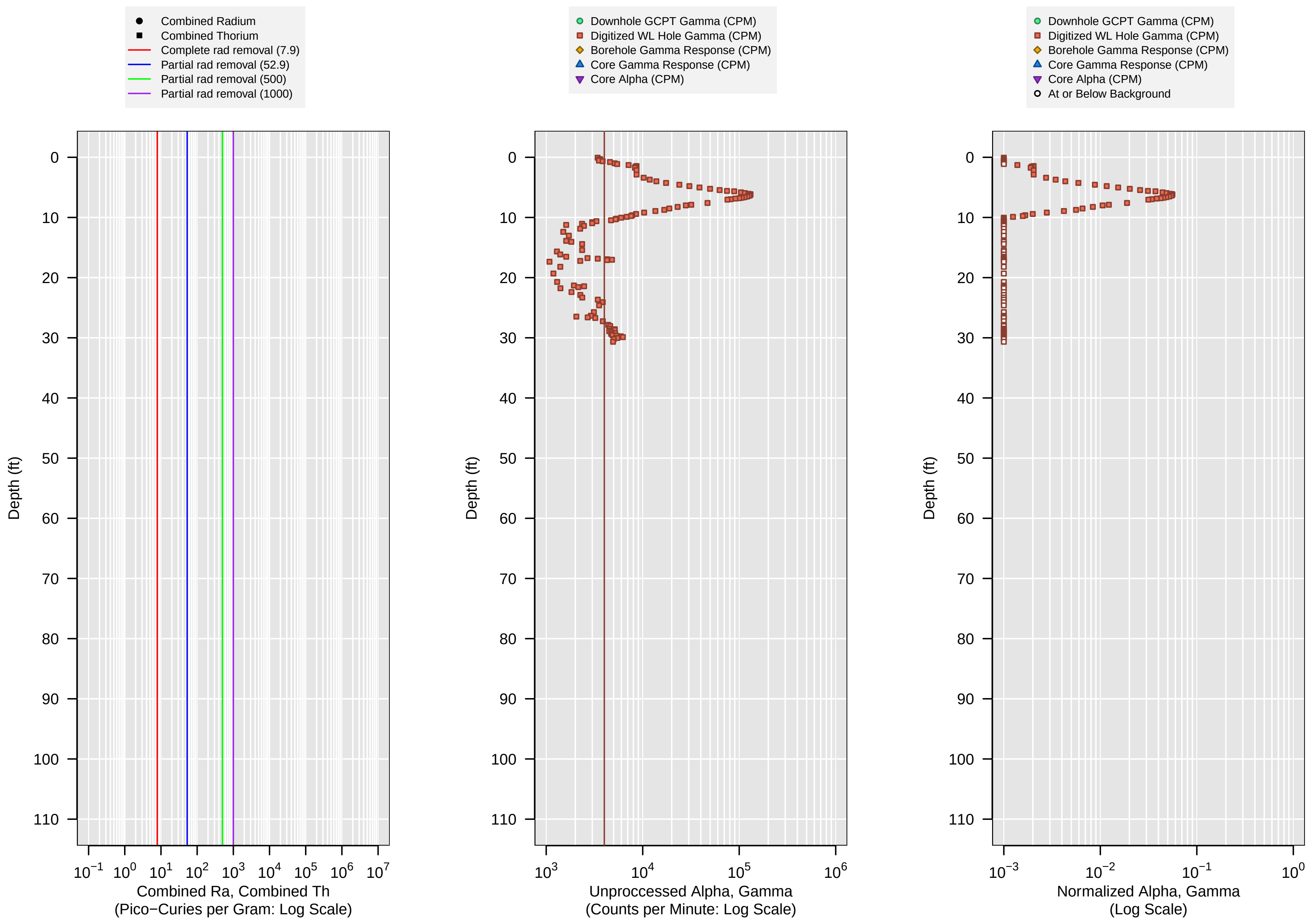
WL−238−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
1000
2000
3000
4000
5000
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)

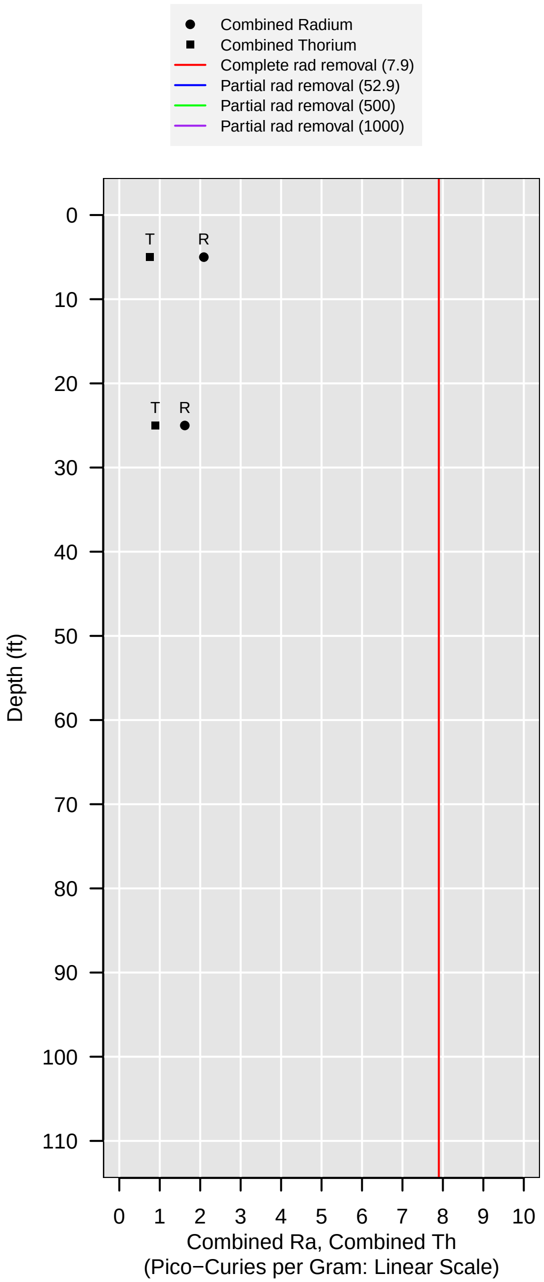

Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
40000
80000
140000
2e+05
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

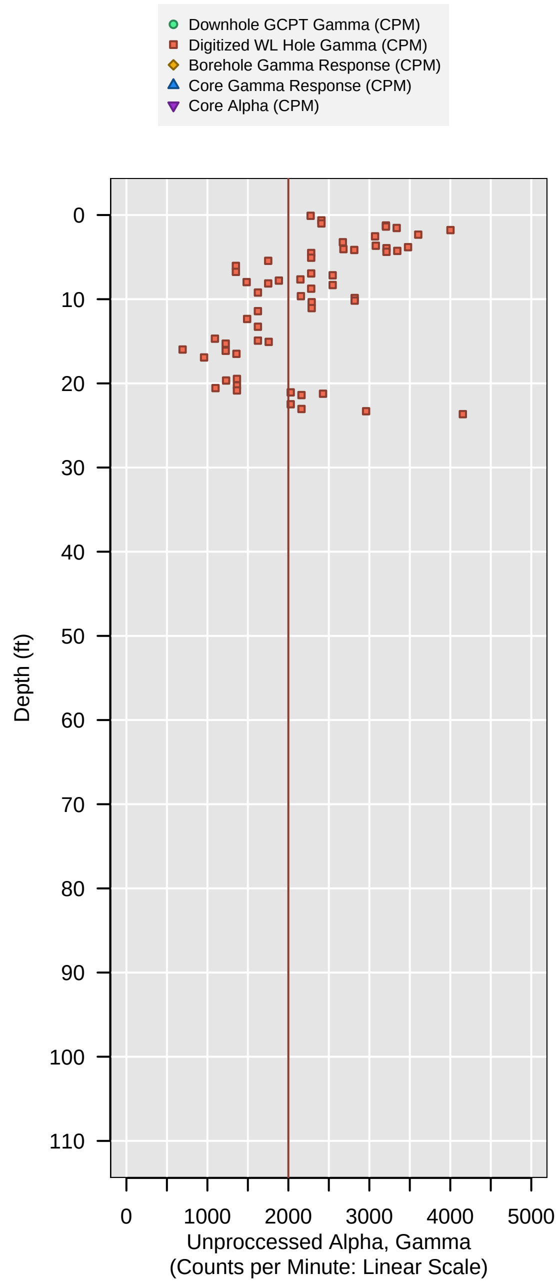
WL−238−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

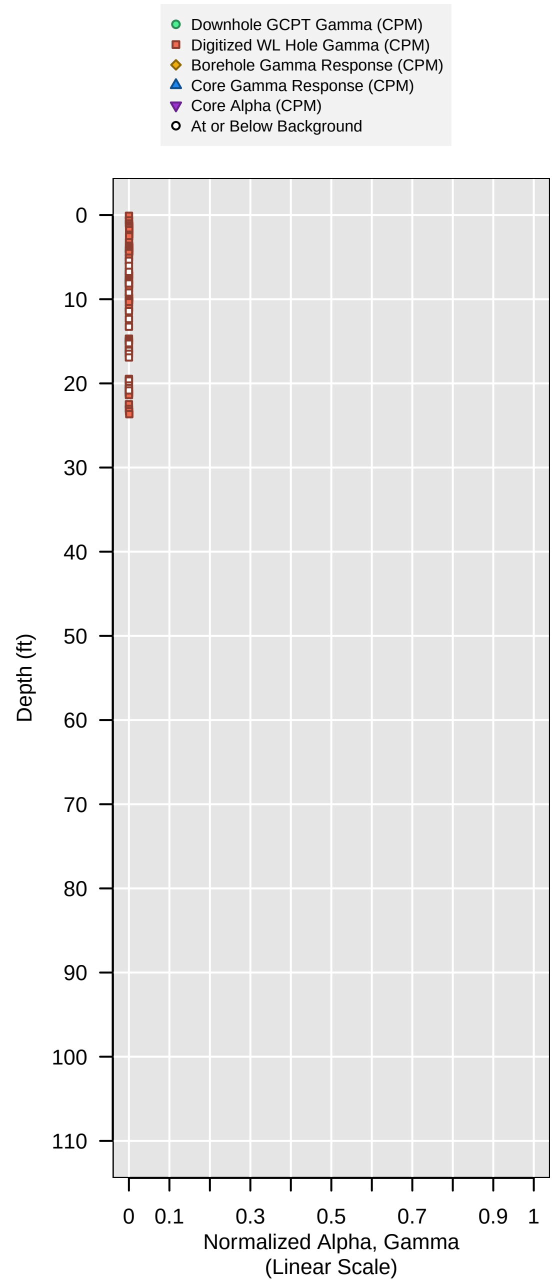
WL−239−MH



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
T
R
T
R
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 1 2 3 4 5 6 7 8 9 10
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)

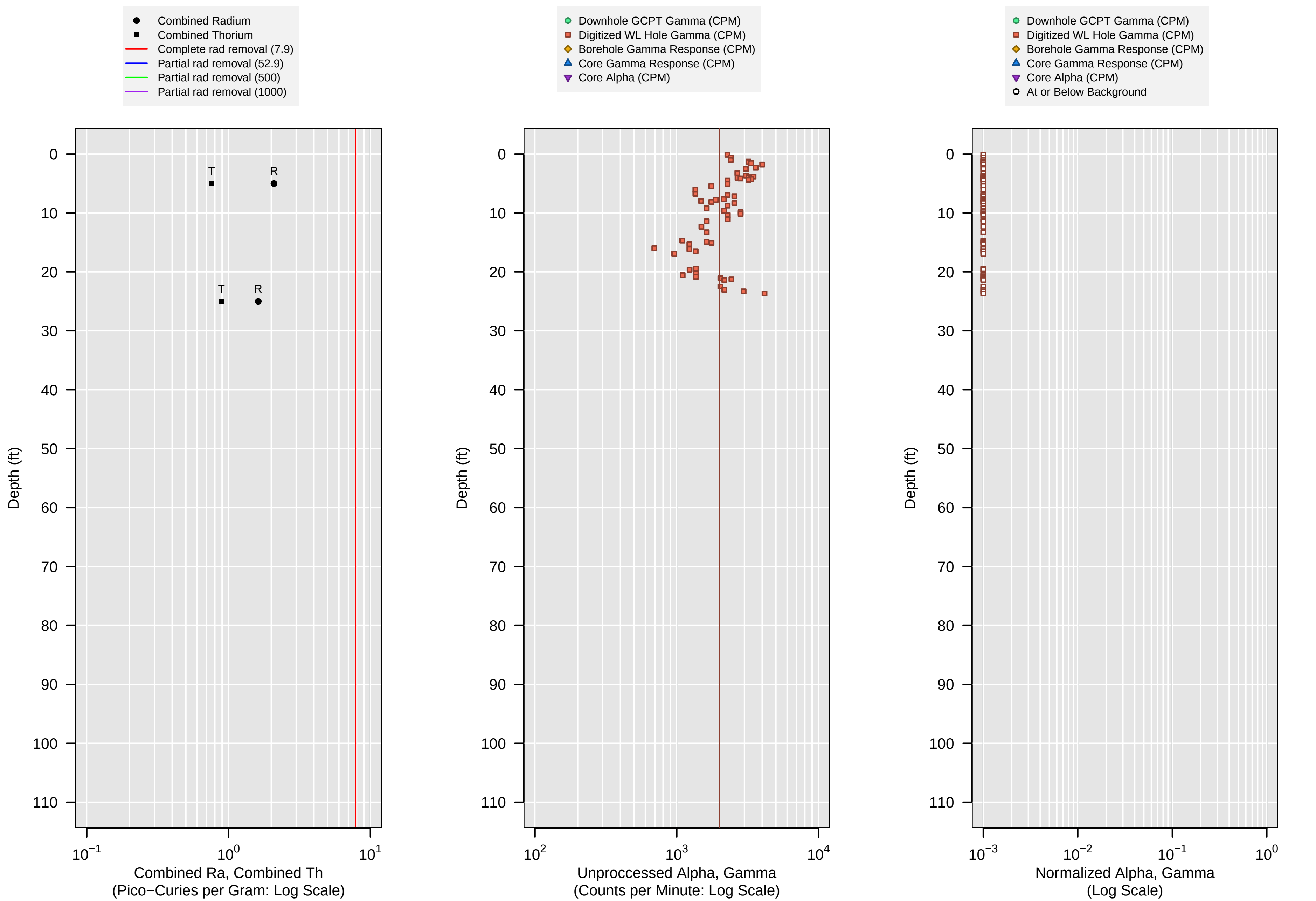


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 1000 2000 3000 4000 5000
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)

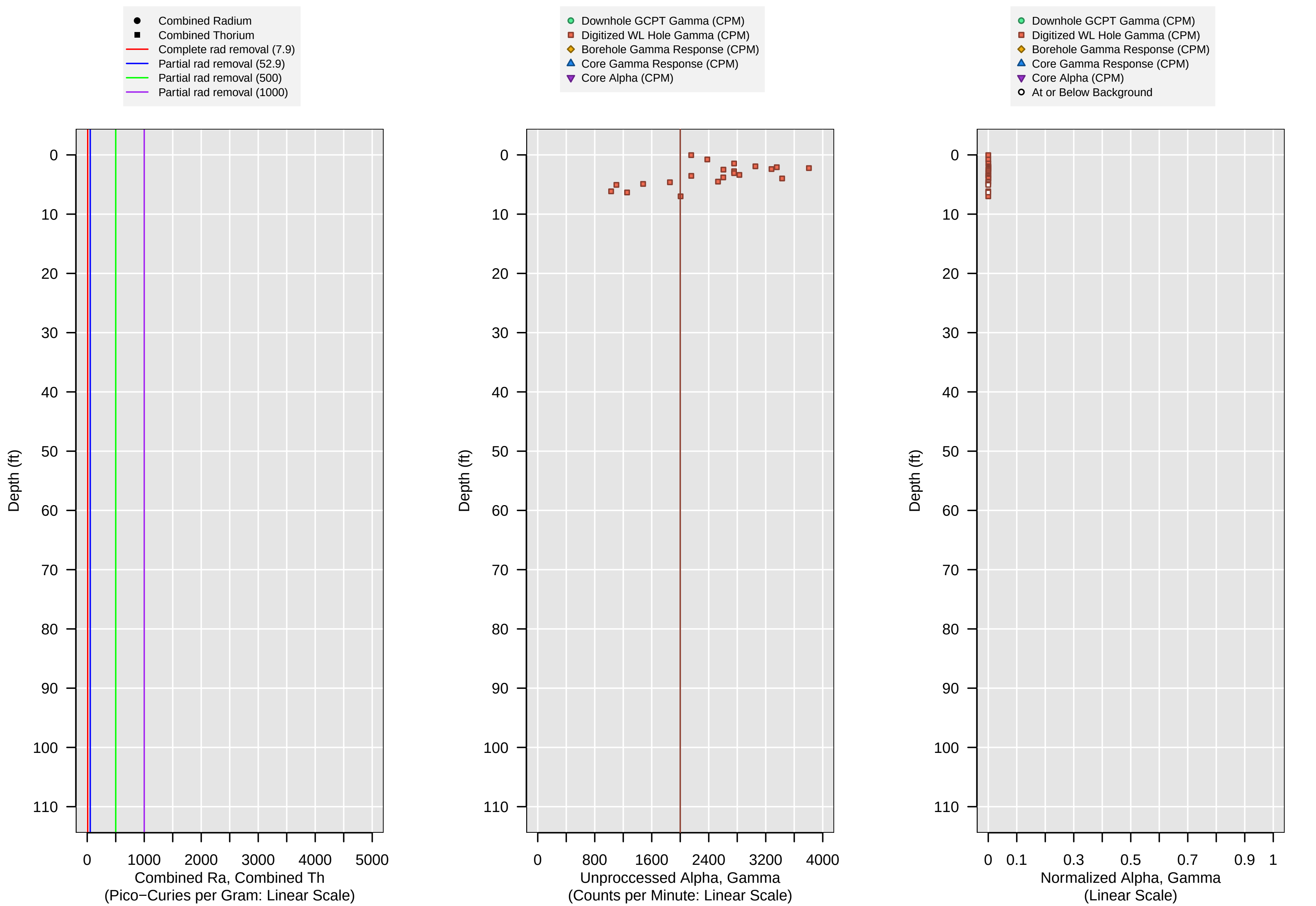


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

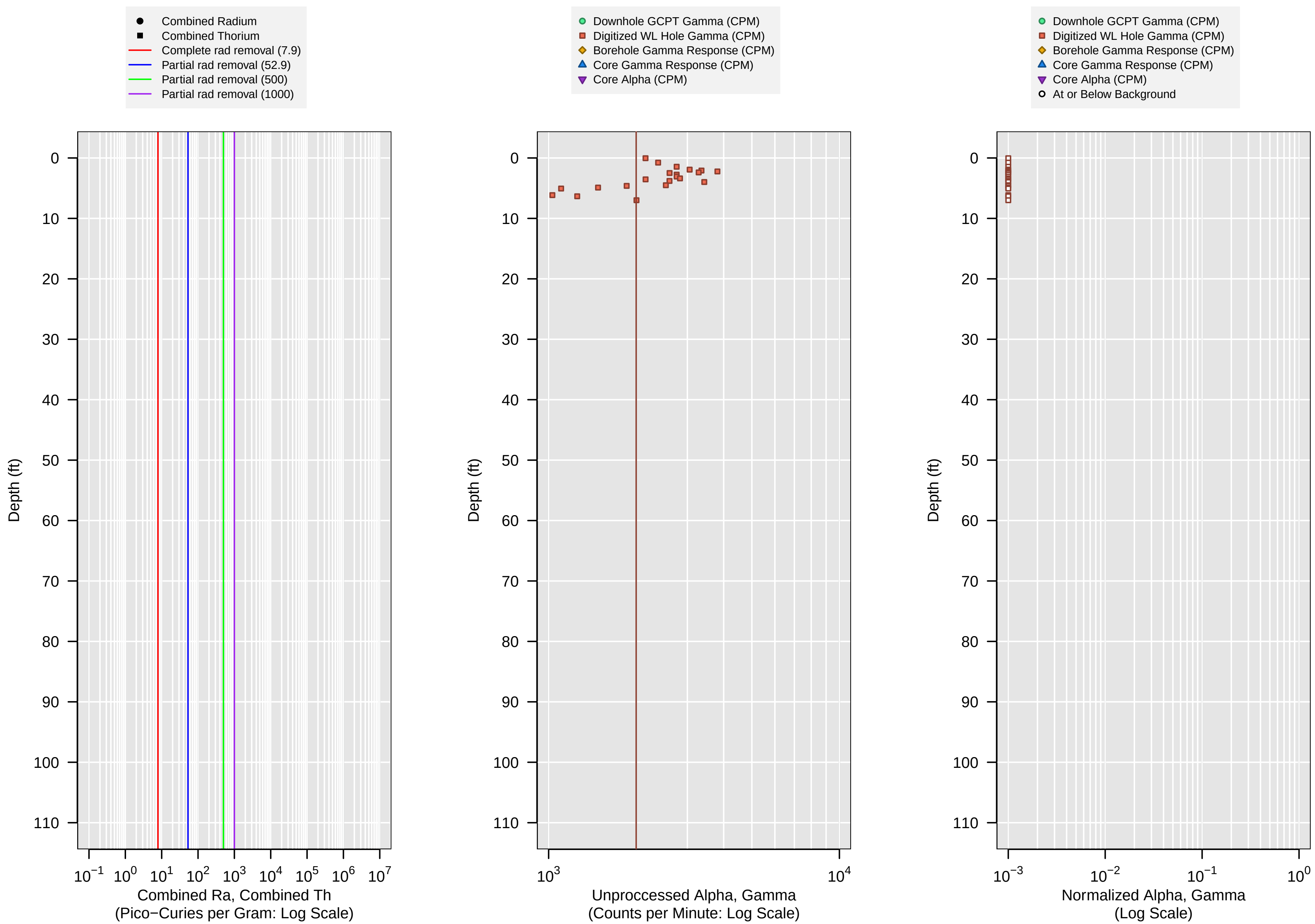
WL−239−MH


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
T
R
T
R
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

WL−240−MH

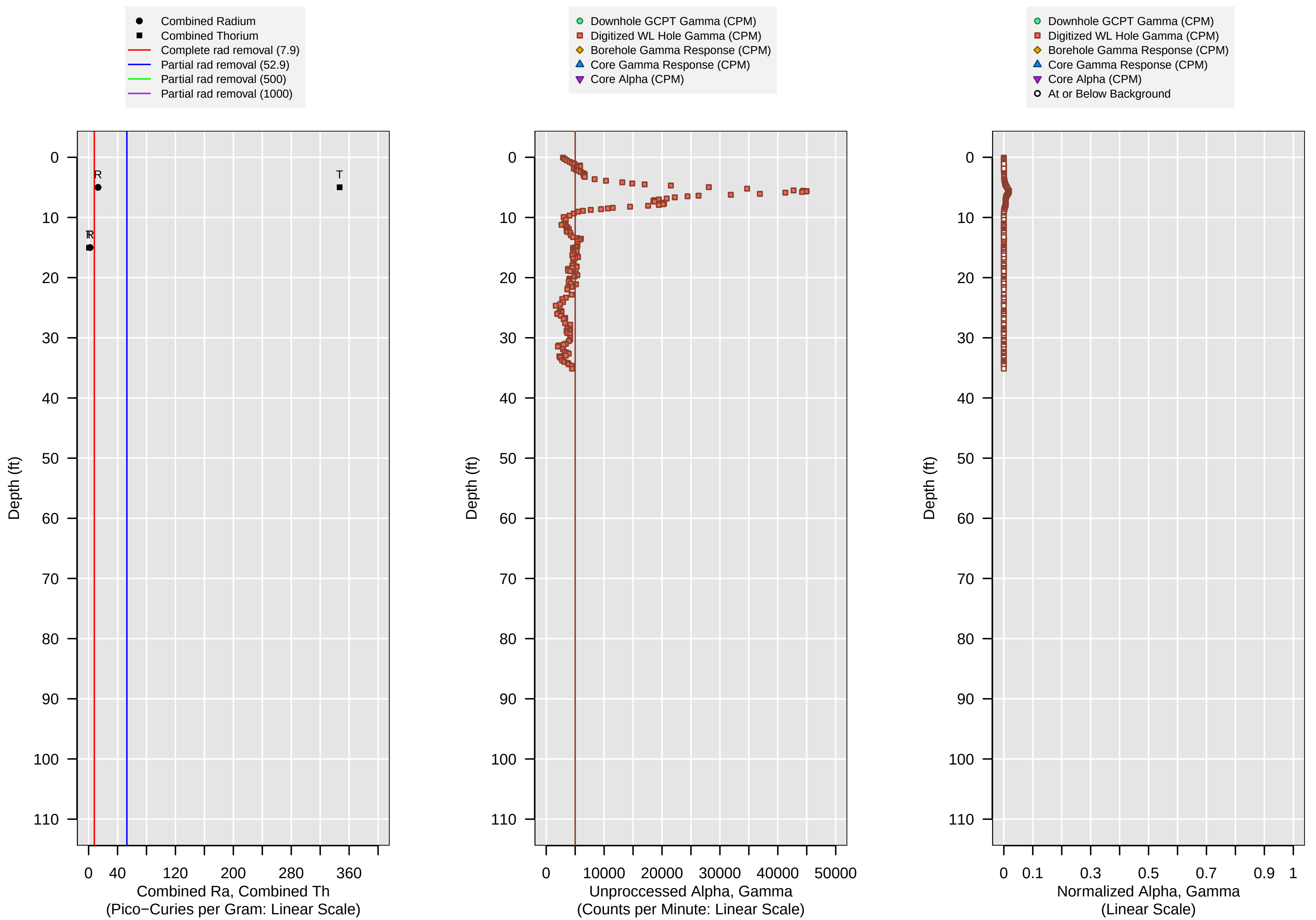

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−240−MH



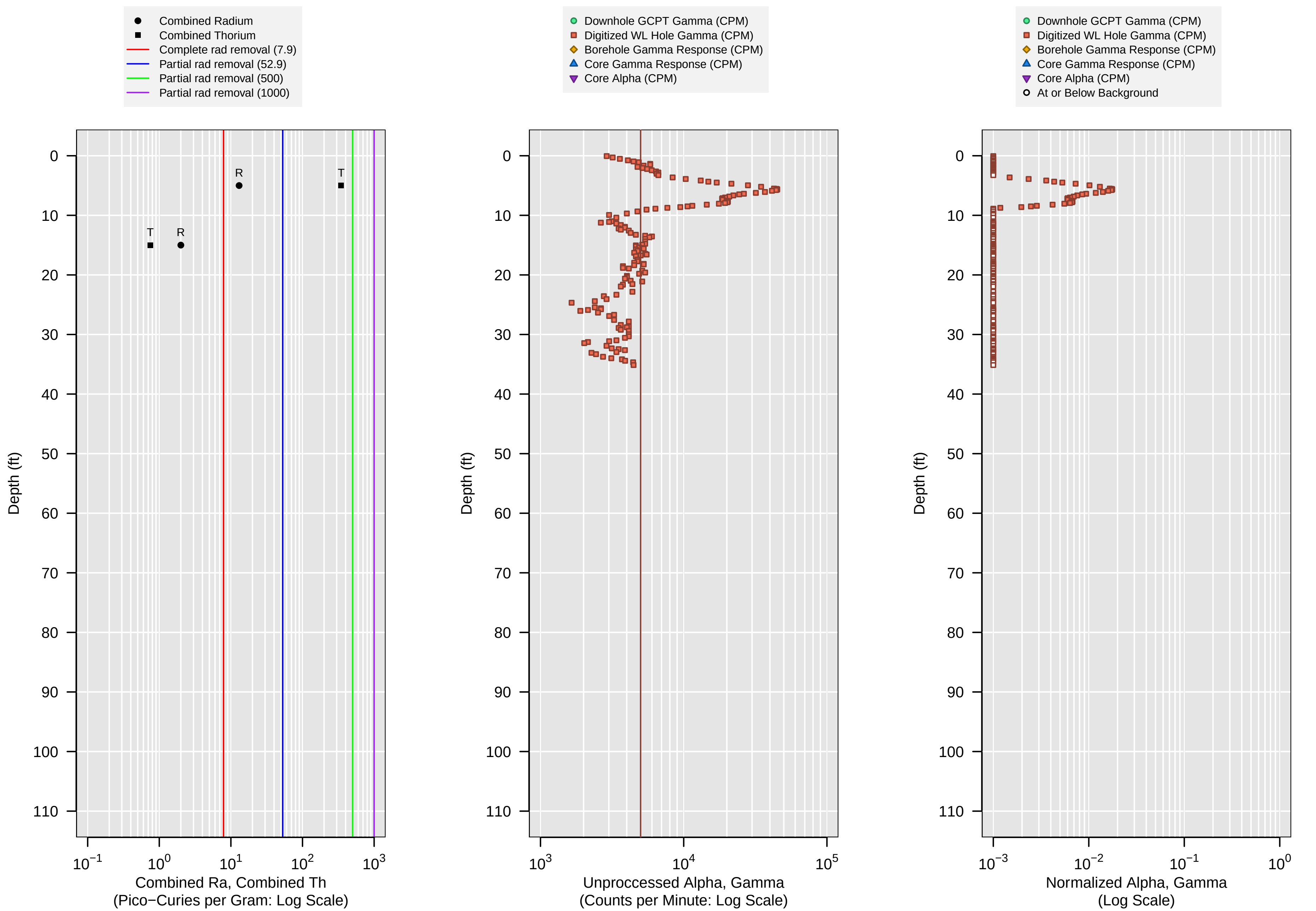
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−241−MH

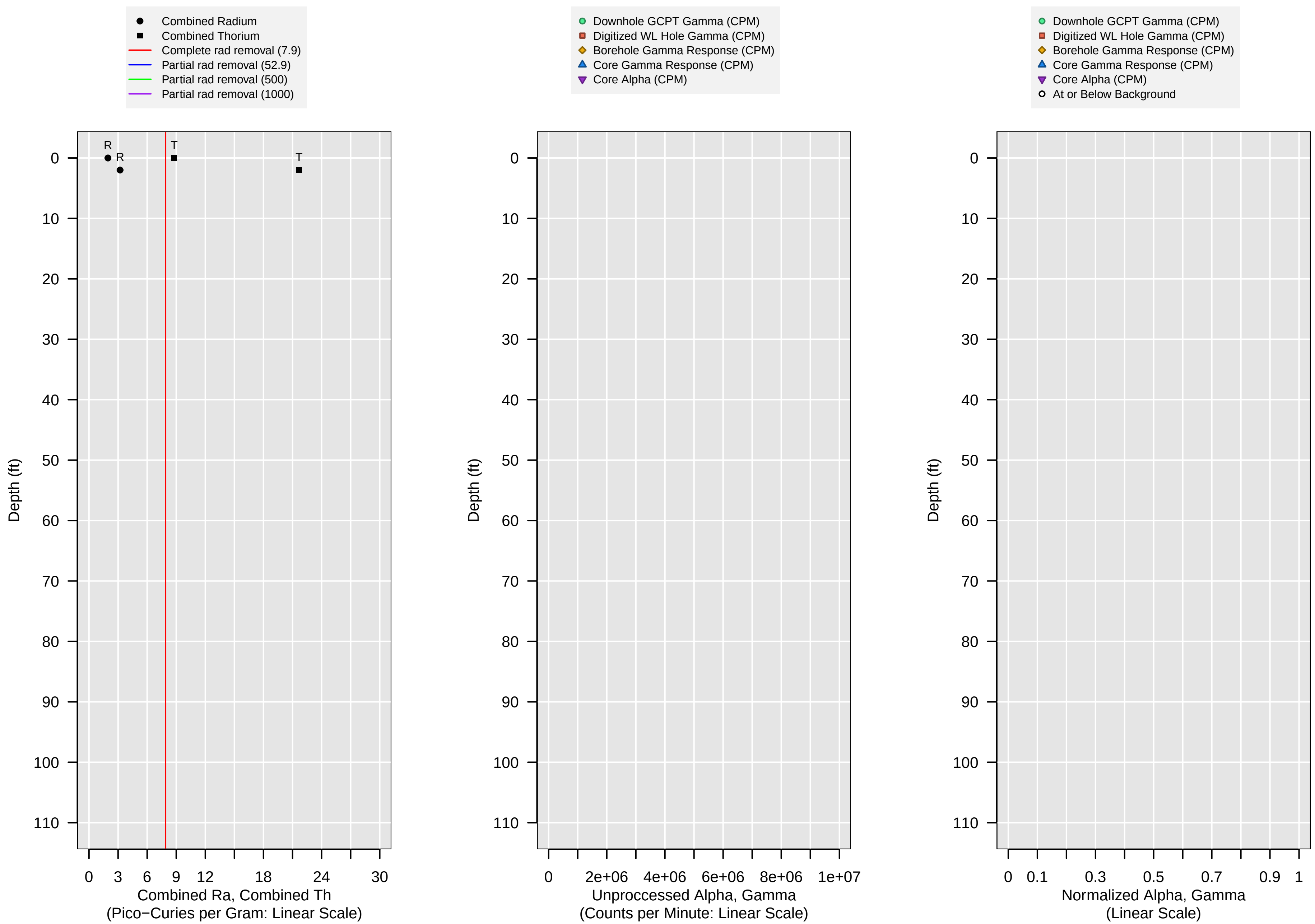


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
Normalized Alpha, Gamma
(Linear Scale)

WL−241−MH

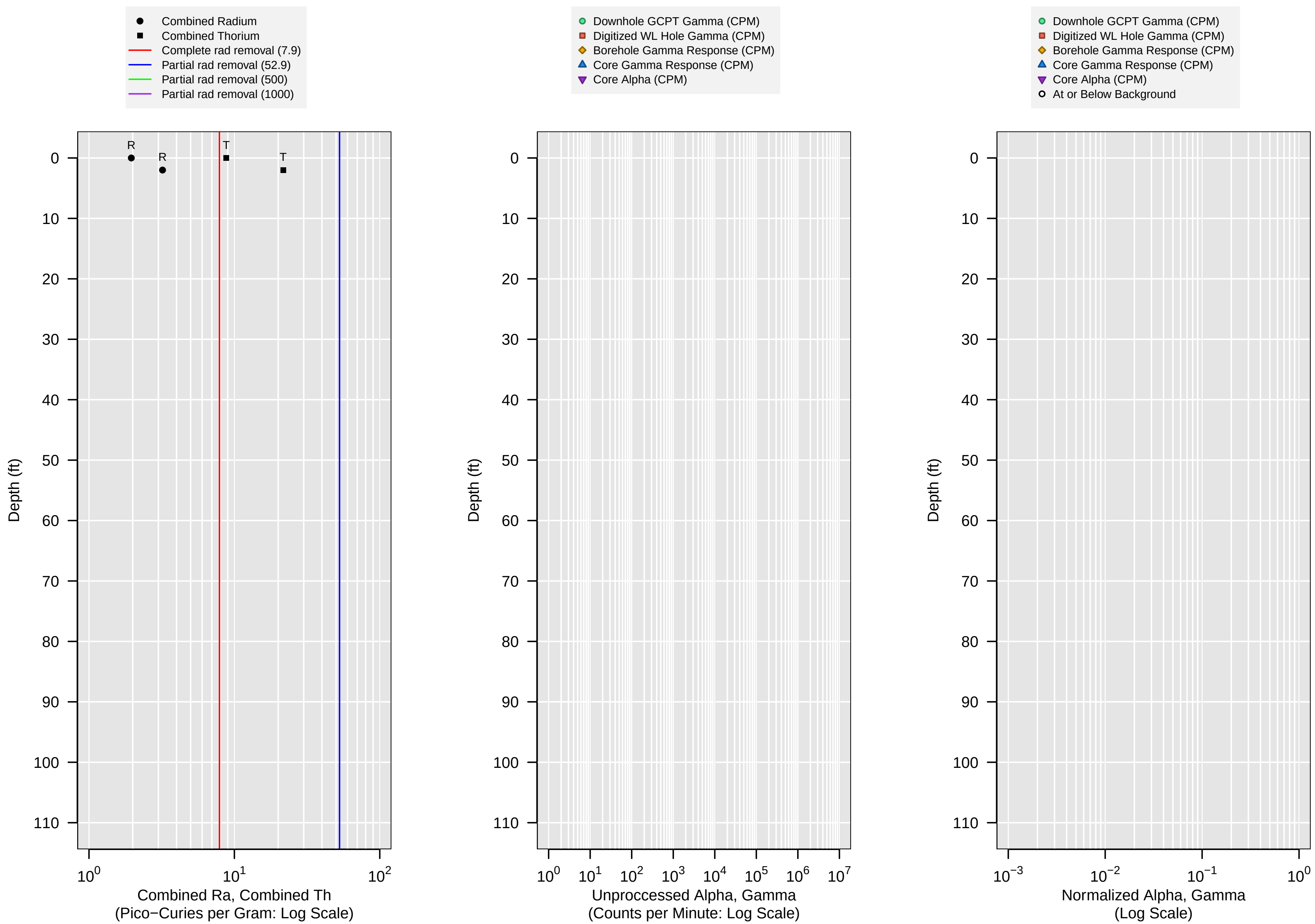

Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

WL−242

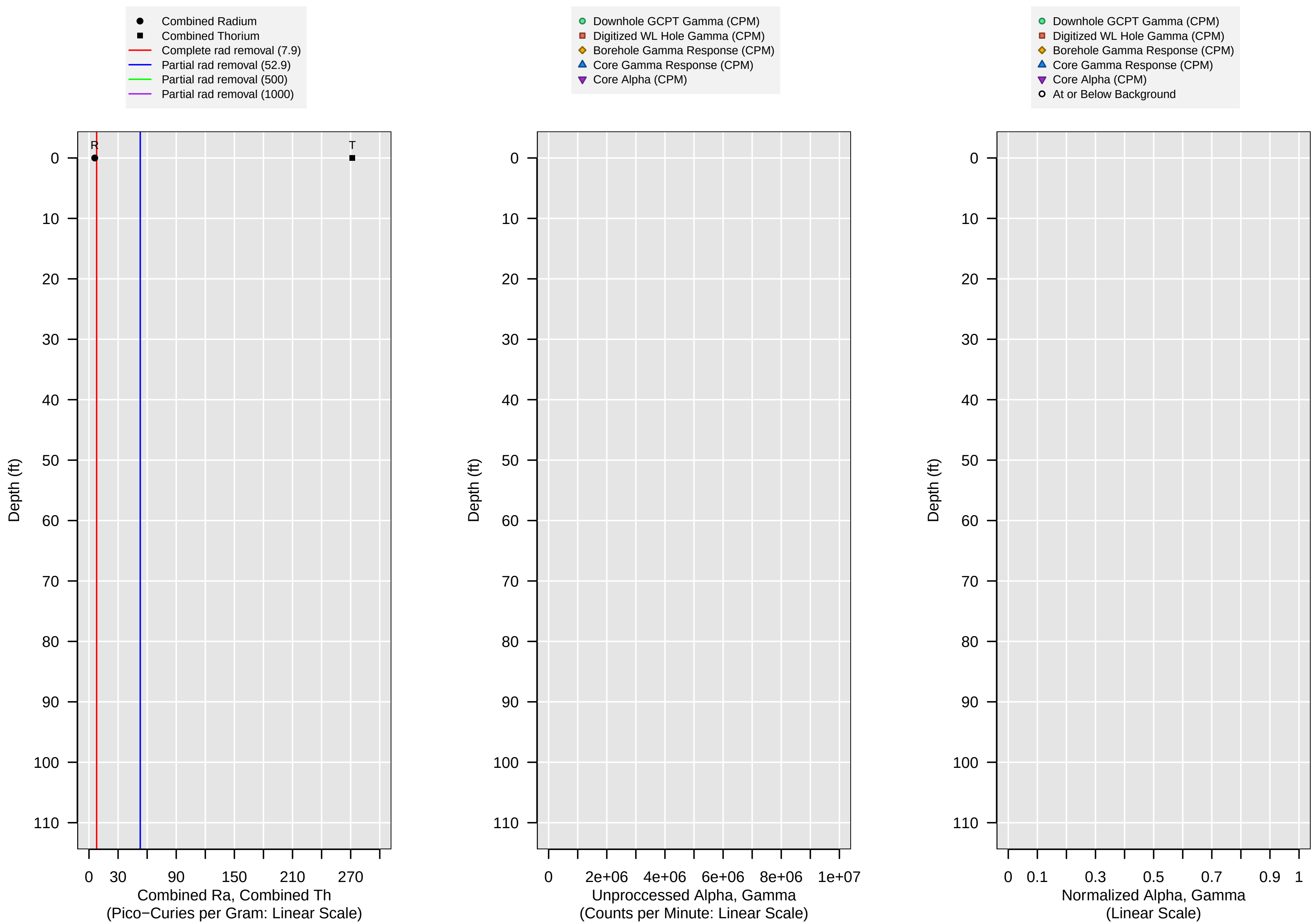


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
R
T
T
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
3
6
9
12
18
24
30
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
2e+06
4e+06
6e+06
8e+06
1e+07
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
0.1
0.3
0.5
0.7
0.9
1
Normalized Alpha, Gamma
(Linear Scale)

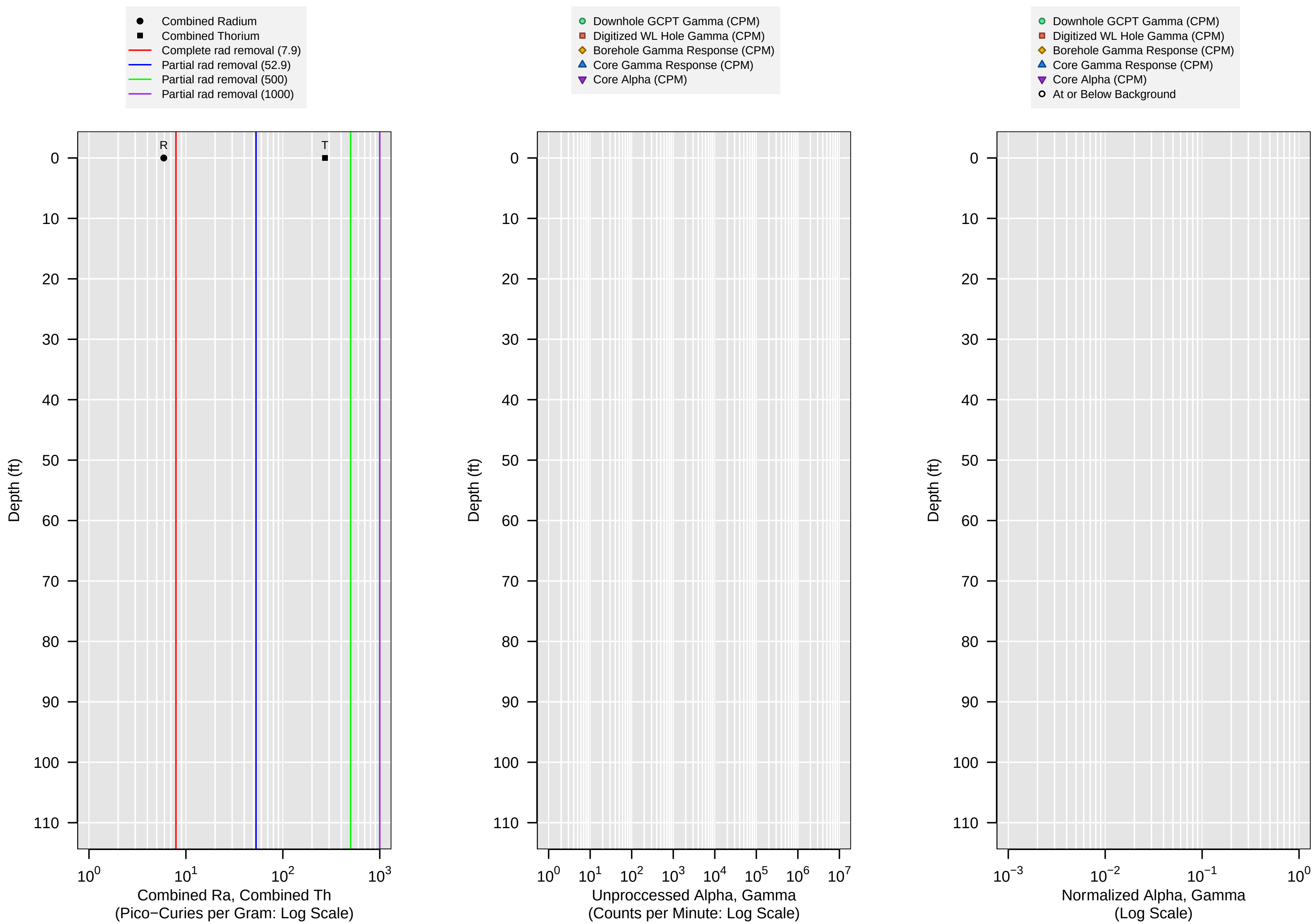
WL−242


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
R
T
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

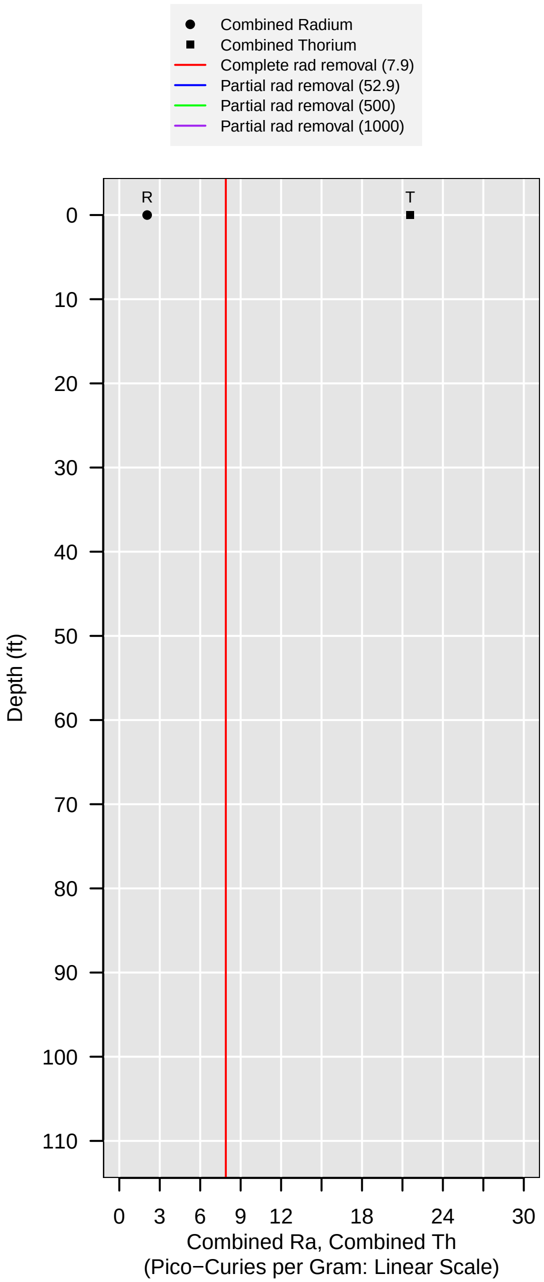
WL−243


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 30 90 150 210 270
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
0 2e+06 4e+06 6e+06 8e+06 1e+07
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)
At or Below Background
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

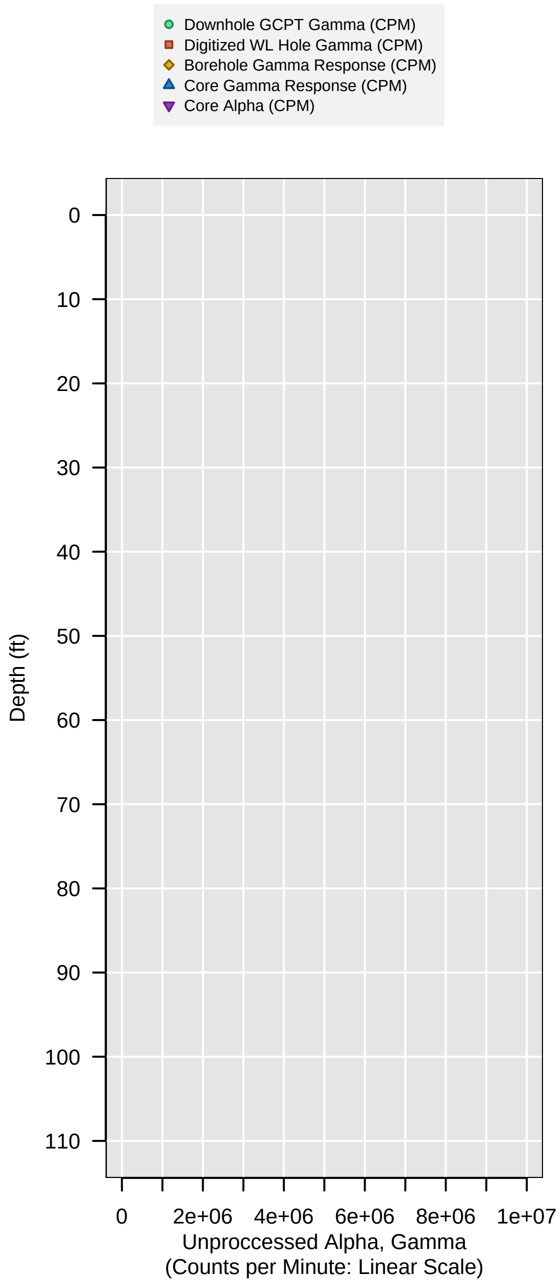
WL−243


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

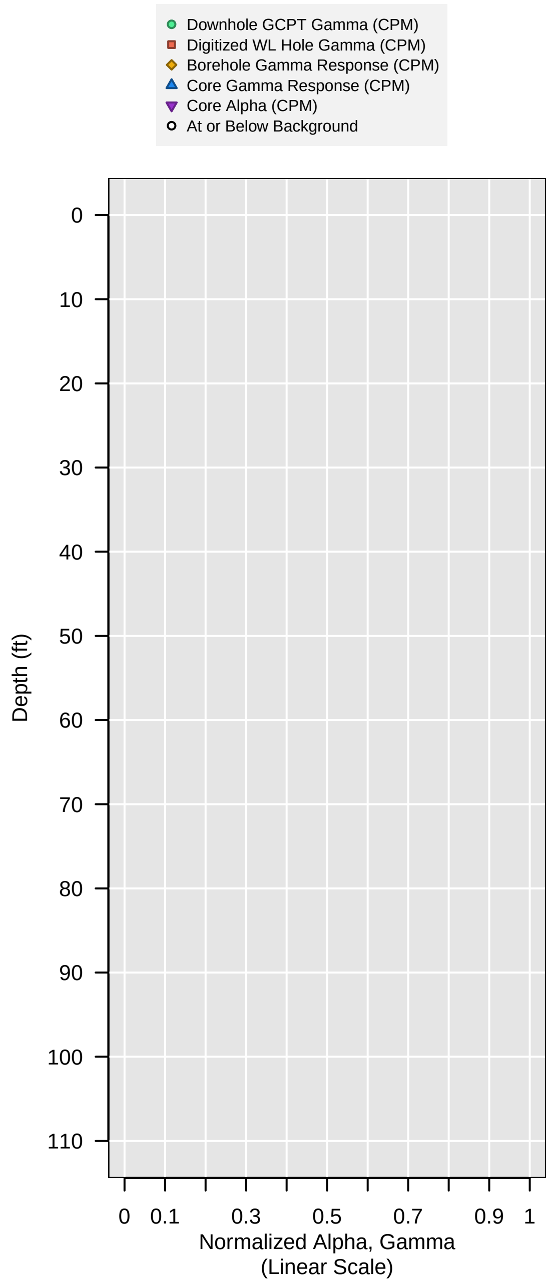
WL−244



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 3 6 9 12 18 24 30
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)

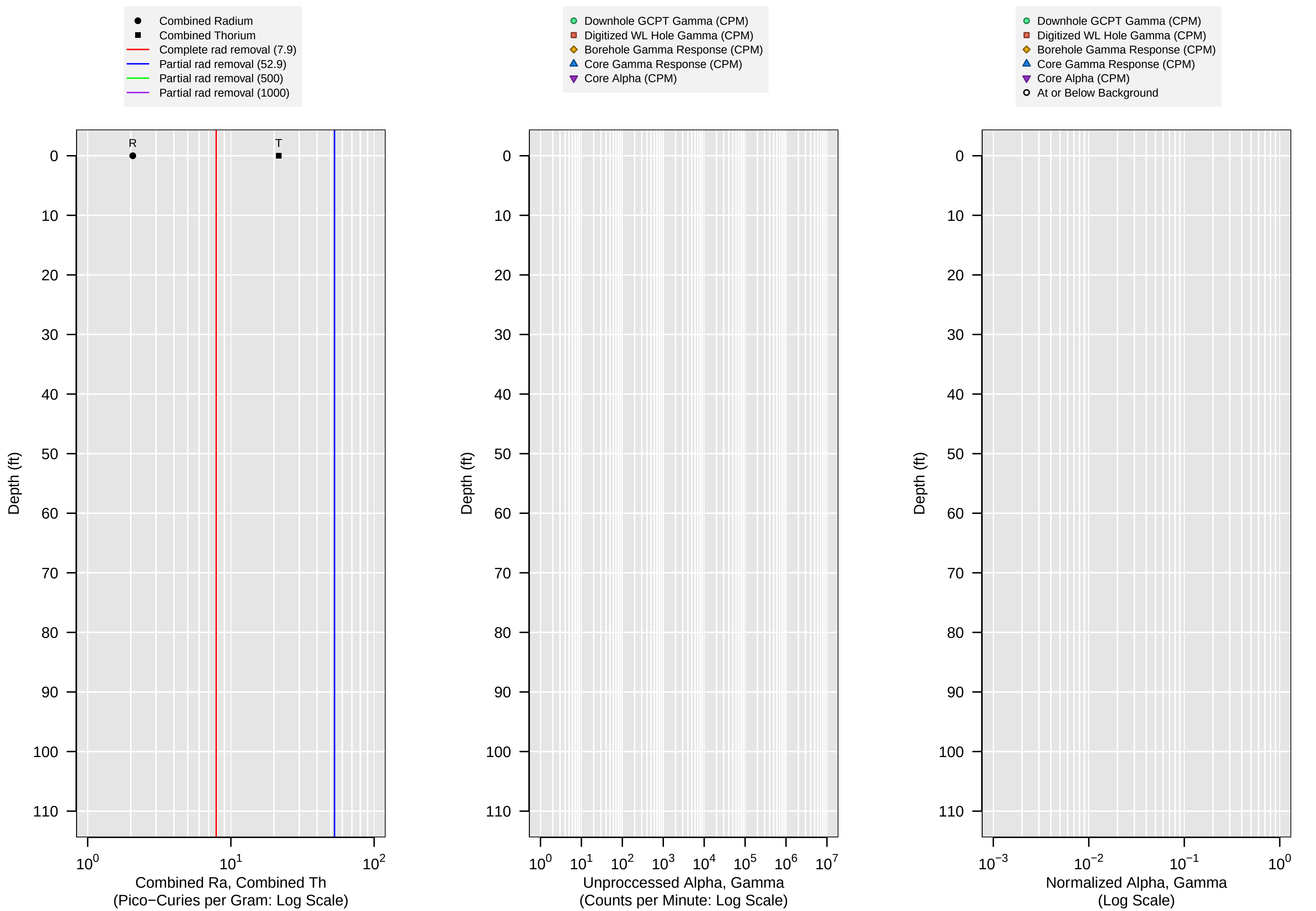


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 2e+06 4e+06 6e+06 8e+06 1e+07
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)

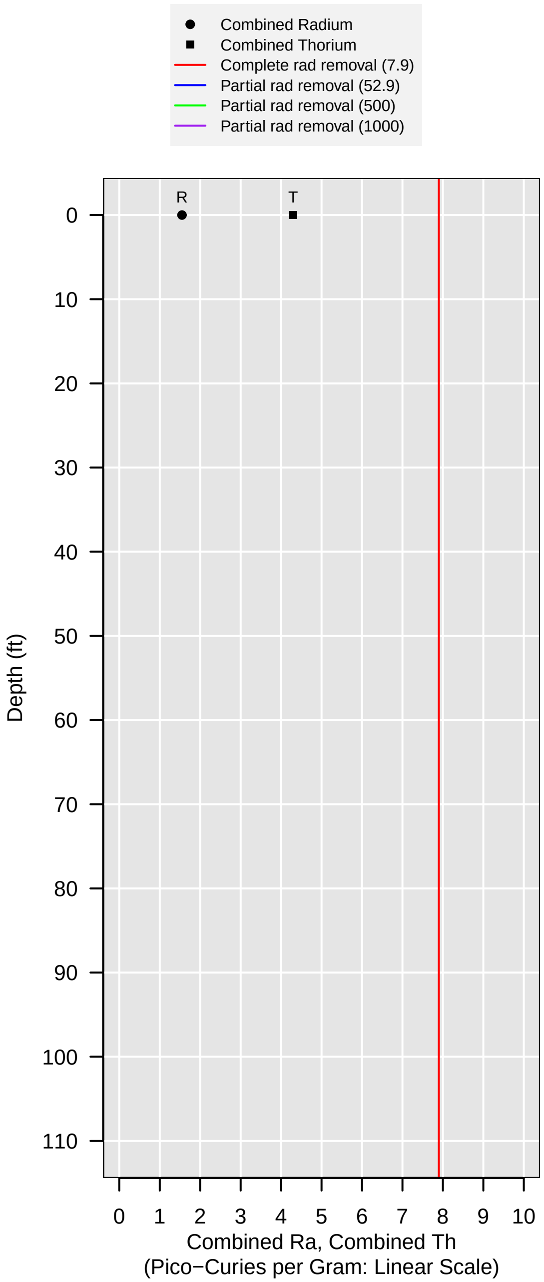


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

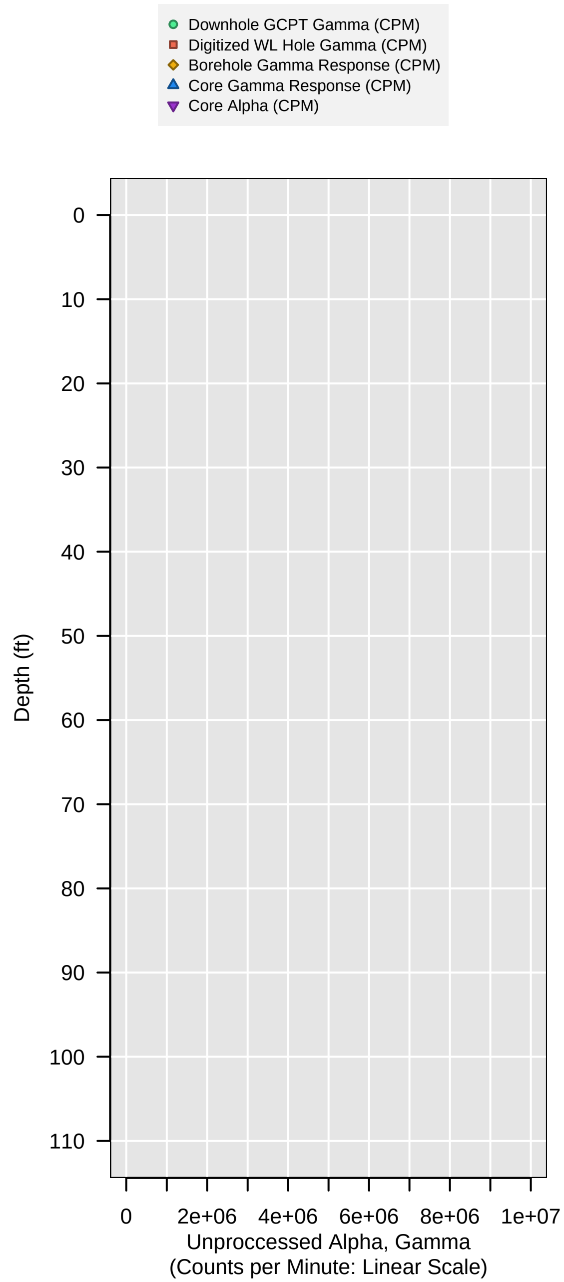
WL−244


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
Normalized Alpha, Gamma
(Log Scale)

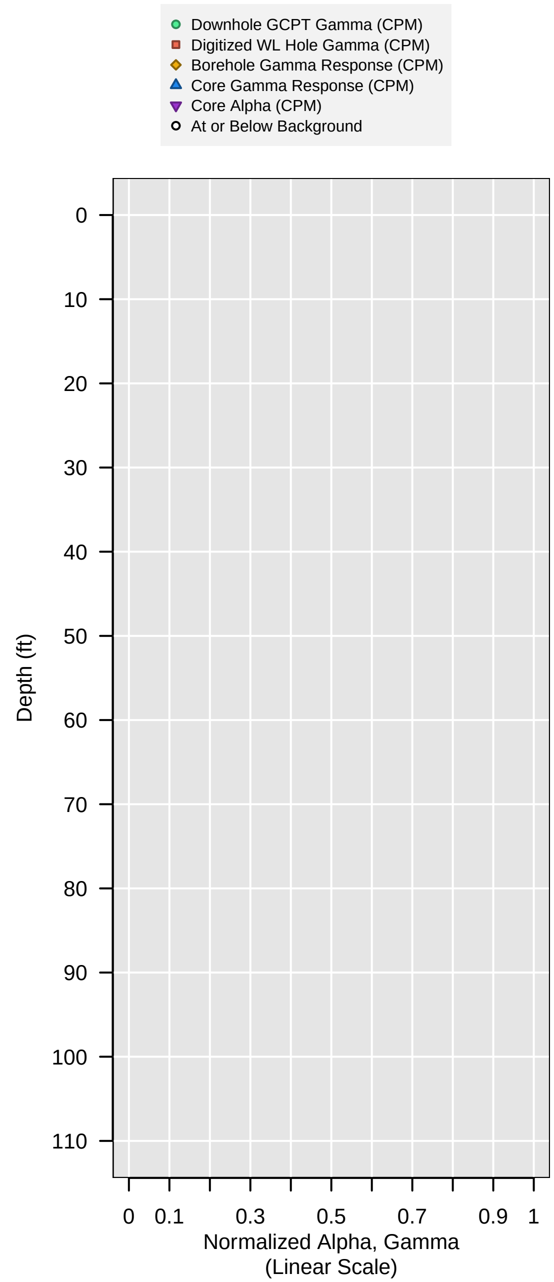
WL−245



Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
0 10 20 30 40 50 60 70 80 90 100 110
0 1 2 3 4 5 6 7 8 9 10
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)

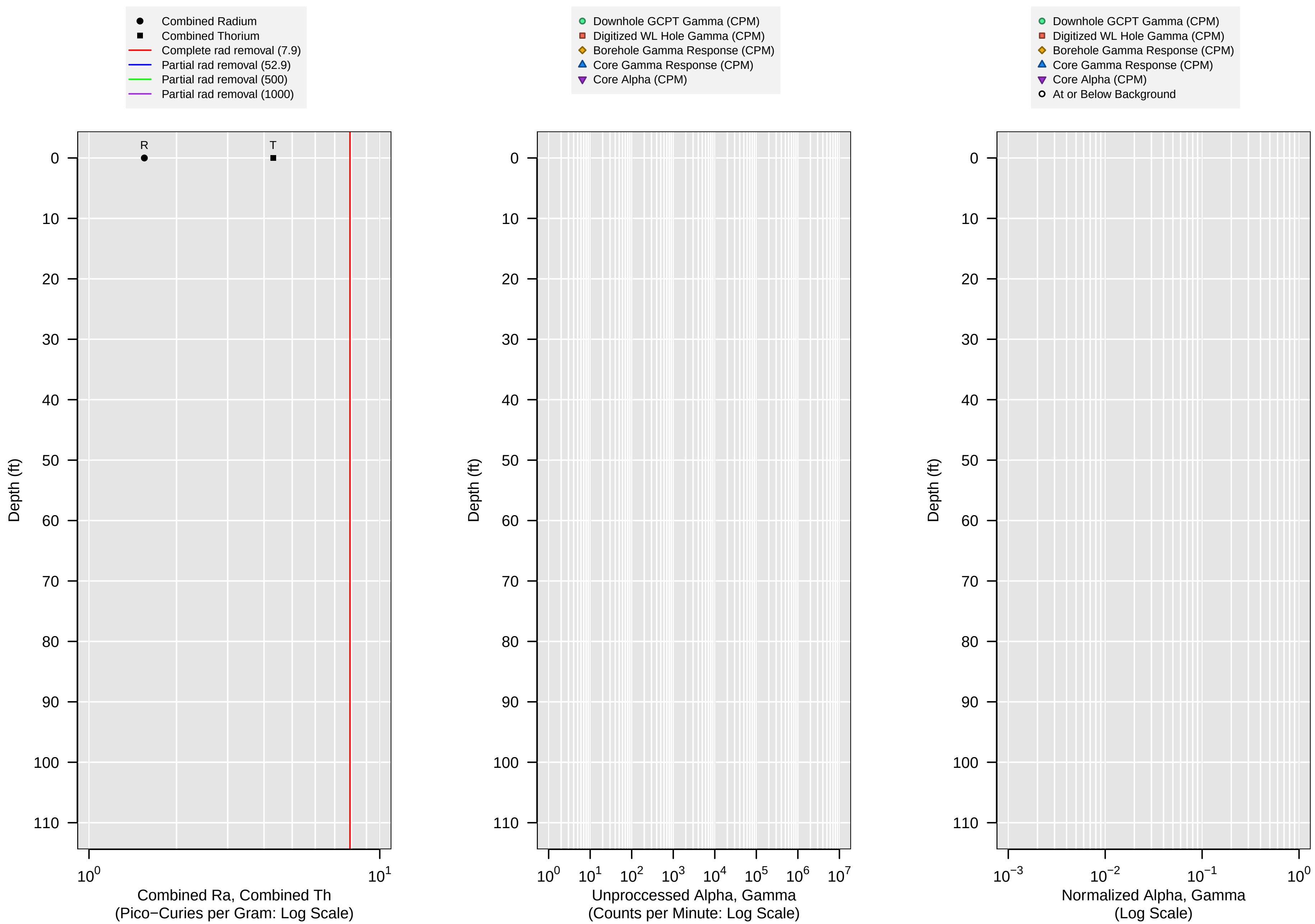


Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0 10 20 30 40 50 60 70 80 90 100 110
0 2e+06 4e+06 6e+06 8e+06 1e+07
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)



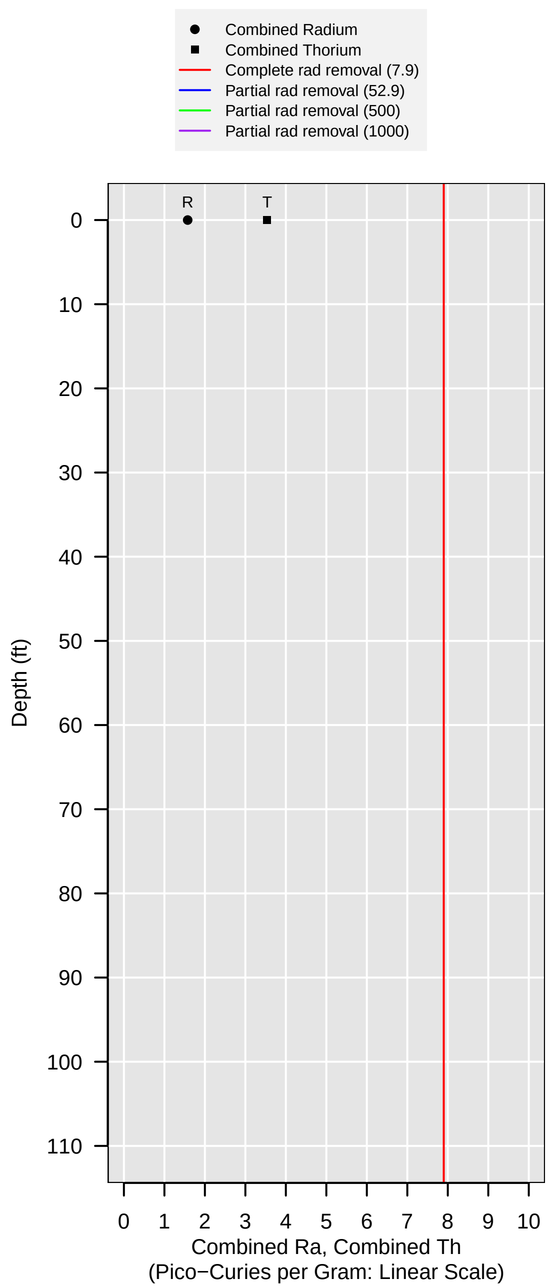
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0 10 20 30 40 50 60 70 80 90 100 110
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)

WL−245

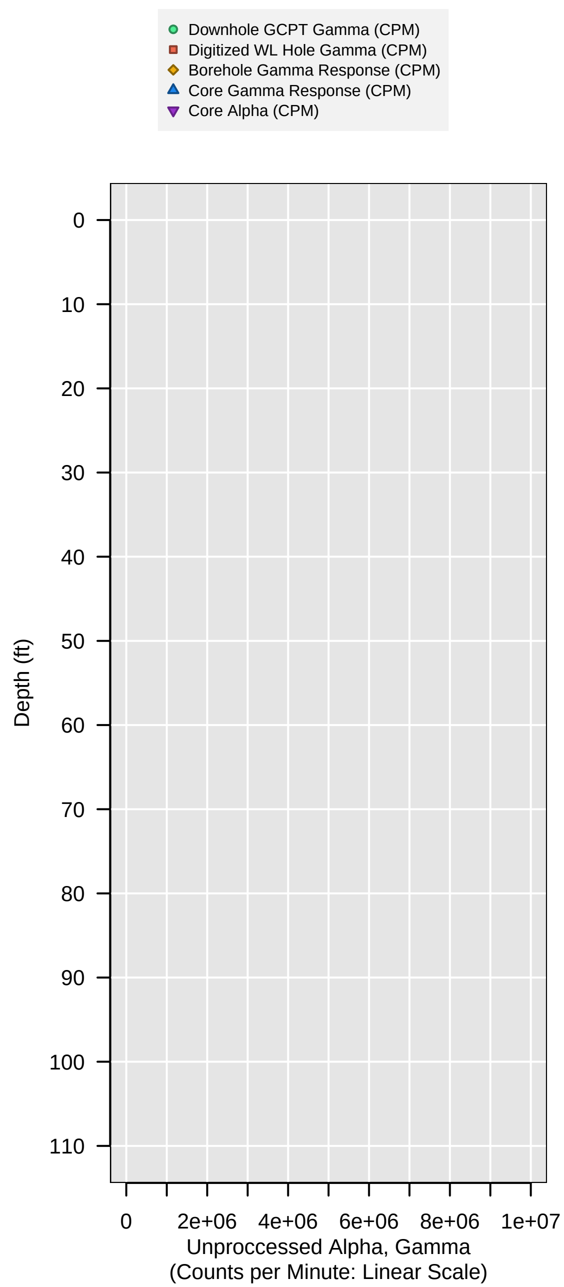


Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
10^0
10^1
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
10^0 10^1 10^2 10^3 10^4 10^5 10^6 10^7
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
10^{-3} 10^{-2} 10^{-1} 10^0
Normalized Alpha, Gamma
(Log Scale)

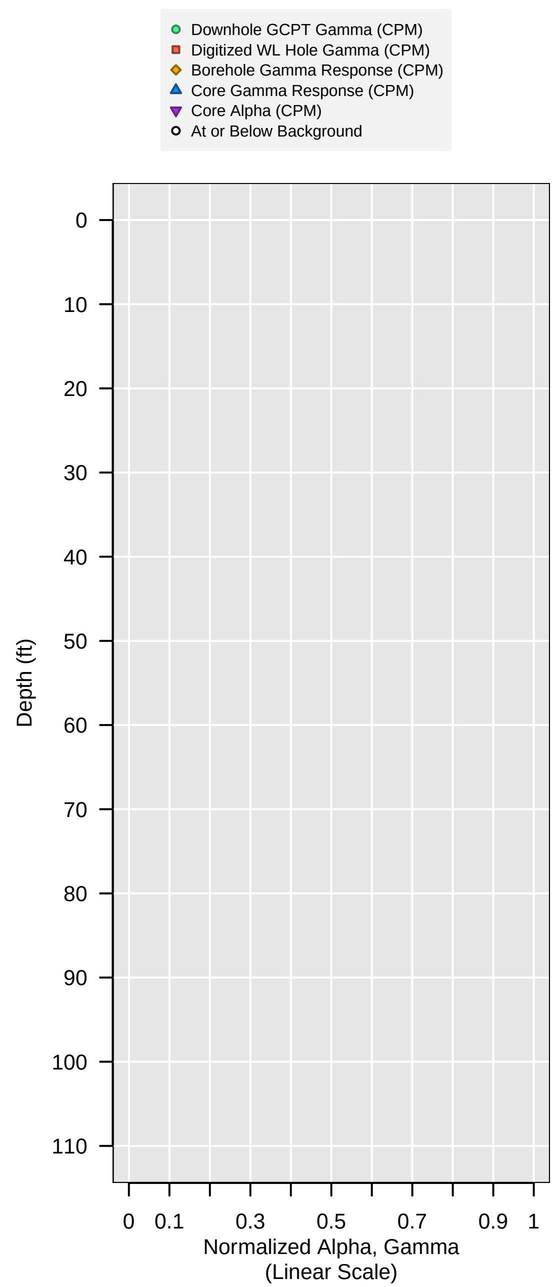
WL−246



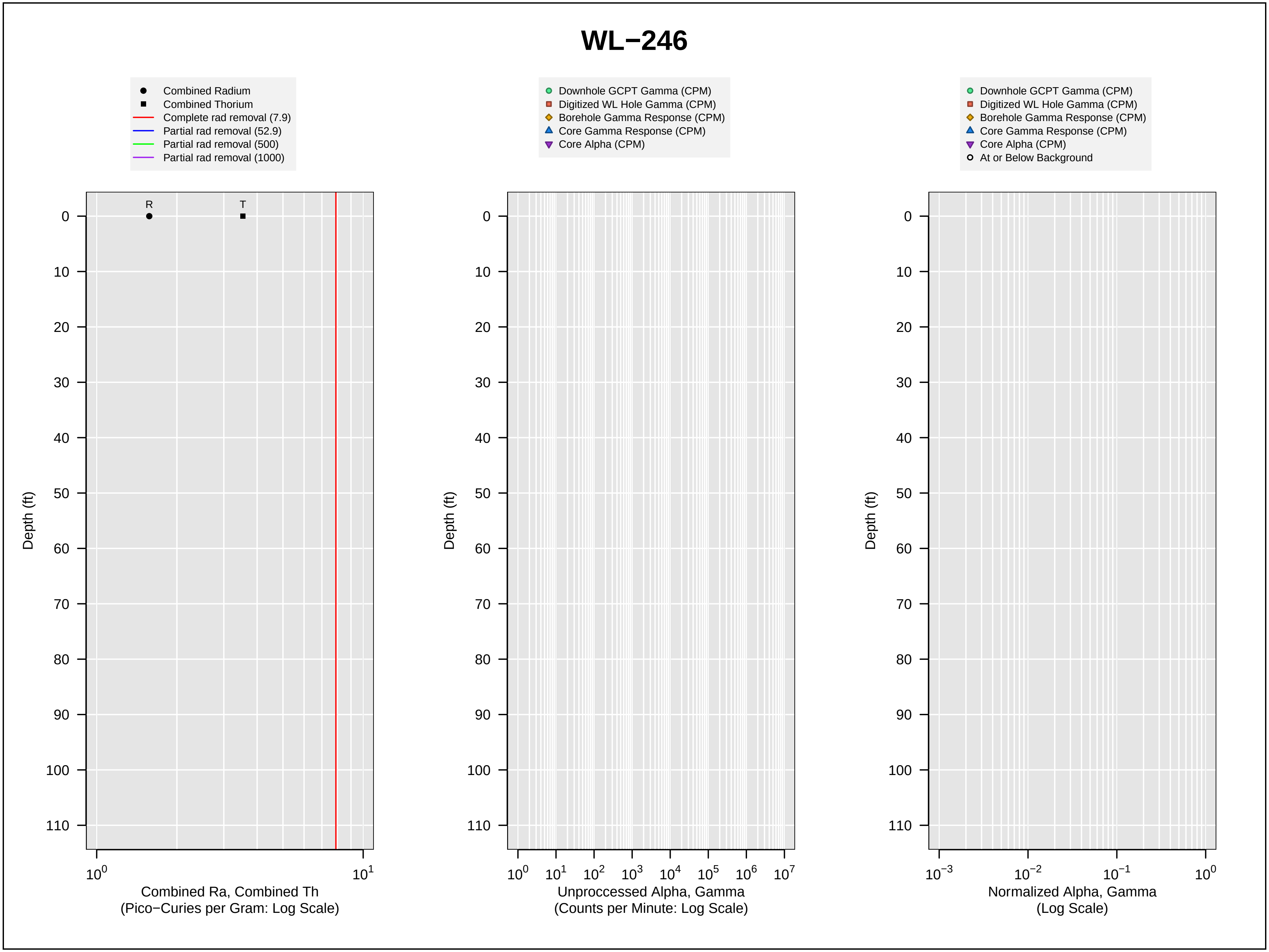
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 1 2 3 4 5 6 7 8 9 10
Combined Ra, Combined Th
(Pico−Curies per Gram: Linear Scale)



Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 2e+06 4e+06 6e+06 8e+06 1e+07
Unproccessed Alpha, Gamma
(Counts per Minute: Linear Scale)



Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
At or Below Background
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
0 0.1 0.3 0.5 0.7 0.9 1
Normalized Alpha, Gamma
(Linear Scale)


WL−246
Combined Radium
Combined Thorium
Complete rad removal (7.9)
Partial rad removal (52.9)
Partial rad removal (500)
Partial rad removal (1000)
R
T
Depth (ft)
Combined Ra, Combined Th
(Pico−Curies per Gram: Log Scale)
Downhole GCPT Gamma (CPM)
Digitized WL Hole Gamma (CPM)
Borehole Gamma Response (CPM)
Core Gamma Response (CPM)
Core Alpha (CPM)
Unproccessed Alpha, Gamma
(Counts per Minute: Log Scale)
At or Below Background
Normalized Alpha, Gamma
(Log Scale)

Appendix C

Ensemble Empirical Variograms in the Vertical Direction

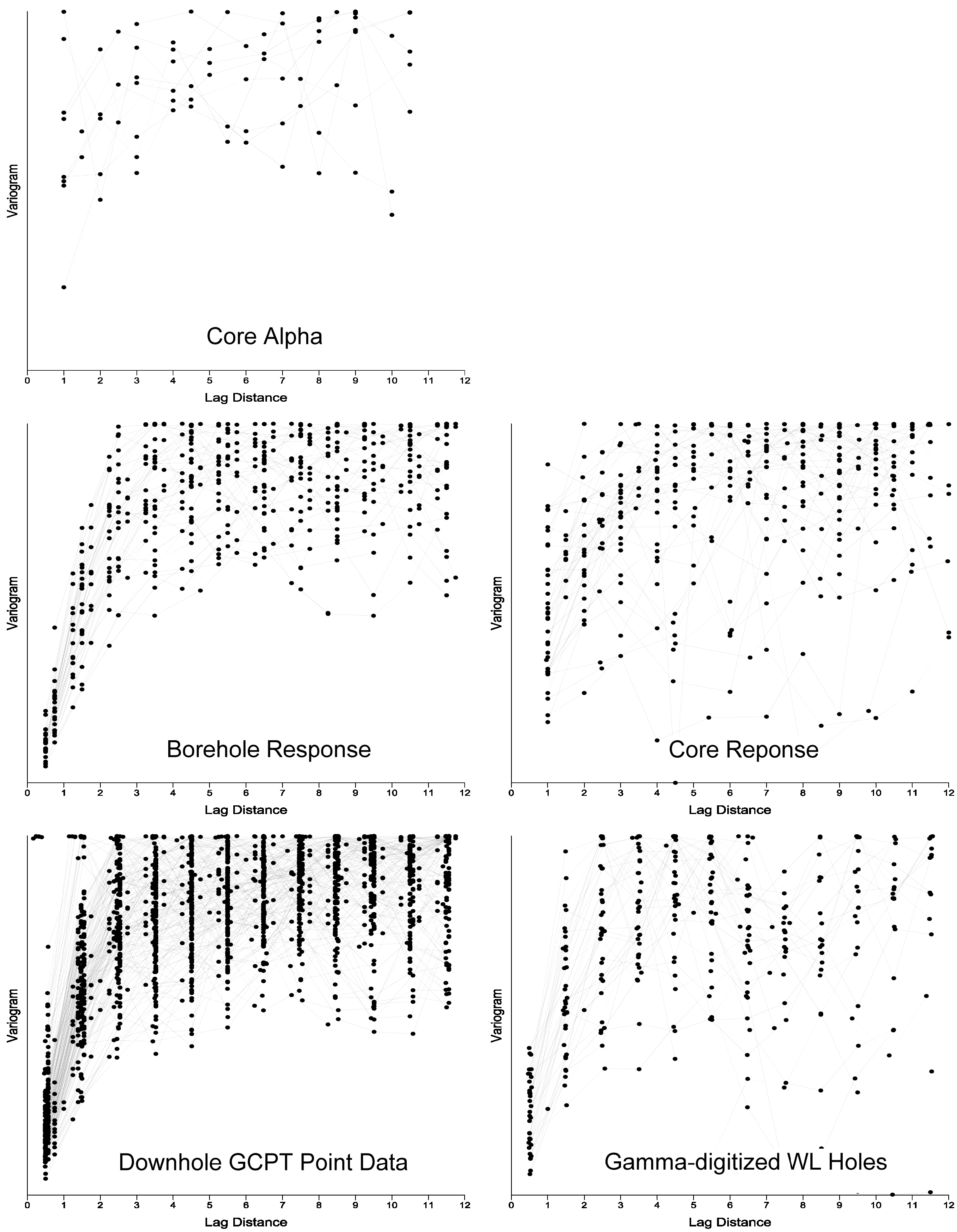


Figure C-1 Ensemble Empirical Variograms – Area 1

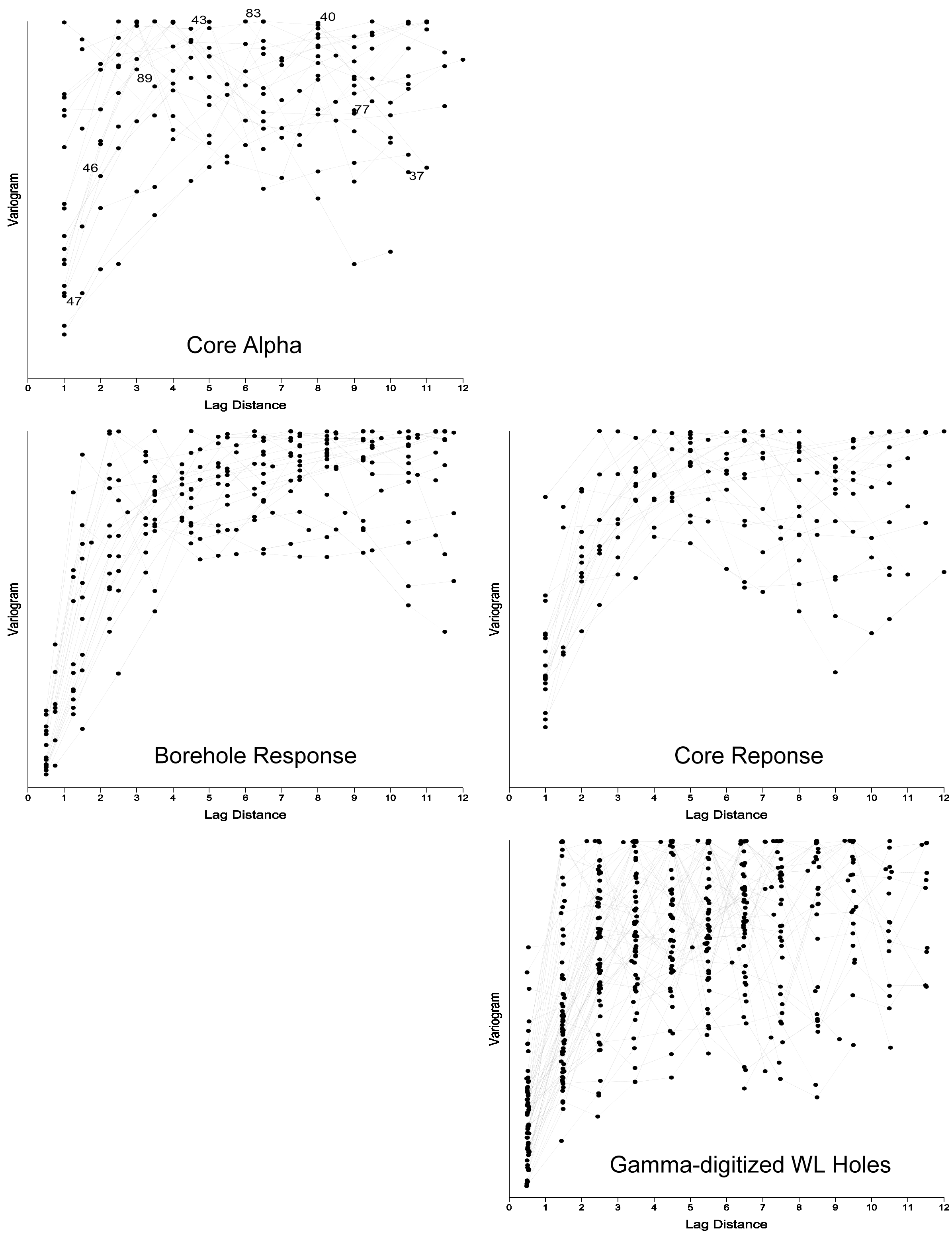


Figure C-2 Ensemble Empirical Variograms – Area 2

Appendix C

Off-site Disposal Facilities – Waste Acceptance Criteria

Appendix C-1:

U.S. Ecology, Inc. – Grandview, Idaho

C.3 WASTE ACCEPTANCE CRITERIA

C.3.1 Pre-acceptance Review

The preacceptance protocol has been designed to ensure that only hazardous and radioactive material that can be properly and safely stored, treated and/or disposed of by USEI are approved for receipt at the facility. A two-step approach is taken by USEI. The first step is the chemical and/or radiological and physical characterization of the candidate waste stream by the generator. The second step is the preacceptance evaluation performed by USEI to determine the acceptability of the waste for receipt at the facility. Figure C-2 presents a logic diagram of the preacceptance protocol that is utilized at the facility.

C.3.2 Radioactive Material Waste Acceptance Criteria

The following waste acceptance criteria are established for accepting radiological contaminated waste material that is generally or specifically exempted from regulation by the Nuclear Regulatory Commission (NRC) or an Agreement State under the Atomic Energy Act of 1954 (“AEA”), as amended. Material may also be accepted if it is not regulated or licensed by the NRC or has been authorized for disposal by the IDEQ and is within the numeric waste acceptance criteria. Waste acceptance criteria are consistent with these restrictions.

The following five tables establish types and concentrations of radioactive materials that may be accepted. These tables are based on categories and types of radioactive material not regulated by the NRC based on statute or regulation or specifically approved by the NRC or and Agreement State for alternate disposal. The criteria are consistent with these restrictions and detailed analyses set forth in *Waste Acceptance Criteria and Justification for FUSRAP Material*, prepared by Radiation Safety Associates, Inc. (RSA) as subsequently refined, expanded and updated in *Waste Acceptance Criteria and Justification for Radioactive Material*, prepared by USEI.

Material may be accepted if the material has been specifically exempted from regulation by rule, order, license, license condition, letter of interpretation, or specific authorization under the following conditions: Thirty (30) days prior to intended shipment of such materials to the facility, USEI shall notify IDEQ of its intent to accept such material and submit information describing the material’s physical, radiological, and/or chemical properties, impact on the facility radioactive materials performance assessment, and the basis for determining that the material does not require disposal at a facility licensed under the AEA. The IDEQ will have 30 days from receipt of this notification to reject USEI’s determination or require further information and review. No response by IDEQ within thirty (30) days following receipt of such notice shall constitute concurrence. IDEQ concurrence is not required for generally exempted material as set forth in Table C.4a.

Based on categories of waste described in the waste acceptance criteria, the concentration of the various radionuclides in the conveyance (e.g., rail car gondola, other container etc.) shall not exceed the concentration limits established in the WAC without the specific written approval of the IDEQ unless generally exempted as set forth in Table C.4a. Radiological surveys will be performed as outlined in ERMP-01 to verify compliance with the WAC. If individual “pockets” of activity are detected indicating the limits may be exceeded, the RSO or RPS shall investigate the discrepancy and estimate the extent or volume of the material with the potentially elevated radiation levels. The RPS or RSO shall then make a determination on the compliance of the entire conveyance load with the appropriate WAC limits. If the conveyance is determined not to meet the limits, USEI will notify IDEQ's RCRA Program Manager within 24 hours of a concentration based exceedance of the facility WAC to evaluate and discuss management options. The findings and resolution actions shall then be documented and submitted to the IDEQ.

The radioactive material waste acceptance criteria, when used in conjunction with an effective radiation monitoring and protection program as defined in the USEI *Radioactive Material Health and Safety Plan* and *Exempt Radioactive Materials Procedures* provides adequate protection of human health and the environment. Included within this manual are requirements for USEI to submit a written summary report of Table C.1 through C.2 radioactive material waste receipts showing volumes and radionuclide concentrations disposed at the USEI site on a quarterly basis. USEI will also submit a Table C.3 through C.4b annual report of exempted products devices, materials or items within 60 (sixty) days of year end (December 31st). The annual report will provide total volumes or mass of isotopes and total activity by isotope listing the activity of each radionuclide disposed during the preceding year, and the cumulative total of activity for each radionuclide disposed at the facility. The report will include an updated analysis of the impact on the facility performance assessment.

These criteria and procedures are designed to assure that the highest potential dose to a worker handling radioactive material at USEI shall not exceed 400 mrem/year TEDE dose, and that no member of the public is calculated to receive a potential dose exceeding 15 mrem/year TEDE dose, from the USEI program. TEDE is defined as the "Total Effective Dose Equivalent", which equals the sum of external and internal exposures. The public dose limit during operation activities is limited to 100 mrem/yr TEDE dose. An annual summary report of environmental monitoring results will be submitted to IDEQ by June 1st for the preceding year.

Materials that have a radioactive component that meets the criteria described in Tables C.1 through C.4b and are RCRA regulated material will be managed as described within this WAP for the RCRA regulated constituents.

Table C.1: Unimportant Quantities of Source Material Uniformly Dispersed* in Soil or Other Media**

	Status of Equilibrium	Maximum Concentration of Source Material	Sum of Concentrations Parent(s) and all progeny present***
a	Natural uranium in equilibrium with progeny	<500 ppm / 167 pCi/g (^{238}U activity)	≤ 3000 pCi/g
	Refined natural uranium (^{238}U, ^{235}U, ^{234}U; ^{234Th}, ^{234m}Pa, ^{231}Th)	<500 ppm / 333 pCi/g	≤ 2000 pCi/g
	Depleted Uranium (^{234Th}, ^{234m}Pa)	<500 ppm / 169 pCi/g	≤ 2000 pCi/g
b	Natural thorium (^{232}Th + ^{228}Th)	<500 ppm / 110 pCi/g	≤ 2000 pCi/g
	^{230}Th in equilibrium with progeny	<0.01 ppm / 200 pCi/g	≤2000 pCi/g
	^{230}Th (with no progeny)	0.1 ppm / ≤2000 pCi/g	
	Any mixture of Thorium and Uranium	Sum of ratios ≤ 1****	≤2000 pCi/g

Table C.2: Naturally Occurring Radioactive Material Other Than Uranium and Thorium Uniformly Dispersed* in Soil or Other Media**

	Status of Equilibrium	Maximum Concentration of Parent Nuclide	Sum of Concentrations of Parent and All Progeny Present***
a	^{226}Ra or ^{228}Ra with progeny in bulk form [1]	500 pCi/g	≤ 4500 pCi/g
b	^{226}Ra or ^{228}Ra with progeny in reinforced IP-1 containers [1]	1500 pCi/g	13,500 pCi/g
c	^{210}Pb with progeny(Bi & ^{210}Po)	1500 pCi/g	4500 pCi/g
	^{40}K	818 pCi/g	N/A
	Any other NORM		≤3000 pCi/g

[1] Any material containing ^{226}Ra greater than 222 pCi/g shall be disposed at least 6 meters from the external point on the completed cell.

Table C.3: Non-Production Particle Accelerator Produced Radioactive Material*****

Acceptable Material	Activity or Concentration
Any non-production particle accelerator produced radionuclide.	All materials shall be packaged in accordance with USDOT packaging requirements. Any packages containing iodine or volatile radionuclides will have lids or covers sealed to the container with gaskets. Contamination levels on the surface of the packages shall not exceed those allowed at point of receipt by USDOT rules. Gamma or x-ray radiation levels may not exceed 10 millirem per hour anywhere on the surface of the package. All packages received shall be directly disposed in the active cell. All containers shall be certified to be 90% full.

*Average over conveyance or container. The use of the phrase "over the conveyance or container is meant to reflect the variability on the generator side. The concentration limit is the primary acceptance criteria.

**Unless otherwise authorized by IDEQ, other Media does not include radioactively contaminated liquid (except for incidental liquids in materials). See radioactive contaminated liquid definition (definition section of Part B permit).

******* Diffuse waste with a total concentration (sum of concentrations of all radionuclides present) which is 2000 pCi/g or less may be accepted at the site (i.e., the controlling limit is 2000 pCi/g).

******** $$\frac{\text{Conc. of U in sample}}{\text{Allowable conc. of U}} + \frac{\text{Conc. of Th in Sample}}{\text{Allowable conc. of Th}} \leq 1$$

***** Any material that has been made radioactive by use of a non-production particle accelerator as set forth in Federal Register, Vol. 72, No. 189, Monday October 1, 2007, page 55868.

Table C.4a: NRC Exempted Products, Devices or Items

Exemption 10 CFR Part*	Product, Device or Item	Isotope, Activity or Concentration
30.15	As listed in the regulation	Various isotopes and activities as set forth in 30.15
30.14, 30.18	Other materials, products or devices specifically exempted from regulation by rule, order, license, license condition, concurrence, or letter of interpretation	Radionuclides in concentrations consistent with the exemption
30.19	Self-luminous products containing tritium, ^{85}Kr, ^{3}H or ^{147}Pm	Activity by Manufacturing license
30.20	Gas and aerosol detectors for protection of life and property from fire	Isotope and activity by Manufacturing license
30.21	Capsules containing ^{14}C urea for *in vivo* diagnosis of humans	^{14}C, one µCi per capsule
40.13(a)	Unimportant quantity of source material: see table above	≤0.05% by weight source material
40.13(b)	Unrefined and unprocessed ore containing source material	As set forth in rule
40.13(c)(1)	Source material in incandescent gas mantles, vacuum tubes, welding rods, electric lamps for illumination	Thorium and uranium, various amounts or concentrations, see rules
40.13(c)(2)	(i)Source material in glazed ceramic tableware (ii)Piezoelectric ceramic (iii) Glassware not including glass brick, pane glass, ceramic tile, or other glass or ceramic used in construction	≤20% by weight ≤2% by weight ≤10% by weight
40.13(c)(3)	Photographic film, negatives or prints	Uranium or Thorium
40.13(c)(4)	Finished product or part fabricated of or containing tungsten or magnesium-thorium alloys. Cannot treat or process chemically, metallurgically, or physically.	≤4% by weight thorium content.
40.13(c)(5)	Uranium contained in counterweights installed in aircraft, rockets, projectiles and missiles or stored or handled in connection with installation or removal of such counterweights.	Per stated conditions in rule.
40.13(c)(6)	Uranium used as shielding in shipping containers if conspicuously and legibly impressed with legend “CAUTION RADIOACTIVE SHIELDING – URANIUM” and uranium incased in at least 1/8 inch thick steel or fire resistant metal.	Depleted Uranium
40.13(c)(7)	Thorium contained in finished optical lenses	≤30% by weight thorium, per conditions in rule.
40.13(c)(8)	Thorium contained in any finished aircraft engine part containing nickel-thoria alloy.	≤4% by weight thorium, per conditions in rule.

Table C.4b: Materials Specifically Exempted by the NRC Or NRC Agreement State

Exemption	Materials	Isotope, Activity or Concentration*
10 CFR 30.11***	Byproduct material including production particle accelerator material exempted from NRC or Agreement State regulation by rule, order, license, license condition or letter of interpretation may be accepted as determined by specific NRC or Agreement State exemption.****	Byproduct material at concentrations consistent with the exemption**
10 CFR 40.14***	Source material exempted from NRC or Agreement State regulation by rule, order, license, license condition or letter of interpretation may be accepted as determined by specific NRC or Agreement State exemption.****	Source material at concentrations consistent with the exemption.
10 CFR 70.17	Special Nuclear Material (SNM) exempted from NRC regulation by rule, order, license, license condition or letter of interpretation may be accepted as determined by specific NRC or Agreement State exemption.****	SNM at concentrations consistent with the exemption.

*Sum of all isotopes up to a maximum concentration of 3,000 pCi/gm.

**Specifically exempted production beam accelerator may be received under Table C.3 provisions [10 CFR 20.2008 (b)]

***Also includes equivalent Agreement State regulation where applicable.

**** Similar material not regulated or licensed by the NRC may also be accepted. Sum of all isotopes up to a maximum concentration of 3,000 pCi/gm. IDEQ shall be notified prior to the receipt of Special Nuclear Material not regulated or licensed by the NRC.

Additional Information for USEI's Waste Analysis Plan

1. US Ecology Idaho, Inc. (USEI) may receive contaminated materials or other materials as described in Tables C.1 - C.4b above. USEI may not accept for disposal any material that by its possession would require USEI to have a radioactive material license from the Nuclear Regulatory Commission (NRC).

2. Unless approved in advance by USEI and IDEQ, average activity concentrations may not exceed those concentrations enumerated in Tables C.1 and C.2. Additionally, for Tables C.1 and C.2, individual pockets of material may exceed the WAC for the radionuclides present as long as the average concentration of all radionuclides within the package or conveyance remains at or below the WAC and the highest dose rate measured on the outside of the unshielded package or conveyance does not exceed those action levels enumerated in ERMP-01.

3. Other items, devices or materials listed in Table C.4a, which are exempted in accordance with 10 CFR Parts 30, 40 or equivalent Agreement State regulations or 10 CFR Part 70 may be accepted at or below the activities (per device or item) or concentrations specified in those exemptions.

4. The generator of the exempted or non-production particle accelerator produced waste must specify that the waste meets applicable acceptance criteria and/or exemption requirements.

5. In accordance with permit requirements, notification of any exceedance of the WAC will be provided to the RCRA Program Manager within 24 hours, in accordance with the permit.

STATE OF IDAHO
DEPARTMENT OF
ENVIRONMENTAL QUALITY

1410 North Hilton • Boise, Idaho 83706-1255 • (208) 373-0502

Dirk Kempthorne, Governor
Toni Hardesty, Director

Permittee: U.S. Ecology Idaho Inc.
Facility Identification/Permit Number: IDD073114654

INTRODUCTION AND SIGNATURE PAGE

Pursuant to the Idaho Hazardous Waste Management Act of 1983 (HWMA), as amended, Idaho Code 39-4401 et seq., and the *Rules and Standards for Hazardous Waste*, as amended, IDAPA 58.01.05.000 et seq., a Hazardous Waste Treatment, Storage, and Disposal Permit is hereby issued to U.S. Ecology Idaho Inc. (USEI or Permittee) for operation of USEI's Site B facility, located in Owyhee county near Grand View, Idaho, on Lemley Road, at latitude 43° 03° 056° North and longitude 116° 15° 044° West.

The Permittee shall comply with all terms and conditions of this Permit, including Attachments 1 through 26. The Permittee must comply with all applicable state and federal regulations, including IDAPA 58.01.05.004 through 58.01.05.008 and 58.01.05.010 through 58.01.05.013 [40 Code of Federal Regulations (CFR), Parts 260 through 266, 268, 270, and 124] and as specified in this Permit. Any reference in this Permit to the Resource Conservation and Recovery Act (RCRA) or the Hazardous and Solid Waste Amendments of 1984 (HSWA), or federal regulations promulgated thereunder in 40 CFR, shall be deemed to include the equivalent HWMA statute or state regulation promulgated thereunder.

Applicable state and federal regulations are those that are in effect on the date of final administrative action on this Permit and any self implementing statutory provisions and related regulations that, according to the requirements of HWMA and/or HSWA, as amended, are automatically applicable to the Permittee's hazardous waste management activities, notwithstanding the conditions of this Permit.

This Permit is based upon the Administrative Record, as required by IDAPA 58.01.05.013 [40 CFR § 124.9]. The Permittee's failure, in the application or during the permit issuance process, to disclose fully all relevant facts, or the Permittee's misrepresentation of any relevant facts, at any time, shall be grounds for the termination or modification of this Permit and/or initiation of an enforcement action. To the extent there are inconsistencies between the Permit and the attachments, the language of the Permit shall prevail. The Permittee must inform the Director of the Idaho Department of Environmental Quality (Director) of any deviation from the permit conditions, or changes in the information on which the application is based that would affect the Permittee's ability to comply, or actual compliance with the applicable regulations or permit conditions, or which alters any permit condition in any way.

The Director shall enforce all conditions of this Permit. Any challenges of any permit condition shall be appealed to the Idaho Board of Environmental Quality, in accordance with IDAPA 58.01.05.013 [40 CFR § 124.19], and in accordance with the Idaho Department of Environmental Quality "*Rules Governing Declaratory Rulings and Contested Case Proceedings,*" IDAPA 58.01.23.043.

The United States Environmental Protection Agency (EPA) shall maintain an oversight role of the state-authorized program, and in such capacity, shall enforce any permit condition based on state requirements if, in the Agency's judgement, the Director should fail to enforce that permit condition. Any challenges to the Agency-enforced conditions shall be appealed to the Agency, in accordance with 40 CFR § 124.19.

This Permit is effective as of November 12, 2004 and shall remain in effect until November 12, 2014, unless, in accordance with IDAPA 58.01.05.012, the Permit is: revoked and reissued [40 CFR § 270.41], terminated [40 CFR § 270.43], modified [40 CFR § 270.42 Appendix I.A.6], or continued [40 CFR § 270.51].

November 12, 2004
Date

Toni Hardesty, Director
Department of Environmental Quality

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COPY

Approval For Disposal and Commercial Storage of Polychlorinated Biphenyl (PCB) Wastes

U.S. Environmental Protection Agency
Region 10
1200 Sixth Avenue, AT-083
Seattle, Washington 98101
Telephone: (206) 553-1270

Issued in accordance with the provisions of Section 6(e)(1) of the Toxic Substances Control Act of 1976, 15 USC §2605(e)(1), and the Federal PCB Regulations, 40 CFR §§761.65(d) and 761.75(c).

ISSUED TO:

Envirosafe Services of Idaho, Inc.
Missile Base Road
Grandview, Idaho 83624
Telephone: (208) 384-1500

This approval is effective as of November 29, 1991, and shall remain in effect until December 15, 1998, unless rescinded for failure to comply with the terms and conditions herein, failure to disclose all relevant facts or for any other reasons which the Regional Administrator of Environmental Protection Agency (EPA) Region 10 deems necessary to protect human health and the environment. This approval on its effective date supersedes, replaces and renders void the March 10, 1982, PCB Landfill Approval (including any subsequent revisions), and the May 22, 1987, Temporary PCB Landfill Approval (including any subsequent revisions).

ISSUED BY THE U.S. ENVIRONMENTAL PROTECTION AGENCY REGION 10

Charles E. Findley (signature)
Charles E. Findley, Director
Hazardous Waste Division
Environmental Protection Agency
Date Sept 20, 1991

TABLE OF CONTENTS

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LIST OF TABLES

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LIST OF FIGURES

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LIST OF ATTACHMENTS

The following documents are excerpts from the Permittee's RCRA Permit Application dated May 5, 2003. The Permit Application and applicable attachments from the previous RCRA Permit are part of the official Administrative Record for the facility. The documents listed below are hereby incorporated, in their entirety, by reference into this Permit. The Department has modified specific language in the attachments, as deemed necessary. These modifications are described in the permit conditions (Modules I through XIII) and, thereby, supersede the language of the original attachment. All references in these attachments to the Agency or to designated representatives of the Agency shall also refer to the Department or to designated representatives of the Department. All references in any of the attachments of this Permit to "Envirosafe Services of Idaho Inc. (ESII)" are superseded by reference to "U.S. Ecology Idaho (USEI)." These incorporated attachments are enforceable conditions of this Permit, as modified by the specific permit conditions.

∗ Taken from existing permit.
† This drawing is contained in Attachment 20, Master Book of Drawings.

Attachment 1	Facility Legal Description and Map of Facility Location, consisting of: Section B, Pages B-1 through B-4, of Permit Application, as last revised May 5, 2003. Appendix B.1, Corporate Warranty Deed of Correction, Pages B.1-1 through B.1-7, of Permit Application, as last revised May 30, 2006. Drawing PRMI-T03, Typical Facility Site Plan, Rev. D, of Permit Application, as last revised September 15, 2008. Drawing PRMI-T01, General Facility Topographic Plan Sheet 1, Rev. D, of Permit Application, as last revised September 15, 2008.
Attachment 2	Waste Analysis Plan, consisting of: Section C, Table of Contents and Pages C-1 through C-61, including Figures C.1 through C.11 and Tables C.1 through C.10, of Permit Application, as last revised July 24, 2009. Appendix C.1, Pages 1 through 3, of Permit Application, as last revised May 5, 2003. Appendix C.2, Page C.2-1 through C.2-20, of Permit Application, as last revised May 5, 2003.
Attachment 3	Security Procedures, consisting of: Subsection F.1, Pages F-1 through F-2, of Permit, as last revised September 3, 2008. Figure F-15a, of Permit Application, as last revised January 22, 2009.
Attachment 4	Inspection Plan, consisting of: Table of Contents and Subsection F.2 and F.3, Pages F-2 through F-12, including Table F-1 and Figures F-1 through F-15, as last revised May 17, 2009.
Attachment 5	Training Plan, consisting of: Section H, Table of Contents and Pages H-1 through H-3, including Tables H-1 through H-4 of Permit Application, as last revised May 5, 2003.

Attachment 6	Hazards Prevention Plan, consisting of: Subsections F.4 and F.5, Pages F-12 through F-19, as last revised May 5, 2003.
Attachment 7	Contingency Plan, consisting of: Section G, Table of Contents and Pages G-1 through G-13, including Tables G-1 through G-8 and Figures G-1 through G-9, of Permit, as last revised October 26, 2009.
Attachment 8	Response Action Plan, consisting of: Table of Contents and Appendix D.4.7, Pages 1-1 through 4-6, including Table 1 and Appendices A, B, and C, of Permit, as last revised May 17, 2009.
Attachment 9	Closure and Post-Closure Plans, consisting of: Section I, Table of Contents and Pages I-1 through I-44, including Tables I.1 through I.8 and Figures I.2 through I.5, of Permit, as last revised May 17, 2009. Drawing PRMI-T04, Facility Topographic Plan Existing Conditions, Rev. E, of Permit, as last revised September 15, 2008. Drawing PRMI-T13, Facility Typical Topographic Plan Final at Closure, Rev. D, of Permit, as last revised September 15, 2008. Drawing PRMI-T12, Facility Topographic Plan Interim Conditions, Rev. D, of Permit, as last revised September 15, 2008. Drawing PRMI-T11, Facility Typical Soil Sampling Plan, Rev. D, of Permit, as last revised September 15, 2008.
Attachment 9a	Alternative Final Cover Assessment Trenches 10 and 11 dated January 15, 1999, as revised July 15, 1999.*
Attachment 9b	Alternative Cover Monitoring Program Plan Trenches 10 and 11 and Test Pad as revised July 15, 1999.*
Attachment 10	Surface Water Management Plan, consisting of: Table of Contents and Pages 1 through 38, Appendix D.4.7, including Tables 1 and 2, and Figure 2, of Permit, as last revised May 17, 2009. Drawing 52-01-09, Site Drainage Existing Conditions and Interim Phase, Rev. C, of Permit, as last revised September 15, 2008.† Figure 1, Facility Overall Drainage Areas Plan and Existing Conditions, Rev. E, of Permit, as last revised September 15, 2008. Drawing PRMI-D01, Rev. F, of Permit Application, as last revised September 15, 2008 Drawing PRMI-D03, Rev. E, of Permit Application, as last revised September 15, 2008.
Attachment 11	Ground Water Monitoring Plan, consisting of: Section E, Table of Contents and Pages E-1 through E-90, including Tables E-1 through E-23, Figures E-2 through E-36, of Permit, as last revised May 17, 2009. Appendix E.6, 2001 Re-evaluation of Rising Ground Water, of Permit Application, as last revised May 5, 2003. Appendix E.11, 1986 Vadose Zone Characteristics Report, of Permit Application, as last revised May 5, 2003.

Appendix E.14, Alternative Concentration Limit Demonstration Report, of Permit Application, as last revised May 5, 2003.
"Proposed Ground Water Monitoring Program Cell 15 U.S. Ecology Idaho Site B," Pages 1 through 4, Table 1, and Figure 1 (Proposed Ground Water Monitoring Wells for Cell 15), from Class 3 Permit Modification, dated June 2002.*
Groundwater Monitoring for Proposed Cell 15 Expansion and Proposed Location for Well L-47, dated September 16, 2008.
IDEQ Response to Proposed Location of Well L-47, dated November 18, 2008.

Attachment 12 — RCRA Part A Permit Application, consisting of:
RCRA Part A Permit Application, dated January 26, 2009.
Section A, Table of Contents and Pages A-1 through A-3, Figures A-1 through A-4, of Permit, as last revised January 22, 2009.

Attachment 13 — Container Management Units - Design and Operations, consisting of:
Section D.1, Table of Contents and Pages D-1 through D-12, including Tables D-1 and D-1A and Figure D-1, of Permit, as last revised January 22, 2009.
Drawing PRMI-R11, Rev. B, as last revised April 8, 2003.
Drawing PRMI-R21, Rev. B, as last revised April 16, 2003.
Additional Container Management Unit Drawings in Attachment 20 including:
Drawing 793P-R01, Rev. E, as last revised May 5, 2003.†
Drawing PRMI-R15, Rev. D, as last revised April 22, 2003.†
Drawing PRMI-R22, Rev. B, as last revised April 22, 2003.†
Drawing PRMI-C11, Rev. B, as last revised May 5, 2003. †
Drawing PRMI-C12, Rev. B, as last revised May 5, 2003. †
Drawing PRMI-C13, Rev. B, as last revised May 5, 2003. †
Drawing PRMI-C14, Rev. B, as last revised May 5, 2003. †
Drawing PRMI-C15, Rev. B, as last revised April 22, 2003. †

Attachment 14 — Bulk Material Tank Systems - Design and Operations, consisting of:
Subsection D-2, Pages D-12 through D-19, including Table D-2, and Figures D-3 through D-7, of Permit Application, as last revised September 3, 2008
Appendix D.2.5, Tank Operation Outline, Pages 1-5, of Permit Application, as last revised May 5, 2003.
Additional Tank Drawings in Attachment 20 including:
Drawing 720C-G02, Rev. D, as last revised May 5, 2003. †
Drawing 720C-G03, Rev. D, as last revised May 5, 2003. †
Drawing 720C-G04, Rev. D, as last revised May 5, 2003. †
Drawing 720C-G05, Rev. E, as last revised May 5, 2003. †
Drawing 720C-G06, Rev. C, as last revised May 5, 2003. †
Drawing 720C-P01, Rev. D, as last revised April 22, 2003. †
Drawing 720C-P02, Rev. B, as last revised April 22, 2003. †
Drawing 793P-C06, Rev. E, as last revised April 22, 2003. †
Drawing 793P-C07, Rev. E, as last revised May 5, 2003. †
Drawing 793P-C08, Rev. E, as last revised May 5, 2003. †
Drawing 793P-C12, Rev. 4, as last revised May 5, 2003. †
Drawing 793P-C13, Rev. L, as last revised April 22, 2003. †

Attachment 14a	Debris Building Bulk Material Tanks System – Design and Operations, consisting of: Tables D-2a, D-2b, and D-2c, as last revised September 3, 2008 Containment Building (Debris Portion) Process Flow Description, as last revised September 3, 2008. Drawing C-1, Rev. B, as last revised September 8, 2006. Drawing C-3, Rev. B, as last revised September 8, 2006. Drawing 1 of 4, Rev. A, as last revised September 15, 2006. Drawing 2 of 4, Rev. A, as last revised September 15, 2006. Drawing 3 of 4, Rev. A, as last revised September 15, 2006. Drawing 4 of 4, Rev. A, as last revised September 15, 2006. Drawing D2020-R02, as last revised November 2, 2006
Attachment 15	Outdoor Stabilization Facility - Design and Operation, consisting of: Figure D-2, Stabilization Facility Process Flow Diagram, of Permit Application, as last revised May 5, 2003. Drawing PRMI-R31, Rev. B, as last revised April 16, 2003.
Attachment 16	General Construction Specifications, consisting of: Appendix D.3.3, Cell 15 Design Specifications, of Permit Application, as last revised May 5, 2003.
Attachment 17	Surface Impoundment Units - Design and Operation, consisting of: Subsection D-4, Pages D-19 through D-33, including Figures D-8 and D-9, of Permit Application, as last revised May 5, 2003. Additional Surface Impoundment Drawings in Attachment 20 including: Drawing PRMI-D05, Rev. B, as last revised April 22, 2003. † Drawing PRMI-D06, Rev. B, as last revised April 22, 2003. † Drawing PRMI-D07, Rev. C, as last revised April 22, 2003. † Drawing PRMI-L41, Rev. B, as last revised April 16, 2003. †
Attachment 18	Engineering Report for Landfill Cell 15 and Drawings, consisting of: Appendix D.3.1, Table of Contents, Pages 1 through 37, Tables 5-1 through 8-2, Figures 1.1 through 7.1, of Permit Application, as last revised May 5, 2003. Appendix D.3.2, Construction Quality Assurance Plan, of Permit Application, as last revised May 5, 2003. Drawing 52-00-0, Rev. 0, of Permit Application, as last revised January 9, 2002. Drawing 52-01-01, Rev. 0, of Permit Application, as last revised January 11, 2002. Drawing 52-01-02, Rev. 0, of Permit Application, as last revised January 9, 2002. Drawing 52-01-03, Rev. 0, of Permit Application, as last revised January 9, 2002. Drawing 52-01-04, Rev. 0, of Permit Application, as last revised January 9, 2002. Drawing 52-01-05, Rev. 0, of Permit Application, as last revised January 10, 2002. Drawing 52-01-06, Rev. 0, of Permit Application, as last revised January 10, 2002. Drawing 52-01-07, Rev. 0, of Permit Application, as last revised January 10, 2002.

Drawing 52-01-08, Rev. A, of Permit Application, as last revised January 14, 2002.
Drawing 52-01-09, Rev. C, of Permit Application, as last revised September 15, 2008.
Drawing 52-01-10, Rev. B, of Permit Application, as last revised January 14, 2002.

Attachment 18a — Landfill Engineering Report Cell 15 Modifications, including:
Appendix A – Report Figures 1-4
Appendix B – Cell 15 Modification Drawing Set
- Drawing 15-08-00 Cell 15 Modification, revised January 29, 2009
- Drawing 15-08-01 Cell 15 Modification, revised September 30, 2008
- Drawing 15-08-02 Cell 15 Modification, revised September 30, 2008
- Drawing 15-08-03 Cell 15 Modification, revised September 30, 2008
- Drawing 15-08-04 Cell 15 Modification, revised September 30, 2008
- Drawing 15-08-05 Cell 15 Modification, revised January 29, 2009
- Drawing 15-08-06 Cell 15 Modification, revised January 29, 2009
- Drawing 15-08-07 Cell 15 Modification, revised January 29, 2009

Appendix C – Laboratory Interface Shear Test Results
Appendix D – Slope Stability Analysis
Appendix E – Specifications
Appendix F – Construction Quality Assurance Plan
Appendix G – Vertical Expansion Analysis
Appendix H – Geotechnical Engineering Report

Attachment 19 — Landfill Units - Design and Operation, consisting of:
Subsections D-6 and D-11, Table of Contents, and Pages D-34 through D-60 and Pages D-88 through D-89, including Table D-3, and Figures D-8 through D-11, as last revised May 17, 2009.
Additional Drawings for Trench 10 and 11, Cell 5, and Cell 14 in Attachment 20, including:
Drawing 720C-G01, Rev. E, of Permit Application, as last revised May 5, 2003. †
Drawing 720C-G07, Rev. C, of Permit Application, as last revised May 5, 2003. †
Drawing PRMI-L01, Rev. F, of Permit Application, as last revised April 22, 2003. †
Drawing PRMI-L11, Rev. B, of Permit Application, as last revised April 23, 2003. †
Drawing PRMI-L12, Rev. B, of Permit Application, as last revised April 23, 2003. †
Drawing PRMI-L15, Rev. B, of Permit Application, as last revised April 23, 2003. †
Drawing PRMI-L16, Rev. B, of Permit Application, as last revised April 23, 2003. †
Drawing PRMI-L17, Rev. B, of Permit Application, as last revised April 23, 2003. †
Drawing PRMI-L18, Rev. B, of Permit Application, as last revised April 23, 2003. †
Drawing PRMI-L21, Rev. B, of Permit Application, as last revised April 23, 2003. †
Drawing PRMI-L22, Rev. C, of Permit Application, as last revised April 23,

2003. †
Drawing PRMI-L24, Rev. B, of Permit Application, as last revised April 23, 2003. †
Drawing PRMI-L25, Rev. B, of Permit Application, as last revised April 23, 2003. †
Drawing PRMI-L26, Rev. C, of Permit Application, as last revised April 23, 2003. †
Drawing PRMI-L27, Rev. B, of Permit Application, as last revised April 23, 2003. †

Attachment 20 — Master Book of Drawings, Overall Facility, consisting of:
Master Book of Drawings, as last revised January 29, 2009.

Attachment 21 — Closure Cover Design Details, consisting of:
Closure Drawings in Attachment 20 including:
Drawing PRMI-L13, Rev. D, of Permit Application, as last revised April 23, 2003. †
Drawing PRMI-L14, Rev. D, of Permit Application, as last revised April 23, 2003. †
Drawing PRMI-L19, Rev. B, of Permit Application, as last revised April 23, 2003. †
Drawing PRMI-L23, Rev. C, of Permit Application, as last revised April 23, 2003. †
Drawing PRMI-L28, Rev. B, of Permit Application, as last revised April 23, 2003. †
Drawing PRMI-L29, Rev. B, of Permit Application, as last revised April 23, 2003. †
Drawing PRMI-D08, Rev. B, of Permit Application, as last revised April 24, 2003. †

Attachment 21a — Closure Cover Design Detail Drawings for Alternative Cover Design consisting of:
Closure Drawings in Attachment 20 including:
Drawing PRMI-L02, Rev. F, of Permit Application, as last revised April 23, 2003. †
Drawing PRMI-L03, Rev. F, of Permit Application, as last revised April 23, 2003. †
Drawing PRMI-L04, Rev. F, of Permit Application, as last revised April 23, 2003. †
Drawing PRMI-L05, Rev. D, of Permit Application, as last revised April 23, 2003. †
Drawing PRMI-L06, Rev. D, of Permit Application, as last revised April 23, 2003. †

Attachment 22 — Past Practice Units, consisting of:
Section J, Table of Contents, and Pages J-1 through J-33, including Tables J-1 through J-8, as last revised May 17, 2009.
Drawing PRMI-T05a, Rev. D, of Permit, as last revised September 15, 2008. †
Underground Structures Capping Plan, Pages 1 through 5, Figures 1-3, and Appendix A, as prepared September 1987.*
Drawing 419-LT3, Rev. 2, as last revised October 30, 1989.*
Drawing 419-LT4, Rev. 2, as last revised October 30, 1989.*

Drawing F565L-LM2, Rev. 13, as last revised November 2, 2006.

Attachment 23

Exempt Radiological Materials Procedures Manual, consisting of:
Exempt Radiological Materials Procedures Manual, Table of Contents, and the following subsections: Exempt Radiological Procedures RESRAD Safety Assessment, SNM Safety Assessment, RESRAD Model, Increased Radium RESRAD Model, Material Receipt Procedures, Exempt Materials Procedures for Decontamination and Release of Empty Containers, Environmental Monitoring Procedures, Landfill Operations, Waste Acceptance Criteria Evaluation, Selection, Care, and Use of Portable Instrumentation, and Drawing No. 7 (Environmental Radiological Monitoring Locations), of Permit Application, as last July 24, 2009.

Attachment 24

Containment Building and Debris Treatment, consisting of:
Section D.9, Pages D-61 through D-69, including Table D-1 and D-1A, of Permit Application, as last revised September 3, 2008.
Additional Drawings for Containment Building in Attachment 20, including:
Drawing PRMI-R31, Rev. F, of Permit Application, as last revised April 22, 2003. †
Drawing PRMI-R32, Rev. B, of Permit Application, as last revised April 23, 2003. †
Drawing PRMI-R33, Rev. B, of Permit Application, as last revised April 23, 2003. †
Drawing PRMI-R34, Rev. B, of Permit Application, as last revised April 16, 2003. †
Drawing PRMI-R35, Rev. B, of Permit Application, as last revised April 23, 2003. †
Drawing PRMI-D04, Rev. B, of Permit Application, as last revised April 23, 2003. †
Drawing 773C-S01, Rev. 6, of Permit Application, as last revised May 5, 2003. †
Drawing 773C-S02, Rev. 6, of Permit Application, as last revised May 5, 2003. †
Drawing 773C-S03, Rev. 6, of Permit Application, as last revised May 3, 2003. †
Drawing 773C-S04, Rev. 6, of Permit Application, as last revised May 5, 2003. †
Drawing D2020-R02, Rev. G, of Permit Application, as last revised April 24, 2003. †
Drawing D2020-A02, Rev. 12, of Permit Application, as last revised April 15, 2003. †
Drawing D2020-A03, Rev. 4, of Permit Application, as last revised April 23, 2003. †
Drawing D2020-A04, Rev. 8, of Permit Application, as last revised April 23, 2003. †
Drawing D2020-A05, Rev. 8, of Permit Application, as last revised April 23, 2003. †
Drawing D2020-A06, Rev. 8, of Permit Application, as last revised April 23, 2003. †
Drawing D2020-A07, Rev. 12, of Permit Application, as last revised April 24, 2003. †
Drawing D2020-C05, Rev. 9, of Permit Application, as last revised April 23, 2003. †

Drawing D2020-C08, Rev. 8, of Permit Application, as last revised April 24, 2003. †
Drawing D2020-H01, Rev. 4, of Permit Application, as last revised April 24, 2003. †
Drawing D2020-H03, Rev. 5, of Permit Application, as last revised April 15, 2003. †
Drawing D2020-H04, Rev. 9, of Permit Application, as last revised April 24, 2003. †
Drawing D2020-P01, Rev. 3, of Permit Application, as last revised April 24, 2003. †
Drawing D2020-R05, Rev. 4, of Permit Application, as last revised April 24, 2003. †
Drawing D2020-R07, Rev. 6, of Permit Application, as last revised April 24, 2003. †
Drawing D2020-R08, Rev. 9, of Permit Application, as last revised April 24, 2003. †
Drawing 793P-C05, Rev. E, of Permit Application, as last revised May 5, 2003. †
Drawing 793P-C09, Rev. E, of Permit Application, as last revised May 5, 2003. †
Drawing 793P-C14, Rev. F, of Permit Application, as last revised April 22, 2003. †
Drawing 793P-C15, Rev. E, of Permit Application, as last revised April 22, 2003. †
Drawing 793P-C16, Rev. E, of Permit Application, as last revised May 5, 2003. †
Drawing 793P-C17, Rev. D, of Permit Application, as last revised April 8, 2003. †
Drawing 793P-G01, Rev. E, of Permit Application, as last revised May 5, 2003. †
Drawing 793P-H01, Rev. E, of Permit Application, as last revised April 22, 2003. †
Drawing 793P-P03, Rev. E, of Permit Application, as last revised May 5, 2003. †
Drawing 793P-P04, Rev. E, of Permit Application, as last revised May 5, 2003. †
Drawing 793P-R01, Rev. E, of Permit Application, as last revised May 5, 2003. †
Drawing 793P-R02, Rev. E, of Permit Application, as last revised May 5, 2003. †

Attachment 25 Treatment Processes Description:
Section D.10, Table of Contents and D-70 through D-89, including Table D-4, of Permit Application, as last revised May 5, 2003, including the following subsections:

D.10.a	Stabilization
D.10.b	Microencapsulation
D.10.c	Macroencapsulation
D.10.d	Chemical Oxidation
D.10.e	Chemical Reduction
D.10.f	Deactivation
D.10.g	Neutralization
D.10.h	Precipitation

	D.10.i	Adsorption
	D.10.j.	Bioremediation
	D.10.k	Evaporation
	D.10.I	Size Reduction
	D.10.m	Decanting
Attachment 26	List of Permit Modifications: Reserved for listing of future modifications.	

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* Taken from existing permit.

† This drawing is contained in Attachment 20, Master Book of Drawings.

DEFINITIONS

All definitions contained in IDAPA 58.01.05.004, .008 and .010 through .013 [40 CFR Parts 260, 264, 266, 268, 270, and 124] are hereby incorporated, in their entirety, by reference into this Permit, except that any of the definitions used below shall supersede any definition of the same term given in IDAPA 58.01.05.000 et seq. Where terms are not defined in the regulations or the Permit, the meaning associated with such terms shall be defined by a standard dictionary reference of the generally accepted scientific or industrial meaning of the term.

a "Application" shall mean Volumes 1 through 8 of the May 2003 HWMA/RCRA Permit Application containing Sections A through L.

b "Cell" shall mean the Landfill Units 5, 14 and 15. This includes, and supersedes, references to "Trench 5 or Trench 14."

c "Containment Building" shall mean the building consisting of the “debris portion” and the “stabilization portion” where hazardous waste management activities shall be conducted, for wastes which USEI is permitted to manage, including the handling and treatment/ stabilization of “fine wastes.”

d "Day," “Daily,” “Normal Working Day,” and “Business Day” shall mean any calendar working day(s) (excluding weekends and holidays) where waste management activities occur at the facility, unless otherwise specified. Any requirement of submittal, under the terms of this Permit, that would be due on a Saturday, Sunday, or a federal or state holiday shall be due on the following business day.

e "Department" shall mean the Idaho Department of Environmental Quality.

f "Director" shall mean the Director of the Idaho Department of Environmental Quality or his or her designee.

g "Facility or Site" shall mean (1) All contiguous land, structures, other appurtenances, and improvements on the land used for treating, storing, or disposing of hazardous waste. A facility may consist of several treatment, storage or disposal operational units (e.g., one or more landfills, surface impoundments, or combinations of these), (2) For the purpose of implementing corrective action under IDAPA 58.01.05.008 §264.101, all contiguous property under the control of the owner or operator seeking a permit under Subtitle C of RCRA. This definition also applies to facilities implementing corrective action under RCRA Section 3008(h). This facility description is as set forth in Attachment 1 of this Permit.

h “Fine Wastes” shall mean any waste containing fine particulate matter as determined by Exhibit A of the December 9, 1996 Consent Order (included as Figure C.11 of Attachment 2 of this Permit).

i "HWMA" shall mean the state of Idaho, Hazardous Waste Management Act of 1983, as amended, Idaho Code § 39-4401 et seq.

j "Hazardous Waste Constituent" means a constituent that could cause or has caused the EPA to list a waste as hazardous per 40 CFR Part 261, Subpart D, or any constituent listed in Appendix VIII of IDAPA 58.01.05.005 [40 CFR Part 261] or in Appendix IX of IDAPA 58.01.05.008 [40 CFR Part 264].

k "Hazardous Waste" shall mean a solid waste, or combination of solid wastes, due to its quantity, concentration, or physical, chemical, or infectious characteristics may cause, or significantly contribute to, an increase in mortality or an increase in serious irreversible or incapacitating reversible illness, or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed in [42 USC § 6903(5)], or that meets the definition of hazardous waste as specified in IDAPA 58.01.05.005 [40 CFR § 261.3].

l "Hazardous Waste Management Unit (HWMU)" shall mean those operable units subject to the requirements of IDAPA 58.01.05.012 [40 CFR §§ 270.14 to 270.25].

m "IDAPA" shall mean the Idaho Administrative Procedures Act, Chapter 52, Title 67, Idaho Code.
n "Load," in reference to temporary storage of interim piles, shall mean one treatment load or batch equal to the capacity of a Containment Building mixing bin tank (not to exceed 100 cubic yards).
o "MCL(s)" shall mean Maximum Contaminant Levels promulgated under the Safe Drinking Water Act.
p "Owner" shall mean U.S. Ecology Idaho Inc.
q "Permit" shall mean this Permit issued by the Idaho Department of Environmental Quality.
r "Permittee" shall mean U.S. Ecology Idaho, Inc.
s "Radioactive contaminated liquids" shall mean those radioactive liquids that exhibit a dose rate which exceeds 40 ΦR/hr.
t "Release" shall mean any spilling, leaking, pouring, emitting, emptying, discharging, injecting, pumping, escaping, leaching, dumping, or disposing of hazardous wastes (including hazardous waste constituents) into the environment (including the abandonment or discarding of barrels, containers, and other closed receptacles containing hazardous wastes or hazardous waste constituents).
u "Schedule of Compliance" shall mean a schedule of remedial and/or closure measures included in a permit, including an enforceable sequence of interim requirements (i.e., actions, operations, or milestone events) leading to compliance with the HWMA and regulations.
v "Solid Waste Management Unit (SWMU)" shall mean any discernable unit at which solid wastes have been placed at any time, despite whether the unit was intended for the management of solid or hazardous wastes. Such units include any area at a facility at which solid wastes have been routinely and systematically released.
w "Stabilization Facility" shall mean the outdoor area at which USEI is permitted to perform hazardous waste treatment activities
x "SW 846" shall mean "Test Methods for Evaluating Solid Waste Chemical/Physical Methods" (latest edition published by EPA).
y "Trench" shall mean shallow Land Disposal Units such as Landfill Units 10 and 11.
z "UHC" shall mean Underlying Hazardous Constituent. UHC means any constituent listed in IDAPA 58.01.05.011 [40 CFR § 268.48], Table UTS – Universal Treatment Standards, except fluoride, selenium, sulfides, vanadium, and zinc, which can reasonably be expected to be present at the point of generation of the hazardous waste at a concentration above the constituent – specific UTS Treatment Standard.

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ACRONYMS AND ABBREVIATIONS

For the purpose of this Permit the following acronyms and abbreviations shall apply:

AASHTO	American Association of State Highway and Transportation Officials
ABS	Acrylonitrile Butadiene Styrene
ACI	American Concrete Institute
ACGIH	American Conference of Governmental Industrial Hygienists
ACL	Alternate Concentration Limit
AGA	American Gas Association
AGST	Above Ground Storage Tank
ALR	Action Leakage Rate
ANSI	American National Standards Institute
APC	Air Pollution Control
APP	Aquifer Protection Permit
API	American Petroleum Institute
ASA	American Standards Association
ASME	American Society of Mechanical Engineers
AST	Aboveground Storage Tanks
ASTM	American Society for Testing and Materials
BACT	Best Available Control Technology
BAT	Best Available Technology
BMP	Best Management Practice
BOD	Biochemical or Biological Oxygen Demand
C	Celsius/Centigrade
CAO	Corrective Action Order
CAA	Clean Air Act, 42 USC Section 7401 et seq. (Federal)
CAMP	Corrective Action Monitoring Program
CAMU	Corrective Action Management Unit
CEG	Certified Engineering Geologist
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CESQG	Conditionally Exempt Small Quantity Generators
CFCs	Chlorofluorcarbons
CFR	Code of Federal Regulations
CGL	Comprehensive General Liability Insurance
CHP	Certified Health Professional
CIH	Certified Industrial Hygienist
cm	centimeter; 1/100 meter
CMP	Compliance Monitoring Program
CMU	Container Management Unit
CNCI	Cyanogen Chloride
CO	Carbon Monoxide
CSA	Container Storage Area
CQA	Construction Quality Assurance
CQAP	Construction Quality Assurance Plan
CSP	Certified Safety Professional
DMP	Detection Monitoring Program
DOE	Department of Energy (Federal)

DOI	Department of the Interior (Federal)
DOT	Department of Transportation
DRE	Destruction/Removal Efficiency
EC	Emergency Coordinator
EIR	Exposure Information Report
EMS	Emergency Medical Service
EMT	Emergency Medical Technician
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EPR	Ethylene Propylene Rubber
EP TOX	Extraction Procedure Toxicity Test (RCRA)
EQL	Estimated Quantitation Limit
ESA	Endangered Species Act, 15 USC Section 1531 et seq.
ESG	English Standard Gauge
ESH	Environmental Health and Safety
ESII	Envirosafe Services of Idaho, Inc.
ESP	Electrostatic Precipitators
F	Fahrenheit
ft.	feet / foot
FDA	Food and Drug Administration (U.S.A.)
FEMA	Federal Emergency Management Agency
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act, 7 USC
FOIA	Freedom of Information Act
FR	Federal Register
FUSRAP	Formerly Utilized Sites Remedial Action Plan
GC	Gas Chromatographic
GCL	Geosynthetic Clay Liner
GC/MS	Gas Chromatography/Mass Spectrometry
GPM	Gallons Per Minute
GPS	Ground Water Protection Standards.
GW	Ground Water
HAPs	Hazardous Air Pollutants
HCFCs	Hydrochlorofluorocarbons
HCS	Hazard Communication Standard (OSHA)
HDPE	High Density Polyethylene
HHW	Household Hazardous Waste
HMTA	Hazardous Materials Transportation Act
HOC	Halogenated Organic Compounds
HSWA	Hazardous and Solid Waste Amendment of 1984
HWMA	Hazardous Waste Management Act of 1983, Idaho Code § 39-4401 et seq.
HWMU	Hazardous Waste Management Unit
ICF	Internal Control Form
IDAPA	Idaho Administrative Procedures Act
IDEQ	Idaho Department of Environmental Quality
IECC	Idaho Emergency Communication Center
IMS	Ion Mobility Spectrometry
in	Inch
Inc.	Incorporated
IPDC	Idaho Poison and Drug Center
IR	Infrared
kg	Kilogram; 1,000 grams

km	Kilometer; 1,000 meters
lb	Pound
LD50	Lethal Dose Level 50%
LCR	Leachate Collection and Removal System
LDCR	Leachate Detection, Collection and Removal System
LDR	Land Disposal Restriction
LEL	Lower Explosive Limit
MACT	Maximum Available Control Technology
MCL	Maximum Contaminant Levels (SDWA)
MCLGs	Maximum Contaminant Level Goals (SDWA)
MDL	Minimum Detection Limit
mg/l	milligrams per liter
µrem	Microrem
mil	1/1000 in
mm	Millimeter; 1/1000 meter
MOU	Memorandum of Understanding
MS	Mass Spectrometry
MSDS	Material Safety Data Sheets
NARM	Nuclear Accelerator Radioactive Material
NCP	National Contingency Plan
NCSA	National Crushed Stone Association
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety & Health
NORM	Naturally Occurring Radioactive Material
NOV	Notice of Violation
NOX	Oxides of Nitrogen
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response (US EPA)
O&M	Operation and Maintenance
oz	Ounce
PAH	Polynuclear Aromatic Hydrocarbons
PCB	Polychlorinated Biphenol
PCDF	Polychlorinated Dibenzofurans
PCE	Perchloroethylene
pCi	Picocurries
PE	Professional Engineer
PEL	Permissible Exposure Limits (OSHA)
PM10	Particulate Matter less than 10 microns in diameter
POTW	Publicly-Owned Treatment Works
ppb	Parts per billion
PPE	Personal Protective Equipment
ppm	Parts per million
ppmw	Parts per million by weight
QA/QC	Quality Assurance/ Quality Control
RCRA	Resource Conservation and Recovery Act of 1976
RG	Registered Geologist
RGN	Reactivity Group Numbers

RTK	Right-to-Know
SARA Title III	Emergency Preparedness and Community Right to Know
SCBA	Self-Contained Breathing Apparatus
SDWA	Safe Drinking Water Act
SOP	Standard Operating Procedures
STEL	Short Term Exposure Limit
SWMP	Stormwater Management Plan
SWMU	Solid Waste Management Unit
TCLP	Toxicity Characteristics Leaching Procedure
TLV	Threshold Limit Value
TCE	Trichloroethylene
TOC	Total Organic Carbon
TSCA	Toxic Substance Control Act
TSDF	Treatment Storage and Disposal Facility
UBC	Uniform Building Code
UFC	Uniform Fire Code
µg/l	Micrograms per liter
UHC	Underlying Hazardous Constituent
UL	Underwriter's Laboratories, Inc
USEI	US Ecology Idaho, Inc.
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UV	Ultraviolet Light
VO	Volatile Organics
VOC	Volatile Organic Compound
WAP	Waste Analysis Plan
WLR	Warning Leakage Rate
WPQ	Waste Product Questionnaire
WSID	Waste Stream Identification Number
yd	Yard
yd^2	Square yard
yd^3	Cubic yard

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MODULE I - STANDARD PERMIT CONDITIONS

I.A. EFFECT OF PERMIT

I.A.1. The Permittee is authorized to store, treat, and dispose of hazardous waste in accordance with the conditions of this Permit. Any storage, treatment, or disposal of hazardous waste by the Permittee, at this facility, that is not authorized by this Permit or by IDAPA 58.01.05.006 [40 CFR § 262.34], and for which a permit is required under Idaho Code § 39-4409 or Section § 3005 of RCRA, is prohibited.

I.A.2. Pursuant to IDAPA 58.01.05.012 [40 CFR § 270.4], compliance with this Permit generally constitutes compliance, for purposes of enforcement, with the Idaho Hazardous Waste Management Act (HWMA), as amended, except for the requirements not included in this Permit, which become effective by future statute or regulatory changes, to include those requirements promulgated under IDAPA 58.01.05.011 [40 CFR Part 268] restricting the placement of hazardous waste in or on the land.

I.B. PERSONAL AND PROPERTY RIGHTS

This Permit does not convey any property rights of any sort, or any exclusive privilege; nor does this Permit authorize any injury to persons or property, or any invasion of other private rights, or any infringement of state or local laws.

I.C. ENFORCEABILITY

I.C.1. The terms and conditions of this Permit are enforceable pursuant to the HWMA or any other applicable federal, state, or local law. Violations of this Permit may result in civil penalties, in accordance with HWMA [Idaho Code § 39-4414] and the HWMA Civil Penalty Policy.

I.C.2. Any person who knowingly makes any false statement or representation in any application, label, manifest, record, report, permit, or other document filed, maintained, or used for the purposes of complying with the provisions of Idaho Code § 39-4415, shall be guilty of a misdemeanor and subject to a fine of not more than ten thousand dollars ($10,000) or to imprisonment not to exceed one (1) year, or to both, for each separate violation or for each day of a continuing violation.

I.D. OTHER AUTHORITY

The Department expressly reserves any right of entry provided by law, and any authority to order or perform emergency or other response activities as authorized by law.

I.E. PERMIT ACTIONS

I.E.1. This Permit may be modified, revoked, and reissued or terminated for cause, as specified in IDAPA 58.01.05.012 [40 CFR §§ 270.41, 270.42, and 270.43].

I.E.2. The filing of a request for a permit modification, or revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance on the part of the Permittee shall not stay the applicability or enforceability of any permit condition.

I.E.3. Except as provided by specific language in this Permit or except for the Director's approval of a Class 1 or 2 Permit Modification, in accordance with IDAPA 58.01.05.012 [40 CFR § 270.42 (a) and (b)], any modification that substantially alters the facility or its operation, as covered by this Permit, shall be administered as a Class 3 Permit Modification prior to such change taking place, in accordance with IDAPA 58.01.05.012 [40 CFR § 270.42(c)].

I.E.4. The Director may modify this Permit when the standards or regulations on which the Permit was based have been changed by statute, the standards or regulations have been amended, or the standards or regulations have changed by way of judicial decision after the effective date of this Permit.

I.E.5. Within forty-five (45) calendar days of a permit modification being put into effect or approved, the Permittee shall provide clean copies of the relevant portions of the Permit and revised Attachments (if not already reflected/provided in the change pages submitted with the Permit Modification Request), reprint the documents (as necessary), and submit to the Director. The Permittee shall submit an electronic version (in a format pre-approved by the Director) of all permit modifications and Permit Applications to the Director.

I.E.6. The Permittee shall ensure that Attachment 26, the permit modification tracking log, is up to date, consistent with Permit Condition I.E.5.

I.F. SEVERABILITY

I.F.1. The provisions of this Permit are severable, and if any provision of this Permit, or the application of any provision of this Permit to any circumstance, is held invalid, the application of such provision to other circumstances and the remainder of this Permit shall not be affected thereby. Invalidation of any state or federal statutory or regulatory provision that forms the basis for any condition of this Permit does not affect the validity of any other state or federal statutory, or regulatory basis for said condition.

I.F.2. In the event that a condition of this Permit is stayed for any reason, the Permittee shall continue to comply with the related applicable and relevant standards of the previous Permit until final resolution of the stayed condition, unless compliance with the related applicable and relevant standards would be technologically incompatible with compliance with other conditions of this Permit that have not been stayed.

I.G. DUTY TO COMPLY

I.G.1. The Permittee shall comply with all conditions of this Permit, except that the Permittee need not comply with the conditions of this Permit to the extent and for the duration such noncompliance is authorized in an emergency permit (issued under IDAPA 58.01.05.012 [40 CFR § 270.61]). Any permit noncompliance, except under the terms of an emergency permit, constitutes a violation of RCRA, amended by

HSWA, and/or of HWMA, and is grounds for enforcement action, permit termination, modification, or revocation and reissuance of the Permit and/or denial of a Permit Renewal Application.

I.G.2. Compliance with the terms of this Permit does not constitute a defense to any action brought under Sections §§ 3007, 3008, 3013, and 7003 of RCRA [42 U.S.C. §§ 6927, 6928, 6934, and 6973], 104, 106(a), or 107 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) [42 U.S.C. § 9604, 9606(a), or 9607], as amended by the Superfund Amendments and Reauthorization Act of 1986, or any other federal or state law governing protection of public health or the environment from any imminent and substantial endangerment to human health or the environment. However, compliance with the terms of this Permit does constitute a defense to any action alleging failure to comply with the applicable standards upon which this Permit is based.

I.H. DUTY TO REAPPLY

The Permittee must apply for a new permit, in accordance with IDAPA 58.01.05.012 [40 CFR § 270.30(b)], at least 180 calendar days prior to the expiration date of this Permit, in accordance with IDAPA 58.01.05.012 [40 CFR § 270.10(h)].

I.I. PERMIT EXPIRATION

I.I.1. Except as renewed, modified, revoked, reissued, or terminated by the Director, this Permit shall automatically expire ten (10) years from the effective date of this Permit.

I.I.2. In accordance with IDAPA 58.01.05.012 [40 CFR § 270.50(d)], this Permit shall be reviewed five (5) years after the effective date and modified, as necessary, in accordance with IDAPA 58.01.05.012 [40 CFR § 270.41].

I.J. CONTINUATION OF EXPIRING PERMIT

This Permit and all conditions herein shall continue in force until the effective date of a new permit, if the Permittee has submitted a timely complete application in accordance with IDAPA 58.01.05.012 [40 CFR §§ 270.10, 270.13 through 270.29], and through no fault of the Permittee, the Director has neither issued nor denied a new permit under IDAPA 58.01.05.013 [40 CFR § 124.15] on or before the expiration date of this Permit.

I.K. NEED TO HALT OR REDUCE ACTIVITY NOT A DEFENSE

It shall not be a defense for the Permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this Permit.

I.L. DUTY TO MITIGATE

In the event of noncompliance with this Permit, the Permittee shall take all reasonable steps to minimize releases to the environment resulting from the noncompliance and shall carry out such measures, as are reasonable, to prevent significant adverse impacts on human health or the environment.

I.M PROPER OPERATION AND MAINTENANCE

The Permittee shall, at all times, properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) that are installed or used by the Permittee so as to achieve compliance with the conditions of this Permit. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems, only when necessary, to achieve compliance with the conditions of this Permit.

I.N. DUTY TO PROVIDE INFORMATION

The Permittee shall furnish to the Director, within a reasonable time period established by the Director, any relevant information that the Director may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this Permit, or to determine compliance with this Permit. The Permittee shall also furnish to the Director, within five (5) days of the Director's request, copies of records required to be kept by this Permit.

I.O. INSPECTION AND ENTRY

Pursuant to IDAPA 58.01.05.012 [40 CFR § 270.30(i)], the Permittee shall allow the Director (or an authorized representative) upon the presentation of credentials and other documents, as may be required by law, to:

I.O.1. Enter (at reasonable times) upon the Permittee's premises where a regulated facility or activity is located or conducted, or where records are kept under the conditions of this Permit;

I.O.2. Have access to and copy (at reasonable times) any records that must be kept under the conditions of this Permit;

I.O.3. Inspect at reasonable times, any portion of the facility, equipment (including monitoring and control equipment), practices, or operations regulated or required under this Permit; and

I.O.4. Sample or monitor (at reasonable times), for the purposes of assuring permit compliance or as otherwise authorized by RCRA or state law, any substances or parameters at any location.

I.P. MONITORING AND RECORDS

I.P.1. The Permittee shall retain records of all monitoring information (including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation), copies of all reports required by this Permit, the certification required by IDAPA 58.01.05.008 [40 CFR § 264.73(b)(9)], and records of all data, used to complete the application for this Permit, for a period of at least three (3) years from the date of the sample, measurement, report, certification, or recording unless a longer retention period is required by other conditions of this

Permit. The three-year period may be extended by the Director (upon request), in writing, to the Permittee.

I.P.2. The Permittee shall retain (at the facility) all monitoring records from all surface water sampling, seep sampling, soil sampling, sediment sampling, and ground water monitoring wells and associated ground water surface elevations for the active life of the facility, and for disposal units for the active life of the facility and the Post-Closure Care Period. The retention periods may be extended by request of the Director, at any time, by written notification to the Permittee, and the retention times are automatically extended, during the course of any unresolved enforcement action regarding this facility, to three (3) years beyond the conclusion of the enforcement action.

I.P.3. Pursuant to IDAPA 58.01.05.012 [40 CFR § 270.30(j)(3)], records of monitoring information shall specify:

I.P.3.a. The date(s), exact place, and times of sampling or measurements;

I.P.3.b. The name(s), title(s), and affiliation of the individual(s) who performed the sampling or measurements;

I.P.3.c. The date(s) analyses were performed;

I.P.3.d. The name(s), title(s), and affiliation of the individual(s) who performed the analyses;

I.P.3.e. The analytical techniques or methods used; and

I.P.3.f. The results of such analyses, including Quality Assurance/Quality Control data.

I.P.4 Samples and measurements taken for monitoring purposes shall be representative of the monitored activity. The method used to obtain a representative sample of the waste, to be analyzed, shall be the appropriate method from IDAPA 58.01.05.005 [40 CFR Part 261, Appendix I], EPA's most recent edition of *Technical Enforcement Guidance Document* (hereinafter referred to as TEGD), or an equivalent method approved by the Director. Laboratory methods shall be those specified in the most recent edition of *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods SW-846* (herein referred to as SW-846), the most recent edition of *Standard Methods for the Examination of Wastewater*, or other alternate method approved in this Permit, or an equivalent method in accordance with Permit Condition I.P.5.

I.P.5. The Permittee may substitute analytical methods that are equivalent to those specifically approved for use in this Permit, in accordance with the following:

I.P.5.a. The Permittee submits to the Director a request for substitution of an analytical method(s) that is equivalent to the method(s) specifically approved for use in this Permit. The request shall provide information demonstrating that the proposed method(s) is equal or superior to the analytical method(s) requested to be substituted in terms of sensitivity, accuracy, and precision (i.e., reproducibility).

I.P.5.b. The Director notifies the Permittee (in writing, by certified mail, or hand delivery) that the substitution of the analytical method(s) is approved. Such approval shall not require a permit modification under IDAPA 58.01.05.012 [40 CFR § 270.42].

I.P.6. Results of all ground water analyses required by this Permit shall be submitted to the Director within thirty (30) calendar days of the Permittee's receipt of sample data from the laboratory, but in no case shall the period between the date of sampling and the date of submission of analytical results, to the Director, exceed one hundred twenty (120) calendar days.

I.Q. REPORTING PLANNED CHANGES

The Permittee shall give notice to the Director, as soon as possible, of any planned physical alterations or additions to the facility before such planned physical alterations or additions occur, in accordance with IDAPA 58.01.05.012 [40 CFR § 270.30(l)(1)].

I.R. CERTIFICATION OF CONSTRUCTION OR MODIFICATION

I.R.1. The Permittee may not commence storage, treatment, or disposal in a new Hazardous Waste Management Unit or in a modified portion of an existing Hazardous Waste Management Unit, except as provided in IDAPA 58.01.05.012 [40 CFR §270.42], until the Permittee has submitted a letter to the Director (by certified mail, express mail, or hand delivery) along with the attachments required under Permit Condition II.A.2, signed by the Permittee and a registered professional engineer, certifying that the permitted unit(s) have been constructed or modified in accordance with the approved plans and specifications in compliance with this Permit (IDAPA 58.01.05.012 [40 CFR §270.30(l)]); and

I.R.2. The Director has reviewed and inspected the modified or newly constructed Hazardous Waste Management Unit(s) and has notified the Permittee in writing that he finds the unit(s) to be in compliance with the conditions of this Permit; or

I.R.3. In accordance with IDAPA 58.01.05.012 [40 CFR § 270.30(l)(2)(ii)(B)], if within fifteen (15) calendar days of the date of submittal, required by I.R.1 of this Permit, the Permittee has not received notice from the Director of his or her intent to inspect, prior inspection is waived and the Permittee may commence treatment, storage, or disposal of hazardous waste.

I.S. REPORTING ANTICIPATED NONCOMPLIANCE

The Permittee shall give advance notice to the Director of any planned changes in the permitted facility or activity that may result in noncompliance with requirements of this Permit, in accordance with IDAPA 58.01.05.012 [40 CFR § 270.30(l)(2)]. Advance notice shall not constitute a defense for any noncompliance.

I.T. TRANSFER OF PERMIT

This Permit is not transferable to any person, except after notice to and acceptance by the Director. The Director may require modification or revocation and reissuance of the Permit, pursuant to IDAPA 58.01.05.012 [40 CFR § 270.40]. Before transferring ownership or operation of the facility during its operating life, or of a disposal facility during the Post-Closure Period, the Permittee must notify the new owner or operator (in writing) of the requirements of IDAPA 58.01.05.008, 58.01.05.012 [40 CFR Parts 264 and 270] and this Permit.

I.U. TWENTY-FOUR HOUR REPORTING

I.U.1. In accordance with IDAPA 58.01.05.012 [40 CFR § 270.30(l)(6)], the Permittee shall verbally report to the Director (or the Idaho Emergency Communication Center during off-hours) any noncompliance with this Permit that might endanger human health or the environment. Any such information shall be reported, as soon as possible, but not later than twenty-four (24) hours from the time the Permittee becomes aware of the noncompliance. Potential endangerment to human health and the environment may include, but not be limited to, information concerning:

I.U.1.a. A release of any hazardous waste that may endanger public drinking water supplies; or

I.U.1.b. A release or discharge of hazardous waste, or of a fire or explosion, at the facility that could threaten human health or the environment outside the facility; or

I.U.1.c. Noncompliance with Permit Condition II.A.1 of this Permit.

I.U.2. The verbal description of the occurrence and its cause, if available, shall include the following (at a minimum):

- Name, title, and telephone number of the individual reporting;
- Name, address, and telephone number of the owner or operator;
- Name, address, and telephone number of the facility;
- Date, time, and type of incident;
- Location and cause of the accident;
- Name and quantity of material(s) involved;
- The extent and description of injuries, if any;
- An assessment of actual or potential hazards to the environment and human health, where this is applicable;
- Description of any emergency action taken to minimize possible threat(s) to human health or the environment;
- Estimated quantity and disposition of recovered material that resulted from the incident; and
- Any other information necessary to fully evaluate the situation and to develop an appropriate course of action.

I.U.3. Within five (5) calendar days after the Permittee is required to provide verbal notification, as specified in Permit Condition I.U.1 and I.U.2 of this Permit, the Permittee shall provide (to the Director) a written submission that shall include, but not be limited to, the following:

- Name, address, and telephone number of the individual reporting;
- A description (including cause, location, extent of injuries, if any, and an assessment of actual or potential hazard(s) to the environment and human health outside the facility, where this is applicable) of the incident (noncompliance and/or release);
- The period(s) in which the incident (noncompliance and/or release) occurred

including exact dates and times;

- Whether the results of the incident remain a threat to human health and the environment (whether the noncompliance has been corrected and/or the release has been adequately remediated); and
- If not, the anticipated time it is expected to continue; the steps taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance; and/or steps taken or planned to adequately remediate the release.

I.U.3.a. The Permittee need not comply with the five (5) calendar day, written notice requirement if the Director waives (in writing) the requirement, and the Permittee submits a written report within fifteen (15) calendar days from the time the Permittee is required to provide verbal notification, as specified in Permit Condition I.U.1 of this Permit.

Twenty-four (24) hour telephone number 1-800-632-8000
(Idaho Emergency Communication Center)
The address and telephone numbers listed above are current as of the effective date of this Permit and may be subject to change.

I.V. OTHER NONCOMPLIANCE

The Permittee shall report to the Director (on a quarterly basis) all other instances of noncompliance, not reported under Permit Condition I.U of this Permit, from the effective date of the Permit. The reports shall contain the applicable information listed in Permit Condition I.U of this Permit. Reporting shall not constitute a defense for any noncompliance.

I.W. OTHER INFORMATION

Whenever the Permittee becomes aware that he/she failed to submit any relevant facts in the Permit Application or submitted incorrect information in a Permit Application, or in any report to the Director, the Permittee shall promptly submit such facts or information to the Director, in accordance with Permit Condition I.Z of this Permit.

I.X. SIGNATURE AND CERTIFICATION

All applications, reports, or other information submitted to the Director (by the Permittee) shall be signed and certified in accordance with IDAPA 58.01.05.012 [40 CFR § 270.11 and § 270.30(k)].

I.Y. CONFIDENTIAL INFORMATION

The Permittee may be able to make a confidentiality claim regarding information submitted to the Department. Any such claim shall be governed by Sections 39-4411 and 39-337 to 39-350 of the Idaho Code, Sections 58.01.05.004 [40 CFR § 260.2], 58.01.05.012 [40 CFR § 270.12] and 58.01.05.997, and any other applicable state or local law. Pursuant to those authorities, if no claim of confidentiality is made at the time of submission, the Department may make the information available to the public without further notice.

I.Z. REPORTS, NOTIFICATIONS, AND SUBMISSIONS TO THE DIRECTOR

All reports, notifications, or other submissions that are required by this Permit and IDAPA 58.01.05.012 [40 CFR § 270.5] shall be sent or given to the Director (in duplicate) by certified mail, or express mail, or hand delivered to:

Director, c/o Hazardous Waste Program Manager
Idaho Department of Environmental Quality
1410 North Hilton
Boise, Idaho 83706-1255
Telephone No. (208) 373-0502

I.AA. DOCUMENTS TO BE MAINTAINED AT THE FACILITY

I.AA.1. The Permittee shall maintain at the facility (until closure is completed and certified by an independent, registered professional engineer) the following documents and amendments, and revisions or modifications to these documents:

I.AA.1.a. A complete copy of this Permit, including all attachments, figures, tables, and modifications (at a minimum) including the following:

- Waste Analysis Plan, as required by IDAPA 58.01.05.008 [40 CFR § 264.13] and this Permit (Attachment 2).
- Inspection Procedures, Schedules, Logs, and Records, as required by IDAPA 58.01.05.008 [40 CFR §§ 264.15(b)(2) and 264.73(b)(5)] and this Permit.
- Personnel training requirements for each position and personnel training records for each individual, involved with the management of hazardous waste, as required by IDAPA 58.01.05.008 [40 CFR § 264.16(d)] and this Permit.
- Contingency Plan, as required by IDAPA 58.01.05.008 [40 CFR § 264.53(a)] and this Permit (Attachment 7).
- Operating Record, as required by IDAPA 58.01.05.008 [40 CFR § 264.73] and this Permit.
- Closure Plan and Closure Cost Estimate, as required by IDAPA 58.01.05.008 [40 CFR § 264.112(a) and § 264.142] and this Permit.

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MODULE II - GENERAL FACILITY CONDITIONS

II.A. DESIGN AND OPERATION OF FACILITY

II.A.1. The Permittee shall design, construct, maintain, and operate the facility to minimize the possibility of a fire, explosion, or any unplanned sudden or non-sudden release of hazardous waste constituents to air, soil, ground water, or surface water that could threaten human health or the environment.

II.A.2. The Permittee shall construct all future and maintain all existing Hazardous Waste Management Units in accordance with the approved designs, specifications, and maintenance schedules that are included in Attachments 10, 11, 13 through 20, 24, and 25 of this Permit, except for minor changes deemed necessary by the Permittee to facilitate proper construction of the Hazardous Waste Management Units. Minor deviations from the approved designs or specifications necessary to accommodate proper construction, and the substitution of the use of equivalent or superior materials or equipment, must be noted on the as-built drawings and the rationale for those deviations must be provided in narrative form. After completion of construction of each future Hazardous Waste Management Unit, the Permittee shall submit to the Director final as-built drawings and the narrative report as part of the construction certification document specified in Permit Condition I.R.1.

II.A.3. A 100-foot wide strip of land, located within the outside perimeter (i.e., the fenceline) of the facility's legal boundaries as defined in Attachment 1 of this Permit, shall be set aside as a buffer strip for any hazardous waste treatment, storage, or disposal. New hazardous waste treatment, storage, or disposal units shall not be constructed within the buffer strip (except as relating to inspection requirements) nor shall the buffer strip be subdivided for the hazardous waste disposal site.

II.A.3.a. The company-owned land surrounding the Facility to the west, east, and south is subject to the Hazardous Waste Facility Siting Act (Idaho Code §§ 39-5801 through 5820).

II.A.3.b. The company-owned land along the northern boundary of the Facility, as defined in Permit Condition II.A.3.b.(1), shall remain undeveloped land and no application under the Hazardous Waste Facility Siting Act (Idaho Code §§ 39-5801 through 5820) shall be made to utilize this land for any activities permitted by the Act. This land shall be set aside as a buffer zone where no new hazardous waste treatment, storage, or disposal units, or ancillary structures, shall be constructed (except as relating to inspection requirements and other permit-required activities, such as corrective action) nor shall the buffer zone be subdivided for use as a hazardous waste disposal site. Except as specified above, the buffer zone, as defined in Permit Condition II.A.3.b.(1), will be maintained in a natural state and will not be developed or used in a manner that will impair the historic viewshed or cultural and natural resources. This Permit Condition shall bind USEI, its successors, and assigns.

II.A.3.b.(1) The buffer zone subject to the requirements of Permit Condition II.A.3.b shall encompass approximately 309 acres and is located as follows:

T4S, R1E, Owyhee County
Section 13: E1/2 SE1/4

T4S, R2E, Owyhee County
Section 18: Lots 3 and 4, E1/2 SW1/4, S1/2 SE1/4

II.A.4. The Permittee shall comply with all applicable requirements of the Land Disposal Restrictions of IDAPA 58.01.05.011 [40 CFR Part 268].

II.B. REQUIRED NOTICES FOR RECEIPT OF OFF-SITE HAZARDOUS WASTE

II.B.1. The Permittee may receive hazardous waste from a foreign source provided that the Permittee notify the Director (in writing) at least four (4) weeks in advance of the date hazardous waste, from a foreign source, is expected to arrive at the facility, as required by IDAPA 58.01.05.008 [40 CFR § 264.12(a)]. Notice of subsequent shipments of the same waste from the same foreign source is not required.

II.B.2. When the Permittee is to receive hazardous waste from an off-site source (except where the Permittee is also the generator), it must inform the generator in writing that it has the appropriate permits for and will accept the waste the generator is shipping. The Permittee must keep a copy of this written notice as part of the Operating Record, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.12(b) and § 264.73(b)(7)] and this Permit.

II.B.3. The Permittee shall notify the Department in writing, within three (3) business days of the occurrence, that the Permittee has rejected for acceptance a hazardous waste shipment. This notice shall contain the following information:

II.B.3.a. Generator name, EPA ID Number, address, and telephone number;

II.B.3.b. Transporter name and EPA ID Number;

II.B.3.c. Waste description and quantity;

II.B.3.d. Reason for rejection;

II.B.3.e. Date of generator signature;

II.B.3.f. Date of receipt and rejection; and

II.B.3.g. Copy of manifest.

II.C. GENERAL WASTE ANALYSIS

II.C.1. The Permittee shall comply with the procedures and requirements of the Waste Analysis Plan, in accordance with IDAPA 58.01.05.008 and 58.01.05.011 [40 CFR § 264.13 and § 268.7], and Attachments 2 and 23 of this Permit.

II.C.2. For every waste stream received, the Permittee shall have on file (at the site), the generator-provided “Waste Product Questionnaire” (Figure C-1 of Attachment 2).

II.C.3. The Permittee may revise Figure C-1, as designated in Permit Conditions II.C.3.a and II.C.3.b, without first obtaining a permit modification under IDAPA 58.01.05.012 [40 CFR § 270.42]. The procedures designated under Permit Condition II.S shall be followed to implement these revisions:

II.C.3.a. The Permittee may add information requirements to Figure C-1 in cases where such additional information will result in a more comprehensive Figure C-1.

II.C.3.b. The Permittee may delete information from Figure C-1 if the information is not essential for determining the acceptability of a waste stream for management at the Permittee's site (i.e., revisions made to Figure C-1 to comply with IDAPA 58.01.05.011 [40 CFR Part 268] restrictions).

II.C.4. The Permittee shall ensure that the wastes are not managed at the facility in violation of the provisions of the Land Disposal Restrictions rule as contained in IDAPA 58.01.05.011 [40 CFR Part 268] with the exception of CAMU-eligible wastes, per section II.C.5 of this permit. To the extent that modifications to the Permittee’s Waste Analysis Plan are needed to comply with future self implementing provisions of IDAPA 58.01.05.011 [40 CFR Part 268], the Permittee must submit a Permit Modification Request to the Director within ninety (90) calendar days of the effective date of the self-implementing provisions.

II.C.4.a. The Permittee is authorized to accept CAMU-eligible wastes for disposal. The Permittee shall ensure CAMU-eligible wastes are managed in accordance with the provisions contained in IDAPA 58.01.05.008 [40 CFR Part 264] and Attachment 2 of this Permit.

II.C.5. All waste analysis procedures designated in Attachment 2 and 17 of this Permit shall be adhered to for the placement of on-site-generated landfill leachate and any other wastes into the evaporation pond.

II.C.6 The Permittee shall maintain a copy of the latest approved Waste Analysis Plan, included as Attachment 2 of this Permit, at the facility until the facility is fully closed and certified per IDAPA 58.01.05.008 [40 CFR § 264 Subpart G].

II.C.7. The Permittee shall comply with the requirements of IDAPA 58.01.05.008 [40 CFR § 264.17(a)] and follow the procedures for handling ignitable, reactive, and incompatible wastes set forth in Attachment 2 of this Permit.

II.C.8. The Permittee shall comply with the 40 CFR 264 Subpart CC waste determination procedures, as required by IDAPA 58.01.05.008 [40 CFR § 264.1083].

II.D. SECURITY PROCEDURES

The Permittee shall comply with the security provisions of IDAPA 58.01.05.008 [40 CFR § 264.14(b)] and as described in Attachment 3 of this Permit.

II.E. INSPECTION PLAN

The Permittee shall follow the procedures of the approved Inspection Plan included as Attachment 4 of this Permit. The Permittee shall comply with the inspection provisions of IDAPA 58.01.05.008 [40 CFR § 264.15], and as follows:

II.E.1. The Permittee shall maintain the inspection records and results, in accordance with Permit Condition I.AA. The Permittee shall record inspections on the Inspection Log sheet (included in Attachment 4 of this Permit) or an equivalent, approved log sheet, as specified in IDAPA 58.01.05.008 [40 CFR § 264.15(d)].

II.E.2. The Permittee shall record on the Inspection Logs and Inspection Log Sheets (required by Permit Condition II.E.1) as specified in IDAPA 58.01.05.008 [40 CFR § 264.15(d)]. At a minimum, the following shall be recorded:

- The date and time of the inspection;
- The name and title of the inspector;
- A notation of the observations made; and
- The date and nature of any repairs or other remedial actions.

II.E.3. The Permittee shall remedy, as required by IDAPA 58.01.05.008 [40 CFR § 264.15(c)], on a schedule approved by the Director, any deterioration or malfunction discovered by an inspection.

II.E.4. The Permittee shall retain the Inspection Logs and Inspection Log Sheets required by Permit Condition II.E.1 until closure is completed and certified, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.73(b)(5)] and Permit Condition I.AA.

II.E.5. In the event of a facility shutdown or an extended holiday, no more than seventy-two (72) hours shall elapse between inspections listed at a frequency of "normal working day" on the inspection schedule (Table F-1 in Attachment 4).

II.E.6. The Permittee may make only the following revisions to the Inspection Plan, without first obtaining a permit modification, in accordance with IDAPA 58.01.05.012 [40 CFR § 270.42]. The procedures designated under Permit Condition II.S shall be followed to implement these revisions.

II.E.6.a. Upon certification of closure of an individual Waste Management Unit, any portion of the Inspection Plan, specific to that unit, may be deleted from the Inspection Plan (Attachment 4 of this Permit).

II.E.6.b. The Permittee may modify orientations of inspection-related items on inspection figures.

II.E.6.c. The Permittee may add inspection requirements to an existing inspection form, table, figure, or disposal record form in cases where such additional requirements will result in a more comprehensive or detailed Inspection Plan.

II.E.6.d. The Permittee may create additional inspection forms, tables, figures, or disposal record forms to address inspection requirements for equivalent replacement equipment that must be routinely inspected.

II.F. TRAINING PLAN

II.F.1. The Permittee shall ensure that all personnel who handle hazardous waste are trained in hazardous waste management, safety and emergency procedures (as applicable to their job description) in accordance with the Permittee's Training Plan. These personnel shall be trained in accordance with the Training Plan, as included in Attachment 5 of this Permit, and documentation of training shall be maintained, as specified in Attachment 5 of this Permit.

II.G. PREPAREDNESS AND PREVENTION

II.G.1. The Permittee shall comply with the preparedness and prevention procedures included as Attachment 6 of this Permit, and in accordance with IDAPA 58.01.05.008 [40 CFR § 264 Subpart C] and as follows:

II.G.2. The Permittee shall operate the permitted units so as to minimize the possibility of a fire, explosion or sudden or non-sudden releases to the air or soil, which could threaten human health or the environment, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.31] and Attachment 6 of this Permit.

II.G.3. The Permittee shall maintain the communications and alarm systems, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.34] and Attachment 6 of this Permit.

II.G.4. The Permittee shall maintain the aisle space necessary to allow the unobstructed movement of personnel, fire protection equipment, spill control equipment, and decontamination equipment, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.35] and Attachment 6 of this Permit.

II.G.5. The Permittee shall maintain arrangements with state and local authorities, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.37] and Attachment 7 of this Permit. If state or local officials refuse to enter into preparedness and prevention arrangements with the Permittee for a given HWMU, the Permittee must document this refusal in the Operating Record.

II.H. CONTINGENCY PLAN

II.H.1. The Permittee shall follow the procedures outlined in the Contingency Plan, included as Attachment 7 of this Permit, and comply with IDAPA 50.01.05.008 [40 CFR 264 Subpart D] and as follows:

II.H.2. The Permittee shall notify the Department by calling the Idaho Emergency Communication Center's 24-hour phone number (1-800-632-8000), as soon as practical, but in no event more than 24 hours after the discovery of any release of hazardous waste that may pose an immediate threat to the Permittee's personnel or the environment, or that requires the Permittee to take corrective action to mitigate the effects of the release, including implementing the Contingency Plan. Releases requiring such notification shall include, but are not limited to, incidents such as personnel exposure or contamination for which outside medical attention is sought; storm events that result in run-off leaving the active areas of the site; or any fire or explosion at the site that requires use of emergency equipment to extinguish or control the fire.

II.H.3. The Permittee shall review and immediately amend, as necessary, the Contingency Plan whenever:

II.H.3.a. This Permit is revised;

II.H.3.b. The Contingency Plan fails in an emergency;

II.H.3.c. The Permittee changes the facility design, construction, operation, maintenance, or other circumstances in a way that materially increases the potential for fires, explosions, or releases of hazardous waste or hazardous waste constituents, or changes the response necessary in an emergency;

II.H.3.d. The list of emergency coordinators changes; or

II.H.3.e. Major changes to the list of emergency equipment occur.

II.H.4. The Permittee shall submit to the Director the names, addresses, and phone numbers of all persons qualified to act as emergency coordinators. The Permittee shall ensure that a trained emergency coordinator be available at all times in case of an emergency.

II.H.5. The Permittee shall submit a copy of the Contingency Plan, and all revisions to the plan, to all local police departments, fire departments, hospitals, and state and local emergency response teams that may be called upon to provide emergency services, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.53(b)].

II.H.6. The Permittee shall document the time, date, and details of any incident that requires implementing the Contingency Plan in the Facility Operating Record. Within fifteen (15) days after the incident, the Permittee shall submit a written report of the incident to the Director.

II.I. MANIFEST SYSTEM

II.I.1. The Permittee shall follow the procedures for using the Manifest System and identifying and resolving manifest discrepancies, in accordance with IDAPA 58.01.05.008, 58.01.05.012 [40 CFR §§ 264.71, 264.72, and 270.30(1)(7)] and the Waste Analysis Plan, included as Attachment 2 of this Permit.

II.I.2. The Permittee shall submit an unmanifested waste report to the Director, in accordance with IDAPA 58.01.05.008, IDAPA 58.01.05.012 [40 CFR §§ 264.76 and 270.30(1)(8)], within fifteen (15) calendar days of receipt of unmanifested waste.

II.J. RECORD KEEPING AND REPORTING

In addition to the record keeping and reporting requirements specified elsewhere in this Permit, the Permittee shall comply with the following:

II.J.1. The Permittee shall maintain a written Operating Record at the facility, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.73(a)], for all records identified in IDAPA 58.01.05.008 [40 CFR §§ 264.73(b)(1) through 264.73(b)(16)].

II.J.2. The Permittee shall, by March 1st of each year, submit to the Director a certification pursuant to IDAPA 58.01.05.008 [40 CFR § 264.73(b)(9)], that the Permittee has a program in place to reduce the volume and toxicity of hazardous waste generated, to the degree determined to be economically practicable; and that the proposed method of treatment, storage, or disposal is the most practicable method currently available to the Permittee, which minimizes the present and future threat to human health and the environment.

II.J.3. The Permittee shall, by March 1st of each even-numbered year, submit to the Director a Biennial Report covering the facility activities during the previous calendar year, pursuant to IDAPA 58.01.05.008, 58.01.05.006, 58.01.05.012 [40 CFR §§ 264.75(a) through (j), 262.41, 270.30(l)(9)].

II.J.4. The Permittee shall retain all hazardous waste management records, including data collected in accordance with procedures of the Response Action Plans, and make such records available to the Director (at reasonable times) for inspection, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.74(a)].

II.J.5. The retention period for all records required by this Permit is extended automatically during the course of any unresolved enforcement action regarding the Permittee or as directed by the Director, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.74(b)].

II.J.6. The Permittee shall submit a survey plat of waste disposal locations to the local land authority and to the Director in accordance with the closure requirements of Permit Condition II.K.8 and IDAPA 58.01.05.008 [40 CFR § 264.116].

II.J.7. The Permittee shall submit additional reports to the Director in accordance with IDAPA 58.01.05.008 [40 CFR § 264.77].

II.K. CLOSURE

II.K.1. The Permittee shall meet the general closure performance standard, as specified in IDAPA 58.01.05.008 [40 CFR § 264.111], during closure of all Hazardous Waste Management Units at the facility. Compliance with IDAPA 58.01.05.008 [40 CFR § 264.111] shall require closure of each Hazardous Waste Management Unit in accordance with the Closure Plan, included as Attachment 9 of this Permit and all applicable requirements of Permit Condition II.K.

II.K.2. For all Hazardous Waste Management Units, other than landfills and surface impoundments, minor deviations from the permitted closure procedures, necessary to accommodate proper closure, must be described in a narrative form with the closure certification statements. The Permittee shall describe the rationale for implementing minor changes as part of this narrative report. Within sixty (60) calendar days after completion of closure of each Hazardous Waste Management Unit, other than Landfill and Surface Impoundment Units, the Permittee shall submit the certification statements and narrative report to the Director.

II.K.3. The Permittee shall amend the Closure Plan, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.112(c)], whenever necessary, by submitting a written request for a permit modification to the Director.

II.K.4. The Permittee shall notify the Director at least sixty (60) calendar days prior to the date it expects to begin closure of any surface impoundment or landfill unit, and at least forty-five (45) calendar days prior to the date it expects to begin closure of any tanks, container storage units, or containment buildings.

II.K.5. The Permittee shall close all Hazardous Waste Management Units within the time limits specified in the Closure Plan in Attachment 9 of this Permit, with the exception that the closure time for the surface impoundments shall be 1,460 days after receiving the final volume of hazardous wastes, unless extended, pursuant to Permit Condition V.B.

II.K.6. The Permittee shall decontaminate or dispose of all facility equipment as specified in the Closure Plan included in Attachment 9 of this Permit.

II.K.7. The Permittee shall provide certification statements attesting that each Hazardous Waste Management Unit at the facility has been closed in accordance with the applicable specifications in the Closure Plan included in Attachment 9 of this Permit, as required by IDAPA 58.01.05.008 [40 CFR § 264.115].

II.K.8. The Permittee shall submit to the local land use authority, and to the Director, upon submission of the certification of closure of each hazardous waste disposal unit, a survey plat indicating the waste disposal locations and dimensions, with respect to permanently surveyed benchmarks, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.116].

II.K.9. In the event that any Hazardous Waste Management Unit, other than the Landfill and Surface Impoundment Units, cannot be closed by removing hazardous waste, hazardous constituents, contaminated subsoil, and any contaminated ground water (i.e., clean-closed) as specified in Permit Condition II.K.1, the Permittee shall revise the Facility Post-Closure Plan to include a Post-Closure Plan for that Hazardous Waste Management Unit. The Permittee shall submit to the Director the Post-Closure Plan for that Hazardous Waste Management Unit, as a Permit Modification Request, within ninety (90) calendar days of the date that the Director notifies the Permittee in writing that the unit must be closed as a landfill, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.118(a)].

II.L. COST ESTIMATE FOR FACILITY CLOSURE

II.L.1. The Permittee shall comply with the requirements of IDAPA 58.01.05.008 [40 CFR § 264.142(a)]. The Permittee shall maintain a current closure cost estimate for each individual Hazardous Waste Management Unit. The costs shall be summarized, by the Permittee, for final closure of the entire facility.

II.L.2. In accordance with IDAPA 58.01.05.008 [40 CFR § 264.142(b)], the Permittee shall annually adjust the closure cost estimate for inflation, prior to June 1st, the anniversary date of the establishment of the original financial instrument(s) used to comply with Permit Condition II.O and IDAPA 58.01.05.008 [40 CFR § 264.143].

II.L.3. During the active life of the facility, the Permittee shall submit to the Director a revised closure cost estimate within thirty (30) calendar days of an approved modification to the Closure Plan, if such modification results in an increase in the closure cost estimate, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.142(c)].

II.L.4. During the operating life of the facility, the Permittee shall keep a copy of each closure cost estimate and adjustment made at the facility, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.142(a), (b), and (c)].

II.L.5. The Permittee shall maintain an updated summary of current closure costs for the entire facility closure, based on the Hazardous Waste Management Units that have received RCRA waste but have not yet been certified as closed, and have not been released from the financial responsibility requirements as specified in Permit Condition II.O (i.e., active units).

II.L.6. Prior to placement of waste in any new Hazardous Waste Management Unit, the Permittee must amend, as necessary, the summary of current closure costs to reflect the estimated closure cost of that new unit. Such amended closure costs shall be annually adjusted for inflation, as required by IDAPA 58.01.05.008 [40 CFR § 264.142(b)].

II.L.7. Upon certification for closure of any Hazardous Waste Management Unit, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.115], and after the Director has released the Permittee from the financial responsibility requirements for that unit as specified in Permit Condition II.O, the Permittee may adjust the summary of current closure costs to reflect the closure cost of that unit. The Permittee shall submit to the Director a current version of the closure cost estimate for the facility, indicating cost estimates for each remaining unit to be closed.

II.M. POST-CLOSURE CARE

II.M.1. The Permittee shall comply with the approved Post-Closure Plan, included in Attachment 9 of this Permit. In addition, the Permittee shall comply with all modifications to the Post-Closure Plan, and with all provisions of IDAPA 58.01.05.008 [40 CFR §§ 264.117, .118, .119, and .120].

II.M.2. Except as the period may be shortened or extended, as provided in IDAPA 58.01.05.008 [40 CFR § 264.117(a)(2)], the period of Post-Closure Care for each Landfill and Surface Impoundment Unit and any other Hazardous Waste Management Unit, as applicable, shall be thirty (30) years after Director approval of closure certification.

II.N. COST ESTIMATE FOR POST-CLOSURE CARE

II.N.1. The Permittee shall comply with IDAPA 58.01.05.008 [40 CFR § 264.144(a)]. The Permittee shall maintain a current post-closure cost estimate for each post-closure activity.

II.N.2. The Permittee shall annually adjust the post-closure cost estimate for inflation, prior to June 1st, the anniversary date of the establishment of the original financial instrument(s) used to comply with Permit Condition II.P and IDAPA 58.01.05.008 [40

CFR § 264.144(b)].

II.N.3. During the active life of the facility, the Permittee shall submit to the Director a revised post-closure cost estimate, within thirty (30) days of an approved modification to the Post-Closure Plan, if such modification results in an increase in the post-closure cost estimate, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.144(c)].

II.N.4. During the operating life of the facility, the Permittee shall keep a copy at the facility of each post-closure cost estimate and adjustments prepared, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.144(a), (b), and (c)].

II.O. FINANCIAL ASSURANCE FOR FACILITY CLOSURE

II.O.1. The Permittee shall comply with IDAPA 58.01.05.008 [40 CFR § 264.143] by providing documentation of financial assurance, as required by IDAPA 58.01.05.008 [40 CFR § 264.151], in the amount of the cost estimates required by Permit Condition II.L.1.

II.O.2. Prior to placement of waste in any new Hazardous Waste Management Unit, the Permittee shall update the closure financial assurance mechanism, as necessary, and demonstrate that an adequately, funded financial assurance mechanism for closure of the facility, including the new Hazardous Waste Management Unit, is in effect. A copy of the updated, financial assurance mechanism shall be approved by the Director before waste is placed in the new unit. (See Permit Condition II.L.6.)

II.O.3. Changes in financial assurance mechanisms for closure must be approved by the Director, pursuant to IDAPA 58.01.05.008 [40 CFR § 264.143].

II.P. FINANCIAL ASSURANCE FOR FACILITY POST-CLOSURE

II.P.1. The Permittee shall comply with IDAPA 58.01.05.008 [40 CFR § 264.145 or 264.146] by providing documentation of financial assurance, as required by IDAPA 58.01.05.008 [40 CFR § 264.151], in the amount of the cost estimates required by Permit Condition II.N.1.

II.P.2. Changes in financial assurance mechanisms for post-closure must be approved by the Director, pursuant to IDAPA 58.01.05.008 [40 CFR § 264.145].

II.Q. LIABILITY REQUIREMENTS

II.Q.1. The Permittee shall comply with the requirements of IDAPA 58.01.05.008 [40 CFR § 264.147(a)] and the documentation requirements of IDAPA 58.01.05.008 [40 CFR § 264.151], including the requirements to have and maintain liability coverage for sudden accidental occurrences in the amount of at least $1 million per occurrence, with an annual aggregate of at least $2 million, exclusive of legal defense costs.

II.Q.2. The Permittee shall comply with the requirements of IDAPA 58.01.05.008 [40 CFR § 264.147(b)] and the documentation requirements of IDAPA 58.01.05.008 [40 CFR § 264.151], including the requirements to have and maintain liability coverage for non-sudden accidental occurrences in the amount of at least $3 million per occurrence, with an annual aggregate of at least $6 million, exclusive of legal defense costs.

II.R. INCAPACITY OF OWNERS OR OPERATORS GUARANTORS, OR FINANCIAL INSTITUTIONS

The Permittee shall comply with IDAPA 58.01.05.008 [40 CFR § 264.148].

II.S. EQUIVALENT MATERIALS/INFORMATION

II.S.1. If certain equipment, materials, and administrative information (such as names, phone numbers, addresses) are specified in this Permit, the Permittee is allowed to use an equivalent or superior substitute. Use of such equivalent or superior items, within the limits (e.g. ranges, tolerances, and alternatives) already specified in sufficient detail in this Permit and the Permit Attachments, shall not be considered a modification of the Permit. However, the Permittee must place in the Operating Record (prior to the institution of such revision) the revision, accompanied by a narrative explanation, and the date the revision became effective. Documentation of the substitution shall be submitted to the Director on a quarterly basis (at a minimum). The Department may judge the soundness of the revision and take appropriate action. The format of tables and forms are not subject to the requirements of this Permit, and may be revised at the Permittee's discretion.

II.S.2. If the Department determines that the substitution was not equivalent to the original, it will notify the Permittee that the Permittee's claim of equivalency has been denied, the reasons for the denial, and that the original material or equipment must be used. If the product substitution is denied, the Permittee shall comply with the original, approved product specification, find an acceptable substitution, or apply for a permit modification, in accordance with IDAPA 58.01.05.012 [40 CFR § 270.42].

II.T. AIR EMISSION STANDARDS

II.T.1. The Permittee shall comply with the Phase 1 Organic Air Emission Standards of IDAPA 58.01.08.008 [40 CFR Part 264] for hazardous waste treatment, storage, and disposal (TSD) facilities including:

- IDAPA 58.01.08.008 [40 CFR Part 264, Subpart AA] for emission standards of total organics from process vents associated with distillation, fractionation, thin-film evaporation, solvent extraction, and air or steam-stripping operations that process hazardous waste, with an annual average total organic concentration of at least ten (10) parts per million by weight (ppmw).
- IDAPA 58.01.08.008 [40 CFR Part 264, Subpart BB] for emission standards that address leaks of total organics from specific equipment (i.e., pumps, valves, compressors, etc.) that contains or contacts hazardous waste that has a total organic concentration of at least 10% by weight.
- IDAPA 58.01.08.008 [40 CFR Part 264, Subpart CC] for emission standards that address the management of hazardous waste, containing an average volatile organic (VO) concentration at the point of waste origination of more than 500 ppmw, in tanks, surface impoundments, and containers.

II.T.2. The Permittee shall not treat, store, or dispose of hazardous wastes subject to

IDAPA 58.01.05.008 [40 CFR § 264.1082] (e.g., wastes that exceed an average volatile organic (VO) concentration at the point of waste origination of more than 500 ppmw) in tanks, surface impoundments, or containers, unless the appropriate emission control requirements are met, as specified in IDAPA 58.01.05.008 [40 CFR Subpart CC]. Prior approval from the Director is required for the treatment or disposal of wastes exceeding an average VO concentration at the point of waste origination of 500 ppmw in tanks, surface impoundments, or containers.

II.T.3. Prior to installing or using any additional equipment (including air emission controls) subject to the requirements of IDAPA 58.01.05.008 [40 CFR Part 264, Subpart CC], the Permittee shall supply the specific Part B information required, pursuant to IDAPA 58.01.05.012 [40 CFR § 270.27], and shall obtain a permit modification in accordance with the provisions of IDAPA 58.01.05.012 [40 CFR § 270.42].

II.T.4. Prior to installing or using any equipment with process vents subject to the requirements of IDAPA 58.01.05.008 [40 CFR Part 264, Subpart AA], the Permittee shall supply the specific Part B information required, pursuant to IDAPA 58.01.05.012 [40 CFR § 270.24], and shall obtain a permit modification in accordance with the provisions of IDAPA 58.01.05.012 [40 CFR § 270.42].

II.T.5. Prior to installing or using any equipment subject to the requirements of IDAPA 58.01.05.008 [40 CFR Part 264, Subpart BB], the Permittee shall supply the specific Part B information required pursuant to IDAPA 58.01.05.012 [40 CFR § 270.25] and shall obtain a permit modification, in accordance with the provisions of IDAPA 58.01.05.012 [40 CFR § 270.42].

II.T.6. The Permittee shall record the information required in accordance with IDAPA 58.01.05.008 [40 CFR § 264.1089] in a log kept in the Facility Operating Record for use in determining exemptions, as provided in the Applicability Section of IDAPA 58.01.05.008 [40 CFR § 264.1050].

II.U. QUARTERLY REPORTS

II.U.1. The following reports shall be submitted to the Department on a quarterly basis:

- Minor discrepancies and items not requiring 24-hour reporting, including documentation of equivalent or superior items, treatment failures (i.e., failed stabilization results), and other noncompliance items under Permit Condition I.V.;
- Summary of NORM/FUSRAP waste receipts, providing volumes and concentrations of waste disposed; and
- Alternative Cover data summary for Test Pad and Trenches 10 and 11.

Note: Ground Water Monitoring Reports shall be submitted per the schedule stated in Module IX of this Permit.

II.V. COMPLIANCE SCHEDULE

II.V.1. Within 180 days of the April following the effective Permit date, the Pug Mill shall be closed in accordance with IDAPA 58.01.08.008 [40 CFR Part 264 Subpart G] and Attachment 9.

II.V.2. Within 180 days of the April following the effective Permit date, landfill Cell 5 shall be closed in accordance with IDAPA 58.01.08.008 [40 CFR Part 264 Subpart G] and Attachment 9.

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MODULE III - CONTAINER STORAGE AND TREATMENT

III. Subject to the terms of this Permit, the Permittee may store and/or treat hazardous wastes in permitted Container Management Units, as follows:

III.A. DESIGN AND OPERATION

III.A.1. The Permittee's compliance with the requirements of Permit Conditions III.A through III.C shall constitute compliance with the requirements of IDAPA 58.01.05.008 [40 CFR Part 264, Subpart I] for the management of hazardous waste in containers.

III.A.2. The Container Management Units are identified as follows: Container Storage Pad 4; Container Storage Pad 5; Container Storage Area 1; Stabilization Facility; Truck Unloading Apron Nos. 1, 2, and 3; and the RCRA portion of the RCRA/PCB Building. In these Container Management Units and in the Containment Building, the Permittee may store and/or treat containerized wastes, as listed on the Part A Permit Application (included as Attachment 12 of this Permit) except that the limitations designated on Table C-8 and Table C-10 of Attachment 2 of this Permit apply to the wastes stored in containers at any time.

III.A.3. The Permittee shall not store waste using glass as the primary container.

III.A.4. The quantity of 55-gallon containers stored in each designated storage unit, or its volumetric equivalent, shall be limited to the maximum storage capacities designated on Tables D-1 and D-1A of Attachment 13 of this Permit.

III.A.5. The Permittee shall store and/or treat containerized waste, in Container Management Units and in the Containment Building, in the manner described in Attachment 13 of this Permit, except as otherwise specified in this Permit, and in accordance with Permit Condition II.A.I. Additionally, the Permittee shall comply with all applicable sections of Attachments 2, 4, 6, 7, 15, 24, and 25 of this Permit.

III.A.6. The Permittee shall assure that the ability of the container to contain the waste is not impaired, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.172].

III.A.7 If a container holding hazardous waste is not in good condition (e.g., severe rusting, apparent structural defects) or if it begins to leak, the Permittee shall transfer the hazardous waste from such container to a container that is in good condition, or otherwise manage the waste in compliance with the conditions of this Permit and IDAPA 58.01.05.008 [40 CFR § 264.171].

III.A.8 The Permittee shall maintain all Secondary Containment Systems, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.175] and the attached plans and specifications in Attachment 13 of this Permit.

III.A.9. The Permittee shall inspect the Container Management Units weekly, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.174] and the inspection schedules in Attachment 4 of this Permit, to detect leaking containers and deterioration of containers and the Containment System caused by corrosion and other factors. The Permittee shall document the results of all inspections and wastes analyses performed in the Operating Record.

III.A.10. The Permittee shall keep all relevant figures, drawings, and diagrams, related to the Container Management Units, readily available for inspection at the facility, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.74].

III.B. INCOMPATIBLE WASTE

III.B.1. The Permittee shall not place incompatible wastes, or wastes and materials which are incompatible in the same container, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.177].

III.B.2. The Permittee shall not place hazardous waste or materials in an unwashed container that previously held an incompatible waste or material.

III.B.3. The Permittee shall not store a container holding hazardous waste that is incompatible with any waste, or any materials stored nearby in containers, without separating these incompatible wastes or materials by protecting the wastes from commingling by means of a dike, berm, or wall.

III.C. SPECIAL REQUIREMENTS

III.C.1. The Permittee shall keep all containers closed during storage and shall not open, handle, or store containers in a manner which may rupture the container or cause it to leak, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.173]. The Permittee shall provide temporary cover for all water-reactive, containerized wastes (meeting Permit Condition II.C) that are stored in the Container Management Units located outside, including Container Storage Pad 4, Container Storage Pad 5, Container Storage Area 1, and the Stabilization Facility. This temporary cover may be in the form of any structure, tarp, or other device that serves to prevent precipitation from accumulating on the tops of containers. Such containers shall be covered at all times except when being removed, rearranged, inspected or otherwise managed as part of routine operation.

III.C.2. The RCRA/PCB Storage Building (100 feet x 100 feet) shall be used for storage of containerized waste materials that do not contain free liquids, as measured with the following test method: Method 9095 (Paint Filter Test). All containerized waste (as described in Attachment 13 of this Permit) shall be placed on pallets with adequate aisle space to facilitate inspection. All spills shall be managed in accordance with the applicable sections of the Contingency Plan (Attachment 7 of this Permit).

III.C.3. The Permittee shall not locate containers holding ignitable or reactive waste within fifteen (15) meters (50 feet) of the facility's property line. The Permittee shall take precautions to prevent accidental ignition or reaction of ignitable or reactive wastes by following the procedures of Attachment 13 of this Permit. In accordance with Section D.1.b of Attachment 13 of this Permit, the Permittee shall designate all containers that are to be transported off-site for disposal (i.e., trans-shipped and brokered waste) with a unique marking (e.g "red label/mark) on the container.

III.C.4. The Permittee shall comply with Permit Condition II.T. of this Permit, for all hazardous wastes subject to IDAPA 58.01.05.008 [40 CFR 264 Subpart CC] in containers.

III.C.4.a For storage of containers of hazardous waste exceeding an average VO concentration at the point of origin of 500 ppmw, the Permittee shall comply with all applicable regulations of 40 CFR 264 Subpart CC, including the container standards in IDAPA 58.01.05.008 [40 CFR § 264.1086] as specified in Permit Condition II.T.2

III.C.4.b For containers within the Containment Building and the Container Management Units that contain organic materials, with a volatile organic concentration at the point of origin less than 500 ppmw, and are therefore exempt from using air emission control equipment, documentation shall be recorded that includes the information that was used by the Permittee for each waste determination (e.g., test results, measurements, calculations, and other documentation) in the Facility Operating Record. If analytical results for waste samples are used for the waste determination, then the Permittee shall record the date, time, and location that each waste sample is collected, in accordance with applicable requirements of 40 CFR § 264.1083, and keep this information in the Operating Record for a minimum of three (3) years.

III.C.5. Reporting Requirements:

If the Permittee does not comply with Permit Condition III.C.4., a report shall be submitted to the Director on each occurrence when hazardous waste is placed in the Waste Management Unit in noncompliance with the conditions of 40 CFR §§ 264.1082(c)(1) or 264.1082(c)(2), as applicable. A written report shall be submitted within fifteen (15) calendar days of the time that the Permittee becomes aware of the occurrence. The written report shall contain: the EPA Identification Number, facility name and address, a description of the noncompliance event and the cause, the dates of the noncompliance, and corrective actions taken to prevent reoccurrence of the noncompliance. The report shall be signed and dated by an authorized representative of the Permittee per IDAPA 58.01.05.008 [40 CFR § 264.1090].

III.D. CLOSURE AND POST-CLOSURE

Closure and Post-Closure Care of all Container Management Units shall be completed in accordance with IDAPA 58.01.05.008 [40 CFR § 264.178], and the applicable sections of Attachment 9 of this Permit.

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MODULE IV - TANK STORAGE AND TREATMENT

IV. Subject to the terms of this Permit, the Permittee may store and /or treat hazardous wastes in the permitted HWMA tanks, as follows:

IV.A. GENERAL OPERATING REQUIREMENTS

IV.A.1 The Permittee's compliance with the requirements of Permit Conditions IV.A through IV.F shall constitute compliance with the requirements of IDAPA 58.01.05.008 [40 CFR Part 264, Subpart J], pertaining to the management of hazardous wastes in tanks.

IV.A.2 The Permittee shall comply with the tank operating requirements of IDAPA 58.01.05.008 [40 CFR § 264.194] and Attachments 14 and 24 of this Permit.

IV.A.3 The Permittee shall inspect the tank systems according to IDAPA 58.01.05.008 [40 CFR § 264.195], and the inspection schedule contained in Attachment 4 of this Permit.

IV.A.4 The Permittee shall maintain all Secondary Containment Systems in accordance with IDAPA 58.01.05.008 [40 CFR § 264.193] and the attached plans and specifications, as contained in Attachments 14 and 24 of this Permit.

IV.A.5. The Permittee shall remove any spilled or leaked wastes and any accumulated precipitation from the Secondary Containment Systems of each tank within 24 hours of detection, unless the waste or precipitation in the Secondary Containment System is frozen. The Permittee shall manage said wastes and precipitation as hazardous wastes. Within two (2) normal working days after the waste or precipitation in the Secondary Containment System is no longer frozen, the contained liquids will be characterized and removed.

IV.A.6. The Permittee shall respond to leaks or spills and disposition of leaking or unfit-for-use tank systems, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.196].

IV.A.7. Ignitable or reactive wastes must not be placed in tank systems unless the special requirements of IDAPA 58.01.05.008 [40 CFR § 264.198] are met.

IV.A.8. Incompatible wastes and materials must not be placed in the same tank system unless the special requirements of IDAPA 58.01.05.008 [40 CFR § 264.199] are met.

IV.A.9. The Permittee shall comply with Permit Condition II.T of this Permit, for all hazardous waste subject to IDAPA 58.01.05.008 [40 CFR Subpart CC] in tanks.

IV.A.9.a. For tanks that manage organic materials with a volatile organic concentration at the point of origin less than 500 ppmw, and are therefore exempt from using air emission control equipment, documentation shall be recorded that includes the information that was used by the Permittee for each waste determination (e.g., test results, measurements, calculations, and other documentation) in the Facility Operating Record. If analytical results for waste samples are used for the waste determination, then the Permittee shall record the date, time, and location that each waste sample is collected in accordance with applicable requirements of 40

CFR § 264.1083, and keep this information in the Operating Record for a minimum of three (3) years.

IV.A.9.b. Reporting Requirements: If the Permittee does not comply with Permit Condition IV.9.a., a report shall be submitted to the Director on each occurrence when hazardous waste is placed in the Waste Management Unit in noncompliance with the conditions of 40 CFR § 264.1082(c)(1) or § 264.1082(c)(2), as applicable. A written report shall be submitted within fifteen (15) calendar days of the time that the Permittee becomes aware of the occurrence. The written report shall contain: the EPA Identification Number, facility name and address, a description of the noncompliance event and the cause, the dates of the noncompliance, and corrective actions taken to prevent reoccurrence of the noncompliance. The report shall be signed and dated by an authorized representative of the Permittee, per IDAPA 58.01.05.008 [40 CFR § 264.1090].

IV.A.10. The Permittee shall keep all relevant figures, drawings, and diagrams, related to the tank systems, readily available for inspection at the facility, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.74].

IV.B. BULK LIQUID STORAGE TANKS

IV.B.1. The Bulk Liquid Storage Tanks shall be defined as four (4) existing storage tank units designated as Nos. 1, 2, 3, and 4. References to the Bulk Liquid Storage Tanks shall also include any associated piping, appurtenances, and the Secondary Containment Systems for these units.

IV.B.2. The Bulk Liquid Storage Tanks shall be designed and operated in accordance with Attachment 14 of this Permit, except as otherwise specified in this Permit, and in accordance with Permit Condition II.A. Additionally, the Permittee shall comply with all applicable sections of Attachments 2, 4, 6, and 7 of this Permit.

IV.B.3. The Permittee may store, in liquid form, any of the hazardous wastes listed on the Part A Form (included as Attachment 12 of this Permit), except that the limitations designated on Table C-8 and Table C-10 of Attachment 2 of this Permit apply to the wastes stored in any Bulk Liquid Storage Tank at any time.

IV.B.4. Since the Secondary Containment Systems for Tank Nos. 1 and 4 are common and shared, the Permittee shall not at any time store incompatible wastes in Tanks Nos.1 and 4. Similarly, since the Secondary Containment Systems for Tank Nos. 2 and 3 are common and shared, the Permittee shall not at any time store incompatible wastes in Tank Nos. 2 and 3.

IV.C. STABILIZATION MIXING BIN TANKS

IV.C.1. The Stabilization Mixing Bin Tanks shall be defined as four (4) existing, open-topped tank units located in the Containment Building. Two tank units are located in the Stabilization Portion of the building and two tank units are located in the Debris Portion of the building. References to the above-defined Mixing Bin Tanks shall also include any appurtenances and the Secondary Containment Systems for these units.

IV.C.2. The Mixing Bin Tanks shall be designed and operated in accordance with

Attachments 14 and 24 of this Permit, except as otherwise specified in this Permit, and in accordance with Permit Condition II.A. Additionally, the Permittee shall comply with all applicable sections of Attachments 2, 4, 6, and 7 of this Permit.

IV.C.3. The storage capacity of each installed Mixing Bin Tank located in the Stabilization Portion of the building shall not exceed 120 cubic yards. The storage capacity of each installed Mixing Bin Tank located in the Debris Portion of the building shall not exceed 226 cubic yards for wastes in solid form. The storage capacity of each installed Mixing Bin Tank located in the Debris Portion of the building shall not exceed 12,000 gallons for waste in liquid form.

IV.C.4. The Permittee shall manage non-containerized waste in the Mixing Bin Tanks such that the height and location of the waste does not allow these materials to overflow.

IV.D. CLOSURE AND POST-CLOSURE

Closure and Post-Closure Care of the tank systems shall be completed in accordance with IDAPA 58.01.05.008 [40 CFR § 264.197], and all applicable sections of Attachment 9 of this Permit.

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MODULE V - SURFACE IMPOUNDMENT STORAGE, TREATMENT, AND DISPOSAL

V. Subject to the terms of this Permit, the Permittee may store, treat, and/or dispose of hazardous wastes in permitted surface impoundments, as follows:

V.A. DESIGN AND OPERATION

V.A.1. Surface impoundments shall consist of Collection Ponds 1, 2, and 3, and Evaporation Pond 1.

V.A.2. The Permittee may store and treat (by evaporation and physical settling) any of the liquid or semi-solid wastes that are listed on the Part A Permit Application, included as Attachment 12 of this Permit, in Evaporation Pond 1, except that the following limitations apply:

V.A.2.a. The Permittee shall not store or treat in the impoundments any wastes that are currently restricted from land disposal under IDAPA 58.01.05.011 [40 CFR Part 268] unless that waste has been granted an exemption, extension, or variance, or unless the applicable treatment standard as specified in IDAPA 58.01.05.011 [40 CFR Part 268] has been achieved prior to placement in the units. In addition, as new wastes are specified for Land Disposal Restriction under IDAPA 58.01.05.011 [40 CFR Part 268], the Permittee shall immediately cease introducing such wastes for storage and treatment in the impoundment upon the effective date of the IDAPA 58.01.05.011 [40 CFR Part 268] regulation unless the waste has been granted an exemption, extension, or variance, or meets the treatment standard as specified in IDAPA 58.01.05.011 [40 CFR Part 268], prior to placement in the units;

V.A.2.b. The Permittee shall not store or treat any wastes that are restricted from placement in the impoundments by the limitations designated on Table C-8 and Table C-10 of Attachment 2 of this Permit;

V.A.2.c. The Permittee shall not place hazardous wastes F020, F021, F022, F023, F026, and F027 in any surface impoundment unless the special requirements of IDAPA 58.01.05.008 [40 CFR § 264.231] are met by submitting a permit modification, in accordance with of IDAPA 58.01.05.012 [40 CFR § 270.42], for the addition of a management plan for handling these wastes.

V.A.3. The Permittee shall comply with Permit Condition II.T of this Permit for all hazardous wastes subject to IDAPA 58.01.05.008 [40 CFR Subpart CC] in surface impoundments.

V.A.3.a. For surface impoundments that receive organic wastes, with a volatile organic concentration at the point of origin less than 500 ppmw, and are therefore exempt from using air emission control equipment, documentation shall be recorded in the Facility Operating Record that includes the information that was used by the Permittee for each waste determination (e.g., test results, measurements, calculations, and other documentation). If analytical results for waste samples are used for the waste determination, then the Permittee shall record the date, time, and location that each waste sample is collected, in accordance with applicable requirements of 40 CFR § 264.1083. This information shall be kept in the Operating Record for a minimum of three (3) years.

V.A.3.b. Reporting Requirements: If the Permittee does not comply with Permit Condition V.A.3.a, a report shall be submitted to the Director on each occurrence when hazardous waste is placed in the Waste Management Unit in noncompliance with the conditions of 40 CFR § 264.1082(c)(1) or § 264.1082(c)(2), as applicable. A written report shall be submitted within fifteen (15) calendar days of the time that the Permittee becomes aware of the occurrence. The written report shall contain: the EPA Identification Number, facility name and address, a description of the noncompliance event and the cause, the dates of the noncompliance, and corrective actions taken to prevent reoccurrence of the noncompliance. The report shall be signed and dated by an authorized representative of the Permittee, per IDAPA 58.01.05.008 [40 CFR § 264.1090].

V.A.4. The Permittee may store and treat (by evaporation and physical settling) in Collection Ponds 1, 2, and 3, any of the following:

V.A.4.a. Surface run-off from the site;

V.A.4.b. Leachate from on-site landfills; and

V.A.4.c. Liquid from Evaporation Pond 1 only under the following condition:

V.A.4.c.(1). Evaporation Pond 1 is required to be taken out of service and emptied as specified by the Contingency Plan (Attachment 7 of this Permit) or the Response Action Plan (Attachment 8 of this Permit).

V.A.5. The Permittee shall maintain the design of Collection Ponds 1, 2, and 3 and Evaporation Pond 1 in accordance with IDAPA 58.01.05.008 [40 CFR § 264.221] and Attachments 17 and 20 of this Permit, except as otherwise specified in this Permit, and in accordance with Permit Condition II.A.

V.A.6. The Permittee shall operate Collection Ponds 1, 2, and 3 and Evaporations Pond 1, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.221 and § 264.227] and Attachments 2, 6, 7, 8, and 17 of this Permit, except as otherwise specified in this Permit, and in accordance with Permit Condition II.A.

V.A.7. The Permittee shall inspect and monitor the surface impoundments in accordance with IDAPA 58.01.05.008 [40 CFR § 264.226] and the inspection schedule contained in Attachment 4 of this Permit.

V.A.8. In accordance with IDAPA 58.01.05.008 [40 CFR § 264.223] and Attachment 8 of this Permit, the Permittee shall follow the Response Action Plan for any exceedance of the action leakage rate.

V.A.9. The Permittee shall sample and analyze all liquid removed from the leak detection, collection, and removal system sump for the surface impoundments, to determine whether the liquid is derived from hazardous waste. The Permittee shall determine the list of parameters for analysis, based on its knowledge of the wastes placed in the unit. Results of analyses shall be maintained in the Operating Record. Alternatively, the Permittee may delete this sampling and analysis requirement if all liquid removed from any leachate detection, collection, and removal system sump is properly managed as hazardous waste.

V.A.10. Ignitable or reactive wastes must not be placed in surface impoundments unless the special requirements of IDAPA 58.01.05.008 [40 CFR § 264.229] are met.

V.A.11. Incompatible wastes and materials must not be placed in surface impoundments unless the special requirements of IDAPA 58.01.05.008 [40 CFR § 264.230] are met.

V.A.12. The Permittee shall keep all relevant figures, drawings, and diagrams related to surface impoundments readily available for inspection at the facility, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.74].

V.B. CLOSURE AND POST-CLOSURE

V.B.1. Closure and Post-Closure Care of the Surface Impoundment Units (Evaporation Pond 1, Collection Ponds 1, 2, and 3) shall be completed in accordance with IDAPA 58.01.05.008 [40 CFR § 264.228] and the applicable sections of Attachments 9, 18, and 21, and Permit Condition II.K.

V.B.1.a. If a soil cover is used during surface impoundment closure, prior to construction of the soil cover of Evaporation Pond 1 and Collection Ponds 1, 2, and 3, the Permittee shall (for clay sources not previously tested) perform field/in-situ hydraulic conductivity testing on a test fill, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.19] and EPA/600/R-93/182, September 1993, *Quality Assurance and Quality Control for Waste Containment Facilities*. The field/in-situ testing shall be done in addition to laboratory testing.

V.B.2. For all Surface Impoundment Units, minor deviations from the permitted closure design specifications or procedures necessary to accommodate proper closure, must be noted on the as-built drawings and the rationale for those deviations in designs, specifications, or procedures must be provided in narrative form with the closure certification statements. Within sixty (60) calendar days after completion of closure of each Surface Impoundment Unit, the Permittee shall submit to the Director the final as-built drawings of the closed unit, the narrative report, and certification statement.

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MODULE VI - LANDFILL DISPOSAL

VI. Subject to the terms of this Permit, the Permittee may dispose of hazardous wastes in permitted Landfill Units, as follows:

VI.A. LANDFILL DESIGN AND OPERATION

VI.A.1. Landfills shall consist of existing units: Cell 5, Trench 10, Trench 11, and Cell 14, and Cell 15.

VI.A.2. The Permittee may dispose of any waste listed on the Part A Application (included as Attachment 12 of this Permit), in Landfill Units Cell 14, and Cell 15, except that the following limitations apply:

VI.A.2.a. The Permittee shall not dispose any waste that is restricted from placement in landfills by the limitations designated on Table C-8 and Table C-10 of Attachment 2 of this Permit.

VI.A.2.b. The Permittee shall not dispose of wastes containing free liquids. Free liquids analyses shall be performed in accordance with the applicable procedures in Attachment 2 of this Permit.

Note: Liquid wastes that are contained in lab packs (packaged in accordance with IDAPA 58.01.05.008 [40 CFR § 264.316]) or very small containers, ampules, capacitors, or batteries (in accordance with IDAPA 58.01.05.008 [40 CFR § 264.314]) may be disposed without stabilization and related stabilization testing and verification procedures, provided other restrictions, as specified in this Permit or by other laws or regulations, do not prohibit the land disposal of such wastes. However, no regulated quantities of hazardous waste lab packs can be disposed in Landfill Units unless the Land Disposal Restriction Standards of IDAPA 58.01.05.011 [40 CFR § 268.42(c)] are met.

VI.A.2.c. The Permittee shall not dispose of any bulk waste that was generated as a liquid and was then stabilized by the generator (or another off-site treatment facility) unless the Permittee has conducted analytical testing to ensure that the waste has been properly stabilized and the applicable treatment standard, as specified in IDAPA 58.01.05.011 [40 CFR Part 268], has been achieved. Such testing shall be done by the Permittee, using sampling and analytical methods consistent with Permit Condition II.C, Attachments 2, 15, 24, and 25 of this Permit. Records of such analyses shall be maintained in the Operating Record for a minimum period of three (3) years. This Permit Condition (VI.A.2.c) shall not apply if the Permittee complies with Permit Condition VI.A.2.d.

Note: Liquid wastes that are contained in lab packs (packaged in accordance with IDAPA 58.01.05.008 [40 CFR § 264.316]) or very small containers, ampules, capacitors, or batteries (in accordance with IDAPA 58.01.05.008 [40 CFR § 264.314]) may be disposed without stabilization and related stabilization testing and verification procedures, provided other restrictions, as specified in this Permit or by other laws or regulations, do not prohibit the land disposal of such wastes. However, no regulated quantities of hazardous waste lab packs can be disposed in Landfill Units unless the Land Disposal Restriction Standards of IDAPA 58.01.05.011 [40 CFR § 268.42(c)] are met.

VI.A.2.d. As an alternative to the bulk waste testing by the Permittee specified in Permit Condition VI.A.2.c, the Permittee shall maintain documentation supplied by the generator (or another off-site treatment facility) that proper stabilization has been achieved. Documentation from the generator (or another off-site treatment facility) must contain a description of the stabilization procedures used, including a signed certification that the stabilized waste achieved the applicable treatment standard, as specified in Attachment 2 of this Permit and in accordance with IDAPA 58.01.05.011 [40 CFR Part 268]. The Permittee shall maintain such documentation in the Operating Record for a minimum period of three (3) years.

VI.A.2.e. The Permittee shall not dispose of any wastes that are restricted from land disposal under IDAPA 58.01.05.011 [40 CFR Part 268] unless that waste has been granted an exemption, extension, or variance, or unless the applicable treatment standard, as specified in IDAPA 58.01.05.011 [40 CFR Part 268], has been achieved prior to placement in the units. In addition, as new wastes are specified for Land Disposal Restriction under IDAPA 58.01.05.011 [40 CFR Part 268], the Permittee shall immediately cease disposing of such wastes upon the effective date of the regulation, unless the waste has been granted an exemption, extension, or variance, or meets the treatment standard specified in IDAPA 58.01.05.011 [40 CFR Part 268], prior to placement in the Landfill Units.

VI.A.2.f. The Permittee shall not dispose of ignitable or reactive wastes (Waste Numbers D001 or D003, respectively) or any listed waste for which the basis for listing is ignitability or reactivity, unless the waste has been treated to render it non-ignitible or non-reactive. For such wastes, the Permittee shall follow testing procedures used to determine ignitability and reactivity as specified in Attachment 2 of this Permit.

Note: Cyanide or sulfide bearing waste, as defined in IDAPA 58.01.05.005 [40 CFR § 261.23(a)(5)], may be packaged in accordance with IDAPA 58.01.05.008 [40 CFR § 264.316], and disposed without first being treated to render it non-reactive. Ignitable wastes in containers may be landfilled without first being treated to render it non-ignitable, if they are disposed in accordance with IDAPA 58.01.05.008 [40 CFR § 264.312].

VI.A.2.g. The Permittee shall limit the number of Interim Processing Loads for storage in the active portion of disposal Cell 14 and Cell 15 to a maximum of 50 loads at any one time (50 loads combined). The Permittee shall manage the storage of Interim Processing Loads in accordance with Attachments 4 and 19 of this Permit.

VI.A.2.h. The Permittee shall comply with IDAPA 58.01.05.008 [40 CFR § 264.317], the 1995 Dioxin Management Plan, and all applicable Land Disposal Restriction treatment standards under IDAPA 58.01.05.011 [40 CFR § 268.40] for disposal of hazardous wastes F020, F021, F022, F023, F026, and F027 in landfills. The Permittee shall make a written request for pre-approval from the Director for the storage, treatment, or disposal of these dioxin-listed wastes.

VI.A.3. The Permittee shall maintain the approved designs of Trench 10, Trench 11, Cell 14, and Cell 5 in accordance with Attachments 19 and 20 of this Permit, except as otherwise specified in this Permit, and in accordance with Permit Condition II.A.1.

VI.A.4. The Permittee shall construct the modified Cell 15, in accordance with Attachments 16, 18, 18a, 19, and 20 of this Permit, except as otherwise specified in this Permit, and in accordance with Permit Conditions II.A.1 and II.A.2.

VI.A.5. Prior to construction of any soil liner for a Landfill Unit, a test fill (using materials characterized the same as those used in the new Landfill Unit) shall be required. The Permittee shall, except as noted below, construct and test the soil liner in accordance with the procedures contained in Attachment 16, 18, 18a, and 19 of this Permit. The exception to these procedures shall be that the Permittee shall perform field/in-situ hydraulic conductivity testing on a test fill, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.19] and EPA/600/R-93/182, September 1993, *Quality Assurance and Quality Control for Waste Containment Facilities*. The field/in-situ testing shall be done in addition to laboratory testing.

VI.A.6. The Permittee shall operate Cells 14 and 15 in accordance with IDAPA 58.01.05.008 [40 CFR § 264.301] and the operating practices described in Attachments 2, 6, 7, 19, and 23 of this Permit, except as otherwise specified in this Permit, and in accordance with Permit Condition II.A.1.

VI.A.6.a. The Permittee shall cease landfilling operations when the sustained wind speed conditions exceed 25 miles per hour (25 mph average for an hour) and apply asphaltic emulsion or soil cover on the freshly spread landfill surface. Waste placement operations in the landfill cells shall resume only after the sustained wind speed is below 25 mph (25 mph average for an hour).

VI.A.7. The Permittee shall monitor and inspect the landfill in accordance with IDAPA 58.01.05.008 [40 CFR § 264.303] and Attachments 4 and 19 of this Permit.

VI.A.8. The Permittee shall maintain a permanent and accurate record of the three-dimensional location of each waste type, based on grid coordinates, within units Cell 5, Trench 11, Cell 14, Cell 15, Trench 10 (to the extent the records exist for Trench 10), and records for all previous disposal areas for which the records exist, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.309]. This record shall include the information necessary to locate a specific waste and shall be based on information contained in the manifest (Generator Identification Number, waste code, and date of disposal). This condition shall apply to all wastes placed in existing units Cell 5, Trench 11, Cell 14, and Cell 15 irrespective of the date of disposal. Upon final closure of the facility, the Permittee shall submit, to the Director, copies of these records for units Cell 5, Trench 11, Cell 14, Cell 15, and for Trench 10 (to the extent the records exist for Trench 10),.

VI.A.9. Liquid in the primary Leachate Collection System of units Cell 5, Cell 14, and Cell 15 shall not exceed 30 cm (one foot) in depth over the primary liner after waste has been placed, as specified in IDAPA 58.01.05.008 [40 CFR § 264.301(c)(2)]. (This does not include the area of the sump used to accumulate sufficient quantities of liquid for pumping). Liquid in the secondary Leachate (leak) Collection System of units Cell 5, Cell 14, and Cell 15 will be removed, when pumpable quantities exist (to the extent practicable) within 24 hours after those quantities are found. The liquid from both the primary and secondary Leachate Collection Systems shall be managed as a hazardous waste. During the Post-Closure Period, after final facility closure, liquid from the secondary Leachate (leak) Collection Systems must be pumped (as described above) within 72 hours after such liquid is found.

VI.A.10. For all Landfill Units, the Permittee shall establish Action Leakage Rates (included in Table VI-1 of this Permit) and follow the Response Action Plan (included as Attachment 8 of this Permit), in accordance with IDAPA 58.01.05.008 [40 CFR § 264.302 and § 264.304].

VI.A.11. The Permittee shall keep all relevant figures, drawings, and diagrams, related to Landfill Disposal Units, readily available for inspection at the facility, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.74].

VI.B. CLOSURE AND POST-CLOSURE

VI.B.1. The Permittee shall close units Cell 5, Trench 10, Trench 11, Cell 14, and Cell 15 in accordance with IDAPA 58.01.05.008 [40 CFR § 264.310(a)] and the applicable sections of Attachment 9, 9a, 9b, 18, 18a, 19, 20, and 21, and Permit Condition II.K and II.V.2.

VI.B.2. The Permittee shall follow the requirements for Post-Closure Care of units Cell 5, Trench 10, Trench 11, Cell 14, and Cell 15 in accordance with IDAPA 58.01.05.008 [40 CFR § 264.310(b)], and the applicable sections of Attachment 9 and Permit Condition II.M. Post-Closure Care for each unit shall begin at the time of receipt of the closure certification statements by the Department.

VI.B.3. Final cover designs for Landfill Cells 5, 14 and 15, and Trenches 10 and 11 shall be specified in Attachments 9, 18a, 20, 21, and 23 of this Permit. These cover designs incorporate a geosynthetic clay liner (GCL) and, where applicable, the following conditions apply:

VI.B.3.a. The gas venting layer shall consist of either a Geosynthetic Drainage System (i.e., geonet), as specified in Attachment 16, or six (6) inches of coarse aggregate meeting the American Association of State Highway & Transportation Officials (AASHTO) Standards and a geotextile above and below the geonet or aggregate layer, or an equivalent alternate approved by the Department, that will provide adequate venting. The procedures designated under Permit Condition II.S shall be followed to implement the use of equivalent materials.

VI.B.3.b. A rock cover meeting the approval of the Department shall be placed over all cover areas where vegetation is not established within two (2) years after placement of the cover, and where significant erosion is occurring. Significant erosion for this item will be defined as the formation of erosion gullies greater than six (6) inches deep for lengths of ten (10) feet or more.

VI.B.3.c. The Temporary Alternative cover design for Landfill Trenches 10 and 11 shall be specified in Attachments 9a, 9b, and 21a. The final cover design for Trenches 10 and 11, if the Alternative Cover Demonstration Program fails, shall be specified in Attachment 9, 20, and 21 of this Permit, except the changes specified in Permit Conditions VI.B.3.a and VI.B.3.b are hereby made to Attachments 9, 20, and 21.

VI.B.3.d. If a GCL is not used, prior to construction of a soil cover for any landfill unit, the Permittee shall (for clay sources not previously tested) perform field/in-situ hydraulic conductivity testing on a test fill, in accordance with IDAPA

58.01.05.008 [40 CFR § 264.19] and EPA/600/R-93/182, September 1993, *Quality Assurance and Quality Control for Waste Containment Facilities*. The field/in-situ testing shall be done in addition to laboratory testing.

VI.B.4. For all Landfill Units, minor deviations from the permitted closure design specifications, or procedures necessary to accommodate proper closure, must be noted on the as-built drawings and the rationale for those deviations in designs, specifications, or procedures must be provided in narrative form with the closure certification statements. Within sixty (60) calendar days after completion of closure of each Landfill Unit, the Permittee shall submit, to the Director, the final as-built drawings of the closed unit, the narrative report, and certification statement. All other deviations from the permitted closure design specifications shall be approved in advance by the Director, in accordance with IDAPA 58.01.05.012 [40 CFR § 270.42].

VI.B.5. The Permittee shall provide certification statements attesting that each Landfill Unit at the facility has been closed in accordance with the applicable specifications in the Closure Plan included as Attachment 9 of this Permit, as required by IDAPA 58.01.05.008 [40 CFR § 264 Subpart G].

VI.B.6. The Permittee shall submit to the local land use authority and to the Director, a survey plat indicating the location and dimensions of closed Landfill Units, with respect to permanently surveyed benchmarks, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.116].

VI.B.7 In the event that any Hazardous Waste Management Unit, other than the Landfill and Surface Impoundment Units listed in Permit Condition V.B.1 and VI.B.1, cannot be closed by removing hazardous waste, hazardous constituents, contaminated subsoil, and any contaminated ground water (i.e., clean-closed) as specified in Permit Condition II.K.1, the Permittee shall revise the Facility Post-Closure Plan to include a Post-Closure Plan for that Hazardous Waste Management Unit. The Permittee shall submit the Post-Closure Plan for that Hazardous Waste Management Unit to the Director, as a Permit Modification Request, within ninety (90) calendar days of the date that the Director notifies the Permittee in writing that the unit must be closed as a landfill, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.118(a)].

VI.B.8 The Permittee may complete the five-year Alternative Cover Demonstration Program for Trench 10 and 11, for the purpose of demonstrating equivalency to the performance standards of IDAPA 58.01.05.008 [40 CFR § 264.111]. The Alternative Cover Demonstration Program for Trench 10 and 11 started in August, 2000. If approved by the Department, the alternative cover, as specified in Attachment 9a and 9b, would displace the approved final cover design specified in Attachment 9. If the Alternative Cover Demonstration Test Pad fails, Trench 10 and 11 shall be closed under the traditional landfill closure specifications on a schedule approved by the Director, as detailed in Section I.2.h of Attachment 9. Completion of the Alternative Cover Demonstration Program for closure of Trench 10 and Trench 11 shall be in accordance with Attachment 9a, Attachment 9b, and as follows:

VI.B.8.a. The Permittee shall perform maintenance of the temporary alternative cover during the demonstration period, as specified in Section I.2.h.(5)(c) of Attachment 9.

VI.B.8.b. Landfill Units 10 and 11 shall be evaluated by the Department during the demonstration period. The demonstration period commenced following Department approval of the Construction Quality Assurance Report, and shall be completed within a period not to exceed five (5) years, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.113(b)(1)(i)].

VI.B.8.c. The Permittee shall monitor the results of the Test Pad for this demonstration, as described in Attachment 9a and 9b and shall provide monitoring data results to the Department on a quarterly basis.

VI.B.8.d. Failure of the Alternative Cover Demonstration Test Pad to demonstrate equivalence shall be defined as follows:

- The bromide concentrations in the Test Pad sub-base material (at a depth of five (5) feet below ground surface) are high (twice background concentrations or higher), providing direct evidence of wetting front movement through the cover and into the underlying sub-base soils; or
- Measured water potentials at the base of the Test Pad (at a depth of five (5) feet below ground surface) exceed an equivalent flux of 3.2 mm/year.

VI.B.8.e. Within ninety (90) days following the completion of the demonstration period of the temporary alternative cover, the Permittee shall submit to the Department a final comprehensive report summarizing all the Test Pad Monitoring Data results and evaluating whether the performance criteria, as specified in Attachment 9a and 9b of this Permit, have been met.

VI.B.8.f. If, at any time during the Trench 10 and 11 Alternative Cover Demonstration Period, the Department determines that the Permittee has failed to achieve the performance criteria, as specified in Permit Condition VI.B.8.d and in Attachment 9a and 9b of this Permit, for the demonstration of the equivalency of the temporary alternative cover, the Department shall provide the Permittee written notification. Within thirty (30) days of Permittee's receipt of written notification by the Department that the Permittee has failed to achieve the performance criteria, the Permittee shall perform Closure and Post-Closure Care, in accordance with Permit Condition II.K and II.M and as follows:

VI.B.8.f.(i). In accordance with 58.01.05.008 [40 CFR §§ 264.112(c) and 264.301(g), (h) & (i)], the Permittee shall submit a Permit Modification Request to the Department to address the following:

VI.B.8.f.(i)(a). An amendment to Attachments 9a, 9b, and 21a of this Permit, to incorporate the traditional closure requirements for Landfill Trenches 10 and 11, as specified in Attachment 9, 19, 20, and 21 of this Permit; and

VI.B.8.f.(i)(b). An update to Attachment 10 of this Permit for changes to the Surface Water Management Plan, as affected by the partial closure of Landfill Trenches 10 and 11. Additionally, the Permittee shall update all applicable drawings to reflect these changes.

VI.B.8.f.(i)(c). Upon Departmental approval of the permit modification in Permit Condition VI.B.8.f.(i), Attachments 9a, 9b, and 21a will be removed and, hence, superseded by Attachments 9, 20, and 21, incorporating the traditional landfill closure design and specifications.

VI.B.8.g. If the Department determines that the Permittee has successfully achieved the performance criteria for the demonstration of the equivalency of the temporary alternative cover, the Permittee shall perform closure and Post-Closure Care, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.310], as specified in Attachment 9 of this Permit, and shall provide notification to the Department in accordance with Permit Condition II.K.4 of this Permit. In addition, in accordance with Permit Condition II.S of this Permit, the Permittee shall submit to the Department notification identifying Attachments 9a, 9b, and 21a as the approved Closure Plan.

TABLE VI-1. ACTION LEAKAGE RATES (ALR)

Disposal Unit	Area (acres)	ALR * (gal/day)	WLR ** (gal/day)
Surface Impoundment 1 (Evaporation Pond)	2.31	2310	1732
Collection Pond 1	0.38	380	285
Collection Pond 2	0.34	340	255
Collection Pond 3	0.54	540	405
Landfill Trench 5 –Phase 1 (Zones 1 and 2)	1.82	182	136
Landfill Trench 5 –Phase 2 (Section 2)	1.92	192	144
Landfill Trench 5 – (Section 3)	1.62	162	121
Landfill Trench 14 – Subcell 1	4.47	447	335
Landfill Trench 14 – Subcell 2	2.32	232	174
Landfill Trench 14 – Subcell 3	2.75	275	206
Landfill Trench 14 – Subcell 4	3.00	300	225
Landfill Trench 14 – Subcell 5	3.00	300	225
Landfill Trench 14 – Subcell 6	5.17	517	388
Landfill Cell 15 – Phase 1	12.1	1,210	907
Landfill Cell 15 – Phase 2	8.5	850	637
Landfill Cell 15 – Phase 3/4 ***	17.3	1,730	1,297

* Based on a 7-day average
** Measured on any given day
*** When constructed, adjust for as-built
Note: ALR's based on EPA Guidance of 100 gallons per acre day (gpad) and 1,000 gpad for surface impoundments
Note: WLR's = 75% of ALR measured on any given day

MODULE VII - SURFACE WATER MANAGEMENT PLAN

VII.A. DESIGN, OPERATION, AND MAINTENANCE OF SURFACE WATER MANAGEMENT SYSTEM

VII.A.1. The Permittee shall construct the Surface Water Management System in accordance with the design, description and specifications in Attachments 10, 16, and 18 of this Permit and in accordance with Permit Condition II.A of this Permit.

VII.A.2. The Permittee shall operate and maintain the Surface Water Management System in the manner specified in Attachment 10 of this Permit and in accordance with Permit Condition II.A.1.

VII.A.3. The Permittee shall be allowed to implement changes to the Surface Water Management Plan, in the event of emergency conditions, without obtaining a permit modification from the Department. Any emergency changes to the Surface Water Management System must be documented and reported to the Director, in writing, within thirty (30) calendar days of such changes. If the Director determines that such changes constitute a significant deviation from the Permit (Attachment 10), the Director shall notify the Permittee that a permit modification, in accordance with IDAPA 58.01.05.012 [40 CFR § 270.42], will be required. The Permittee shall submit any required Permit Modification Request within thirty (30) calendar days of such notification.

VII.A.4. The Permittee shall be allowed to implement changes to the Surface Water Management Plan, consistent with the criteria specified in Permit Conditions VII.A.4.a and VII.A.4.b, after providing revisions to narrative, tables, and drawings in Attachment 10 necessary to incorporate these changes, and providing calculations necessary to support these changes, and upon receipt of written acceptance (by certified mail or hand delivery) of these changes by the Department. These changes and their acceptance by the Department shall not require a permit modification, pursuant to IDAPA 58.01.05.012 [40 CFR § 270.42].

VII.A.4.a. The collection ponds shall be operated to maintain available capacity for the volume from the greater of either the 25-year, 24-hour storm event, plus two (2) feet of freeboard or a 100 year, 24-hour storm; and

VII.A.4.b. Run-off from on-site areas, which are designated within a development phase of the Surface Water Management System, to be contained on-site, shall not be diverted off-site during that development phase.

VII.A.5. The Permittee shall keep all relevant figures, drawings, and diagrams related to the Surface Water Management Plan readily available for inspection at the facility, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.74].

VII.B. COMPLIANCE SCHEDULE

The portion of the facility Surface Water Management System that is designed to serve proposed Waste Management Units must be installed and operational prior to placement of waste into that unit. The Permittee shall follow the provisions of Permit Condition I.R for new system construction.

MODULE VIII - PAST PRACTICE UNITS

VIII.A. POST-COVER CARE

VIII.A.1. The Permittee shall maintain ground water monitoring wells and implement a Ground Water Monitoring Program for Past Practice Units Silo 1, Silo 2, and Silo 3, Exhaust Shaft, the Radar Silos, the Elevator Shaft and the Control Center (the locations of which are designated on Drawing PRMI-T05 in Attachment 22 of this Permit) and Past Practice Units PCB 1, PCB 2, PCB 3, and PCB 4, Chem 1, Chem 1B, Chem 2, Chem 2B, Chem 2C, Chem 2D, Chem 2E, Chem 3, Chem 4, Chem 4B, Chem 5, Chem 5B, Chem 6, Chem 6A, Chem 6B, Chem 7, Chem 8, Chem 9, Buried Drum Area 1 (NW corner - near Silo 2), Buried Drum Area 2 (middle of site - near Silo 3), Acid Disposal Pits, Chemical Area 1, Disposal Area 9A, and the Electrical Vault (the locations of which are designated on drawings in Attachment 22 of this Permit).

VIII.A.2. The Permittee shall conduct Post-Cover Care, inspection, and maintenance of the Past Practice Units Silo 1, Silo 2, and Silo 3 with their ancillary equipment, exhaust and propellant shafts, the Radar Silos, the Elevator Shaft, and the openings to the powerhouse dome (the locations of which are designated on Drawing PRMI-T05 in Attachment 22 of this Permit) and Past Practice Units PCB 1, PCB 2, PCB 3, and PCB 4, Chem 1, Chem 1B, Chem 2, Chem 2B, Chem 2C, Chem 2D, Chem 2E, Chem 3, Chem 4, Chem 4B, Chem 5, Chem 5B, Chem 6, Chem 6A, Chem 6B, Chem 7, Chem 8, Chem 9, and the Electrical Vault (the locations of which are designated on drawings in Attachment 22 of this Permit), as specified in Attachment 9 [Section I.3.h.(3)] of this Permit for closed Land Disposal Units, with the following exceptions:

VIII.A.2.a. Prior to final closure, the Permittee shall inspect the leachate collection/ observation wells for Past Practice Units PCB 1, PCB 2, PCB 3, and PCB 4, Chem 1, Chem 1B, Chem 6 and Chem 6B as specified in Attachment 4 of this Permit. All pumpable quantities of liquids found in the leachate collection/ observation wells shall be removed (to the extent practical), within 24 hours of the time such liquid is found. After facility closure, the requirement for removal of leachate shall be to the extent practical within 72 hours of the time such liquid is found.

VIII.A.2.b. The Permittee shall install and maintain the Carbon Adsorption Units for the exhaust vents of Past Practice Units Silo 1, Silo 2, Silo 3, Powerhouse Dome, the Radar Silos, and the Control Center, in accordance with the approved Capping Plan in Attachment 22. The Permittee shall monitor the Carbon Adsorption Units and determine a replacement frequency as specified in Permit Condition VIII.D.1.

VIII.A.3. The period of Post-Cover Care for the Past Practice Units, designated in Permit Condition VIII.A.2, shall be at least thirty (30) years after Director approval of closure certification.

VIII.A.4. The Director reserves the right to re-open Permit Condition VIII.A.3 and extend the Post-Cover Period for any applicable unit at any time during the life of this Permit, as deemed necessary to protect human health and the environment. In such a case, re-opening the Permit would be done as a major permit modification, in accordance with

IDAPA 58.01.05.012 [40 CFR § 270.42].

VIII.A.5. The Permittee shall keep all relevant figures, drawings, and diagrams (related to Past Practice Units) readily available for inspection at the facility, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.74].

VIII.B. POST-COVER MAINTENANCE COST ESTIMATE

VIII.B.1. The Permittee shall prepare a detailed cost estimate for inspection and maintenance of the cover systems for the Past Practice Units identified in Permit Condition VIII.A to be submitted to the Department, along with the cost estimates prepared under Permit Conditions II.L and II.N.

VIII.B.2. The Permittee shall adjust the cost estimate for inflation within sixty (60) calendar days prior to the anniversary date on which the first cost estimate was prepared under Permit Condition VIII.B.1.

VIII.B.3. The Permittee shall revise the post-cover cost estimate for the Past Practice Units within thirty (30) calendar days of an approved modification to the Past Practice Units.

VIII.C. POST-COVER FINANCIAL ASSURANCE
The Permittee shall, within sixty (60) calendar days of preparation of the cost estimates required by Permit Condition VIII.B.1, establish and maintain financial assurance by one of the forms provided for under IDAPA 58.01.05.008 [40 CFR §§ 264.143 and 264.145], in the amount of the cost estimates required by Permit Condition VIII.B.

VIII.D. COMPLIANCE SCHEDULE

VIII.D.1. In accordance with IDAPA 58.01.05.008 [40 CFR § 264.101(a)], the Permittee shall institute corrective action to address air emissions from the six (6) Past Practice Units (PPUs): Silo 1, Silo 2, Silo 3, Powerhouse Dome, Control Room, and Radar Silo. The Permittee shall submit to the Department, within 180 days of the effective date of this Permit, a Plan describing the Carbon Unit System used to treat air emissions, including maintenance of the activated carbon (i.e., replacement frequency).

VIII.D.2. Failure on the part of the Permittee to complete the total scope of work approved under Permit Condition VIII.D.1, in the time frame specified within the approved Work Plan, shall constitute a permit violation unless granted a written extension from the Department.

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MODULE IX – GROUND WATER MONITORING

IX.A. GROUND WATER MONITORING PROGRAM

The Ground Water Monitoring Program, applicable under the terms of this Permit, shall be undertaken in accordance with IDAPA 58.01.05.008 [40 CFR §§ 264.97, 264.98, 264.99 and 264.100]. Table IX-1 summarizes key components of the Ground Water Monitoring Program. The Ground Water Monitoring Program shall consist of and be implemented as follows:

IX.A.1. A Detection Monitoring Program (DMP) shall be put into effect immediately and shall remain in effect until:

IX.A.1.a. The detection monitoring criteria, as listed in Permit Condition IX.F.1 as the Estimated Quantitation Limits (EQL), for any single constituent(s) are exceeded. The EQL for all parameters shall be one (1) microgram per liter for any single Volatile Organic Constituent (VOC) or as specified in Table IX-2. At that time, the Permittee shall comply with Permit Condition IX.G and proceed in accordance with Permit Condition IX.A.2; or

IX.A.1.b. The Post-Closure Period is over.

IX.A.2. A Compliance Monitoring Program (CMP) shall be put into effect at such time as the detection monitoring criteria are demonstrated, through Permit Condition IX.G, to have been exceeded. A CMP is currently in effect for monitoring Wells U-1, U-5, U-6, U-7, U-20, U-21, U-23, U-24, and U-25. The CMP shall remain in effect until:

IX.A.2.a. The detection monitoring criteria are demonstrated, through Permit Condition IX.G, to not have been exceeded during four (4) consecutive CMP sampling events, at which time the Permittee shall reactivate the DMP specified in Permit Condition IX.F; or

IX.A.2.b. The compliance monitoring criteria, demonstrated through Permit Condition IX.G, have been exceeded, at which time the Permittee shall proceed in accordance with Permit Condition IX.A.3 (Corrective Action); or

IX.A.3. A Corrective Action Monitoring Program (CAMP), which shall be put into effect at such time as any Ground Water Protection Standard (GPS) criteria are exceeded. The CAMP shall remain in effect until: a) the compliance monitoring criteria are not exceeded during four (4) consecutive CAMP events. At such time the CMP shall be reactivated; or b) until such time as a Corrective Measures Implementation Plan is submitted to meet the requirements of IDAPA 58.01.05.008 [40 CFR § 264.100] and is approved by the Director.

TABLE IX-1. GROUND WATER MONITORING CRITERIA FOR THE GROUND WATER MONITORING PROGRAMS

MONITORING PROGRAM	BEGIN	MONITORING CRITERIA
Corrective Action Monitoring Program	In accordance with Permit Condition IX.A.3.	Exceedance of Ground Water Protection Standard for one or more constituent(s).
Compliance Monitoring Program	At Permit issuance for the following monitoring wells: U-1, U-5, U-6, U-7, U-20, U-21, U-23 U-24, U-25; or in accordance with Permit Condition IX.A.2, when the detection monitoring criteria are exceeded.	Constituent concentrations less than, or equal to, the Ground Water Protection Standards, but are greater than the Estimated Quantitation Limit of 1 microgram per liter (1 µg/l). [Refer to Table IX-6]
Detection Monitoring Program	At Permit issuance for all monitoring wells except: U-1, U-5, U-6, U-7, U-20, U-21, U-23, U-24, and U-25; or in accordance with Permit Condition IX.A.1.	Analytical results indicate constituent concentrations are below the Estimated Quantitation Limit (EQL), as shown in Table IX-2. EQLs for all constituents shall be 1 µg/l.

IX.B. GROUND WATER MONITORING WELLS

IX.B.1. The Ground Water Monitoring Network shall consist of the Upper and Lower Aquifer monitoring wells and piezometers listed in Table IX-3, and shown on Figures 1 and 2 of this Permit. The sampling frequencies for all ground water monitoring wells are listed in Table IX-3. For each regulated unit, the point of compliance monitoring wells are listed in Table IX-4 and Figures E-27 and E-28 of Attachment 11 of this Permit.

IX.B.2. All changes to the Ground Water Monitoring Network and sampling frequencies shall require a permit modification, in accordance with IDAPA 58.01.05.012 [40 CFR § 270.42] and Permit Condition I.E.3. The only exceptions to this are the monitoring wells addressed in Permit Condition IX.B.3.

IX.B.3. Lower Aquifer Monitoring Wells L-43, L-44, and L45 were installed during construction of Cell 15, Phases 2 and 3. Monitoring well L-47 was installed as part of the Cell 15, Phase 4 construction, as specified in Permit Condition IX.D.3 and Attachment 11 of this permit, and replaced L-46, which was abandoned due to its proximity to the Phase 4 construction area. The location of L-47 is shown on Figure 2.

IX.B.4. The Permittee shall calculate the ground water elevations, flow directions, and rates for the Ground Water Monitoring Network on a semi-annual basis, during the spring and fall monitoring events. The methods, calculations, and parameters used shall be provided in the Ground Water Monitoring Reports required under Permit Conditions IX.F.6 and IX.G.9. Ground water flow rates, directions, contour maps, and summary tables shall be submitted annually to the Director with the analytical results of the spring sampling event. Additionally, the Permittee shall submit, at this time, a written review of the adequacy of the Ground Water Monitoring System.

IX.C. MONITORING WELL MAINTENANCE

IX.C.1. The Permittee shall maintain all monitoring wells in good working order, making necessary repairs in a timely manner so that the sampling program is not unreasonably hindered or delayed.

IX.C.2. A Monitoring Well Maintenance Program consisting of wellhead monitoring, well sounding, well yield and specific capacity determination and well redevelopment will be conducted for the facility as part of the Ground Water Monitoring Program as follows:

IX.C.2.a. The Permittee shall perform well maintenance activities in accordance with the schedule set forth in Attachment 11 of this Permit.

IX.C.2.b. The Permittee shall maintain complete records of all well maintenance activities for the term of this Permit, in accordance with Permit Condition I.P.

IX.C.2.c. The Permittee shall inspect and maintain all monitoring wells throughout operation, closure and post-closure, in accordance with Permit Condition II.E and Attachments 4 and 11 of this Permit.

IX.C.3. The Permittee shall maintain borehole integrity of each monitoring well, as required by IDAPA 58.01.05.008 [40 CFR § 264.97(c)]. The Permittee shall maintain the wells utilized solely as piezometers, in accordance with Permit Condition IX.C.4.

IX.C.3.a. Monitoring wells shall be sounded every two years. If the well has a build up of one (1) foot or more of sediment, USEI will note the build up in the resulting monitoring report. If build up of two (2) feet or more is measured, or if the well is unable to yield sufficient water for analysis, the well shall be redeveloped and the sediment removed prior to the next monitoring event.

IX.C.3.b. The Permittee shall perform a slug test or pumping test for all new monitoring wells during construction/development to determine hydraulic conductivity. This data may be used at a later date to determine adequate performance of the monitoring well.

IX.C.4. Wells utilized solely as piezometers shall only be subject to the maintenance requirements of well head inspection and sounding. Redevelopment of these wells is only required if the buildup of sediment interferes with the Permittee's ability to take water-level measurements.

IX.C.5. The need for maintenance shall not constitute grounds for missing a sampling event. The only reason this would constitute grounds for missing a scheduled sampling event would be the accidental destruction of the well. Under no circumstances shall a monitoring well remain out of commission for two (2) consecutive sampling events. The construction of the repair or replacement shall be in accordance with Attachment 11 of this Permit.

IX.C.6. In the event a monitoring well is destroyed, the Permittee shall:

- Notify the Director within seven (7) calendar days of discovery of the destroyed well.
- The Permittee shall immediately propose a new location for a replacement well that is neither less than twenty (20) feet nor more than fifty (50) feet from the original destroyed well, or other suitable location upon approval from the Director.
- The Permittee shall plug and abandon the destroyed well in accordance with the Idaho Department of Water Resources' abandonment criteria.
- The Permittee shall notify the Director at least five (5) days before installation of any replacement wells. Replacement wells shall be constructed in accordance with Permit Condition IX.D and Attachment 11 of this Permit.

IX.C.7. If a monitoring well/piezometer must be replaced for any reason during the term of this Permit, it shall be replaced within ninety (90) calendar days of the date taken out of service, and/or be fully operational at the time of the next sampling event.

IX.D. MONITORING WELL CONSTRUCTION

IX.D.1. All monitoring wells will be constructed and developed in accordance with EPA's *Technical Enforcement Guidance Document* (latest edition), Attachment 11 of this Permit, and as follows:

IX.D.2. The Permittee shall submit to the Director a copy of the well construction record and boring logs, with the as-built drawings for each well, within sixty (60) days after completion of each well.

IX.D.3. The monitoring wells specified in Table IX-4 of this Permit for proposed units (Cell 15 Phase 4) shall not be required to be constructed until ninety (90) calendar days prior to the placement of waste in the unit. Sampling shall have taken place and analytical results evaluated prior to waste placement in these units. The following exceptions to the requirements for installation of the future monitoring wells, listed in Table IX-4 of this Permit, shall also apply as follows:

IX.D.3.a. Prior to the placement of any waste in Phase 4 of Cell 15, as described in Attachment 18a, monitoring well L-47, as specified in Table IX-3 and Attachment 11, shall be fully operational. At least one sampling event shall be completed and analytical results evaluated by the director a minimum of thirty (30) days prior to any waste placement into this unit. Also, the Monitoring Well Construction Report for L-47 shall be submitted to and approved by the Director, prior to waste placement into this unit.

IX.D.4. If at anytime, perched water is identified (whether seasonal or manmade), the Permittee shall submit a Monitoring Plan, within sixty (60) calendar days, of the discovery for the Department's review and approval. The Monitoring Plan shall propose additional perched zone monitoring wells, for the purpose of determining (but not limited to) the perched water characteristics, flow path(s) and a proposed schedule for the drilling and completion of the proposed wells.

IX.E. GROUND WATER SAMPLING AND ANALYSIS

IX.E.1. The Permittee shall sample (semi-annually) all monitoring wells designated in Table IX-3 of this Permit. The Permittee shall perform this sampling in accordance with Permit Condition IX.A and Attachment 11 of this Permit.

IX.E.1.a. The spring monitoring event shall take place during the months of April, May, or June of each year.

IX.E.1.b. The fall monitoring event shall take place during the months of September, October, or November of each year.

IX.E.1.c. The fall and spring monitoring events shall be separated by at least one hundred twenty (120) days.

IX.E.2. The Permittee shall notify the Director of all planned sampling events at least five (5) working days in advance of the planned sampling, and shall notify the Director of all other sampling events, as soon as possible prior to the event.

IX.E.3. The Permittee shall analyze the ground water samples obtained for the volatile organic compounds (VOC) or other constituents as defined on Table IX-2 of this Permit. The Permittee shall perform this analysis in accordance with Method 8260 of the Third Edition, or latest, of EPA SW-846 "Test Methods for evaluating Solid Waste, Physical/Chemical Methods" or an equivalent or superior method, with prior Director approval.

IX.E.4. Sample Collection Procedures

IX.E.4.a. Wellhead Inspection and Organic Vapor Screening
On arrival at each wellhead, the sampling team shall determine background organic vapor levels in the breathing zone and at the level of the wellhead, in accordance with Attachment 11 of this Permit.

IX.E.4.b. Measurement of Static Water Elevation
Prior to purging or sampling any monitoring wells, the elevation of the ground water shall be determined as required by IDAPA 58.01.05.008 [40 CFR § 264.97(f)] and Attachment 11. Ground water elevations shall be measured to the nearest 0.01 foot. A registered surveyor shall survey the elevation datum and water level measurement point, relative to mean sea level, for all monitoring wells. This datum shall be related to a fixed reference point on the well casing, prior to the first monitoring event for each well.

IX.E.4.c. Field Measurements for field parameters including temperature, pH, and specific conductivity shall be measured and recorded at each monitoring well, in accordance with Attachment 11.

IX.E.4.d. Pre-sample Purging

Monitoring wells shall be purged of standing water in the casing. Low-yield wells shall be evacuated to dryness, and a minimum of three casing volumes shall be removed from higher yielding wells. Casing volumes shall be calculated prior to each monitoring event. Field parameter readings shall be stabilized to within 10% for temperature and specific conductance; pH shall stabilize to within 0.1 units.
For low-yielding wells purged to dryness, samples shall be collected as soon as a sufficient volume of water is available for collection. Under no circumstances shall collection of the sample take place more than 24 hours after evacuation. If adequate water is not available to sample within 24 hours, the Permittee shall notify the Director and redevelop or replace the well within ninety (90) days. The Permittee may, with prior Director approval, substitute purging stabilization parameters without effecting a modification to this Permit.

The Permittee shall store all purge water in properly labeled, secure containers until analytical results are obtained and the appropriate method of disposal of the containerized ground water is identified. Alternatively, the Permittee may assume that all purge water is hazardous waste and immediately treat the waste in an appropriate manner.

IX.E.4.e. Sample Collection

The Permittee shall conduct sample collection and preservation in accordance with Attachment 11 of this Permit.

IX.E.4.f. Chain-of-Custody Control

As required by IDAPA 58.01.05.008 [40 CFR § 264.97(d)(4)], and Attachment 11 of this Permit, the Ground Water Monitoring Program shall include chain-of-custody control to maintain integrity of samples.

IX.E.4.f.(1). Field Log Book

A field log book shall be kept for each sampling event. A copy of the field log book shall be kept at the facility and shall be available for inspection. The field log book shall include those items in accordance with Attachment 11.

IX.E.4.f.(2). Sample Receipt

Upon receipt of the samples at the contract laboratory, the security of the shipping containers shall be checked. Outer seals that are broken or missing shall be noted, and reported to the Permittee's facility contact.

IX.E.4.g. Quality Assurance/Quality Control (QA/QC)

Quality Assurance of sampling, analysis, and reporting of data to the Department shall be the responsibility of the Permittee. The Permittee shall be responsible for the QA/QC activities of the samplers, drillers, and analytical laboratories.

Components of the QA/QC Program shall be in accordance with Attachment 11 of this Permit; and

IX.E.4.g(1). A full laboratory QA/QC Report shall accompany each data report and shall be kept on file at the facility.

IX.E.4.g(2). Sample Collection: A standardized field log book shall be kept for each sampling event, including the information described in Attachment 11 of this Permit. It shall include documentation of all QA/QC procedures related to sample collection and the type and number of QA/QC samples. QA/QC samples may include (but are not limited to) duplicate, field, trip, lab, equipment, and blind/spike, and shall be consistent with the Third (*or latest)* Edition of EPA SW-846 "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods."

IX.E.4.g(3). QA/QC of Raw Data: The raw data from the analytical laboratory, as reported, shall be reviewed to determine that it is correctly and accurately reported. If outliers are identified and can be documented, they shall be flagged and included in the data submission.

IX.F. DETECTION MONITORING PROGRAM

IX.F.1. The detection monitoring criteria for evaluating data from each sampling event for any volatile organic compound, shall be the EQL, of 1 microgram per liter for any single VOC, or as specified in Table IX-2 for any other constituent.

IX.F.2. Upon detection of any VOC or other constituents exceeding an EQL for any monitoring well, the Permittee shall, within seven (7) calendar days, notify the Director in writing of the findings, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.98(g)(1)]. At this time, the Permittee may elect to immediately collect two (2) verification samples from any affected well(s), purging the well(s) between samples, and reanalyze for all VOCs or other constituents included in the Detection Monitoring Program.

IX.F.3. If analytical results from either verification sample, described in Permit Condition IX.F.2, confirm the detection of VOCs or other constituents above the detection monitoring criteria, described in Permit Condition IX.F.1, the affected well(s) shall be sampled and analyzed for the constituents identified in IDAPA 58.01.05.008 [40 CFR Part 264, Appendix IX]. The Permittee shall notify the Director, in writing, within seven (7) days of making this finding and submit all analytical results. Within 90 (ninety) calendar days of confirmation of an exceedance, as described in Permit Condition IX.F.2, the Permittee shall submit to the Director either of the following:

IX.F.3.a. A report summarizing the analytical results from the monitoring events described in Permit Conditions IX.F.2 and IX.F.3, and the notification that the affected well(s) is being removed from the Detection Monitoring Program and is being incorporated into the CMP or CAMP; or

IX.F.3.b. A report demonstrating that a source, other than a regulated unit or Past Practice Unit, caused the detection or that the detection resulted from an error in sampling, analysis, or evaluation. This demonstration report must be submitted to the Director for approval.

IX.F.4. If the Permittee is unable to verify that the source of contamination is from other than a regulated unit or Past Practice Unit (in accordance with Permit Condition IX.F.3.b), or if the report submitted in accordance with Permit Condition IX.F.3.b is not approved by the Director, then the Permittee shall, within 90 (ninety) days of receiving notice the demonstration report of Section IX.F.3 has been denied, remove the affected well(s) from the Detection Monitoring Program and incorporate the affected well and all other monitoring wells associated with the applicable Hazardous Waste Management Unit or Past Practice Unit into the Compliance Monitoring Program, in accordance with Permit Condition IX.G.

IX.F.5. If analytical results from both verification samples, described in Permit Condition IX.F.2, fail to confirm the detection of VOCs or other constituents above an EQL, the Director shall be notified in writing that the Detection Monitoring Program is being resumed.

IX.F.6. Data Reporting for Detection Monitoring

While in the Detection Monitoring Program, the Permittee shall submit to the Director a semi-annual Detection Monitoring Report, in accordance with Permit Condition IX.E.1. This report shall contain a narrative summary of ground water monitoring data that has been collected to date, and a detailed listing of the monitoring and analytical data obtained since submitting the previous report, including (at a minimum) all QA/QC information, a table summary of ground water elevations, all equations, calculations, and parameters used to calculate ground water velocities and flow direction, in accordance with Permit Condition IX.B.4.

IX.G. COMPLIANCE MONITORING PROGRAM

IX.G.1. As of the effective date of this Permit, Monitoring Wells U-1, U-5, U-6, U-7, U-20, U-21, U-23, U-24, and U-25 shall be in the Compliance Monitoring Program. All other compliance monitoring wells shall be determined in accordance with Permit Condition IX.A.2.

IX.G.2. The Permittee shall sample the monitoring wells in the Compliance Monitoring Program semi-annually, during the compliance monitoring period.

IX.G.3. The Permittee shall perform this sampling in accordance with Permit Condition IX.E, and as follows:

IX.G.3.a. The Permittee shall sample the CMP wells for the VOCs or other constituents outlined in Table IX-2.

IX.G.3.b. On an annual basis, the Permittee shall sample all monitoring wells in the CMP and analyze for the constituents identified in IDAPA 58.01.05.008 [40 CFR Part 264, Appendix IX], in lieu of the parameters outlined in Permit Condition IX.G.3.a. Upon detection of any additional monitoring constituents, as a result of the annual Appendix IX sampling, the permittee may resample within thirty (30) days and repeat the Appendix IX analysis. The Permittee shall submit the resample analytical results to the Director, and if the second analysis confirms the presence of the new constituents, the Permittee shall, within seven (7) calendar days of receiving the data that identifies new constituents, notify the Director in writing of the findings and the new constituents shall be included in the Detection and Compliance Monitoring Programs.

IX.G.3.c. All analytical results shall meet the established reporting limit or EQL. If the reporting limit is greater than the established EQL, the Director may require the analysis to be rerun.

IX.G.4. The Permittee shall obtain water-level measurements from the CMP wells prior to each sampling event. Measurements for each monitoring well shall be obtained prior to purging the well. The Permittee shall incorporate this data in determining the rate and direction of ground water flow annually, in accordance with Permit Condition IX.B.5.

IX.G.5. Data Evaluation for Compliance Monitoring

IX.G.5.a. Data in the CMP will be evaluated by comparing the analytical results to the GPS(s) presented in Table IX-6. Level 1 monitoring well criteria was established by the Alternate Concentration Limits (ACL) presented in Table IX-6. The GPSs for Level 2 monitoring wells shall be those established in Table IX-6 of this Permit and determined by Permit Conditions IX.G.5.b through IX.G.5.e, IX.G.8, and IX.G.9, and as follows:

IX.G.5.b. The down-gradient monitoring wells have been divided into two (2) categories as follows:

IX.G.5.b.(1). Level 1 Compliance Wells:
Level 1 Compliance Wells consist of interior monitoring wells located down-gradient of designated Solid Waste Management Units and regulated units and include the following Wells: U-1, U-17, U-18, U-19, U-20, U-21, U-22, U-23, U-24, U-25, L-31, L-32, L-33, L-37, L-39, L-41, and L-42.

IX.G.5.b.(2). Level 2 Compliance Wells:
Level 2 Compliance Wells consist of down-gradient wells on the eastern and northern site boundaries where ground water flow paths will potentially carry impacted ground water off the facility. Level 2 Compliance Wells consist of the following wells: U-5, U-6, U-7, U-8, U-9, U-10, U-11, U-12, L-28, L-29, L-30, L-43, L-44, L-45, and L-47.

IX.G.5.c. The compliance monitoring criteria (GPS) for evaluating data collected from Level 1 and Level 2 Compliance Wells for each monitoring event for any anthropogenic organic compound, shall be as follows:

IX.G.5.c.1. Level 1 Compliance Wells
Any single Table IX-2 organic compound equal to one-half percent (0.5%) of its solubility in water, as presented in Table IX-6. If multiple constituents are present, a cumulative total of 0.5% solubility based on the summation of solubility percentages, presented by the concentration of each constituent detected.

IX.G.5.c.2. Level 2 Compliance Wells
For any single Table IX-2 organic constituent equal to the Maximum Concentration Limit (MCL), as established by EPA, for drinking water presented in Table IX-6; or

IX.G.5.c.2(a). Where an MCL has not been established, a concentration equal to 1×10^{-5} industrial cancer risk for carcinogenic constituents will apply. This will be calculated in accordance with Permit Condition IX.G.5.e.

IX.G.5.c.2(b). If multiple carcinogenic compounds are present, but none exceed their respective MCL (if appropriate), a cumulative 1×10^{-5} industrial cancer risk will apply; or

IX.G.5.c.2(c). For individual non-carcinogenic hazardous constituents, the compliance monitoring criteria shall be a hazard quotient of 1 based upon the calculation of the hazard quotient, in accordance with Permit Condition IX.G.5.d.

IX.G.5.c.2(d). If multiple non-carcinogenic hazardous constituents are present, but none exceed their respective MCL (if available), the cumulative hazard quotient shall be calculated in accordance with the equation presented in Permit Condition IX.G.5.d. The action criteria shall be based upon a cumulative hazard quotient of 1.

IX.G.5.c.2.(e). In the event additional anthropogenic compounds are identified through Appendix IX sampling, GPSs for Level 1 and Level 2 Monitoring Wells shall be established and incorporated into this Permit through a modification.

IX.G.5.d. Calculation for determination of the Hazard Quotient (Index) using standard default factors.

Industrial Non-Carcinogenic Hazard Quotient Determination:

HQ={C * 1 mg/1000 ug * EFr * EDr *[(IRWa/RfDo) + (VFw * IRAa/RfDi)]} / (BWa * ATn)

Where:

HQ	=	Hazard Quotient
C	=	Chemical Concentration in the ground water (ug/L) of the specific constituent
RfD_O	=	Oral reference dose in mg/kg-day (Table IX-7)
IRWa	=	Ingestion Rate, water, adult (2 L/day)
IRAa	=	Inhalation Rate, adult (20 m^3/day)
EFr	=	Exposure Frequency, occupational (250 days/year)
EDr	=	Exposure Duration, occupational (25 years)
BWa	=	Body weight, adult (70 kg)
RfDi	=	Inhalation Reference Dose, in mg/kg-day (Table IX-7)
ATn	=	Averaging time, 9125 days (25 yr*365 days/yr)
VFw	=	Volatilization Factor for water (0.5 L/ m^3)

Refer to Table IX-7, *Toxicity Values for RfDo and RfDi values for calculating the Industrial Non-Carcinogenic Hazard Quotient*. Note: N-A means that no oral and/or inhalation reference dose is available for use.

Non-cancer Hazard Determination for multiple constituents:
For each non-carcinogenic constituent from Permit Condition IX.I.G.a, detected at or above the EQL limit, calculate the Hazard Quotient as shown above and sum as follows:

Hazard Index = $HQ_1 + HQ_2 + HQ_3 + \ldots$

IX.G.5.e. Calculation for determination of the Total Cancer Risk using standard default factors.

Calculating the Estimated Industrial Cancer Risk for Each Constituent:

CR={C * 1 mg/1000 ug * EFr[(IFWadjo * SFo)+(VFw * InhFadjo * SFi)]} / (ATc)

Where:

CR	=	Constituent Cancer Risk (based on industrial exposure factors)
C	=	Chemical Concentration in the ground water (ug/L) of the specific constituent
EFr	=	Exposure Frequency (250 days/year)
ATc	=	Averaging Time, carcinogenic (25550 days)
IFWadjo	=	Ingestion Factor, water, occupational (0.714 L-yr/Kg-day) *Calculated as follows: IFWadjo = IRWa*1/BWa*EDo =* *2 L/day*1/70kg* 25 yrs*
SF_0	=	Oral slope factor in kg-day/mg (Table IX-8)
VFw	=	Volatilization Factor for water (0.5 L/m^3)
InhFadjo	=	Inhalation Factor, occupational (7.14 m^3-yr/Kg-day) *Calculated as follows: InhFadjo = IRAa*1/BWa*EDo =* *20 m3/day*1/70kg*25 yrs*
SF_i	=	Inhalation slope factor in kg-day/mg (Table IX-8)

Refer to Table IX-8, *Toxicity Values for SFo and SFi values for calculating Total Cancer Risk*. Note: *N-A* means that no oral and/or inhalation reference dose is available for use.
Calculating the Total Industrial Cancer Risk:
For each constituent from Permit Condition IX.G.3.a, detected at or above the EQL limit, calculate the Cancer Risk as shown above and sum as follows:

Total Cancer Risk = $CR_1 + CR_2 + CR_3 + ...$

IX.G.5.f. The toxicity values in Table IX-7 and Table IX-8 will be updated during the Permit Reopener five (5) years from the effective date of permit issuance per IDAPA 58.01.05.012 [40 CFR § 270.50(d)]. Toxicity factors will be updated, based on the published values in: 1) Integrated Risk Information System (IRIS); 2) Health Effects Assessment Summary Tables (HEAST), databases maintained by the U.S. EPA; and 3) EPA Region 9, Preliminary Remediation Goals (PRGs). The Permittee shall use the updated, toxicity values for all calculations.

IX.G.5.g. Upon detection of VOC concentrations at concentrations exceeding the GPS, set forth in Permit Condition IX.G.5.a and/or listed in Table IX-6 of this Permit, the Permittee shall:

IX.G.5.g(1). Notify the Director of the finding (in writing) within seven (7) calendar days of receipt of the analytical results, identifying the presence of contaminants at or above the established GPSs, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.99(h)(1)]. At this time, the Permittee may elect to immediately collect two (2) verification samples from any affected well(s), purging the well(s) between samples, and reanalyze for all compounds required in the Compliance Monitoring Program. If analytical results from either verification sample confirm the detection of compounds above the Compliance Monitoring Criteria, as specified in Permit Condition IX.G.5.a, then the Permittee shall:

IX.G.5.g(2). Submit to the Director a Corrective Action Plan, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.100], applicable to the affected area(s) and constituents, within 120 calendar days of receipt of the analytical results, identifying the presence of contaminants at or above the established GPSs; or

IX.G.5.g(3). Submit to the Director, a report demonstrating that a source (other than a Past Practice Unit or regulated unit) caused the contamination and/or that the reported contaminant concentrations resulted from an error in sampling, analysis, or evaluation. In making this demonstration, the Permittee shall follow procedures in accordance with IDAPA 58.01.05.008 [40 CFR § 264.99(i)]:

- Notify the Director, in writing, within seven (7) calendar days of the Permittee's intent to make such a demonstration;
- Within ninety (90) days, submit a report to the Director that demonstrates that a source (other than the Past Practice Unit or regulated unit) caused the standard to be exceeded or that the apparent noncompliance with the standards resulted from an error in sampling, analysis, or evaluation;
- Within ninety (90) days, submit to the Director an application for a permit modification to make any appropriate changes to the Compliance Monitoring Program at the facility; and
- Continue ground water monitoring for the affected well(s), in accordance with the Compliance Monitoring Program.

IX.G.6. The Permittee shall continue the Compliance Monitoring Program at the affected well(s) until:

IX.G.6.a. Constituents identified in the affected well(s) do not exceed the limit specified in Permit Condition IX.G.5.a for four (4) consecutive sampling events; or

IX.G.6.b. The Permittee enters into a Corrective Action Program under IDAPA 58.01.05.008 [40 CFR § 264.101] for the affected area(s).

IX.G.7. If the Permittee determines that the Compliance Monitoring Program no longer satisfies the requirements of the IDAPA 58.01.05.008 [40 CFR § 264.99], the Permittee shall, within ninety (90) days, submit an application for permit modification to make any appropriate changes to the program, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.99(j)].

IX.G.8. In the event VOCs are detected above an EQL in an up-gradient or background monitoring well, the well shall be incorporated in the Compliance Monitoring Program, as a Level 1 Compliance Well, in accordance with Permit Condition IX.G.

IX.G.9. Data Reporting for Compliance Monitoring

While in the Compliance Monitoring Program, the Permittee shall submit a semi-annual Compliance Monitoring Report, to the Director, in accordance with Permit Condition I.P.6. This report shall contain a narrative summary of ground water monitoring data that has been collected over the past five (5) years, a detailed listing of the monitoring, and analytical data obtained since the previous report (including any/all newly identified compounds from the Appendix IX Sampling), and (at a minimum) all QA/QC information, a table summary of ground water elevations, all equations, calculations, and parameters used to calculate ground water velocities, and ground water flow direction, in accordance with Permit Condition IX.B.4.

IX.H. POST-CLOSURE AND POST-COVER CARE MONITORING

IX.H.1. All procedures described in Part IX of this Permit for inspection, maintenance, and monitoring shall apply to the Post-Closure Care Period, as well as the active life of each regulated unit, and to the Post-Cover Care Period for each Past Practice Unit.

IX.H.2. The period of Post-Closure for each regulated unit shall be as specified in Permit Condition II.M.2. The period of Post-Cover Care for each Past Practice Unit shall be as specified in Permit Conditions VIII.A.3 and VIII.A.4.

IX.I. UNSATURATED ZONE MONITORING

Upon the Director's request, the Permittee shall prepare a Work Plan for the design, construction, operation, and maintenance of an Unsaturated Zone Monitoring System for the facility, capable of detecting changes from unsaturated to saturated conditions that could move contaminants laterally above the monitored aquifer. The Director shall reserve the right to reopen this permit condition, at any time, to include a specific design and implementation schedule, if the Director determines that the Permittee is not making all reasonable efforts to meet this permit condition. The reopening of this permit condition would be done as an agency-initiated permit modification under IDAPA 58.01.05.012 [40 CFR § 270.41].

IX.J. COMPLIANCE SCHEDULE — RISING WATER TABLE STUDY

IX.J.1. On December 17, 1998, the Department approved the Rising Water Table Study Work Plan. The Department evaluated the Rising Ground Water Study's results and issued a conditional approval on November 23, 1999. As stated in the approval, the Permittee shall submit in reports to the Director (every two years) the continuing evaluations of the rising ground water, beginning in 2001. After submittal of the third such report, the Permittee may request a five (5) -year interval for evaluation of the rising ground water. These reports shall include a summary of current rising ground water conditions, an assessment of the probable scenarios causing the rising ground water, an evaluation of the potential consequences to the Ground Water Monitoring Network (due to the rising ground water), and a description of proposed future tasks to address the situation.

IX.J.2. Failure on the part of the Permittee to carry out the approved Work Plan in the time specified shall be deemed as a violation of this Permit unless the Permittee has been granted a written extension from the Department.

TABLE IX-2. CONSTITUENTS FOR DETECTION MONITORING PROGRAM		
Constituent	**CAS No.**	**EQL (ug/l)**
Benzene	71-42-2	1
Bromodichloromethane	75-27-4	1
Bromoform	75-25-2	1
Bromomethane	74-83-9	1
Carbon Tetrachloride	56-23-5	1
Chlorobenzene	108-90-7	1
Chloroethane	75-00-3	1
Chloroform	67-66-3	1
Chloromethane	74-87-3	1
Cis-1,3-Dichloropropene	10061-01-5	1
Trans-1,3-Dichloropropene	10061-02-6	1
Cis-1,2-Dichloroethene	156-59-2	1
Trans-1,2-Dichloroethene	156-60-5	1
Dibromochloromethane	124-48-1	1
1,1-Dichloroethane	75-34-3	1
1,2-Dichloroethane	107-06-2	1
1,1-Dichloroethene	75-35-4	1
1,2-Dichloropropane	78-87-5	1
Ethylbenzene	100-41-4	1
Methylene Chloride	75-09-2	1
1,1,2,2-Tetrachloroethane	79-34-5	1
Tetrachloroethene	127-18-4	1
Toluene	108-88-3	1
1,1,1-Trichloroethane	71-55-6	1
1,1,2-Trichloroethane	79-00-5	1
Trichloroethene	79-01-6	1
1,1,2-Trichlor-1,2,2-Triflouroethane (CFC 113)	76-13-1	1
Vinyl chloride	75-01-4	1

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TABLE IX-3. GROUND WATER MONITORING NETWORK

Well ID	Description	Sampling Frequency
U-1	Level 1	Semiannual
U-2	Upgradient	Semiannual
U-3	Upgradient	Semiannual
U-4	Upgradient	Semiannual
U-5	Level 2	Semiannual
U-6	Level 2	Semiannual
U-7	Level 2	Semiannual
U-8	Level 2	Semiannual
U-9	Level 2	Semiannual
U-10	Level 2	Semiannual
U-11	Level 2	Semiannual
U-12	Level 2	Semiannual
U-17	Level 1	Semiannual
U-18	Level 1	Semiannual
U-19	Level 1	Semiannual
U-20	Level 1	Semiannual
U-21	Level 1	Semiannual
U-22	Level 1	Semiannual
U-23	Level 1	Semiannual
U-24	Level 1	Semiannual
U-25	Level 1	Semiannual
L-28	Level 2	Semiannual
L-29	Level 2	Semiannual
L-30	Level 2	Semiannual
L-31	Level 1	Semiannual
L-32	Level 1	Semiannual
L-33	Level 1	Semiannual
L-35	Upgradient	Semiannual
L-36	Upgradient	Semiannual
L-37	Level 1	Semiannual
L-38	Upgradient	Semiannual
L-39	Level 1	Semiannual
L-41	Level 1	Semiannual
L-42	Level 1	Semiannual
L-43	Level 2	Semiannual
L-44	Level 2	Semiannual
L-45	Level 2	Semiannual
L-47	Level 2	Semiannual
LP-11, LP-12, LP-13, LP-14, LP-15, LP-27	Piezometer	Semiannual Water Levels Only
UP-1, UP-2, UP-3, UP-4, UP-5,UP-6, UP-7, UP-8, U-13, U-14, U-26, UP-26, UP-28, UP-29	Piezometer	Semiannual Water Levels Only

TABLE IX-4. MONITORING WELL SUMMARY		
UPPER AQUIFER		
Well No.[a]	Old Well No.[b]	Well Material[c]
Background Wells		
U-2 U-3 U-4	UMW-38 UMW-150 UMW-37	SS SS SS
Regulated Units Trench 11 and Collection Pond 1		
U-5 U-6 U-7	None MW-9 UMW-47	SS SS SS
Regulated Unit Collection Pond 3 and Past Practice Units PCB 1, 2, and 3, Acid Disposal Pits, CHEM Area 1, CHEM-1, CHEM-2, CHEM-2B, CHEM-2C, CHEM-2D, CHEM-2E, CHEM-3, CHEM-4, CHEM4B, CHEM-5, CHEM5B, CHEM-6, CHEM-6A, CHEM-6B		
U-9 U-10	None MW-11	SS SS
Regulated Unit Evaporation Pond 1		
U-11 U-12	None None	SS SS
Regulated Units Trench 10 and Collection Pond 2		
U-8	UMW-46	SS
Past Practice Unit Silo 3		
U-20	SW-3	SS
Past Practice Unit Silo 2		
U-21	SW-2	SS
Past Practice Unit Silo 1		
U-22	SW-1	SS
Past Practice Unit Trench PCB-4		
U-17 U-18 U-19	UWL-41 UMW-40 UMW-39	SS SS SS
Past Practice Unit Buried Drum Area 2 (Near Silo 2)		
U-18 U-19	UMW-40 UMW-39	SS SS
Past Practice Unit Buried Drum Area 1 (Near Silo 3)		

a Well No. – designates the Monitoring Well Numbering System pursuant to this Permit, and as designated on Figures 1 and 2 of this Permit.
b Old Well No. – designates ESII Well Numbering System.
c Well Materials = Materials below static water level: SS – Either 304 stainless steel or Schedule 80 PVC: PVC = Schedule 40 polyvinyl chloride.

TABLE IX-4. MONITORING WELL SUMMARY		
UPPER AQUIFER		
Well No.[a]	Old Well No.[b]	Well Material[c]
U-19	UMW-39	SS
Past Practice Unit Control Center		
U-17	UWL-41	SS
Past Practice Unit Elevator Shaft and Disposal Area 9		
U-17	UWL-41	SS
U-18	UMW-40	SS
Past Practice Unit Electrical Vault		
U-17	UWL-41	SS
Regulated Unit Cell 5		
U-1	UMW-16	PVC
U-23	UPCB-1	PVC
U-24	PCB-3	SS
U-25	UMW-36	SS
LOWER AQUIFER		
Regulated Unit Cell 14		
L-28 Subcell 1	LMW-49	SS
L-29 Subcell 2	LMW-50	SS
L-30 Subcell 3	LMW-51	SS
L-39 Subcell 4	None	SS
L-32 Subcell 5	LMW-53	SS
L-33 Subcell 6	LMW-31	SS
L-34 Subcell 7	LMW-54	SS
Past Practice Units Radar (Antenna) Silos		
L-31	UML-42	SS
Background Wells		
L-35	LMW-30	PVC
L-38	LMW-13	PVC
Regulated Unit Cell 15		
L-36	LMW-27	PVC
L-37	LMW-28	PVC
L-41	*N-A*	SS
L-42	*N-A*	SS
L-43	*N-A*	SS
L-44	*N-A*	SS
L-45	*N-A*	SS
L-47	*N-A*	SS

TABLE IX-5. EXISTING PIEZOMETERS

Upper Aquifer		Lower Aquifer	
Well No.	**Old Well No.**	**Well No.**	**Old Well No.**
UP-1	D-19	LP-11	D-29
UP-2	D-23	LP-12	MW-21
UP-3	PCB-2	LP-13	MW-25
UP-4	MW-21	LP-14	MW-14
UP-5	MW-10	LP-15	MW-24
UP-6	SW-3-2	LP-27	
UP-7	MW-1		
UP-8	SW-1-2		
UP-26			
UP-28			
UP-29			

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TABLE IX-6. ALTERNATE CONCENTRATION LIMITS AND GROUND WATER PROTECTION STANDARDS, LEVEL 1 AND LEVEL 2 COMPLIANCE MONITORING WELLS

Compliance Monitoring Constituent	Level 1 Compliance Wells	Level 2 Compliance Wells			Applicable Criteria for Level 2 Compliance Wells
	Concentration @ 0.5% Solubility ug/L	Concentration @ Industrial HQ = 1 ug/L	Concentration @ 1 x 10-5 Cancer Risk ug/L	MCL ug/L	
Acetone	5.00E+06	8.52E+02	N-A	N-A	HQ
Acrolein	1.04E+06	5.83E-02	N-A	N-A	HQ
Acrylonitrile	3.68E+05	5.23E+00	5.30E+00	N-A	CR
Allyl chloride	1.80E+04	2.96E+00	N-A	N-A	HQ
Benzene	8.90E+03	N-A	9.87E+01	5E+0	MCL
Bromodichloromethane	2.25E+04	1.70E+02	4.62E+01	1E+2	MCL
Bromoform (Tribromomethane)	1.60E+04	1.70E+02	3.62E+02	1E+2	MCL
Bromomethane	6.50E+04	1.19E+01	N-A	N-A	HQ
2-Butanone (Methyl ethyl ketone)	1.38E+06	2.70E+03	N-A	N-A	HQ
Carbon disulfide	1.45E+04	1.46E+03	N-A	N-A	HQ
Carbon tetrachloride	4.00E+03	N-A	2.20E+01	5E+0	MCL
Chlorobenzene	2.44E+03	5.51E+01	N-A	1E+2	MCL
Chlorodibromomethane	2.00E+04	1.70E+02	3.41E+01	1E+2	MCL
Chloroethane (Ethyl chloride)	2.87E+04	N-A	N-A	N-A	N-A
2-Chloroethyl vinyl ether	7.50E+04	N-A	N-A	N-A	N-A
Chloroform	4.65E+04	8.52E+01	4.69E+02	1E+2	MCL
Chloromethane	3.18E+04	N-A	2.20E+02	N-A	CR
1,2-Dibromo-3-chloropropane	5.00E+03	4.85E-01	2.04E+00	2E-01	MCL
1,2-Dibromoethane (EDB)	5.85E+04	4.85E-01	3.37E-01	5E-01	MCL
1,1-Dichloroethane	2.75E+04	1.12E+03	N-A	N-A	HQ
1,2-Dichloroethane (EDC)	4.35E+04	N-A	3.14E+01	5E+0	MCL
1,1-Dichloroethylene	2.00E+03	7.67E+01	4.77E+00	7E+0	MCL
Cis-1,2-Dichloroethylene	3.00+03	1.70E+02	N-A	1E+2	MCL
Trans-1,2-Dichloroethylene	3.00E+03	1.70E+02	N-A	1E+2	MCL
1,4-Dichloro-2-butene		N-A	3.08E-01	N-A	CR
Dichlorodifluoromethane	1.40E+03	5.51E+02	N-A	N-A	HQ
1,2-Dichloropropane	1.35E+04	9.37E+00	4.21E+01	5E+0	MCL
Cis-1,3-Dichloropropene	1.35E+04	1.21E+01	1.59E+01	N-A	CR
Trans-1,3-Dichloropropene	1.40E+04	1.21E+01	1.59E+01	N-A	CR
Ethylbenzene	7.60E+02	1.88E+03	N-A	7E+2	MCL
Ethyl methacrylate	1.00E+02	7.67E+02	N-A	N-A	HQ
2-Hexanone	1.75E+05	N-A	N-A	N-A	N-A
Iodomethane (Methyl iodide)	7.00E+04	N-A	N-A	N-A	N-A
Methacrylonitrile	1.25E+05	1.46E+00	N-A	N-A	HQ
Methylene bromide	2.15E+04	8.52E+01	N-A	N-A	HQ

TABLE IX-6. ALTERNATE CONCENTRATION LIMITS AND GROUND WATER PROTECTION STANDARDS, LEVEL 1 AND LEVEL 2 COMPLIANCE MONITORING WELLS

Compliance Monitoring Constituent	Level 1 Compliance Wells	Level 2 Compliance Wells			Applicable Criteria for Level 2 Compliance Wells
	Concentration @ 0.5% Solubility ug/L	Concentration @ Industrial HQ = 1 ug/L	Concentration @ 1 x 10-5 Cancer Risk ug/L	MCL ug/L	
Methylene chloride	8.35E+04	2.27E+03	3.82E+02	5E+0	MCL
Methyl methacrylate	8.00E+04	1.99E+03	N-A	N-A	HQ
Methyl Isobutyl Ketone	9.55E+04	2.22E+02	N-A	N-A	HQ
Propiononitrile	5.15E+05	N-A	N-A	N-A	N-A
Styrene	1.50E+03	2.30E+03	N-A	1E+2	MCL
1,1,1,2-Tetrachloroethane	1.00E+03	2.56E+02	1.10E+02	N-A	CR
1,1,2,2-Tetrachloroethane	1.45E+04	N-A	1.43E+01	N-A	CR
Tetrachloroethylene (PCE)	7.50E+02	N-A	N-A	5E+0	MCL
Toluene	2.55E+03	1.01E+03	N-A	1E+3	MCL
1,1,1-Trichloroethane	2.20E+04	N-A	N-A	2E+2	MCL
1,1,2-Trichloroethane	2.25E+04	3.41E+01	5.02E+01	5E+0	MCL
Trichlorofluoromethane	5.50E+03	1.80E+03	N-A	N-A	HQ
1,1,2-Trichlor-1,2,2-trifluoroethane (CFC-113)	1.57	E+03	N-A	N-A	HQ
1,2,3-Trichloropropane	9.50E+03	4.38E+01	4.09E-01	N-A	CR
Trichloroethylene (TCE)	5.50E+03	N-A	N-A	5E+0	MCL
Vinyl acetate	1.00E+05	5.76E+02	N-A	N-A	HQ
Vinyl chloride	5.50E+03	N-A	1.51E+00	2E+0	MCL
Xylene	9.95E+02	N-A	N-A	1E+4	MCL

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Table IX-7. Toxicity Values for Calculating Industrial Non-Carcinogenic Hazard Quotient

CONSTITUENT	CAS #	RfD_0	RfDi
Acetone	67-64-1	0.9	0.1
Acrolein	107-02-8	0.0005	0.0000057
Acrylonitrile	107-13-1	0.001	0.00057
Allyl chloride	107-05-1	0.05	0.000286
Benzene	71-43-2	0.004	0.00857
Bromodichloromethane	75-27-4	0.02	0.02
Bromoform	75-25-2	0.02	0.02
Bromomethane	74-83-9	0.0014	0.0014
2-Butanone (MEK, methyl ethyl ketone)	78-93-3	0.6	0.29
Carbon disulfide	75-15-0	0.1	0.2
Carbon Tetrachloride	56-23-5	0.0007	0.0007
Chlorobenzene	108-90-7	0.02	0.0017
Chloroethane (ethyl chloride)	75-00-3	0.4	2.86
2-Chloroethylvinyl ether	110-75-8	N-A	N-A
Chloroform	67-66-3	0.01	0.00086
Chloromethane (or Methyl Chloride)	74-87-3	N-A	0.03
1,3 Dichloropropene	542-75-6	0.03	0.00571
Dibromochloromethane (or Chlorodibromomethane)	124-48-1	0.02	0.02
1,2 Dibromo-3-chloropropane (DBCP)	96-12-8	0.000057	0.0000571
Dibromomethane	74-95-3	0.01	0.01
1,2-Dibromoethane	106-93-4	0.000057	0.000057
1,1-Dichloroethane	75-34-3	0.1	0.14
1,2-Dichloroethane	107-06-2	0.03	0.0014
1,1-Dichloroethene	75-35-4	0.05	0.0571
cis-1,2-Dichloroethene (or cis-1,2-Dichloroethylene)	156-59-2	0.01	0.01
trans-1,2-Dichloroethene (or trans-1,2-Dichloroethylene)	156-60-5	0.02	0.02
1,2-Dichloropropane	78-87-5	0.0011	0.0011
1,4-Dichloro-2-butene	764-41-0	N-A	N-A
Dichlorodifluoromethane (CFC-12)	75-71-8	0.2	0.057
Ethylbenzene	100-41-4	0.1	0.0286
Ethyl methacrylate	97-63-2	0.09	0.09
2-Hexanone (Methyl butyl ketone)	591-78-6	N-A	N-A
Iodomethane	74-88-4	N-A	N-A
Methacrylonitrile	126-98-7	0.0001	0.0002
Methylene Chloride	75-09-2	0.06	0.86
Methyl methacrylate	80-62-6	1.4	0.2
4-Methyl-2-pentanone (methyl isobutyl ketone)	108-10-1	0.08	0.857
Propionitrile	107-12-0	N-A	N-A
Styrene	100-42-5	0.2	0.286
1,1,1,2-Tetrachloroethane	630-20-6	0.03	0.03
1,1,2,2-Tetrachloroethane	79-34-5	0.06	0.06
Tetrachloroethene (or Tetrachloroethylene)	127-18-4	0.01	0.17
Toluene	108-88-3	0.2	0.114
Trichlorofluoromethane (CFC-11)	75-69-4	0.3	0.2
1,2,3-Trichloropropane	96-18-4	0.006	0.0014
1,1,2-Trichlor-1,2,2-trifluoroethane (CFC-113)	76-13-1	30	8.6
1,1,1-Trichloroethane	71-55-6	0.28	0.63
1,1,2-Trichloroethane	79-00-5	0.004	0.004
Trichloroethene	79-01-6	0.0003	0.01
Vinyl Acetate	108-05-4	1.0	0.0571
Vinyl Chloride	75-01-4	0.003	0.0286
Xylenes (total)	1330-20-7	0.2	0.0286

Note: N-A means that no oral and/or inhalation reference dose is available for use.

TABLE IX-8. TOXICITY VALUES FOR CALCULATING TOTAL CANCER RISK

CONSTITUENT	CAS #	SF_0	SF_i
Acetone	67-64-1	N-A	N-A
Acrolein	107-02-8	N-A	N-A
Acrylonitrile	107-13-1	0.54	0.24
Allyl chloride	107-05-1	N-A	N-A
Benzene	71-43-2	0.055	0.029
Bromodichloromethane	75-27-4	0.062	0.062
Bromoform	75-25-2	0.0079	0.0039
Bromomethane	74-83-9	N-A	N-A
2-Butanone (MEK, methyl ethyl ketone)	78-93-3	N-A	N-A
Carbon disulfide	75-15-0	N-A	N-A
Carbon Tetrachloride	56-23-5	0.13	0.053
Chlorobenzene	108-907	N-A	N-A
Chloroethane (ethyl chloride)	75-00-3	0.0029	0.0029
2-Chloroethylvinyl ether	110-75-8	N-A	N-A
Chloroform	67-66-3	0.031	0.019
Chloromethane (or Methyl Chloride)	74-87-3	0.013	0.0063
1,3 Dichloropropene	542-75-6	0.1	0.014
Dibromochloromethane (or chlorodibromomethane)	124-48-1	0.084	0.084
1,2 Dibromo-3-chloropropane (DBCP)	96-12-8	1.4	0.0024
Dibromomethane	74-95-3	N-A	N-A
1,2-Dibromoethane	106-93-4	85.0	0.77
1,1-Dichloroethane	75-34-3	N-A	N-A
1,2-Dichloroethane	107-06-2	0.091	0.091
1,1-Dichloroethene	75-35-4	N-A	N-A
Cis-1,2-Dichloroethene (or cis-1,2-Dichloroethylene)	156-59-2	N-A	N-A
Trans-1,2-Dichloroethene (or trans-1,2-Dichloroethylene)	156-60-5	N-A	N-A
1,2-Dichloropropane	78-87-5	0.068	0.068
1,4-Dichloro-2-butene	764-41-0	9.3	9.3
Dichlorodifluoromethane (CFC-12)	75-71-8	N-A	N-A
Ethylbenzene	100-41-4	0.00385	.00385
Ethyl methacrylate	97-63-2	N-A	N-A
2-Hexanone (Methyl butyl ketone)	591-78-6	N-A	N-A
Iodomethane	74-88-4	N-A	N-A
Methacrylonitrile	126-98-7	N-A	N-A
Methylene Chloride	75-09-2	0.0075	0.0016
Methyl methacrylate	80-62-6	N-A	N-A
4-Methyl-2-pentanone (methyl isobutyl ketone)	108-10-1	N-A	N-A
Propionitrile	107-12-0	N-A	N-A
Styrene	100-42-5	N-A	N-A
1,1,1,2-Tetrachloroethane	630-20-6	0.026	0.026
1,1,2,2-Tetrachloroethane	79-34-5	0.2	0.2
Tetrachloroethene (or Tetrachloroethylene)	127-18-4	0.052	0.01
Toluene	108-88-3	N-A	N-A
Trichlorofluoromethane (CFC-11)	75-69-4	N-A	N-A
1,2,3-Trichloropropane	96-18-4	2.0	2.0
1,1,2-Trichlor-1,2,2-trifluoroethane (CFC-113)	76-13-1	N-A	N-A
1,1,1-Trichloroethane	71-55-6	N-A	N-A
1,1,2-Trichloroethane	79-00-5	0.057	0.056
Trichloroethene	79-01-6	0.21	0.4
Vinyl Acetate	108-05-4	N-A	N-A
Vinyl Chloride	75-01-4	0.75	0.016
Xylenes (total)	1330-20-7	N-A	N-A

Note: N-A means that no oral and/or inhalation reference dose is available for use.

MODULE X - CONTAINMENT BUILDING AND DEBRIS TREATMENT

X. Subject to the terms of this Permit, the Permittee may store and/or treat hazardous wastes in the Containment Building, as follows:

X.A. CONTAINMENT BUILDING

X.A.1. Containment Building Design and Equipment

The Permittee shall maintain the containment building, in accordance with the design standards for a containment building, as provided in IDAPA 58.01.05.008 [40 CFR § 264.1101], Attachment 24 of this Permit, and Permit Condition II.A.1 of this Permit. The containment building houses a Size Reduction System that consists of a Crusher System and associated equipment. The Permittee shall maintain the Crusher System in accordance with the requirements of IDAPA 58.01.05.008 [40 CFR § 264 Subpart X] and as provided by Permit Module XII. The arrangement of the equipment is depicted in Drawings D2020-R05, D2020-R07, and D2020-R08 of Attachment 20 of this Permit. The containment building is enclosed; and in areas where waste could become mobile, air pollution control equipment has been installed. Drawings D2020-H01, D2020-H03, and D2020-H04 in Attachment 20 of this Permit provide design details of the Air Handling and Pollution Control System for the containment building. The debris portion of the containment building contains three (3), steel-lined sort floors and two (2) Mixing Bin Tanks. The steel lined sort floors will not be in use when the Mixing Bin Tanks are in place. The stabilization portion of the containment building contains two (2) Mixing Bin Tanks. The Mixing Bin Tanks are further described in Permit Module IV. The permitted storage areas are depicted in drawings in Attachment 20 of this Permit.

X.A.1.a. The Permittee shall keep all relevant figures, drawings, and diagrams related to the containment building readily available for inspection at the facility, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.74].

X.A.1.b. Within forty-five (45) days after approval of the CQA Report for Mixing Bin Tanks 3 and/or 4, the Permittee shall submit all relevant updated drawings, which were not included in the CQA Report, illustrating current conditions in the Debris Portion of the Containment Building.

X.A.2. Containment Building Operation

X.A.2.a. The Permittee shall follow the approved containment building operation procedures, included as Attachments 2, 4, 6, 7, 13, 14, 24, and 25 of this Permit, and as provided by Permit Conditions X.A.2.a.(1) through (8).

X.A.2.a.(1). The Permittee shall operate the containment building so as not to exceed the maximum waste processing rate for the containment building (stabilization portion and debris portion) of 300 tons of waste per hour for the building based on a daily average, nor exceed 2,628,000 tons of waste per year for the building.

X.A.2.a.(2). The maximum waste processing rate for the other operations performed in the containment building shall not exceed 50 tons per hour for the Crusher System and

100 tons per hour for the sort floor, based on daily averages.

X.A.2.a.(3). The Permittee shall maintain non-containerized waste in the containment building sort floors such that the height and location of the waste does not allow these materials to escape or overflow the walls of the containment building.

X.A.2.a.(4). In the event of a power outage, or other event that reduces the operating efficiency below the manufacturer's specifications of the air pollution control equipment for the sort floors and mixing bins, the Permittee shall cease all hazardous waste and debris treatment operations on the sort floors and mixing bins that generate a "fine waste" until such time as the power is restored, or the air pollution control equipment is repaired.

X.A.2.a.(5). In the event of a power outage, or other event that reduces the operating efficiency below the manufacturer's specifications of the air pollution control equipment for the general floor area, the Permittee shall cease all hazardous debris treatment operations that generate a "fine waste" (including crushing and movement of non-containerized hazardous debris/waste and all operations on the general floor area other than storage or movement of closed containers of hazardous debris/waste, in the Containment Building on the general floor area) until such time as the power is restored or the air pollution control equipment is repaired.

X.A.2.a.(6). Containers of hazardous wastes removed from the Containment Building must be managed in accordance with IDAPA 58.01.05.008 [40 CFR § 264.173]. Prior to the transportation of any crushed wastes from the Containment Building, a determination for the presence of 'fine wastes' shall be made.

X.A.2.a.(7). The Permittee shall operate, service, and maintain the air pollution control equipment listed and/or depicted in Attachment 24 of this Permit according to the manufacturers' recommended instructions and/or specifications, which shall be maintained on-site.

X.A.2.a.(8). Closure of the Containment Building and associated areas and equipment shall be conducted in accordance with Attachment 9 of this Permit.

X.B. HAZARDOUS DEBRIS TREATMENT

X.B.1. All hazardous waste and debris-processing operations including unloading, staging, storing, sorting, pre-treating, or treating shall be conducted in compliance with IDAPA 58.01.05.011 [40 CFR Part 268] and Attachment 25 of this Permit. The hazardous waste and debris treatment processes include, but are not limited to, the following (as described in Attachment 25): stabilization, microencapsulation, macroencapsulation, chemical oxidation, chemical reduction, deactivation, solidification, neutralization, precipitation, adsorption, bioremediation, size reduction, decanting, and mechanical processing (sorting/crushing).

X.B.2. Hazardous waste and debris processing, treatment, and storage shall be in accordance with Attachments 2, 4, 6, 7, 13, 14, 15, 24, and 25 of this Permit.

X.B.3. Hazardous waste and debris processing, treatment, and storage shall be in accordance with Permit Condition II.T and IDAPA 58.01.05.008 [40 CFR 264 Subpart CC].

X.B.4. Hazardous waste and debris treated by the Permittee, using macroencapsulation or microencapsulation technologies, shall meet the requirements of IDAPA 58.01.05.011 [40 CFR § 268.45, Table 1] and the following permit conditions.

X.B.5. Macroencapsulation

X.B.5.a. The Permittee shall conduct macroencapsulation treatment of hazardous debris in the Containment Building and in Container Storage Pads 4 and 5 and at the Outdoor Stabilization Facility in accordance with Attachment 13, 15, and 25 of this Permit, and as provided by Permit Conditions X.B.4.a.(1) through X.B.4.a.(3).

X.B.5.a.(1). For macroencapsulation of hazardous debris, the Permittee shall use only high density polyethylene liner materials or polyethylene drums as specified in Attachment 25 of this Permit.

X.B.5.a.(2). For macroencapsulation of large pieces of debris that are wrapped or coated with an inert surface coating material, the Permittee shall demonstrate to the Director that the requirements of IDAPA 58.01.05.011 [40 CFR § 268.45, Table 1] have been met.

X.B.5.a.(2)(a). Upon the Director's approval of the demonstration in Permit Condition X.B.5.a.(2), the Permittee may begin utilizing the requested macroencapsulation process.

X.B.5.a.(3). Landfill placement of containers of macroencapsulated hazardous debris shall be in accordance with Attachments 19 and 25 of this Permit.

X.B.6. Microencapsulation

X.B.6.a. The Permittee shall conduct microencapsulation treatment of hazardous debris in accordance with Attachment 25 of this Permit, and as provided by the following permit conditions.

X.B.6.b. The Permittee shall conduct microencapsulation of hazardous debris at the Stabilization Facility or the Containment Building.

X.B.6.c. All size reduction operations of hazardous debris, prior to microencapsulation treatment, shall be performed in the containment building. Additional locations for size reduction operations, such as Container Management Units, may be utilized upon the Director's approval.

X.B.6.d. Landfill placement of microencapsulated hazardous debris shall be in accordance with Attachment 19 and 25 of this Permit.

X.C. CYANIDE DESTRUCTION

X.C.1. Cyanide destruction shall be conducted in accordance with all applicable sections of Attachments 2, 4, 6, 7, and 25 of this Permit.

X.C.2. Cyanide destruction performed by the Permittee shall be limited to chemical oxidation (e.g., alkaline chlorination), and shall be limited to the following parameters in order to protect human health and the environment:

- Waste containing less than 10,000 ppm of total cyanide may be accepted for cyanide destruction provided that the appropriate safety controls and procedures are followed. Prior approval from the Director is required for the receipt of any cyanide wastes exceeding 10,000 ppm.

- Cyanide destruction shall be performed in the Stabilization Facility and/or the Containment Building in containers and/or the Mixing Bin Tanks.

X.D. CLOSURE AND POST-CLOSURE

Closure and Post-Closure Care of the Containment Building shall be completed in accordance with IDAPA 58.01.05.008 [40 CFR § 264.1102], and all applicable sections of Attachment 9 of this Permit.

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MODULE XI - STABILIZATION OPERATIONS

XI.A. GENERAL OPERATING REQUIREMENTS

XI.A.1. The Permittee shall remove spilled or leaked wastes and accumulated liquid from the Secondary Containment Systems of the Stabilization Facility and the containment building (stabilization and/or debris portion) within 24 hours of detection, unless the waste or liquid in the Secondary Containment System is frozen. The Permittee shall manage these wastes and liquid as hazardous wastes. Within two (2) normal working days after the waste or liquid in the Secondary Containment System is no longer frozen, the contained liquids will be characterized and removed.

XI.A.2. The Permittee shall keep all relevant figures, drawings, and diagrams related to the Stabilization Facility and Containment Building (stabilization portion) readily available for inspection at the facility, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.74].

XI.B. STABILIZATION FACILITY

XI.B.1. The outdoor Stabilization Facility includes rolloffs (stabilization bins) of 25 to 52 cubic yards in capacity and shall be designed, constructed, and operated by the Permittee in accordance with Attachments 2, 4, 6, 7, 13, 15, 24, and 25 of this Permit, except as otherwise specified in this Permit, and in accordance with Permit Conditions II.A.1 and II.A.2.

XI.B.2. The Permittee may conduct treatment utilizing stabilization at the Stabilization Facility on all hazardous wastes listed in the Part A Permit Application (included as Attachment 12 of this Permit), except for "fine wastes" as defined in Attachment 2, and subject to any other applicable conditions in Attachment 2 of this Permit that apply to hazardous wastes to be stabilized.

XI.C. CONTAINMENT BUILDING (STABILIZATION OPERATIONS)

XI.C.1. Containment Building Design and Construction

XI.C.1.a. The Containment Building includes four (4) Mixing Bin Tanks, and the building shall be equipped with air pollution control equipment to control particulate emissions. Two (2) tanks are located in the Stabilization Portion and two (2) tanks are located in the Debris Portion of the building.

XI.C.1.b. The Containment Building includes container storage capacity, as shown in Attachment 13 of this Permit. The maximum waste processing rate for the Containment Building shall not exceed 300 tons of waste per hour based on a daily average, nor exceed 2,628,000 tons of waste per year.

XI.C.2. Containment Building Operation

XI.C.2.a. The Permittee may conduct stabilization, microencapsulation, macroencapsulation, and size reduction within the stabilization portion of the containment building.

XI.C.2.b. The Permittee shall follow, as appropriate, the operating procedures for stabilization, microencapsulation, macroencapsulation, and size reduction as provided in Attachments 2, 4, 6, 7, 13, 24, and 25 of this Permit and as provided by Permit Conditions X.B and XI.B.2.

XI.C.2.c. The Permittee shall operate each Stabilization Portion mixing bin tank so as not to exceed the maximum capacity of 120 cubic yards. The Permittee shall operate each Debris Portion mixing bin tank so as not to exceed the maximum capacity of 226 cubic yards for wastes in solid form. The Permittee shall operate each Debris Portion mixing bin tank so as not to exceed the maximum capacity of 12,000 gallons for wastes in liquid form.

XI.C.2.d. The Permittee shall manage non-containerized waste in the Containment Building such that the height and location of the waste does not allow these materials to overflow any mixing bin tank.

XI.C.2.e. In the event of a power outage, or other event that reduces the required operating efficiency of the air pollution control equipment, the Permittee shall cease all unloading and treatment operations of “fine wastes” until such time as the power is restored or the air pollution control equipment is returned to normal operation. Other treatment and storage operations not involving “fine wastes” may continue.

XI.C.2.f. The Permittee shall maintain and operate the air pollution control equipment, provided in Attachment 24 of this Permit, in accordance with the manufacturers' instructions and/or specifications, and shall keep these on-site.

XI.D. CLOSURE AND POST-CLOSURE

Closure and Post-Closure Care of the Containment Building (stabilization portion and debris portion) and Stabilization Facility, and associated equipment, shall be completed in accordance with IDAPA 58.01.05.008 [40 CFR § 264 Subpart G] and all applicable sections of Attachment 9 of this Permit.

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MODULE XII - MISCELLANEOUS UNITS UNDER SUBPART X

XII.A. APPLICABILITY OF RULES

The Permittee's compliance with the requirements of Permit Conditions XII.A through XII.G shall constitute compliance with the requirements of IDAPA 58.01.05.008 [40 CFR Parts 264.601 - 603] pertaining to the treatment, storage, or disposal of hazardous waste in miscellaneous units.

XII.B. DESCRIPTION OF MISCELLANEOUS UNIT

The miscellaneous unit consists of the Crusher System and associated equipment. An equipment list for the Crusher System and associated equipment is provided as Table I-2 of Attachment 24 of this Permit. The arrangement of the equipment is depicted in Drawings D2020-A02, -R07, and –R08 of this Permit.

XII.C. APPROVED WASTE

The Permittee may process waste meeting the general waste acceptance criteria in Permit Condition II.C and Attachment 2 of this Permit.

XII.C.1. The Permittee shall comply with Permit Condition II.T of this Permit, and the requirements of IDAPA 58.01.05.008 [40 CFR § 264.601] by not accepting or managing hazardous waste subject to the 40 CFR 264 Subpart CC requirements (e.g. wastes exceeding a volatile organic concentration of 500 ppmw at the point of origin).

XII.C.2. For miscellaneous units that receive organic wastes with a volatile organic concentration at the point of origin less than 500 ppmw, and are therefore, exempt from using air emission control equipment, documentation shall be recorded, in the Facility Operating Record, that includes the information that was used by the Permittee for each waste determination (e.g., test results, measurements, calculations, and other documentation). If analytical results for waste samples are used for the waste determination, then the Permittee shall record the date, time, and location that each waste sample is collected, in accordance with applicable requirements of 40 CFR § 264.1083. This information shall be kept in the Operating Record for a minimum of three (3) years.

XII.C.3. Reporting Requirements: If the Permittee does not comply with Permit Condition V.A.3.a, a report shall be submitted to the Director on each occurrence when hazardous waste is placed in the Waste Management Unit in noncompliance with the conditions of 40 CFR §§ 264.1082(c)(1) or 264.1082(c)(2), as applicable. A written report shall be submitted within fifteen (15) calendar days of the time that the Permittee becomes aware of the occurrence. The written report shall contain: the EPA Identification Number, facility name and address, a description of the noncompliance event and the cause, the dates of the noncompliance, and corrective actions taken to prevent reoccurrence of the noncompliance. The report shall be signed and dated by an authorized representative of the Permittee per IDAPA 58.01.05.008 [40 CFR § 264.1090].

XII.D. PROCESS DESIGN CAPACITY

The maximum waste processing rate for the Crusher System in the containment building shall not exceed 50 tons per hour or 50,000 tons per year.

XII.E. GENERAL MISCELLANEOUS UNIT MANAGEMENT PRACTICES

XII.E.1. The Permittee shall not place waste, treatment reagents, or other material in the miscellaneous unit that may cause the unit to rupture, leak, corrode, or otherwise fail.

XII.E.2. The Permittee shall maintain the Operating Record in accordance with IDAPA 50.01.05.008 [40 CFR § 264.73] and Permit Condition II.J of this Permit.

XII.E.3. The Permittee shall track waste processed through the miscellaneous unit, in accordance with Permit Condition XII.D.

XII.E.4. The Permittee shall maintain the Environmental Performance Standards for the miscellaneous unit, in accordance with IDAPA 50.01.05.008 [40 CFR § 264.601], as described in Attachments 24 and 25 of this Permit.

XII.E.5. In the event of a power outage, or other event that reduces the operating efficiency below the manufacturer's specifications of the air pollution control equipment for the Crusher System, all crushing operations shall cease until such time as the power is restored or the air pollution control equipment is repaired.

XII.E.6. The satellite accumulation container under the crusher discharge chute may remain uncovered/open under the following conditions:

XII.E.6.a. The immediate area around the crusher discharge chute must fully enclose the container on all four sides and above, with suspended tarps or an equivalent or superior curtain or structural material; and

XII.E.6.b. The containment building overhead door, adjacent to the crusher discharge chute, remains closed.

XII.F. INSPECTIONS

XII.F.1. The Permittee shall inspect the Crusher System, including the crusher discharge chute, the transfer vertical conveyor, Dust Collector System, and feed hopper for waste accumulation, in accordance with IDAPA 50.01.05.008 [40 CFR § 264.601], as described in Attachment 4 of this Permit.

XII.F.2. The Permittee shall keep all relevant figures, drawings, and diagrams related to the miscellaneous unit readily available for inspection at the facility, in accordance with IDAPA 58.01.05.008 [40 CFR § 264.74].

XII.G. CLOSURE AND POST-CLOSURE

Closure and Post-Closure Care of the miscellaneous unit shall be completed in accordance with IDAPA 58.01.05.008 [40 CFR § 264.603] and all applicable sections of Attachment 9 of this Permit.

MODULE XIII – CORRECTIVE ACTION

XIII.A. SOLID WASTE MANAGEMENT UNITS

XIII.A.1. The Director may require corrective action, as specified in the following permit conditions for any newly identified Solid Waste Management Units (SWMUs), where newly identified SWMUs are those not documented in the facility Administrative Record, maintained by the Department, as having undergone corrective action.

XIII.A.2. The Permittee shall conduct a corrective action investigation, in accordance with Permit Conditions XIII.B through XIII.H of this Permit, for each newly identified SWMU.

XIII.B. STANDARD CONDITIONS

XIII.B.1. Failure to submit the information required by the permit conditions within Module XIII of this Permit, or falsification of any submitted information, is grounds for termination of this Permit in accordance with IDAPA 58.01.5012 [40 CFR § 270.43], and for an enforcement action pursuant to Permit Condition I.C of this Permit.

XIII.B.2. All plans, reports, notifications, and other submissions to the Director, as required by the permit conditions within Module XIII of this Permit, shall be signed and certified in accordance with Permit Condition I.R of this Permit.

XIII.B.3. The Permittee shall submit to the Director (by certified mail, express mail, or hand delivered to the address specified in Permit Condition I.Z of this Permit) a minimum of three (3) copies of each plan, report, notification, or other submissions required by the permit conditions within Module XIII of this Permit.

XIII.B.4. All plans and schedules, as required by the permit conditions in Module XIII of this Permit (upon written approval from the Director) shall be incorporated into Module XIII of this Permit, in accordance with Permit Condition XIII.H of this Permit. Any noncompliance with such approved plans and schedules shall be deemed noncompliance with this Permit.

XIII.B.5. The Permittee shall only receive extension(s) of the specified Compliance Schedule due date(s) for the submittal(s), required by the permit conditions within Module XIII of this Permit, upon written approval from the Director, in accordance with Permit Condition XIII.H of this Permit.

XIII.B.6. If the Director determines that further actions beyond those provided by the permit conditions within Module XIII of this Permit, or changes to permit conditions stated herein, are warranted, the Director shall modify the permit condition in Module XIII, in accordance with Permit Condition XIII.H of this Permit.

XIII.B.7. All raw data (such as laboratory reports, drilling logs, bench-scale or pilot-scale data, and other supporting information gathered or generated during activities undertaken, pursuant to the permit conditions in Module XIII of this Permit) shall be maintained at the facility during the effective term of this Permit.

XIII.C. NOTIFICATION REQUIREMENTS & ASSESSMENT OF NEWLY-IDENTIFIED SWMUs

XIII.C.1. The Permittee shall notify the Director in writing (by certified mail, express mail, or hand delivery) of any newly identified SWMU(s). The Permittee shall submit written notification within thirty (30) calendar days of discovering the SWMU(s). The notification shall include the location of the new SWMU(s) and information on the suspected or known wastes at the site.

XIII.C.2. Within one hundred fifty (150) calendar days following discovery of the SWMU(s), the Permittee shall submit to the Director (by certified mail or hand delivery)a SWMU Assessment Plan.

XIII.C.3. The SWMU Assessment Plan shall include the information or the means by which the following information will be obtained:

XIII.C.3.a. Information concerning past and present operations at the unit(s); and

XIII.C.3.b. Any ground water, surface water, soil (surface or subsurface strata), or air sampling and analysis data needed to determine whether a release of hazardous waste and/or hazardous waste constituent(s) from such unit(s) has occurred, is occurring, or is likely to occur. The SWMU Assessment Plan shall demonstrate that the Sampling and Analysis Program (if applicable) is capable of yielding representative samples, and must include parameters sufficient to identify migration of hazardous waste and/or hazardous waste constituent(s) from the newly discovered SWMUs to the environment.

XIII.C.4. The Permittee shall receive written approval from the Director for the SWMU Assessment Plan; or

XIII.C.5. The Permittee shall receive written notice from the Director of the SWMU Assessment Plan's deficiencies, and the written notice will specify a due date for submittal of a revised Assessment Plan; or

XIII.C.6. The Permittee shall receive written notice from the Director of the revisions incorporated, by the Director, in the SWMU Assessment Plan. The revised Assessment Plan shall become the approved SWMU Assessment Plan.

XIII.C.7. The SWMU Assessment Plan, as approved by the Director and as specified in Permit Conditions XIII.C.4, XIII.C.5, or XIII.C.6 of this Permit, shall be incorporated within Module V of this Permit, in accordance with Permit Condition XIII.H of this Permit. The Permittee shall be notified in writing of the approval of the permit modification.

XIII.C.8. The Permittee shall implement the approved SWMU Assessment Plan within thirty (30) calendar days of receiving written notice of the permit modification approval, specified in Permit Condition XIII.C.7 of this Permit.

XIII.C.9. The SWMU Assessment Plan shall contain a schedule, including the submission date for a SWMU Assessment Report.

XIII.C.10. The SWMU Assessment Report shall describe all results obtained from the implementation of the approved SWMU Assessment Plan. At a minimum, the report shall provide the following information for each newly SWMU identified:

XIII.C.10.a. The SWMU location, identified on a map;

XIII.C.10.b. The type and function of the unit, including general dimensions and a structural description;

XIII.C.10.c. The period during which the unit was operated; and

XIII.C.10.d. All wastes that were or are being managed at the SWMU, including results of any sampling and analysis used to determine whether releases of hazardous wastes and/or hazardous waste constituent(s) have occurred, are occurring, or are likely to occur from the unit.

XIII.C.11. Based on the results of SWMU Assessment Report, the Director shall determine the need for further investigations at specific unit(s) included in the SWMU assessment. If the Director determines that such investigations are needed, the Director will require the Permittee to prepare a plan for such investigations. This plan shall be reviewed for approval in accordance with the requirements of Permit Condition XIII.D of this Permit.

XIII.C.12. The Permittee shall notify the Director (in writing by certified mail, express mail, or hand delivery) of any release(s) of hazardous waste and hazardous waste constituent(s) discovered during the course of ground water monitoring, field investigation, environmental auditing, or other activities undertaken during the RCRA Facility Investigation (RFI) and Permit Condition XIII.D of this Permit. The written notification shall be received by the Director no later than fifteen (15) calendar days after discovery. Such releases may be from already documented or newly identified units. The Director may require further investigation of the new releases. Further investigation, if required, shall be performed in accordance with the requirements of Permit Condition XIII.D of this Permit.

XIII.D. RCRA FACILITY INVESTIGATION (RFI)

XIII.D.1. The Permittee shall conduct a RFI, as deemed necessary by the Director, to determine the nature and extent of known and suspected releases of hazardous wastes and/or hazardous waste constituent(s) from each SWMU at the facility, identified in accordance with Permit Condition XIII.C of this Permit, and to gather data to support a Corrective Measures Study. The Permittee shall conduct the RFI in accordance with an approved Work Plan, completed in accordance with current guidance documents from EPA (*RCRA Facility Investigation Guidance, Volumes I through IV*, or equivalent).

XIII.D.2. The Permittee shall conduct the RFI for each newly identified SWMU, in accordance with the schedule specified in Table XIII-1 of this Permit.

XIII.D.3. The RFI Compliance Schedules, specified in Table XIII-1 of this Permit, may be modified in accordance with Permit Condition XIII.H of this Permit.

XIII.E. INTERIM MEASURES

XIII.E.1. If, during the course of any activity initiated in compliance with the permit conditions of Module XIII of this Permit, the Director determines that a release or potential release of hazardous waste and/or hazardous waste constituent(s) from a SWMU poses a threat to human health or the environment, the Director may require the Permittee to perform specific interim measures.

XIII.E.2. The Director shall notify the Permittee in writing of the requirement to perform the interim measures specified in the Interim Measures Plan, in accordance with Permit Condition XIII.E.3 of this Permit. The Permittee shall comply with the specified Interim Measures Plan alternative (Permit Condition XIII.E.3.a or XIII.E.3.b of this Permit) designated in the written notification.

XIII.E.3. The Permittee shall perform the requirements of the Interim Measures Plan, in accordance with the alternative specified in either Permit Condition XIII.E.3.a or XIII.E.3.b of this Permit.

XIII.E.3.a. The Director shall determine specific actions to implement the interim measures. The Director shall provide an Interim Measures Plan with the written notification specified in Permit Condition XIII.E.2 of this Permit; or

XIII.E.3.b. Within thirty (30) calendar days of receiving the written notification requiring the Interim Measures Plan, as specified in Permit Condition XIII.E.2 of this Permit, the Permittee shall provide (by certified mail, express mail, or hand delivery) the Interim Measures Plan to the Director for approval.

XIII.E.4. The Interim Measures Plan shall identify specific action(s) to be taken to implement the interim measures and a schedule for implementing the required measures. At a minimum, the Interim Measures Plan shall consider (but not be limited to) the following factors:

XIII.E.4.a. Time required to develop and implement a final remedy;

XIII.E.4.b. Actual and potential exposure of human and environmental receptors;

XIII.E.4.c. Actual and potential contamination of drinking water supplies and sensitive ecosystems;

XIII.E.4.d. The potential for further degradation of the medium absent of interim measures;

XIII.E.4.e. Presence of hazardous waste in containers that may pose a threat of release;

XIII.E.4.f. Presence and concentration of hazardous waste, including hazardous waste constituent(s) in solids that have the potential to migrate to ground water or surface water;

XIII.E.4.g. Weather conditions that may affect the current levels of contamination;

XIII.E.4.h. Risks of fire, explosion, or accident; and

XIII.E.4.i. Other situations that may pose threats to human health and the environment.

XIII.E.5. The Interim Measures Plan shall be incorporated into this Permit, in accordance with Permit Condition XIII.H of this Permit.

XIII.F. CORRECTIVE MEASURES STUDY AND IMPLEMENTATION

XIII.F.1. Based on the results of the RFI, the Permittee shall identify, screen, and develop the alternative or alternatives for removal, containment, treatment and/or other remediation of the contamination. The Permittee shall conduct the Corrective Measures Study in accordance with an approved Work Plan, completed in accordance with current guidance documents from EPA (*RCRA Corrective Action Interim Measures Guidance – Interim Final, RCRA Facility Investigation Guidance, Volumes I through IV*, or equivalent).

XIII.F.2. Upon the Director's approval of the Corrective Measures Study, pursuant to Permit Condition XIII.F.1 of this Permit, the Permittee shall prepare and submit to the Director for approval (by certified mail, express mail, or hand delivery), the Corrective Measures Implementation Program Plan, in accordance with an approved Work Plan.

XIII.F.3. Upon the Director's approval of the Corrective Measures Implementation Program Plan, pursuant to Permit Condition XIII.F.2 of this Permit, the Permittee shall conduct the Corrective Measures Implementation Program Plan, in accordance with the approved Work Plan for the corrective measures design and construction.

XIII.F.4. The Permittee shall conduct the Corrective Measures Study and prepare the Corrective Measures Implementation Program Plan, as specified in Permit Conditions XIII.F.1 and XIII.F.2 of this Permit, in accordance with the schedule specified in Table XIII-2.

XIII.F.5. The Permittee shall prepare and submit to the Director for approval a Compliance Schedule for conducting the Corrective Measures Implementation Program Plan, as required by Permit Condition XIII.F.3 of this Permit.

XIII.F.5.a. The Permittee shall provide a justification for each compliance date in the Compliance Schedule, based on the complexity of the Corrective Measures Implementation Program Plan, and reasonable contract and administrative time requirements.

XIII.F.5.b. On or before the compliance date for submittal of the draft Corrective Measures Implementation Program Plan specified in Table XIII-2 of this Permit, the Permittee shall submit to the Director for approval (by certified mail, express mail, or hand delivery) the Compliance Schedule and subsequent justification, pursuant to Permit Condition XIII.F.5 of this Permit,.

XIII.F.5.c. Upon the Director's approval of the Corrective Measures Implementation Program Plan Compliance Schedule, the Compliance Schedule shall be incorporated into this Permit concurrently with the final Corrective Measures Implementation Program Plan, in accordance with IDAPA 58.01.5012 [40 CFR §§ 270.41 and 270.42].

XIII.F.6. The Permittee shall conduct the Corrective Measures Implementation, as specified in Permit Condition XIII.F.3 of this Permit, in accordance with Permit Condition XIII.F.5 of this Permit.

XIII.F.7. The Corrective Measures Study and Corrective Measures Implementation Compliance Schedules, specified in Table XIII-2 of this Permit, shall be modified in accordance with Permit Condition XIII.H of this Permit.

XIII.G. REPORTING REQUIREMENTS

XIII.G.1. The Permittee shall submit to the Director signed quarterly progress reports of all activities (i.e., SWMU Assessments, Interim Measures, RFIs, and/or Corrective Measures Studies) conducted, pursuant to the permit conditions of Module V of this Permit. The Permittee shall initially submit the quarterly progress reports no later than ninety (90) calendar days after being notified in writing that the approved SWMU Assessment Plan has been incorporated within Module XIII of this Permit, through a permit modification, in accordance with Permit Condition XIII.H of this Permit.

XIII.G.2. At a minimum, the quarterly progress reports shall contain the following:

XIII.G.2.a. A description of the work completed;

XIII.G.2.b. Summaries of all findings and all raw data;

XIII.G.2.c. Summaries of all problems or potential problems encountered during the reporting period, and actions taken or to be taken to rectify the problems; and

XIII.G.2.d. Projected work for the next reporting period.

XIII.G.3. The Permittee shall maintain copies of other reports, drilling logs, etc. at the facility during the effective period of this Permit. The Permittee shall provide copies of the said reports, logs, etc. to the Director upon request.

XIII.G.4. As specified under Permit Condition XIII.B.5 of this Permit, the Director may require the Permittee to conduct new or more extensive assessments, investigations, or studies (as needed) based on information provided in these progress reports or other supporting information.

XIII.H. MODIFICATION OF THE CORRECTIVE ACTION SCHEDULE OF COMPLIANCE

XIII.H.1. Requests for modifications of the final compliance dates, pursuant to the permit conditions in Module XIII of this Permit, shall be submitted to the Director for approval, in accordance with IDAPA 58.01.5012 [40 CFR §§ 270.41 and 270.42]. The Corrective Action Schedule of Compliance (final compliance dates), subject to modification, includes the following:

XIII.H.1.a. The compliance date(s), as specified in Table XIII-1 of this Permit, for submittal of the RFI Final Report;

XIII.H.1.b. The compliance date(s), as specified in Table XIII-2 of this Permit, for submittal of the Corrective Measures Study Report;

XIII.H.1.c. The compliance date(s), as specified in Table XIII-2 of this Permit, for submittal of the final Corrective Measures Implementation Program Plan, in accordance with Permit Condition XIII.F.2 of this Permit;

XIII.H.1.d. Once established in accordance with Permit Condition XIII.F.5 of this Permit, the compliance date(s) for submittal of the corrective measures final (100% completion) Design and Construction Plans, in accordance with Permit Condition XIII.F.3 of this Permit;

XIII.H.1.e. Compliance dates, as specified in Tables XIII-1 and XIII-2 of this Permit, for implementing the approved plans and/or reports; and

XIII.H.1.f. Compliance dates for quarterly submittal of progress reports.

XIII.H.2. Pursuant to IDAPA 58.01.5012 [40 CFR § 270.42(a)], the Compliance Schedules, specified by the Director, shall be modified if the Director determines that good cause exists for which the Permittee had no control, and for which there is no reasonable available remedy.

XIII.H.3. If adequate funds for Corrective Measures Implementation are not available, the Director and the Department reserve the right to pursue any actions deemed necessary to protect human health and the environment, not excluding judicial recourse or termination of this Permit.

XIII.H.4. The Permittee shall submit to the Director for approval a request for modifications of the interim compliance dates that do not affect the final compliance dates. If the Director approves the interim compliance date modifications, Tables XIII-1 and/or XIII-2 of this Permit shall incorporate the modified compliance dates as approved, and such change shall not be considered a permit modification under IDAPA 58.01.5012 [40 CFR § 270.41].

TABLE XIII-1. RCRA FACILITY INVESTIGATION (RFI) COMPLIANCE SCHEDULE FOR NEWLY IDENTIFIED SOLID WASTE MANAGEMENT UNITS (SWMUs)

RFI ACTIVITY	DUE DATE
Submit Draft RFI-Phase II (Task II & III) Work Plan and Schedule	Within ninety (90) calendar days of the Director's notification that an RFI is needed, in accordance with Permit Condition XIII.C.11 of this Permit.
Initiate RFI-Phase II (Task II & III) Activities	Within forty-five (45) calendar days of the Director's approval of the Task II and III Work Plan and Schedule.
Submit Task IV Draft Report	As specified in the Director's approved RFI-Phase II (Task II & III) Work Plan and Schedule.
Submit Task IV Final & Summary Reports	As specified in the Director's approved RFI-Phase II (Task II & III) Work Plan and Schedule.
Progress Reports on Tasks II through IV	Quarterly (every 90 days) beginning ninety (90) calendar days after the Director's approved RFI-Phase II (Task II & III) activities.

TABLE XIII-2. CORRECTIVE MEASURES STUDY AND IMPLEMENTATION COMPLIANCE SCHEDULE
SOLID WASTE MANAGEMENT UNITS (SWMUs)

CMS SUBMISSION/CMI SUBMISSION	**DUE DATES**
Submit CMS Work Plan (Appendix B, Task I & II)	Within sixty (60) calendar days of the RFI Final Report.
Submit Draft CMS Report (Appendix B, Task I, II & III)	Within three hundred (300) calendar days of the Director's approval of the CMS Work Plan.
Submit Final CMS Report (Appendix B, Task I, II & III)	Within sixty (60) calendar days of receiving the Director's comments on the Draft CMS Report.
Submit Draft CMS Program Plan (Appendix B, Task IV)	Within ninety (90) calendar days of the Director's approval of the Final CMS Report.
Submit Final CMS Program Plan (Appendix B, Task IV)	Within sixty (60) calendar days of receiving the Director's comments on the Draft CMI Program Plan.
Submit Corrective Measures Design Preliminary Design Approximately 30% Complete	As specified in the Director's approved CMI Program Plan.
Submit Corrective Measures Design Preliminary Design Approximately 60% Complete	As specified in the Director's approved CMI Program Plan.
Submit Corrective Measures Design Preliminary Design Approximately 95% Complete	As specified in the Director's approved CMI Program Plan.
Submit Final Corrective Measures Design	As specified in the Director's approved CMI Program Plan.
Progress Reports on Appendix B, Tasks I through IV	Quarterly, every ninety (90) calendar days, beginning 90 calendar days after the Director's approval of the Final RFI Report.
Submit Draft CQA Program Plan	As specified in the Director's approved CMI Program Plan.
Submit Final CQA Program Plan	Within sixty (60) calendar days of the Director's approval of the Draft CQA.
Construction of Corrective Measures	Within sixty (60) calendar days of the Director's approval of the Final CQA.
Pre-Final Inspection	Forty-five (45) calendar days following report of pre-final inspection.
Corrective Measures Construction Report	Within ninety (90) calendar days following completion of construction.
Corrective Measures Implementation Quarterly Progress Reports	Quarterly, every ninety (90) calendar days, beginning 90 calendar days after the Director's approval of the Final RFI Report.

FIGURES

[Place figure here]

Figure 11. Ground Water Monitoring Well Network for Upper Aquifer.

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Figure 22. Ground Water Monitoring Well Network for Lower Aquifer

SECTION C
WASTE ANALYSES PLAN (WAP)
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C.1 INTRODUCTION

The purpose of this Waste Analysis Plan (WAP) is to provide guidance on the necessary waste characterization, sampling methodologies, analytical techniques, and overall procedures which are undertaken during hazardous waste management activities including treatment, storage and/or disposal. Treatment and disposal activities include but are not limited to stabilization[1], solidification, chemical oxidation, chemical reduction, neutralization, deactivation, evaporation, macro/micro encapsulation, adsorption (clay, carbon, etc.) and subsequent landfilling of hazardous and non-hazardous wastes. As a general rule, USEI use the term stabilization in the more industry wide generic sense, which implies the treatment of a waste material to make it physically and chemically stable. In this sense, stabilization consists of those treatment processes (including but not limited to all the treatment types described above), which are used to meet applicable LDR treatment standards or other applicable standard(s). The specific treatment technologies utilized by USEI are defined in more detail in Section C.8.3. Process operation descriptions for hazardous waste management units are provided in Section D.10. Specifically and in accordance with IDAPA 58.01.05.008 {40 CFR § 264.13(b)}, this plan delineates the following:

- Waste determination procedures (Section C.2);
- Waste Acceptance Criteria and associated review procedures for radioactive materials (Section C. 3);
- Sampling Methodologies and associated sampling equipment (Section C.4);
- The parameters for which each hazardous waste will be analyzed and the rationale for the selection of these parameters [i.e.; how analysis for these parameters will provide sufficient information on the properties of the waste (Section C.5)];
- Test methods which will be used to test for these parameters (Section C.5);
- The frequency with which the initial analysis of the waste will be reviewed or repeated to assure the analysis is accurate and up to date (Section C.6.3);
- The methods which will be used to meet the additional waste analysis requirements for specific waste management methods as specified in IDAPA 58.01.05.008 {40 CFR § 264.17, 264.314, 264.341, 268.7} (Section C.5.2);
- Waste receipt and acceptance procedures (Section C.6 & C.7);
- The types of treatment technologies (Section C.8);
- The treatment units (Section C.9);

[1] The term "stabilization" is defined by the EPA under 40 CFR 268.42 as "Stabilization with the following reagents (or waste reagents) or combination of reagents (1) Portland Cement; or (2) lime/pozzolans (e.g., fly ash and cement kiln dust) – this does not preclude the addition of reagents (e.g., iron salts, silicates, and clays) designed to enhance the set/cure time and/or compressive strength, or to overall reduce the leachability of the metal or organic. USEI uses the term Stabilization in a more generic sense to mean the treatment of a waste material to make it physically and chemically stable. In this sense, it consists of those processes, which make the material conform to applicable LDR treatment standards or other applicable standard(s).

- The quality control and quality assurance procedures (Section C.10); and

- Other general considerations for treatment, storage and disposal operations.

It is USEI's policy that all wastes managed on-site will adhere to the procedures outlined in this WAP. This document will ensure facility compliance with applicable permits and regulations. For the purpose of implementation and performance of this WAP, "USEI" means any US Ecology Idaho laboratory, subsidiary/affiliated laboratory, or designated contract laboratory.

USEI maintains, as part of its WAP required records, generator/internally developed information. This documentation may be received, stored, transmitted, and/or retrieved electronically in addition to, or in lieu of, hard (paper) copy.

"Facility Management" includes the General Manager and the managers of the major facility functions, such as Laboratory, Technical, Operations, Health and Safety, Environmental, and/or their designees.

References are made throughout this plan to regulations promulgated by the EPA regarding waste analysis requirements for hazardous waste management facilities. These requirements are found in IDAPA 58.01.05.008 and 40 CFR Part 264, Subpart B, which have been adopted by reference in the rules of the Idaho Department of Environmental Quality (IDEQ). Unless otherwise specified herein, cited federal regulations have been adopted by the IDEQ. USEI strives to maintain full compliance with the hazardous waste regulations. New testing requirements, such as those promulgated under the Land Disposal Restrictions (LDRs), often become effective prior to the time WAP revisions can be formally executed and approved by all appropriate agencies. Accordingly, the WAP utilizes references to the most recent appropriate EPA and ASTM methods and analytical procedures. If WAP revisions are necessary because of a new regulatory rule, they will be submitted as appropriate within 90 days after their effective date.

C.2 WASTE DETERMINATION

Waste determinations will be conducted in accordance with IDAPA 58.01.05.006 {40 CFR § 262.11}. In general, generators are required to conduct waste determination as follows:

- Determine if the waste is excluded from regulation under IDAPA 58.01.05.005 {40 CFR § 261.4};
- Determine if the waste is listed as a hazardous waste in subpart D of IDAPA 58.01.05.005 {40 CFR Part 261};
- Determine if the waste is identified in subpart C of IDAPA 58.01.05.005 {40 CFR Part 261} by either testing the waste using analytical methods or applying knowledge of the hazard characteristics of the waste;
- Determine if the waste is regulated by a state other than Idaho and associated manifesting requirements; and
- If the waste is determined to be hazardous, the generator must refer to IDAPA 58.01.05.005/008/009/010/016 {40 CFR parts 261, 264, 265, 266, 268, and 273} for possible exclusions or restrictions pertaining to management of the specified waste.

The waste characterization on the Waste Product Questionnaire (WPQ) provides information concerning the distribution/concentration, as well as the characteristics of the waste components. An example of the WPQ is provided in Figure C.1.

Certain generators will not utilize USEI's WPQ and insist on using their own waste characterization form. This is often the case with large generators that are trying to reduce the amount of paperwork associated with the characterization process. Under these circumstances, USEI will transfer the waste characterization information to USEI's WPQ and identify data deficiencies, if any. Any data deficiencies necessary for the treatment, storage and disposal of the waste will be added to USEI's WPQ by contacting the generator and requesting the deficient information. USEI will then include both USEI's WPQ and the generator supplied waste characterization form as part of the profile package.

When a waste shipment arrives on-site for treatment, storage, or disposal, a determination has usually been made by the generator that the waste is either:

- Excluded as a solid waste under IDAPA 58.01.05.005 {40 CFR § 261.4(a)};
- A listed hazardous waste, as defined in Subpart D of IDAPA 58.01.05.005 {40 CFR Part 261};
- A characteristic hazardous waste, as defined in Subpart C of IDAPA 58.01.05.005 {40 CFR Part 261};
- A solid waste, which is not hazardous waste, as defined by IDAPA 58.01.05.005 {40 CFR § 261.4(b)}; and
- A Corrective Action Management Unit (CAMU)-eligible waste, as defined by IDAPA 58.01.05.008 {40 CFR 264.552(a)(1) & (2)

C.3 WASTE ACCEPTANCE CRITERIA

C.3.1 Pre-acceptance Review

The preacceptance protocol has been designed to ensure that only hazardous and radioactive material that can be properly and safely stored, treated and/or disposed of by USEI are approved for receipt at the facility. A two-step approach is taken by USEI. The first step is the chemical and/or radiological and physical characterization of the candidate waste stream by the generator. The second step is the preacceptance evaluation performed by USEI to determine the acceptability of the waste for receipt at the facility. Figure C-2 presents a logic diagram of the preacceptance protocol that is utilized at the facility.

C.3.2 Radioactive Material Waste Acceptance Criteria

The following waste acceptance criteria are established for accepting radiological contaminated waste material that is generally or specifically exempted from regulation by the Nuclear Regulatory Commission (NRC) or an Agreement State under the Atomic Energy Act of 1954 (“AEA”), as amended. Material may also be accepted if it is not regulated or licensed by the NRC or has been authorized for disposal by the IDEQ and is within the numeric waste acceptance criteria. Waste acceptance criteria are consistent with these restrictions.

The following five tables establish types and concentrations of radioactive materials that may be accepted. These tables are based on categories and types of radioactive material not regulated by the NRC based on statute or regulation or specifically approved by the NRC or and Agreement State for alternate disposal. The criteria are consistent with these restrictions and detailed analyses set forth in *Waste Acceptance Criteria and Justification for FUSRAP Material*, prepared by Radiation Safety Associates, Inc. (RSA) as subsequently refined, expanded and updated in *Waste Acceptance Criteria and Justification for Radioactive Material*, prepared by USEI.

Material may be accepted if the material has been specifically exempted from regulation by rule, order, license, license condition, letter of interpretation, or specific authorization under the following conditions: Thirty (30) days prior to intended shipment of such materials to the facility, USEI shall notify IDEQ of its intent to accept such material and submit information describing the material’s physical, radiological, and/or chemical properties, impact on the facility radioactive materials performance assessment, and the basis for determining that the material does not require disposal at a facility licensed under the AEA. The IDEQ will have 30 days from receipt of this notification to reject USEI’s determination or require further information and review. No response by IDEQ within thirty (30) days following receipt of such notice shall constitute concurrence. IDEQ concurrence is not required for generally exempted material as set forth in Table C.4a.

Based on categories of waste described in the waste acceptance criteria, the concentration of the various radionuclides in the conveyance (e.g., rail car gondola, other container etc.) shall not exceed the concentration limits established in the WAC without the specific written approval of the IDEQ unless generally exempted as set forth in Table C.4a. Radiological surveys will be performed as outlined in ERMP-01 to verify compliance with the WAC. If individual “pockets” of activity are detected indicating the limits may be exceeded, the RSO or RPS shall investigate the discrepancy and estimate the extent or volume of the material with the potentially elevated radiation levels. The RPS or RSO shall then make a determination on the compliance of the entire conveyance load with the appropriate WAC limits. If the conveyance is determined not to meet the limits, USEI will notify IDEQ's RCRA Program Manager within 24 hours of a concentration based exceedance of the facility WAC to evaluate and discuss management options. The findings and resolution actions shall then be documented and submitted to the IDEQ.

The radioactive material waste acceptance criteria, when used in conjunction with an effective radiation monitoring and protection program as defined in the USEI *Radioactive Material Health and Safety Plan* and *Exempt Radioactive Materials Procedures* provides adequate protection of human health and the environment. Included within this manual are requirements for USEI to submit a written summary report of Table C.1 through C.2 radioactive material waste receipts showing volumes and radionuclide concentrations disposed at the USEI site on a quarterly basis. USEI will also submit a Table C.3 through C.4b annual report of exempted products devices, materials or items within 60 (sixty) days of year end (December 31st). The annual report will provide total volumes or mass of isotopes and total activity by isotope listing the activity of each radionuclide disposed during the preceding year, and the cumulative total of activity for each radionuclide disposed at the facility. The report will include an updated analysis of the impact on the facility performance assessment.

These criteria and procedures are designed to assure that the highest potential dose to a worker handling radioactive material at USEI shall not exceed 400 mrem/year TEDE dose, and that no member of the public is calculated to receive a potential dose exceeding 15 mrem/year TEDE dose, from the USEI program. TEDE is defined as the "Total Effective Dose Equivalent", which equals the sum of external and internal exposures. The public dose limit during operation activities is limited to 100 mrem/yr TEDE dose. An annual summary report of environmental monitoring results will be submitted to IDEQ by June 1st for the preceding year.

Materials that have a radioactive component that meets the criteria described in Tables C.1 through C.4b and are RCRA regulated material will be managed as described within this WAP for the RCRA regulated constituents.

Table C.1: Unimportant Quantities of Source Material Uniformly Dispersed* in Soil or Other Media**

	Status of Equilibrium	Maximum Concentration of Source Material	Sum of Concentrations Parent(s) and all progeny present***
a	Natural uranium in equilibrium with progeny	<500 ppm / 167 pCi/g (^{238}U activity)	≤ 3000 pCi/g
	Refined natural uranium (^{238}U, ^{235}U, ^{234}U; ^{234Th}, ^{234m}Pa, ^{231}Th)	<500 ppm / 333 pCi/g	≤ 2000 pCi/g
	Depleted Uranium (^{234Th}, ^{234m}Pa)	<500 ppm / 169 pCi/g	≤ 2000 pCi/g
b	Natural thorium (^{232}Th + ^{228}Th)	<500 ppm / 110 pCi/g	≤ 2000 pCi/g
	^{230}Th in equilibrium with progeny	<0.01 ppm / 200 pCi/g	≤2000 pCi/g
	^{230}Th (with no progeny)	0.1 ppm / ≤2000 pCi/g	
	Any mixture of Thorium and Uranium	Sum of ratios ≤ 1****	≤2000 pCi/g

Table C.2: Naturally Occurring Radioactive Material Other Than Uranium and Thorium Uniformly Dispersed* in Soil or Other Media**

	Status of Equilibrium	Maximum Concentration of Parent Nuclide	Sum of Concentrations of Parent and All Progeny Present***
a	^{226}Ra or ^{228}Ra with progeny in bulk form [1]	500 pCi/g	≤ 4500 pCi/g
b	^{226}Ra or ^{228}Ra with progeny in reinforced IP-1 containers [1]	1500 pCi/g	13,500 pCi/g
c	^{210}Pb with progeny(Bi & ^{210}Po)	1500 pCi/g	4500 pCi/g
	^{40}K	818 pCi/g	N/A
	Any other NORM		≤3000 pCi/g

[1] Any material containing ^{226}Ra greater than 222 pCi/g shall be disposed at least 6 meters from the external point on the completed cell.

Table C.3: Non-Production Particle Accelerator Produced Radioactive Material*****

Acceptable Material	Activity or Concentration
Any non-production particle accelerator produced radionuclide.	All materials shall be packaged in accordance with USDOT packaging requirements. Any packages containing iodine or volatile radionuclides will have lids or covers sealed to the container with gaskets. Contamination levels on the surface of the packages shall not exceed those allowed at point of receipt by USDOT rules. Gamma or x-ray radiation levels may not exceed 10 millirem per hour anywhere on the surface of the package. All packages received shall be directly disposed in the active cell. All containers shall be certified to be 90% full.

*Average over conveyance or container. The use of the phrase "over the conveyance or container is meant to reflect the variability on the generator side. The concentration limit is the primary acceptance criteria.

**Unless otherwise authorized by IDEQ, other Media does not include radioactively contaminated liquid (except for incidental liquids in materials). See radioactive contaminated liquid definition (definition section of Part B permit).

******* Diffuse waste with a total concentration (sum of concentrations of all radionuclides present) which is 2000 pCi/g or less may be accepted at the site (i.e., the controlling limit is 2000 pCi/g).

******** $$\frac{\text{Conc. of U in sample}}{\text{Allowable conc. of U}} + \frac{\text{Conc. of Th in Sample}}{\text{Allowable conc. of Th}} \leq 1$$

***** Any material that has been made radioactive by use of a non-production particle accelerator as set forth in Federal Register, Vol. 72, No. 189, Monday October 1, 2007, page 55868.

Table C.4a: NRC Exempted Products, Devices or Items

Exemption 10 CFR Part*	Product, Device or Item	Isotope, Activity or Concentration
30.15	As listed in the regulation	Various isotopes and activities as set forth in 30.15
30.14, 30.18	Other materials, products or devices specifically exempted from regulation by rule, order, license, license condition, concurrence, or letter of interpretation	Radionuclides in concentrations consistent with the exemption
30.19	Self-luminous products containing tritium, ^{85}Kr, ^{3}H or ^{147}Pm	Activity by Manufacturing license
30.20	Gas and aerosol detectors for protection of life and property from fire	Isotope and activity by Manufacturing license
30.21	Capsules containing ^{14}C urea for *in vivo* diagnosis of humans	^{14}C, one µCi per capsule
40.13(a)	Unimportant quantity of source material: see table above	≤0.05% by weight source material
40.13(b)	Unrefined and unprocessed ore containing source material	As set forth in rule
40.13(c)(1)	Source material in incandescent gas mantles, vacuum tubes, welding rods, electric lamps for illumination	Thorium and uranium, various amounts or concentrations, see rules
40.13(c)(2)	(i)Source material in glazed ceramic tableware (ii)Piezoelectric ceramic (iii) Glassware not including glass brick, pane glass, ceramic tile, or other glass or ceramic used in construction	≤20% by weight ≤2% by weight ≤10% by weight
40.13(c)(3)	Photographic film, negatives or prints	Uranium or Thorium
40.13(c)(4)	Finished product or part fabricated of or containing tungsten or magnesium-thorium alloys. Cannot treat or process chemically, metallurgically, or physically.	≤4% by weight thorium content.
40.13(c)(5)	Uranium contained in counterweights installed in aircraft, rockets, projectiles and missiles or stored or handled in connection with installation or removal of such counterweights.	Per stated conditions in rule.
40.13(c)(6)	Uranium used as shielding in shipping containers if conspicuously and legibly impressed with legend "CAUTION RADIOACTIVE SHIELDING – URANIUM" and uranium incased in at least 1/8 inch thick steel or fire resistant metal.	Depleted Uranium
40.13(c)(7)	Thorium contained in finished optical lenses	≤30% by weight thorium, per conditions in rule.
40.13(c)(8)	Thorium contained in any finished aircraft engine part containing nickel-thoria alloy.	≤4% by weight thorium, per conditions in rule.

Table C.4b: Materials Specifically Exempted by the NRC Or NRC Agreement State

Exemption	Materials	Isotope, Activity or Concentration*
10 CFR 30.11***	Byproduct material including production particle accelerator material exempted from NRC or Agreement State regulation by rule, order, license, license condition or letter of interpretation may be accepted as determined by specific NRC or Agreement State exemption.****	Byproduct material at concentrations consistent with the exemption**
10 CFR 40.14***	Source material exempted from NRC or Agreement State regulation by rule, order, license, license condition or letter of interpretation may be accepted as determined by specific NRC or Agreement State exemption.****	Source material at concentrations consistent with the exemption.
10 CFR 70.17	Special Nuclear Material (SNM) exempted from NRC regulation by rule, order, license, license condition or letter of interpretation may be accepted as determined by specific NRC or Agreement State exemption.****	SNM at concentrations consistent with the exemption.

*Sum of all isotopes up to a maximum concentration of 3,000 pCi/gm.

**Specifically exempted production beam accelerator may be received under Table C.3 provisions [10 CFR 20.2008 (b)]

***Also includes equivalent Agreement State regulation where applicable.

**** Similar material not regulated or licensed by the NRC may also be accepted. Sum of all isotopes up to a maximum concentration of 3,000 pCi/gm. IDEQ shall be notified prior to the receipt of Special Nuclear Material not regulated or licensed by the NRC.

Additional Information for USEI's Waste Analysis Plan

1. US Ecology Idaho, Inc. (USEI) may receive contaminated materials or other materials as described in Tables C.1 - C.4b above. USEI may not accept for disposal any material that by its possession would require USEI to have a radioactive material license from the Nuclear Regulatory Commission (NRC).

2. Unless approved in advance by USEI and IDEQ, average activity concentrations may not exceed those concentrations enumerated in Tables C.1 and C.2. Additionally, for Tables C.1 and C.2, individual pockets of material may exceed the WAC for the radionuclides present as long as the average concentration of all radionuclides within the package or conveyance remains at or below the WAC and the highest dose rate measured on the outside of the unshielded package or conveyance does not exceed those action levels enumerated in ERMP-01.

3. Other items, devices or materials listed in Table C.4a, which are exempted in accordance with 10 CFR Parts 30, 40 or equivalent Agreement State regulations or 10 CFR Part 70 may be accepted at or below the activities (per device or item) or concentrations specified in those exemptions.

4. The generator of the exempted or non-production particle accelerator produced waste must specify that the waste meets applicable acceptance criteria and/or exemption requirements.

5. In accordance with permit requirements, notification of any exceedance of the WAC will be provided to the RCRA Program Manager within 24 hours, in accordance with the permit.

C.4 SAMPLING METHODOLOGY

Sampling is performed by the generator and/or their representatives to make the initial waste determination and/or by USEI to identify incoming waste shipments. Waste generators are referred to IDAPA 58.01.05.005 {40 CFR Part 261}, Appendix I, II and III for sampling procedures. IDAPA 58.01.05.005 {40 CFR Part 261, Appendix I, II and III} describes sampling and analysis method selection procedures generators should consult when determining the specific sample analysis situation. Sampling is usually conducted as described in EPA document SW-846.
The sampling strategy employed for a given WAP activity is dependent on the nature of the waste being sampled, the type of container/vehicle in which it has been shipped, or the type of hazardous waste management unit in which the waste resides. Hazardous waste is received at the facility in various containers/vehicles including, but not limited to, bulk tanks, end dump trucks, drums, and boxes. Inside the facility, hazardous wastes are contained in landfills, surface impoundments, tanks, waste bins, containers, and other hazardous waste management units. Access to the container/vehicle or hazardous waste management unit influences sampling strategy.

This section presents sampling methodologies to be utilized by USEI personnel when collecting representative samples for analysis pursuant to IDAPA 58.01.05.008 {40 CFR §§264.13(a), 264.13(b), and 264.13(c)}.

The waste shipment is inspected, sampled, and/or analyzed to ensure it matches the overall identity of the waste designated on the accompanying manifest (or shipping paper) and the pre-acceptance paperwork (WPQ, etc). If examination indicates strata in the waste, then each layer may be composited in proportion to its estimated volume or analyzed separately.

The sampling equipment and procedures described in this WAP represent USEI's recommended sampling protocol for general types of waste materials and containment. Specific waste materials or shipments may require different sampling techniques as outlined in the Waste Analysis at Facilities That Generate, Treat, Store, and Dispose of Hazardous Wastes: A Guidance Manual, USEPA OSWER 9938.4-03, April 1994. Therefore, deviations from the recommended protocol do not constitute violations of acceptable sampling practices or conditions of this WAP. USEI personnel follow the QA/QC procedures outlined in Section C.10 when collecting samples for characterization.

C.4.1 Sampling Materials

At a minimum, the methodologies utilized for specific materials correspond to those referenced in IDAPA 58.01.05.005 {40 CFR Part 261, Appendix I}. The types of sampling methods and the most common equipment utilized for different materials are presented in the following table.

Table C.5 Sampling Methods and Equipment

Material	Equipment
Extremely viscous liquid	Thief or COLIWASA/tube sampler
Crushed or powdered material	Tube sampler, trier, auger, scoop, or shovel
Soil-like material	Tube sampler, trier, auger, scoop, or shovel
Fly ash-like material	Tube sampler, trier, auger, scoop, or shovel
Containerized liquids	COLIWASA/tube sampler, weighted bottle, cup, bomb, or tank sampling port

C.4.2 Sampling of Containers

USEI has instituted specific methodologies for taking samples from various container types. The type of container may be stationary or transportable, such as drums, tanks, portable transport units (e.g., tote bins, drums, roll-off boxes, Iugger boxes), tankers, or dump-type trucks. Sampling devices are selected depending on the size and type of the container and on the specific material involved.

Access to a container influences the location from which samples can be taken. Specific sampling procedures are dependent on both the distribution and the nature of the waste components in the container. Due to these variations, minor modifications may be needed to the recommended sampling procedure in order to obtain a sample.

C.4.2.1 Sampling Containers and Tanks

Sampling small containers (e.g., drums, boxes, cartons, & other small units) varies with the nature of the waste. For flowable materials, the sampling device of choice is either a Coliwasa or tubing (or other device noted in Table C.5). For non-flowable wastes, a tubing or trier is typically used to obtain a representative sample (or other device noted in Table C.5).

Large containers and tanks of flowable materials and bulk containers of solid materials may be either stationary or mobile. Liquids may be sampled with Coliwasa, tubing, weighted bottle, or bomb sampler to allow for sampling at various depths. Tank sampling may be accomplished through ports or taps located along the side of the tank or sampling through pumps or fittings at the tank inlet or outlet.

Under some circumstances, multiple samples collected from a single container/tank or hazardous waste management unit are composited prior to analysis. For example, multiple point samples obtained from a bulk truckload can be composited so long as there are no obvious physical differences among the samples. In all cases, wastes exhibiting distinctly different visual physical characteristics that are inconsistent with the approved WPQ and/or Internal Control Form (ICF) are sampled and analyzed independently.

C.4.3 Compositing Samples

Compositing of samples is conducted at the facility laboratory. Each composited sample is composed of equal portions, by weight, of each sample. The individual sample portions are combined and mixed until homogenous (i.e., the sample visually appears uniform in texture, particle size distribution, and color). The weight of sample portions utilized for the composited sample is determined with consideration of the sample size required by the analytical method to be performed. The appropriate sized sample, in accordance with the analytical procedures to be utilized, is then randomly removed from the homogenous composited sample for analysis.

Where the composited samples of separate batches of treated waste are to be further composited for additional testing, the composited sample from each batch is stored for inclusion in the final composited sample for additional testing. At the time of additional testing, each composited batch sample is particle size reduced and mixed until homogeneous, as necessary, in accordance with the analytical procedures to be utilized. The individual composited samples of each treated batch are then composited, as described above, to produce the final composited sample for additional testing.

C.5 ANALYTICAL RATIONALE

Waste characterization information is obtained by USEI on a WPQ. An example of the WPQ is provided in Figure C.1. USEI obtains all the information required by IDAPA 58.01.05.008 {40 CFR §§264.13(a)(1) and 264.13(a)(2)} to treat, store, or dispose of a waste. At a minimum, the analysis must contain all the information necessary to treat, store, or dispose of the waste.

Analyses are provided by USEI to augment the waste characterization, when necessary, and to identify incoming waste shipments. Analyses are utilized to provide data necessary for proper waste handling.

Analytical parameters are classified as Fingerprint Analyses and Supplemental Analyses.

Fingerprint Analyses – Fingerprint Analyses are performed on incoming waste shipment samples, except as noted in Section C.5.1 and C.7.1.6, in order to: 1) identify a waste shipment; and 2) ensure the appropriate waste management technique will be utilized. Fingerprint Analyses will be performed on a waste sample, when necessary for pre-acceptance purposes, if the generator-supplied information is not sufficient.

Supplemental Analyses – Facility management may select additional supplemental analyses to obtain information required for efficient process control or to further evaluate a positive result from a screening test (for example, a flash point may be run to provide more specific waste data when a positive flammability potential is reported during the initial testing). Supplemental analyses are performed on incoming waste shipment and in-process samples as specified by this WAP or facility management to:

- Confirm and/or augment existing information on the waste;
- Further identify a waste;
- Further ensure the appropriate treatment, storage, or disposal process(es) can be utilized to provide operations information utilized for control of these processes; and
- Supplemental Analyses may also be performed on any waste sample, when necessary for pre-acceptance purposes, if the generator-supplied information is not sufficient.

This arrangement allows a tiered approach to waste identification, enabling USEI to structure the analyses to adequately identify the waste or to define operational parameters for various treatment processes. At a minimum, all wastes, except as noted in Section C.7.1.6, are subjected to the Fingerprint Analyses as a 1st step in the analytical scheme. Supplemental Analyses are performed at the direction of facility management. The parameters which constitute the Fingerprint Analyses and Supplemental Analyses are described below and primarily consist of "standard" analytical techniques (recognized by the EPA, ASTM or other authoritative sources). In addition to the identified Fingerprint and Supplemental Analyses, USEI may utilize other "standard" analytical techniques and "unique" analyses (developed by USEI) for analysis of wastes. A summary of the analytical parameters and their usage is provided herein. Analyses will be consistent with the QA/QC procedures outlined in Section C.10.

C.5.1 Fingerprint Analyses

Fingerprint Analyses consist of basic screening procedures performed to provide general waste identification and associated waste confirmation. The Fingerprint Analyses is compared with the WPQ/ICF and pre-acceptance evaluation data to confirm that the waste is the same waste that was characterized during the pre-acceptance process (e.g., WPQ, manifest and/or shipping papers). These analyses may be used in conjunction with other waste analyses and information to further identify a waste and/or ensure the type of on-site management chosen is suitable for that particular waste.

During the Pre-Acceptance process, USEI personnel develop a fingerprint analysis based on the characteristics of the waste in question as well as the limits of fingerprint parameter variability. Parameters that are applicable to the waste stream will be specified for fingerprinting. Certain types of waste streams that are not conducive to fingerprint sampling (e.g., debris, solid resins) are not readily sampled and as a result fingerprint parameters may be limited to field-testing and observations. Also, due to the diversity of potential waste streams, the selection of discretionary parameters for waste receipt (and process control) is made on a case-by-case evaluation. If a discretionary fingerprint is no longer needed for proper waste receipt control, it may be suspended or eliminated. USEI will conduct a visual inspection on 100% of all waste received.

Table C.6 provides a default list of fingerprint control parameters and the allowable variability for fingerprint parameters. Unless otherwise specified by the Lab Manager (or his/her designee) or on the WPQ/ICF the default values from Tables C.6 will apply.

The primary parameters and associated rationale of the Fingerprint Analyses are as follows:

- **Physical Description** (appearance) is used to determine the general properties of the waste. This facilitates comparison of the sampled waste with prior waste descriptions or samples. It is also used to verify the presence or absence of free standing liquid, as well as any obvious change in physical properties. Typical physical properties include color, physical description, texture, and percent water (free liquids).

- **pH Screen** is undertaken to indicate the pH and, in general, the corrosive nature of the waste. pH may not apply to certain waste types, (e.g., organic wastes, oil waste, or wastes which are not water soluble).

- **Water Reactivity Screen (Water Compatibility)** is used to determine whether the waste has a potential to vigorously react with water to form gases or other products, or whether it generates significant heat. This testing does not apply to wastes that are already in contact with excess water, or for which sufficient analytical data indicate no potential reactivity with water.

- **Flammability Potential Screen** is used to indicate the fire-producing potential of the waste. This testing can be applied to all waste liquids, semi-solids or solids. It is used to identify obvious changes in a waste such as flammable waste substituted for an inert solid. This test is not performed on solids unless the waste contains free liquids.

- **Cyanides Screen** is used to indicate whether the waste has the potential to produce hydrogen cyanide gas upon acidification below pH 2. It is not required if the pH of the waste is < 5.0, or if the waste is not water-soluble.

- **Sulfide Screen** is used to indicate whether the waste has the potential to produce hydrogen sulfide gas upon acidification below pH 2. It is not required if the pH of the waste is < 5.0, or if the waste is not water-soluble.

- **Radioactive Screen** is used on material that are considered radioactive (per the WPQ) to ensure the compliance with the WAC. A radioactive screen is not required on non-radioactive waste streams.

C.5.2 Supplemental Analyses

Supplemental Analyses are performed to further identify wastes, verify treatment standards, provide safety information, and/or to provide process control information, as directed by facility management. The results of these analyses provide additional confidence concerning the proper management methods. Most of the parameters, which constitute the Supplemental Analyses utilize the most recent analytical techniques recognized by EPA, ASTM and other authoritative sources or have been developed by USEI through its operating experience for general waste identification and / or proper waste management and which meet USEI performance standards. Standard supplemental analytical parameters are identified in Table C.7. The referenced method or equivalent standard method will be used for analyses of these parameters. Table C.7 provides a list of available test methods.

TABLE C.7 – Test Methods

Sample Work Up Techniques:	
Method	Reference
General Extractions	
EP Toxicity	1-1310A
TCLP	1-1311
Metals Acid Digestion	
Flame atomic absorption spectroscopy (AAS) or inductively coupled plasma spectroscopy (ICP)	1-3005, 3010
Microwave assisted	1-3015, 2-3030, 3-D4309, D5258
Graphite furnace atomic absorption spectroscopy (GFDAA)	1-3020
Oils, greases, or waxes	1-3031
Dissolution procedure for oils, greases, waxes	1-3040
Sludge's, soils, and oils	1-3050
Microwave assisted	1-3051
Alkaline digestion	1-3060
Parr acid bomb digestion	3-E886, E926
Organic Extractions and Cleanups	
Extraction Procedure for Oily Wastes	1-1330
Organic Extraction and Sample Preparation	1-3500
Waste Dilution	1-3580, 3585
Separatory funnel liquid-liquid extraction	1-3510
Continuous liquid-liquid extraction	1-3520
Soxhlet extraction	1-3540, 3541
Sonication extraction	1-3550
Purge and Trap	1-5030
Solid phase extraction (SPE)	1-3535
Hexadecane Extraction and Screening of purgeable organics	1-3820
Alumina cleanup	1-3610, 3611
Florisil cleanup	1-3620
Silica gel cleanup	1-3630
Gel-permeation cleanup	1-3640
Acid-base partition cleanup	1-3650
Sulfur cleanup	1-3660
Sulfuric acid / permanganate cleanup	1-3665
Inorganic analytical methods:	
Inductively coupled plasma atomic emission spectroscopy/Mass spec.	1-6010, 6020
Antimony	
Atomic absorption, direct aspiration method	1-7040, 4-204.1
Atomic absorption, furnace method	1-7041, 4-204.2
Arsenic	
Atomic absorption, furnace method	1-7060, 4-206.2
Atomic absorption, gaseous hydride method	1-70614-206.3
Barium	
Atomic absorption, direct aspiration method	1-7080, 4-208.1
Atomic absorption, furnace method	1-7081, 4-208.2
Beryllium	
Atomic absorption, direct aspiration method	1-70904-210.1
Atomic absorption, furnace method	1-7091, 4-210.2
Cadmium	
Atomic absorption, direct aspiration method	1-7130, 4-213.1
Atomic absorption, furnace method	1-7131, 4-213.2
Calcium	
Atomic absorption, direct aspiration method	1-7130, 4-213.1
Atomic absorption, furnace method	1-7131, 4-213.2
Chromium	
Atomic absorption, direct aspiration method	1-7190, 4-218.1
Atomic absorption, furnace method	1-7191, 4-218.2
Hexavalent chromium: Co-precipitation	1-7195

Sample Work Up Techniques:	
Method	Reference
Hexavalent chromium: Colorimetric	1-7196, 2-3500CrD
Hexavalent chromium: Chelation-extraction	1-7197, 4-218.4
Hexavalent chromium: Diff. phase polarography	1-7198
Copper	
Atomic absorption, direct aspiration method	1-7210, 4-220.1
Atomic absorption, furnace method	1-7211, 4-220.2
Iron	
Atomic absorption, direct aspiration method	1-7380, 4-236.1
Atomic absorption, furnace method	1-7381, 4-236.2
Phenanthroline method (ferrous)	2-3500FeD
Lead	
Atomic absorption, direct aspiration method	1-7420, 4-239.1
Atomic absorption, furnace method	1-7421, 4-239.2
Magnesium	
Atomic absorption, direct aspiration method	1-7450, 4-242.1
Manganese	
Atomic absorption, direct aspiration method	1-7460, 4-243.1
Atomic absorption, furnace method	1-7461, 4-243.2
Mercury (manual cold-vapor technique	
In liquid waste	1-7470
In solid or semisolid waste	1-7471
Nickel	
Atomic absorption, direct aspiration method	1-7520, 4-249.1
Atomic absorption, furnace method	1-7521, 4-249.2
Osmium	
Atomic absorption, direct aspiration method	1-7550
Atomic absorption, furnace method	1-7551
Selenium	
Atomic absorption, furnace method	1-7740, 4-270.2
Atomic absorption, gaseous hydride method	1-7741, 4-270.3
Atomic absorption, gaseous hydride method	1-7742, 4-206.3
Silver	
Atomic absorption, direct aspiration method	1-7760, 4-272.1
Atomic absorption, furnace method	1-7761, 4-272.2
Thallium	
Atomic absorption, direct aspiration method	1-7840, 4-279.1
Atomic absorption, furnace method	1-7841, 4-279.2
Vanadium	
Atomic absorption, direct aspiration method	1-7910
Atomic absorption, furnace method	1-7911
Zinc	
Atomic absorption, direct aspiration method	1-7950, 4-289.1
Atomic absorption, furnace method	1-7951, 4-289.2
Organic Analytical Methods:	
Gas Chromatographic Methods	
Halogenated volatile organics	1-8010, 8021
Non-halogenated Volatile Organics	1-8015
Aromatic Volatile Organics	1-8020, 8021
Acrolein, Acrylonitrile, Acetonitrile	1-8031
Phenols	1-8040, 8041
Phthalate Esters	1-8060, 8061
Nitrosamines	1-8070
Organochlorine pesticides, halowaxes, and PCB's	1-8080, 8081
PCBs	1-8080, 8082
Nitroaromatics and cyclic ketones	1-8090, 8091
Polynuclear Aromatic Hydrocarbons	1-8100
Haloethers	1-8110, 8111
Chlorinated Hydrocarbons	1-8120, 8121

Sample Work Up Techniques:	
Method	Reference
Organophosphate Pesticides	1-8140, 8141
Chlorinated Herbicides	1-8150, 8151
Gas Chromatographic/Mass Spectroscopy Methods	
Volatile Organics	1-8240, 8260, 7-624
Semi-volatile Organics:	1-8250, 8270, 7-625
Other Organic Methods	
Qualitative infrared (IR) spectroscopy method	1-8410, 8430, 8440, 3-D2621, D4053
GC/FTIR method	1-8410
Heating value, bomb combustion method	1-5050, 3-D240, D2015
Halogen and Sulfur Content	
Chlorine content	3-D808, D2361, D4327
Halogen content	3-D808, D2361, D4327
Sulfur content	3-D129, D3177, D4327
Oil and Grease	1-4030, 9070, 9071, 2-5520, 4-413.1, 413.2
Petroleum hydrocarbons, total recoverable	2-5520, 4-418.1
Solvent distillation	4-D86, D1078
Total organic carbon	1-9020, 9060, 2-5310, 3-D2579
Total Organic Halides (TOX)	2-506
Screening Methods	
Physical description	3-D4979
Flammability potential screen	3-D4982
Water compatibility	3-D5058
Oxidizer screen	3-D4981
pH screen	3-D4980
Sulfide screen	3-D4978
	Gas Detection Tubes (e.g. Dragger, Sensidyne, MSA
Cyanide screen	3-D5049
	Gas Detection Tubes (e.g. Drager, Sensidyne, MSA
Commingled liquid waste compatibility test	3-D5058
Polymerization potential	3-D5058
Paint filter test	1-9095
Bulk density and apparent specific gravity screen	3-D5057
Polychlorinated biphenyl's (PCBs) screen	1-4020, 9097
Liner compatibility determination	1-9090
Miscellaneous Analytical Methods:	
Acidity	2-2310
Alkalinity	2-2320
Ammonia	2-4500NH_3, 4-350.3
Anions	
By ion chromatography	1-9056, 3-D4327, 4-300.0
Chlorides	1-9250, 9251, 9252, 9253, 2-4500Cl^-, 4-300.0, 325.3
Sulfates	1-9035, 9036, 9038, 2-4500SO_4^{2-}, 4-300.0, 375.3
Nitrates	1-9200, 9210, 2-4500NO_3^-, 4-300.0, 352.1, 353.2
Fluoride	1-9214, 2-4500F^-, 4-300.0, 340.2, 340.3
Bromides	1-9211, 2-4500Br^-, 4-300.0, 320.1
Phosphates	2-4500P, 4-300.0, 365.1
% Ash	2-2540, 3-D482, D3174
Conductivity / conductance	1-9050, 2-2510, 3-D1125, 4-120.1
Cyanides	
Total and amenable cyanides	1-9010, 9012, 9013, 2-4500CN^-, 4-335.1
Dissociable cyanides	1-9213, 2-4500CN^-
Test Method to Determine Hydrogen Cyanide Released from Wastes (Reactive Cyanides)	1-7.3.3.2
Flash point / Ignitability	

Sample Work Up Techniques:	
Method	Reference
Pensky-Martens closed-cup method	1-1010, 3-D93
Setaflash closed-cup method	1-1020, 3-D3278
Cleveland open-cup method	3-D1498
Oxidation / reduction (redox) potential (ORP)	3-D1498
PH measurement	1-9040, 9041, 9045, 2-4500H$^-$, 3-E70, 4-150.1
Solids	
Total (TS) at 103/105^{O}C	2-2540, 4-160.3
Dissolved (TDS) at 180^{O}C	2-2540, 4-160.1
Total suspended (TSS) at 103/1`05^{O}C	2-2540, 4-150.2
Fixed and volatile at 500^{O}C	2-2540, 4-160.4
Total Solids (moisture content)	e.g., Ohaus, Microwave, Oven
Specific Gravity	1-9030, 2-2710F, 3-D70, D891, D1217, D1429
Sulfides	
Extractable sulfides	1-9031
Soluble sulfides	1-9215, 2-4500S^{2-}
Test Method to Determined Hydrogen Sulfide Released from Wastes (Reactive Sulfides)	1-7.3.4.2
Total sulfides	1-9030A, 2-4500S^{2-}
Viscosity	3-D88, D446, D2983
Water Content	3-D95, D3173, D4006, E203

The above referenced procedures are described in the following publications (the latest update to any of the below referenced documents are acceptable). The first digit of the reference numbers above are keyed to the numbers shown below:

1.	***Test Methods for Evaluating Solid Waste***, SW-846, U.S. Environmental Protection Agency, Office of Water and Waste Management, Washington, D.C. 20406
2.	***Standard Methods for the Examination of Water and Waste Water***, American Public Health Association (APHA), American Water Works Associations, Water Environment Federation
3.	***Annual Book of ASTM Standards***, American Society for Testing Materials (ASTM), 100 Barr Harbor Drive, West Conshohocken, PA 19428
4.	***Methods for Chemical Analysis of Water and Wastes***, EPA-600/4-79-020, U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory (EMSL), Cincinnati, Ohio 45268
5.	“Infrared Analysis Method,” IERL-RTP Procedures Manual: level I Environmental Assessment, EPA-600/7-78-201
6.	“Acid Digestion Bombs,” Bulletin 4745, Parr Instrument Company, Moline, IL 61265
7.	“Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater,” Title 40, Part 136, Appendix A, CFR, USEPA, EMSL
8.	Bellar, T.A., and Lichtenberg, J.J., “The Determination of Polychlorinated Biphenyls in Transformer Fluid and Waste Oils,” EPA-600/4-81-045, USEPA, EMSL

Standard analytical procedures not listed here, which may be needed, will be taken from the above-referenced sources or other recognized sources (e.g.; Official Methods of Analysis of the Association of Official Analytical Chemist (AOAC), 15th Edition, AOAC, Arlington Virginia, 1990) or more recent supplements or editions.

The following list provides a general explanation of various analytical methods that may be used:

- **Beilstein Screen** is used to indicate the presence of halogenated organics in aqueous and organic wastes.

- **Bench-Scale Treatment Evaluation** to determine the appropriate ratios of wastes to reagents or waste-to-waste to be used in the treatment process to produce the desired reaction / result.

- **Chlorides** determine if the major acid component is hydrochloric acid or its salt.

- **Cyanides Peroxide Amenability** determines the effectiveness of H_2O_2 for cyanide treatment.

- **Cyanides Chlorination Amenability** (Sodium Hypochlorite or direct Chlorination) is run to determine the effectiveness of hypochlorite for cyanide treatment.

- **Cyanides Conversion Amenability** is performed to determine the effectiveness of other types of reagents treatment for cyanides.

- **Filter time** is used to determine filterability of waste.

- **Filterable Residue** quantifies the suspended solids present to determine filtration requirements in process operations.

- **Flash Point/Ignitability** further identifies ignitable wastes to establish proper storage mode and conformance with permit conditions.

- **Gas Chromatographic Scan** is used to identify specific organic compounds.

- **Qualitative IR Spectroscopy** is run to provide a fingerprint spectrum of organic wastes.

- **Liquid Waste Compatibility** determines whether liquid wastes which are to be combined together are compatible. This is a required supplemental analysis when combining different wastes.

- **Metals Content** may be determined to quantify metals concentrations for process operating parameters or potential salt precipitation for monitoring certain processes.

- **Nitrates** determine if the major acid component is nitric acid or its salt.

- **Non-Filterable Residue** quantifies the dissolved solids present to determine acceptability for certain processes.

- **Oil and Grease** quantifies the amount of oil and grease so as not to impact certain processes.

- **Organic Content** (OC) provides a conservative measure of organic carbon in a waste. This determination may use the procedure for Total Organic Carbon (for suitable waste forms), or my be calculated based on the results of a water content test using Karl Fisher or Dean Stark methods. Organic content is conservatively determined as the difference of water and ash from the total sample.

- **Oxidizer Screen** is used to indicate the oxidation characteristics of a waste stream.
- **Paint Filter Test** is used to indicate if free liquids are present in a solid or semi-solid material.
- **PCB Screening** indicates whether or not PCBs are present in a waste.
- **PCBs in Aqueous Liquids** determines whether PCBs are present in a liquid waste.
- **Percent Acidity** determines the acidity in the waste. It may be performed if the waste is aqueous and below a pH of 4.
- **Percent Alkalinity** determines the amount of alkalinity in the waste. It may be performed if the waste is aqueous and above a pH of 7.
- **Percent Ash** is used to determine the ash content in waste feeds to the indirect thermal desorber.
- **Percent Solids by Centrifuge** determines the percentage of suspended solids by centrifugation.
- **pH** provides a more precise measurement of pH and an indication of corrosivity when determining process parameters.
- **Phosphates** determine if the major acid component is phosphoric acid or its salt.
- **Soluble Sulfides** are analyzed to provide quantitative backup to the reactive sulfides screen.
- **Solvent Screen** is used to identify the presence of LDR solvent constituents.
- **Specific Gravity / Bulk Density** indicates density of the waste. This information is used to convert weight of materials to volumes (and vice versa).
- **Stabilization Treatment Studies** are run to determine if a waste is amenable to stabilization and to determine the appropriate reagent-to-waste ratio.
- **Sulfates** determine if the major acid component is sulfuric acid or its salt.
- **Sulfide** Peroxide Amenability determines the effectiveness of H_2O_2 for sulfide treatment.
- **Sulfide Conversion Amenability** is tested to determine the effectiveness of other types of reagents treatment for sulfides.
- **Sulfur Content** determines the sulfur content of waste to be incinerated and thus its capability to generate SO_2 (SO_x) gases.

- **Total and Amenable Cyanides** quantifies the concentration of all free and most complexed cyanides (total cyanides) and/or cyanide species amenable to alkaline chlorination (amenable cyanides). Results may be used for treatability determinations, to monitor treatment processes, and/or to meet disposal restrictions including Land Disposal Restrictions.

- **TOC** may be used to determine the organic concentration in waste.

- **TOX** may be used to determine the organic-chloride concentration in waste.

- **Total Solids** quantifies suspended and dissolved solids and moisture content for selected processes.

- **Total Sulfides** is used to quantify the concentration of total sulfides to back up the sulfides screen.

- **Viscosity** determines the waste pumpability.

- **Visual Oil and Grease** provides a qualitative assessment of filterability and organic contents.

- **Waste Compatibility** is tested to determine whether wastes stored or processed together are compatible.
- **Water Compatibility** is used to deter whether the waste has a potential to react vigorously with water, to form gases, other products, or to generate extreme heat and to determine if it is soluble in water. This test does not apply to wastes already in contact with excess water or to wastes known to be water reactive.

- **Water Content** is used to determine the percent of water present in a waste.

Other standard analytical techniques not listed here may be added as required by changes in regulations, company policy, etc. These techniques will be taken from recognized sources (e.g., SW-846, ASTM, AWWA, etc.).

C.6 PRE-ACCEPTANCE PROCEDURES

The generator is responsible for characterizing the waste (IDAPA 58.01.05.006) (40 CFR §262.11) and determining the applicability of IDAPA 58.01.05.008 {40 CFR Part 264, Subpart CC} via an associated certification of subpart CC compliance. The generator is also responsible for presenting the waste characterization results on a completed WPQ. Although USEI cannot require generators to submit a certification by regulation, USEI asks waste generators to provide a certification on the WPQ as follows:

> "I hereby certify that as an authorized representative of the generator named above, all information submitted in this and all attached documents are true and accurate. Pre-shipment and all other samples provided and a true representative sample of the waste and were samples in accordance with 40 CFR Part 261.20. Any analysis of the waste was conducted in accordance with the approved test methods in 40 CFR Part 261 on a representative sample as defined in 40 CFR Part 261.20. To the best of my knowledge all known and suspected hazardous components have been included in this documentation. All material, descriptions, and packaging will comply with current regulations".

The generator's waste characterization normally includes an analysis of at least one representative sample of the waste for hazardous characteristics and chemical composition. In some cases, generator knowledge of the waste is sufficient. The generator or an independent laboratory (including USEI) may perform analyses. Testing and analyses are performed using standard test methods (EPA, ASTM, AWWA, or other approved standards) or alternative methods approved in the facility's RCRA permit.

The generator also evaluates the candidate waste for additional characteristics that may prohibit the waste from acceptance at USEI and certifies that the waste does not exhibit any of these characteristics. Table C.8 provides a complete list of materials that are restricted from on-site disposal. .

USEI has developed a series of criteria to determine the acceptability of specific wastes for management at USEI. These criteria are referred to as pre-acceptance reviews and dictate what information USEI must have available in order to determine the acceptability of the waste for on-site management. At a minimum, USEI will obtain all the information required by IDAPA 58.01.05.008 {40 CFR §264.13(a)(1)}.

The pre-acceptance review is the mechanism for deciding to reject or accept a particular type of waste, prior to its acceptance at the facility, based on the conditions or limitations of existing permits, the waste's compatibility with other wastes being managed on-site, and the waste's suitability for management utilizing the process options available on-site. The pre-acceptance review for USEI may be carried out on-site, or upon receipt of the load prior to (or in conjunction with) waste acceptance. Accordingly, and consistent with EPA guidance and this WAP, USEI will obtain applicable information, either during the pre-acceptance, incoming load review, or prior to on-site disposal to confirm the concentration level of constituents of concern (those reasonably expected to be in the waste).

C.6.1 Procedural Requirements

For each new waste stream that is a candidate for on-site management, except where noted herein, the following procedures are implemented:

During the pre-acceptance process USEI will obtain:

- Pertinent chemical and physical data (i.e., waste characteristics) and associated certification on the WPQ.
- A representative sample, if required (a representative sample may not be required by USEI if facility management determines the pre-acceptance documentation gives sufficient information to maintain compliance with permit and operational constraints and submittal of a sample for analysis would not aid in the disposal decision process).
- Land Disposal Restriction Notification/Certification and/or data (IDAPA 58.01.05.011) (40 CFR §268.7) unless submitted on a load-by-load basis or the certification required by IDAPA 58.01.05.008 (40 CFR § 264.555) if the waste is received under a CAMU-eligibility determination.
- Other supporting documentation as appropriate, including any information such as process description, additional analytical results, Material Safety Data Sheets (MSDS), product ingredients, etc.

As required, USEI will perform the Fingerprint Analyses and any Supplemental Analyses necessary on a pre-acceptance sample of the waste. These analyses are performed to provide the information needed to determine if the waste can be managed on-site and/or to determine if it matches the identity of the waste from the pre-acceptance review. The analyses will be performed utilizing the parameters outlined in Section C.5.

After evaluating the above information and any information obtained from the Fingerprint Analyses or Supplemental Analyses, USEI will determine the acceptability of the waste based on:

- The permit conditions for the facility, and
- The availability of the proper waste management techniques.

USEI maintains, as part of its pre-acceptance information, generator-supplied and USEI-developed information. This information may be accessed either electronically or via hard copy.

C.6.2 Pre-Acceptance Evaluation

USEI is responsible for the pre-acceptance evaluation decision (i.e., whether to accept or reject the waste). Samples of waste necessary for pre-acceptance consideration are subjected to Fingerprint Analyses. USEI may require Supplemental Analyses to screen samples for other contaminants or properties, which indicate possible treatment or disposal modes. Figure C.2 provides a flow diagram for the pre-acceptance evaluation. The basis for requiring these additional analyses is:

- Determination of waste management technique(s) to be used;
- Facility management's experience and judgment;
- WPQ description of the chemical and physical properties of the waste;
- WPQ description of the process generating the waste;
- Any additional documentation supplied by the generator, including information that the waste is subject to the Land Disposal Restrictions of IDAPA 58.01.05.011 {40 CFR Part 268}, or the treatment standards referenced in IDAPA 58.01.05.008 {40 CFR § 264.555) if appropriate; and
- Results of any Fingerprint Analyses and any previous Supplemental Analyses, including LDR confirmatory analyses.

The pre-acceptance evaluation is concluded with documentation of the decision regarding the acceptability of the waste and the proposed method of management. Included within the documentation is the required notification to the generator that the waste is approved for management in accordance with the facility's permit and IDAPA 58.01.05.008 {40 CFR §264.12(b)}. A Waste Shipment Identification Number (WSID) is assigned to the waste shipment upon approval for acceptance.

USEI's technical disposal decisions are based on:

- Management methods available;
- Conditions or limitations of existing permits and regulations;
- Capability to manage the waste in a safe and environmentally sound manner;
- WPQ description of the process generating the waste;
- WPQ description of the chemical and physical properties of the waste;
- Any additional documentation supplied by the generator, including information that the waste is subject to a Land Disposal Restriction of IDAPA 58.01.05.011 {40 CFR Part 268}, or the treatment standards referenced in IDAPA 58.01.05.008 {40 CFR § 264.555) if appropriate;
- Results of Fingerprint Analyses, if necessary;
- Results of Supplemental Analyses, as appropriate; and
- Management's technical experience and judgment.

Table C.8 provides a list of restricted waste for on-site disposal and the management response if this type of material is received.

C.6.3 Waste Profile/WPQ Re-evaluation

In accordance with IDAPA 58.01.05.008 {40 CFR §264.13(a)(3)}, a WPQ/waste profile re-evaluation will be repeated as necessary to ensure that it is accurate and up to date. At a minimum, the analysis must be conducted when one of the following occurs:

- A generator notifies USEI that the process generating the waste has changed; or
- The results of inspection or analysis indicate the waste received at the facility does not match the identity of the waste designated on the accompanying manifest (or shipping paper).

When this occurs USEI will review the available information, if existing analytical/knowledge of the waste is not sufficient, the generator may be asked to review and update the current WPQ, supply a new WPQ, and/or to submit a sample for analysis, or USEI may utilize a sample obtained from a load of the waste. Figure C.3 provides a flow chart for waste/process changes management methods.

C.6.4 Requirements for Ignitable, Reactive, or Incompatible Wastes

USEI takes precautions to prevent the accidental ignition or reaction of ignitable or reactive waste per the requirements of IDAPA 58.01.05.008 {40 CFR §264.17}. This waste must be separated and protected from sources of ignition or reaction including but not limited to: open flames, smoking, cutting, and welding hot surfaces, frictional heat, sparks, spontaneous ignition, and radiant heat.

Any time USEI treats, stores, or disposes of ignitable or reactive wastes, or mixes reactive incompatible wastes, USEI will take precautions to prevent reactions which:

- Generate extreme heat or pressure, fire or explosions, or violent reactions;
- Produce uncontrolled toxic mists, fumes or gasses in sufficient quantities to threaten human health or environment;
- Produce uncontrolled flammable fumes or gasses in sufficient quantities to threaten human health or environment;
- Damage the structural integrity of the device or facility;
- Through other means threaten human health or environment.

USEI will document compliance with these requirements through references to published literature, data from test trials (e.g., treatability studies), waste analysis or the results from similar treatment processes under similar conditions.

Highly reactive wastes and other wastes identified in Table C.8 are restricted from on-site disposal at the facility.

C.6.5 Compatibility Groups

Establishing waste compatibility and identifying potential incompatibilities are important components of the pre-acceptance evaluation. The waste compatibility evaluation accomplishes the following:

- Prevents the intermingling of incompatible wastes;
- Prevents the contact of waste streams or leachate from wastes with incompatible process equipment; and
- Establishes handling, storage, treatment, and disposal requirements consistent with regulatory compliance, worker safety and health, and the protection of human health and the environment.

To achieve these objectives, waste compatibility information and processing requirements for each waste stream are required. The basic waste compatibility characteristics for a given candidate waste stream are established using the generator's waste characterization information as reviewed and approved by USEI. The key compatibility concerns at this stage of the pre-acceptance evaluation are compatibility groupings as follows:

- Waste/waste compatibility;
- Waste/tank compatibility;
- Waste/container compatibility;
- Waste/stabilization equipment compatibility;
- Waste/landfill liner compatibility;
- Waste/evaporation pond liner compatibility; and
- Waste/containment building barrier compatibility.

The pre-acceptance waste/waste compatibility determination identifies:

- Drum storage, landfill disposal, and laboratory pack segregation requirements;
- Storage tanks or the stabilization unit decontamination requirements; and
- Preliminary classifications for tank storage and evaporation pond scheduling (confirmed by waste-to-waste testing).

Waste/waste compatibility is determined by categorizing a waste's reactive characteristics. The USEPA guidance document "A Method for Determining the Compatibility of Hazardous Wastes" (EPA-600/2-80-076) is used as a guide to group the wastes listed in the Part A of this Document into the 41 different reactivity groups established in the USEPA guidance manual. An example of the Hazardous Waste Compatibility Chart provided in EPA-600/2-80-076 is included in Appendix

C.1 for reference. The 41 reactivity groups established in the guidance document have been composited into eight compatibility groupings (Groups A through H). A majority of the USEPA-listed wastes accepted by the facility are listed by both reactivity group numbers (RGNs) and by USEI compatibility groupings in Table C.9 and Appendix C.2. Additional wastes not listed on this compatibility chart will be placed in the appropriate compatibility grouping based on the characteristics of the material in question. Chemical composition plays an important role in classifying wastes into compatibility groups. The major constituents of the waste determine the primary compatibility characteristics of the waste. Minor components are screened and assessed on the basis of their relative proportion to the total waste and the potential incompatibilities they might present. If the hazardous constituent contained in the USEPA waste listing is a minor component, and if the major component(s) is of a different compatibility group than that indicated for the listing constituent, then the major components will generally determine the compatibility group. If necessary, analyses for compatibility are conducted to assist in the proper compatibility group classification.

Waste/waste compatibility is typically determined using the following three steps:

1. Initially, all data regarding the waste are compared with the waste compatibility chemical listings in Appendix C.2 and with USEPA guidance document EPA-600/2-80-076 to determine waste/waste compatibility.

2. If necessary, a representative sample of the candidate waste is submitted by the generator to the facility for compatibility testing. The waste is tested for compatibility with a mixture of laboratory reagent chemicals representing each reactivity group (in equal proportion) within the candidate waste's compatibility group. If the compatibility group mixture results in separate liquid or solid phases, waste compatibility testing is performed on each phase.

3. The information generated in Steps 1 and 2 is evaluated to verify that no excessive, flammable, or toxic gas is generated, that fire and/or explosions do not occur, and that violent polymerization or uncontrolled reactions do not occur. Should the data indicate any of these conditions, testing may be conducted to identify the correct reactivity group.

The compatibility group determination is used to segregate drummed wastes and laboratory pack wastes for storage and landfill disposal, to segregate bulk wastes for landfill disposal, and to determine the probable compatibility for direct contact of liquids in tank storage and evaporation pond treatment. Should a waste be suspected of having any storage, treatment, or disposal incompatible with other wastes within its assigned compatibility group, additional compatibility tests will be performed.

There are multiple methods and schemes for determining compatibility. As a result, USEI may submit an alternate method for compatibility for Department review.

C.7 INCOMING WASTE SHIPMENT PROCEDURES

Each shipment of waste will be inspected, sampled and analyzed as defined herein before acceptance, except as noted in Section C.7.1.6. This serves two purposes. First, it compares the actual waste identity with that determined in the pre-acceptance phase and the waste manifest. Second, it further ensures proper disposition of the waste for treatment, storage, and/or disposal. Other USEI personnel (or USEI-approved subcontractor) can provide the Fingerprint and/or Supplemental Analyses required for acceptance. Waste shipments, which have arrived on-site, are considered to be in the receiving process until a final decision regarding waste acceptability is made; at such time the wastes are considered “accepted” or “rejected”. Waste may be stored at the "staging area" or one of waste management units while awaiting receipt determination. Figure C.4 provides a flow chart for waste receipt control procedures.

In addition, all initial waste shipments which are subject to the Land Disposal Restrictions of IDAPA 58.01.05.011 {40 CFR Part 268}, or the CAMU-eligible treatment standards referenced at IDAPA 58.01.05.008 {40 CFR § 264.555}, and which have been treated, exempted, subject to a variance, or already meet the appropriate treatment standard may be accompanied by a one-time form from the treater or generator certifying the waste meets the appropriate treatment standard, treated with the prescribed treatment method, prohibition exemption, or variance. This form must include the applicable analytical data or reference to such data, in accordance with IDAPA 58.01.05.011 {40 CFR §268.7}. Furthermore, initial waste shipments subject to the Land Disposal Restrictions of IDAPA 58.01.05.011 {40 CFR Part 268} that require treatment may be supported by one-time written documentation notifying USEI of the appropriate treatment standard or prohibition including any applicable data or reference to such data or documentation which must be met in accordance with IDAPA 58.01.05.011 {40 CFR §268.7}, except as otherwise allowed.

C.7.1 Receiving Procedures

Upon receipt of a waste shipment, samples are assigned an internal tracking number. If the waste is a routine waste stream, it has an associated Internal Control Form (ICF)/load number assigned. The sample identification number consists of an ICF/load number followed by the ICF item number and a specific container designation. Non-routine sample (those without an ICF number) are consecutively numbered based upon yearly sequential numbers as follows:

03-0001

- “03” indicates the year the received and/or sample collected and
- “0001” is a consecutive number that progresses upwards throughout the year.

The type of tracking system may change depending on the type of waste management tracking software and other operational considerations, however, the facility will have a waste tracking system in place at all times.

The sampling and analysis of the incoming waste will utilize appropriate methods (Section C.4) and parameters (Section C.5). Inspections are performed as described in Section F. Upon arrival of a waste shipment at USEI, the accompanying manifest is reviewed for completeness and the shipment is inspected for agreement with the manifest information (see Section C.11.8 for resolution of significant manifest discrepancies).

All shipments arriving on-site will be visually inspected. The visual inspection is the first step in the fingerprint process. The intent of the visual is to identify any obvious discrepancies such as unidentified liquids or other physical properties.

Incoming shipments are also sampled and analyzed for the Fingerprint Parameters as identified in Section C.5 and any Supplemental Analyses specified by facility management, except as noted in Section C.7.1.6.

C.7.1.1 Debris Receipt

For Debris, a visual inspection will be utilized to determine if the waste meets the definition of debris. Debris refers to solid material exceeding 60 mm in particle size that is a manufactured object, plant or animal matter, or natural geologic material. However, the following materials are not debris:

- Any material for which a specific treatment standard is provided in Subpart D, Part 268 (e.g., lead acid batteries, cadmium batteries, radioactive lead solids);
- Process residuals such as smelter slag and residues from the treatment of waste, wastewater, sludge's, or air emission residues; and
- Intact containers of hazardous waste that are not ruptured and contain at least 75% of their original volume.

A mixture of debris that has not been treated to the standards provided by IDAPA 58.01.05.011 {40 CFR §268.45} and other material is subject to regulation as debris if the mixture is comprised primarily of debris, by volume based on the visual inspection. Figure C.5 provides a flow chart describing the decision process for the pre-acceptance of debris and debris loads.

C.7.1.2 Bulk Receipt

Subject to the exceptions in Section C.7.1.6, bulk waste loads are sampled and analyzed, except where large volumes from a campaign shipment of a single waste stream are received from a single source, (e.g., a site cleanup, a large volume generator, etc.). In such cases, all shipments are visually inspected and at least 10% of such loads are sampled and analyzed except as otherwise noted in Section C.5.1. Bulk waste may also be sampled in an original bulk container (e.g., rail tanker, gondola car, etc.).

For campaign shipments, 50 percent of the first 10 truckloads are sampled for fingerprint analysis. In addition, every truck comprising a campaign shipment is visually inspected (per Waste Receipt Control procedures) and any truckload of waste showing unexpected variations in color, texture, or moisture content is subject to sampling. If the sampled truckloads show variation, the 50 percent sampling frequency is continued for the next 10 truckloads. If there are no variations among the sampled truckloads, the sample regime is reduced to 10 percent of the truckloads for the remainder of the campaign shipment, thereafter. If variations are later found during the 10 percent sampling regime, the 50 percent sampling frequency is re-instituted for the next 10 truck loads. If these do not show variation, then the frequency is returned to 10 percent of the next 10 truckloads.

Bulk solids are sampled by obtaining point samples using the sampling equipment indicated in Table C.5. These samples are collected from the following three points:

- The front 1/3 of the truck/container load;
- The center 1/3 of the truck/container load; and
- The rear 1/3 of the truck/container load, within one (1) to two (2) feet of the rear tailgate or container wall, if possible.

Samples are collected in a manner that is best representative of the vertical composition of the waste within the limitations of the available sampling equipment and container configuration. If the physical characteristics of the hazardous waste are such that a full vertical section of the load cannot be reasonably sampled with the equipment listed in Table C.5 then a sample is collected at an approximate depth of one foot at each sampling point. The three point samples are composited prior to analysis. If a truckload is domed and easily accessible to within one (1) to two (2) feet of the bottom of the load, then one of the samples is collected near the bottom to obtain a more appropriate vertical sample of the waste.

In addition, all visible areas of each bulk hazardous waste load are inspected for physical differences and for variations from the characterization of the hazardous waste presented in the WPQ. The load is also visually observed during off-loading for any such variations. Any portion of the waste that exhibits such variations is sampled and analyzed separately, if possible.

A hazardous waste bulk load (e.g., truck and trailer or two truck-mounted rolloffs) manifested as a single item is considered one shipment for sampling purposes. Each container is sampled per the previous paragraph, and the six sample points are composited into one sample for analysis. Alternatively, a hazardous waste bulk load (i.e., truck and trailer or two truck-mounted rolloffs) manifested on separate distinct manifests or presented as two waste streams is considered two units for sampling and analysis purposes.

C.7.1.3 Bulk Liquid Receipt

Liquids are sampled utilizing the appropriate sampling equipment as shown in Table C.5. Shipments of bulk liquid are generally received in tanker trucks. For each tanker, a single sample is removed for analysis from each segregated compartment within the tanker. If the compartments all hold the same waste stream, the samples may be composited at a rate of five samples per composite. This presumes that all samples are visually equivalent and match the characteristics expected from information on the WPQ.

A tanker may be sampled by withdrawing a sample from available valves on the tanker. This necessitates that the waste within the tanker is either homogenous or that the tanker is adequately circulated/mixed prior to sampling to ensure a representative sample is obtained.

C.7.1.4 Sludge Receipt

Bulk shipments of sludge are sampled as either liquids in bulk or solids in bulk depending on the physical characteristics of the sludge. If the sludge is primarily liquid in nature, then it is sampled as appropriate for a liquid in bulk. Conversely, if the sludge is essentially a solid, then it is sampled as appropriate for a solid in bulk.

C.7.1.5 Non-Bulk Receipt

In the case of shipments of non-bulk containers, at least 10% of the containers from each waste stream in the shipment are sampled, except as provided in Section C.7.1.6. Container samples from the same profile may be composited prior to analysis, providing the individual samples are similar. Any composited samples will be composited as described in Section C.4.3. At a minimum, all remaining unopened containers are visually inspected for container integrity and consistent labeling. If a significant discrepancy in waste type is discovered, the contents of all of the containers for that waste stream are inspected. In some cases, where the waste stream is consistent but packaged for ease of transportation or disposal (e.g., multiple yd^3 bags containing the same waste) the load may be managed as a bulk load.

C.7.1.6 Exceptions

Exceptions to the foregoing requirements include the following:

- Waste contained in a lab-Pack (combination packaging). Combination packaging is defined in 49 CFR §171.8 as "......one or more inner packaging secured in a non-bulk outer packaging" and is subject to the Department of Transportation shipping package requirements of 49 CFR Part 173.

- Commercial products or chemicals: off-specification, outdated, unused, or banned. This also includes products voluntarily removed from the market place by a manufacturer or distributor.

- "Empty" containers of waste materials, commercial products or chemicals. This applies to portable containers which have been emptied, but which may hold residues of the product, chemical, or containers containing other empty containers. Examples of containers are: tanks, drums, barrels, cans, bags, liners, etc. A container shall be determined "empty" according to the criteria specified at IDAPA 58.01.05.005 {40 CFR §261.7}. These empty containers may be crushed, shredded, or intact.

- Residue and debris from the cleanup of spills or releases of chemical substances, previously approved wastes, commercial products, or a waste, which would otherwise qualify as an exception.

- Wastes, which are visually identifiable through an inspection process. (Examples may include cathode ray tubes, batteries, fluorescent light tubes, filters and filter cartridges, wire or tubing, paper products, metal sheeting and parts, crushed glass, piping, etc.)

- Demolition wastes. This consists of waste produced from the demolition or dismantling of industrial process equipment or facilities contaminated with chemicals from the process. Knowledge of the process and chemicals used in the process allows characterization of the waste sufficient for safe management.

- Articles, debris, non-RCRA wastes, equipment and clothing containing or contaminated with polychlorinated biphenyl's (PCBs). This includes PCB capacitors, transformers, gloves or aprons from draining operations, empty drums that formerly held PCBs, etc.

- PCB draining and flushing removed from PCB articles. This includes PCB articles flushed with a substance (e.g. toluene or unused diesel).

- USEI site generated waste, including hazardous and non-hazardous waste.

- Controlled substances regulated by government agencies including drugs and/or materials from clandestine labs.

- Materials that are brokered for management at an alternate facility. These materials are received for storage and subsequent offsite management only. If it is determined USEI will process a waste previously designated for storage and subsequent off-site shipment, the waste will be reviewed utilizing the normal approval process prior to on-site processing. For materials received at another regulated company and subsequently shipped to USEI, the other facility may transmit the relevant information to USEI for use in the pre-acceptance or load arrival review programs, as is appropriate.

- Wastes from remedial projects in which the waste characterization is known through a sampling plan that was approved by a federal or state agency (e.g.; CERCLA or Potentially Responsible Party type project) or other well-developed plan.

- Debris as defined at IDAPA 58.01.05.011 {40 CFR §268.2}. These materials will be visually inspected prior to acceptance in order to ensure the waste meets the definition of debris. Detailed procedures are provided in Section C.7.1.1.

- Contaminated personnel protective equipment (PPE) (e.g., gloves, tyveks, respirator cartridges).

- Aerosol cans.

- Vitrified, Cemented, and Other Materials Exhibiting High Structural Integrity. There are several materials which are not conducive to sampling which must be recognized. Structural steel, tanks, pipe, cement, glass, empty drums, machinery, equipment, manufactured items, monolithic / cemented materials, and several other materials are managed which do not allow for normal sampling protocols. By necessity, these materials must be managed on a case-by-case basis. In some cases a clean-up agency (e.g., EPA, IDEQ, etc.), generator, or contractor has established a rational basis of data and waste characterization information. In those cases, this information may be utilized in lieu of pre-acceptance analytical and incoming load analytical information, and the physical appearance screen will be utilized to confirm material acceptability upon arrival;

- Non- RCRA Radioactive Waste (including NORM, NARM, etc) and waste as described below:

  - Sampling and analysis of the above waste materials is not required: unless specifically requested by USEI. These materials are not sampled and analyzed because if the chemical and physical characteristics of the waste are known in sufficient and reliable detail or if the waste has been previously characterized and shipped from another generator, broker or TSDF, or visual inspection of these shipments is sufficient for verification of their identity. USEI will obtain and evaluate all the information required by IDAPA 58.01.05.008 {40 CFR §§264.13(a)(1) and 264.13(a)(2)} necessary to characterize, treat, store, or dispose of the waste.

- In addition, USEI may waive incoming waste load sampling and analysis where the pre-acceptance documentation supplies sufficient information to assure compliance with permit conditions and operational constraints, or any of the following conditions exist:

  - A sample cannot be reasonably obtained, such as filter cartridges, tank clean-out sludge (prior to the clean-out), large pieces of contaminated material, or contaminated debris;

  - In these cases, the shipment will still be inspected for conformance with manifest and pre-acceptance documentation as previously described;

  - Obtaining a representative sample poses an unnecessary or unavoidable hazard of acute or chronic exposure of USEI employees to carcinogenic, mutagenic, neoplasticgenic, teratogenic, or sensitizing materials (e.g., asbestos); or.

C.7.2 Decision Evaluation Logic

There are major decision points regarding the need for evaluation of whether a waste found to be dissimilar to the pre-acceptance evaluation can still be accepted. USEI decides whether additional analyses are required for a particular waste based on the following:

- Results of Fingerprint Analyses;
- Knowledge of generator and/or waste-generating process;
- Results of pre-acceptance evaluation; and
- Waste codes.

Further testing will be conducted as necessary if the results indicate unexpected characteristics with respect to pre-acceptance analytical results, or if there is suspicion the waste composition has changed. Effectiveness of the waste identification step is dependent on the following components:

- Inspection;
- Sampling (where required);
- Analytical results (where required);
- Waste Product Questionnaire;
- Hazardous Waste Manifest;
- Waste Screening Analytical Results;
- Facility management's judgment.

To facilitate the waste identification process, fingerprint analytical data is compared to the corresponding pre-acceptance analysis (WPQ, ICF, etc.). The Fingerprint Analysis verifies the waste is indeed the same waste as represented by the pre-acceptance analysis. When a load is received, the pre-acceptance information is reviewed. USEI classifies waste as being in non-conformance when it is significantly different in composition from the information shown in the WPQ or the pre-acceptance results, or if there is a significant discrepancy between the waste shipment and the manifest (as defined in IDAPA 58.01.05.008 and 40 CFR §264.72), unless the discrepancy can be clarified. Figure C.6 provides a flow chart for waste reevaluation procedures.

Wastes found to be in non-conformance may be rejected immediately, or may be re-evaluated for possible acceptance despite the variance. Re-evaluation will be based on any or all of the following criteria:

- Permit authorization;
- Land Disposal Restrictions;
- Discussions with the generator; and
- Facility conditions.

Pursuant to IDAPA 58.01.05.008 {40 CFR §264.72}, USEI must attempt to resolve with the generator or transporter significant discrepancies between the actual waste and that shown on the manifest. Changes to the manifest or WPQ may be made with the customer's concurrence or at the customer's request. Any corrections or other changes made to the manifest or WPQ will be initialed by the person making the change. Other discrepancies noted (such as improper mailing addresses, identification numbers, telephone numbers) may be either corrected or noted in manifest block 19.

For bulk loads manifested by weight, the load is typically weighed on-site. However, if the scale is out of service, other methods may be employed to estimate the weight of the delivery. Other methods include utilization of nearby (off-site) scales, weight estimation techniques, and utilization of tare weights to calculate approximate net weights. If a significant weight discrepancy is noted, the procedures of IDAPA 58.01.05.008 {40 CFR §264.72} are employed. For piece count deliveries (e.g., vans of containers, etc.), the piece count is confirmed. Under typical conditions all of these activities are conducted upon delivery to the facility or within a short time thereafter. However, there are situations when these conditions are not satisfied upon delivery (e.g., a load is delivered and staged prior to being approved or accepted, small containers are contained within heat shrink material and cannot be counted prior to breaking the load, etc.). In these instances and consistent with IDAPA 58.01.05.008 {40 CFR §264.71(a)(3)}, the transporter is given a signed copy of the manifest. If a significant weight or piece count discrepancy is later discovered, an attempt to reconcile it will be made. If a significant manifest discrepancy cannot be resolved within 15 days of discovery, notification of the discrepancy will be sent to the IDEQ, along with the steps taken to resolve the discrepancy.

C.8 PROCESS OPERATIONS PROCEDURES

Each movement of a waste within the facility, during which any change in its characteristics may occur, may make the waste subject to additional inspection, sampling, and analysis to determine appropriate handling and management of the waste. Many of the analyses needed for the treatment, storage, and/or disposal functions are performed during incoming shipment identification and are not repeated unless it is known or believed that waste characteristics may have significantly changed during storage or processing and/or such information is deemed necessary for the safe management of the waste.

Existing and anticipated process operations at the facility, for which current and periodic sampling and analyses are important, include the following:

- Treatment, including stabilization;
- Storage; and
- Disposal, consisting of landfilling and/or solar evaporation.

The analytical procedures for each of these processes are described in the following Sections.

C.8.1 Storage

Before any waste is placed into storage USEI will assess the compatibility of the waste with wastes already in storage as described in Section C.6.5.

C.8.1.1 Liquid Storage / Transfer / Management

Liquid wastes may be transferred from containers to tanks or to trucks although a waste may be fed directly to the designated treatment unit (e.g.; tanks). Upon arrival, liquid waste will be subjected to the appropriate waste identification analyses, plus a commingled waste compatibility test, if appropriate, to assure safe storage. If a liquid load is exempted from sampling, as described in Section C.7.1.6, the waste will be segregated from other wastes based on USEI's technical assessment of the waste (e.g., compatibility class).

C.8.1.2 Containerized Storage

Using the predominant hazard classification on incoming containerized waste, the proper storage area will be designated to insure segregation of stored incompatible waste.

Based on the initial hazard determination made by the generator on the WPQ and/or the final identification of the waste shipment, containerized waste will be segregated in the following manner: flammable, corrosive, and oxidizing waste materials will be separated from incompatible materials or stored in separate areas. Wastes are separated/maintained in separate storage areas until they are treated, transferred, or disposed as described in Section C.6.5.

C.8.2 Brokering and Material Transfer Operations

This section discusses process analyses associated with the brokering of materials. Transfer of materials for off-site disposition is discussed, since this process may involve consolidation/bulking of waste materials to meet the receiving facility's specifications.

C.8.2.1 Consolidation/Bulking for Off-Site Transfer

This activity involves the consolidation/bulking of solid wastes into rolloffs or other appropriate containers or the pumping of containerized liquid wastes into tank trucks or other large containers for delivery off-site. Additionally, liquid waste containing sufficient heating values for combustion are bulked with other suitable waste. The resultant liquid bulked materials are used to provide heat content for combustion processes (either as hazardous waste derived fuel or as a hazardous waste, as applicable) at off-site lime kilns, incinerators, or similar operations (e.g. disposal).

According to IDAPA 58.01.05.004 {40 CFR §260.10}, treatment is defined as "Any method, technique, or process, including neutralization, designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize such waste, or so as to recover energy or material resources from the waste, or so as to render such wastes non-hazardous; safer to transport, or dispose of; or amenable for recovery, amenable for storage or reduced volume". In short, if an activity does not change a hazardous waste, it is not treatment. Waste bulking or otherwise containerizing multiple hazardous wastes for transportation will not typically change the physical and chemical properties of the waste.

The EPA has provided guidance (Faxback 13308, 13720, 11281, 11497, 12458, and 13764) that activities such as bulking, containerizing, and consolidation are not considered treatment, as long as no blending (e.g., selective mixing to meet a fuel standard) is taking place. Incidental mixing of wastes that occurs when several waste streams of similar waste types are bulked is not considered treatment. Also, if the intent of consolidation is to make it more efficient and cost effective to transport the shipment, the activity is not considered treatment. The important point in this discussion is that as long as the intent of the consolidation/bulking in question is not intended as treatment and the material is still sent to an appropriate TSD facility for treatment, then the activity is not considered treatment (i.e., intent of the consolidation/bulking is not to conduct treatment).

When evaluating hazardous waste for consolidation/bulking, the pre-acceptance analyses is used to determine the acceptability of each waste stream. Additional analysis for heat value may be required for materials destined for supplemental fuels, depending on the regulatory status of the potential receiving BIF(s), to evaluate sham-recycling restrictions. For materials destined for incineration, or other processes this analysis is not necessary.

In-process analyses may be performed to assure the aggregation / bulking of wastes is within the receiving facility's specifications, if any. This is necessary because acceptance criteria for the USEI facility may be different than the receiving facility's specifications, which are based upon that facility's permits, regulations, or other needs. For example, if the receiving facility has a minimum requirement for heat value and a maximum requirement for chlorides, then the bulked material requirements will be a function of the receiving facility's requirements for both parameters.

Post-consolidation analyses may consist of tests necessary to confirm that the bulked material is suitable for offsite disposal. Consolidation activities will occur in the CMU's as described in Section D.1.

C.8.3 Treatment Technologies

USEI utilizes several different treatment technologies in order to meet the applicable land disposal restriction (LDR) or other standard as applicable. USEI utilizes the term "stabilization" throughout this document in a generic sense to mean the treatment of a waste material to make it physically and chemically stable. In this sense, it consists of those processes, which make the material pass applicable LDR standards or other applicable standard(s).

In this process, waste is treated to meet land disposal restrictions (e.g., elimination of free liquids, chemical and/or physical stabilization to remove or immobilize hazardous constituents, micro-encapsulation, macro-encapsulation, etc) or to meet other appropriate requirements (e.g., permit or regulatory requirements). IDAPA 58.01.05.011 {40 CFR §268.42} provides specific definitions for several potentially distinct treatment technologies including Stabilization, Chemical Oxidation, Chemical Reduction, Deactivation, Macro/Micro Encapsulation, Neutralization, Adsorption, Bio-remediation, Evaporation, and Precipitation. Although the above treatment technologies may be considered distinct processes, the stabilization process is defined in the more generic sense due to the overlap of the associated treatment technologies and methods.

Pre-treatment analyses consist of tests necessary to insure the wastes can be treated to meet the applicable treatment requirement. In-process analyses are generally not required. Post-treatment analyses are performed, as necessary, to ensure restricted wastes meet applicable treatment standards.

The following technologies, defined as "stabilization" within this WAP and associated documents are utilized by USEI:

C.8.3.1 Stabilization

Stabilization is defined by IDAPA 58.01.05.011 {40 CFR §268.42} as stabilization with the following reagents (or waste reagents) or combinations of reagents (1) Portland Cement; or (2) lime/pozzolans (e.g., fly ash and cement kiln dust) – this does not preclude the addition of reagents (e.g., iron salts, silicates, and clays) designed to enhance the set/cure time and/or compressive strength, or to overall reduce the leachability of the metal or organic. Stabilization is the treatment of appropriate waste streams by use of pozolonic materials or wastes with pozolonic properties to reduce the leachability of organic, inorganic or metals of concern. Appropriate use of this treatment technology is determined during the approval process. A mix design is developed prior to the treatment of a waste stream. Stabilization may be performed within Mix Bin Tanks, or Containers. Treatment locations may be the Stabilization portion of the Containment Building, the Debris portion of the Containment Building or the Stabilization Facility. Treatment is performed to meet applicable LDR standards. Sampling, analysis verification of the treatment effectiveness and frequency of testing follows the guidelines presented in this WAP.

C.8.3.2 Chemical Oxidation

Chemical oxidation is a treatment process targeted primarily at organic constituents, (e.g., toluene and benzene) but may be used for inorganic constituents as well (e.g., cyanides and heavy metals such as mercury). An organic or inorganic species is oxidized when its respective chemical oxidation number increases (i.e., loses electrons). Consistent with IDAPA 58.01.05.011 {40 CFR 268.42}, the following oxidation reagents (or waste reagents) may be used in part or whole: (1) Hypochlorite (e.g. bleach); (2) chlorine; (3) chlorine dioxide; (4) ozone or UV (ultraviolet light) assisted ozone; (5) peroxides; (6) persulfates; (7) perchlorates; (8) permanganates; and/or (9) other oxidizing reagents of equivalent efficiency. An approved mix design is formulated and tested prior to treatment.

Chemical oxidation may be performed within Mix Bin Tanks or Containers. Treatment is performed to meet EPA LDR standards. Sampling, analysis verification of the treatment effectiveness and frequency of testing follows the guidelines presented in this WAP.

C.8.3.3 Chemical Reduction

Chemical reduction or redox occurs when the targeted component/constituent atoms change as a resultant transfer of electrons from one chemical species to another. The chemical oxidation number for the targeted components decreases (i.e., gains electrons) when the target constituents are reduced. Conversely, the reducing reagents used in this process lose electrons or become oxidized. Derived from IDAPA 58.01.05.011 {40 CFR 268.42}, the following reducing reagents (or waste reagents) may be used in whole or part: (1) Sulfur dioxide; (2) sodium, potassium, (salts), or other alkali salts or sulfites, bisulfites, metabisulfites and polyethylene glycols (e.g., NaPEG and KPEG); (3) sodium hydrosulfide; (4) ferrous salts; and/or (5) other reducing reagents of equivalent efficiency. An approved mix design is formulated and tested prior to treatment.

Chemical reduction may be performed within Mix Bin Tanks or Containers. Treatment is performed to meet EPA LDR standards. Sampling, analysis verification of the treatment effectiveness and frequency of testing follows the guidelines presented in this WAP.

C.8.3.4 Deactivation

Deactivation is the treatment of those wastes that exhibit the characteristics of ignitability, corrosivity, and/or reactivity. Appropriate use of this treatment technology is determined during the pre-acceptance process. A mix design is developed prior to the treatment of the waste stream. Deactivation may be performed within Mix Bin Tanks, or Containers. Treatment is performed to meet applicable LDR standards. Sampling, analysis verification of the treatment effectiveness and frequency of testing follows the guidelines presented in this WAP.

C.8.3.5 Macro Encapsulation

Macro-encapsulation is a confining or immobilization technology used to treat all types of hazardous debris independent of the hazardous constituents involved (with the exception of cyanide-reactive debris). The macro-encapsulation process encases the debris to provide a physical barrier that prevents/minimizes potential leaching of hazardous constituents from the debris. The encapsulating barrier does not need to chemically bond to either the debris or hazardous constituents. Macro-encapsulation is defined in IDAPA 58.01.05.011 {40 CFR §268.42, Table 1} as the application of surface coating materials such as polymeric organics (e.g., resins, plastics) or use of a jacket of inert inorganic materials to substantially reduce surface exposure to potential leaching media. Inert non-waste material, or waste meeting appropriate LDRs, may be used for filler material.

Macro-encapsulation does not require specific testing for LDR constituent standards. This waste is treated at the facility to meet all requirements of the LDR treatment technology standard and is certified by USEI to meet these requirements prior to disposal. Macro-encapsulation may be performed at the Containment Building, CMU's: CSP # 4/5, Truck Unloading Aprons, and the RCRA/PCB Building.

The performance standard for the macro-encapsulation technology is described under IDAPA 58.01.05.011 {40 CFR Part §268.45, Table 1}, entitled "Alternative Treatment Standards for Hazardous Debris". This standard states that "Encapsulating material must completely encapsulate debris and be resistant to degradation by the debris and its contaminants and materials into which it may come into contact after placement (leachate, other wastes, microbes).

C.8.3.6 Micro Encapsulation

Micro-encapsulation is confining or immobilization technology that requires the stabilization of the debris with the following types of reagents (or waste reagents) such that the leachability of the hazardous contaminants is reduced: (1) Portland cement; or (2) lime/pozzolans (e.g., fly ash and cement kiln dust) (3) Additional reagents (e.g., iron salts, silicates, carbon, polymers or clays) as appropriate.

Micro encapsulation does not require specific testing for LDR constituent standards. Following the treatment process, the micro-encapsulated debris is visually inspected. Micro encapsulation may be conducted in tanks or containers. The performance standard for the micro-encapsulation technology is described under IDAPA 58.01.05.011 {40 CFR Part §268.45, Table 1} titled "Alternative Treatment Standards for Hazardous Debris". This standard states that "Leachability if contaminants must be reduced".

C.8.3.7 Neutralization

Neutralization is a treatment process designed to render corrosive matrices non-corrosive. According to IDAPA 58.01.05.011 {40 CFR 268.42}, the following reagents (or waste reagents) in part or whole may be used for neutralization: (1) Acids; (2) Bases; or (3) water (including wastewater's) resulting in a pH greater than 2 but less than 12.5 measured in the aqueous residuals. An approved mix design will be formulated and tested before waste is treated by neutralization.

Neutralization may be performed within Mix Bin Tanks or Containers. Treatment is performed to meet EPA LDR standards. Sampling, analysis verification of the treatment effectiveness and frequency of testing follows the guidelines presented in this WAP.

C.8.3.8 Precipitation.

Precipitation is the process by which regulated metals and/or inorganics are precipitated out as insoluble precipitates of oxides, hydroxides, carbonates, sulfates, chlorides, fluorides, or phosphates. This process entails adjusting the pH of the waste matrix between 9 and 11. This pH range is ideal for hydroxide precipitation. An alternative to this common standard practice is sulfide precipitation. Sulfide precipitates are less soluble and non-amphoteric (less pH dependent than hydroxyl precipitates). However, caution must be employed to ensure hydrogen sulfide is not released at harmful levels by maintaining a pH greater than 8 throughout the treatment process. Based on IDAPA 58.01.05.011 {40 CFR 268.42}, the following reagents (or waste reagents) are typically used alone or in combination: (1) Lime (i.e., containing oxides and/or hydroxides of calcium and/or magnesium; (2) caustic (i.e., sodium and/or potassium hydroxides; (3) soda ash (i.e., sodium carbonate); (4) sodium sulfide; (5) ferric sulfate or ferric chloride; (6) alum; or (7) sodium sulfate. Additional flocculating, coagulation or similar reagents/processes that pertain to precipitation are not precluded from use. An approved mix design will be tested prior to treatment.

Precipitation may be performed within Mix Bin Tanks or Containers. Treatment is performed to meet EPA LDR standards. Sampling, analysis verification of the treatment effectiveness and frequency of testing follows the guidelines presented in this WAP.

C.8.3.9 Adsorption

Adsorption is the use of an appropriate reagent (e.g. activated carbon or treated clay) to remove chemical components from aqueous or compressed gas waste streams. It is most commonly employed for the removal of organic compounds, although some inorganic constituents are effectively removed as well. This process is achieved through physical, chemical, and electrostatic interactions between the waste material and the adsorbent media. Pursuant with IDAPA 58.01.05.011 {40 CFR 268.42}, Total Organic Carbon can be used as an indicator parameter for the adsorption of many organic constituents that cannot be directly analyzed in wastewater residues.

Adsorption primarily occurs in the Tanks 1, 2, 3 and 4, however it may be performed within Mix Bins, Tanks or Containers. Treatment is performed to meet EPA LDR standards. Sampling, analysis verification of the treatment effectiveness and frequency of testing follows the guidelines presented in this WAP and Appendix D.2.5 (for on-site generated waste).

C.8.3.10 Evaporation.

Evaporation of wastes primarily occurs within the Evaporation Pond. Non-hazardous liquids and hazardous liquids meeting applicable LDR's that meet the conditions of this WAP are placed in the Evaporation Pond for evaporation. The USEI facility has a net evaporation rate of approximately 53 inches per year, which allows for evaporation of liquids using solar energy. Waste liquids selected for evaporation must meet Evaporation Pond Parameters set forth in this WAP before being placed in the pond.

C.8.3.11 Bio-remediation.

Bio-remediation is the use of biological mechanisms to destroy, transform, or immobilize environmental contaminants. Bio-remediation is normally conducted in-situ, however, there may be scenarios where it would be conducted at an alternate facility such as a TSDF. Bio-remediation would be performed within tanks or containers.

Certain wastes are treated on-site to meet specified treatment standards. Typically, USEI requires a representative sample of the waste prior to on-site management. The waste sample is then mixed with various types of reagents[2] to determine an acceptable mix design (recipe) by which the waste is treated (separately or along with other wastes) to pass the required standard(s).

C.8.4 Acceptance and Management of Corrective Active Management Unit (CAMU) Wastes

The Permittee is authorized to accept, manage, and dispose of CAMU-eligible wastes, as defined in IDAPA 58.01.05.008 [40 CFR § 264.552(a)(1) & (2).]

For each CAMU remediation waste proposed for acceptance, the Permittee must submit a CAMU-eligible waste stream information package for review by the Director unless exempted as provided below. The information package will document that:

1. The designation of CAMU-eligible waste has been performed by a duly authorized agency,
2. Principal hazardous constituents have been identified and are required to be treated to meet any of the standards referenced in 40 CFR §264.555 (a) (2),
3. The CAMU-eligible waste designating authority provided a public notice and an opportunity for public comment for both the CAMU designation and the placement of the CAMU in an off-site permitted hazardous waste landfill,
4. The approval is specific to a single remediation,
5. All information provided by the person seeking approval (the waste generator) to the duly authorized agency making the CAMU-eligible waste designation has been included in the information package.

For each CAMU-eligible waste proposed for acceptance, the Director and persons on the Permittee's mailing list will be notified of the Permittee's intent to receive CAMU-eligible wastes. This notification shall include the source of the remediation waste, the principal hazardous constituents in the waste, and the treatment requirements. The mailing list notice will be sent within 7 days of the request to the Director and will state that comments or objections to receipt of the waste may be submitted to the Director within 15 days of the notice. Proof of the mailing list notification will be submitted to the Director within seven (7) days of completion.

The Permittee must comply with 40 CFR § 268.7(b)(4) except the certification must state the CAMU wastes meet the referenced treatment requirements at 40 CFR § 264.555(a)(2). The Permittee must dispose of all CAMU-eligible wastes in Permitted landfill cells only. Prior to disposal, all CAMU-eligible wastes must meet one of the standards as discussed in 40 CFR § 264.555(a)(2)(i), (ii), or (iii).

The Permittee may not receive any CAMU-eligible waste until written approval is received from the Director. The Director may take a 30-day review period, with an optional 30-day extension, from the date of receipt of the request from the Permittee.

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[2] Typical reagents utilized on-site include fly ash, portland cement, cement kiln dust, lime, gypsum, water, clays, and carbon, although many other treatment reagents may be utilized, including other wastes with characteristics appropriate for treatment.

The Director may object to the Permittee's acceptance of any specific CAMU-eligible waste stream. If such written objection is issued, the Permittee may not receive the specific CAMU-eligible waste stream. If at the end of the review period the Director has not notified the Permittee that he or she has chosen not to object, the Permittee may not receive the specific CAMU-eligible waste stream until the objection has been resolved, or the Permittee obtains a permit modification specifically authorizing receipt of the specific CAMU-eligible waste stream.

As part of the permit modification process, the Director may modify, reduce, or eliminate the notification requirements described in this section of the WAP as they apply to specific categories of CAMU-eligible waste, based on minimal risk.

C.8.5 Wastes Meeting the Treatment or Technology Standard upon Arrival

USEI receives waste meeting applicable treatment standards that either has been treated by the generator, a treatment facility, or meets the standard as initially generated. These shipments must be accompanied by a proper notification and certification or, if determined to meet the standard by USEI, USEI may complete the certification. Wastes in this category may be analyzed for conformance with the treatment standards during the pre-acceptance review, during the load acceptance review, or when USEI believes the waste may no longer meet the standard.

Wastes received meeting a technology-based treatment standard will not be tested for LDR constituent standards. The only LDR required analysis for this type of waste is that it is properly certified, in full or in part, to have been treated by the appropriate technology for the waste codes applied.

C.8.6 Treating Wastes Containing Free Liquids

In this process, wastes not otherwise restricted are treated solely to stabilize (solidify) free liquids. Pre-treatment analyses consist of the Fingerprint Analyses performed on incoming shipments unless freestanding liquids are observed (in which case USEI can conclude the waste has free liquids without the analytical test). If free standing liquids are present, they are either removed, stabilized by either placing a stabilization agent in the container or placing the contents into a stabilization unit, or by shredding the container and its contents and, if necessary, stabilizing the shredded material. If freestanding liquids are not observed and process specific criteria are met, (e.g., paint filter test) then the waste may be landfilled directly. If free liquids are decanted, any remaining material containing free liquids will be stabilized using appropriate reagents prior to landfilling, if necessary. Bulk loads, which otherwise do not contain significant quantities of free standing liquids may be "spot stabilized" in order to meet the requirements of IDAPA 58.01.05.008 {40 CFR §264.314(a)(2)} as is sometimes necessary for otherwise dry wastes which have received precipitation during transportation.

In addition, Supplemental Analyses may be requested by USEI to further evaluate the waste. Stabilized wastes will be tested using the Paint Filter Liquids test if the presence of free liquids is still suspected. Figure C.8 provides a flow chart for potential decanting techniques, if necessary.

C.8.7 Treating Wastes to an Approved Delisting Requirement

USEI successfully petitioned the IDEQ to implement its patented treatment technology for the delisting of K061 waste. Wastes treated to an approved delisting requirement shall be sampled and analyzed in accordance with the specific delisting requirements outlined in IDAPA 58.01.05.005.01. This includes specific verification testing and delisting levels.

C.8.8 Landfill Disposal

USEI's sampling & analyses program is an integral part of this phase of operation as the results serve to evaluate compliance with permit constraints, land disposal restrictions, and determine safety constraints. Landfill disposal operations require only pre-disposal analyses. Wastes to be landfilled are subject to the Fingerprint Analyses for pre-acceptance samples and incoming waste shipments, unless otherwise specified.

C.8.9 Solar Evaporation

The Evaporation Pond is used to reduce the volume of waste by solar evaporation of the liquid components of waste. There are three other permitted surface impoundments (Collection Pond Nos. 1, 2, and 3) at the facility which collect surface runoff from active portions of the facility. This water may also be stabilized prior to disposal/evaporation or may be used in the stabilization process as an additive. The end use of the collected runoff depends on its quantity and composition. The runoff is evaluated prior to transfer from the collection ponds to confirm that it is suitable for the intended use.

Pre-acceptance evaluation and waste receipt control requirements are discussed in Section C.6. These control requirements are also used as part of the waste process controls. Wastes designated for placement in the Evaporation Pond are also subjected to the balance of process control parameter analyses as presented in Table C.6 to verify that the waste is amenable to Evaporation Pond treatment. Figure C.9 shows the process control procedures used for the Evaporation Pond.

The wastes to be placed in the Evaporation Pond consist of aqueous wastes. They have relatively low concentrations of total or suspended solids, relatively non-aggressive corrosive characteristics (pH of 2 to 12.5), low concentrations of organic compounds, and no visible oil phase separation, which would impede evaporation.

No hazardous waste subject to IDAPA 58.01.05.008 {40 CFR Part 264} Subpart CC management requirements is accepted for placement into the Evaporation Pond. Waste/liner compatibility and waste/waste compatibility are established in the pre-acceptance evaluation.

USEI's sampling & analyses program is also an integral part of the Evaporation Pond as the results serve to evaluate compliance with permit constraints, land disposal restrictions, and determine safety constraints. Evaporation operations require only pre-disposal analyses. Wastes to be evaporated are typically subject to the Fingerprint Analyses for pre-acceptance samples and incoming waste shipments. Figure C.9 provides a flow chart of process control parameters for evaporation activities.

C.8.10 Wastes Treated On-site

Certain wastes are treated on-site to meet specific treatment standards. Typically, USEI requires a representative sample of the waste prior to on-site management. The waste sample is then mixed with various types of reagents to determine an acceptable mix-design (recipe) by which the waste is treated (separately or along with other wastes) to pass the required LDR standard(s).

A mix design is chosen by USEI, which will meet LDR standard(s). Waste shipments of that particular waste are then treated according to the treatment identified as capable of meeting the applicable treatment standard(s). A treatment certification will be made for each batch treated. In some cases, it may be appropriate to create mix designs after acceptance, but prior to treatment (e.g., batches of mixed wastes streams, etc.), or perhaps during or after treatment (if an approximate recipe is first determined and in-process analysis aids in further mix design development).

Debris, as defined in IDAPA 58.01.05.08 (40 CFR §268.45) may be treated by micro-encapsulation or macro-encapsulation.

C.8.11 LDR and CAMU Verification

The treatment standards are verified prior to ultimate disposal per the requirements of this WAP. LDR or CAMU conformational testing is conducted on waste stabilized at the facility or the CAMU remediation site to verify applicable treatment standards, except alternate treatment standards (e.g.; macro- & micro-encapsulation). Samples are collected from the first two batches of each hazardous waste streams treated at the facility, and at least once a year thereafter. In order to perform verification testing on batches of wastes exceeding 50yds.^{3} treated in MBT-3 or MBT-4 in the Containment Building – Debris Portion, samples will be collected from each truckload of treated waste removed from the tank(s) in accordance with the procedures described in Section C.4. Batches of treated waste less than or equal to 50yds.^{3} will be sampled in the same manner as MBT-1 and MBT-2 in the Containment Building – Stabilization Portion. The sampling frequency may be increased on waste stream that exhibit significant variable characteristics, as determined necessary by the technical reviewers.

Since treated wastes are treated based on an established recipe, they are assumed to meet the applicable treatment standard(s) and may be staged pending verification analyses, if applicable. Additional samples may be collected as necessary while performing verification analyses. Resampling associated with interim Processing Piles is discussed in more detail in Section C.11.5.

Macro-encapsulation does not require specific testing for LDR constituent standards. The performance standard for the macro-encapsulation technology is described under IDAPA 58.01.05.011 {40 CFR Part §268.45, Table 1}, entitled “Alternative Treatment Standards for Hazardous Debris”. This standard states that “Encapsulating material must completely encapsulate debris and be resistant to degradation by the debris and its contaminants and materials into which it may come into contact after placement (leachate, other wastes, microbes).

Additionally, micro-encapsulation does not require specific testing for LDR constituent standards. Following the treatment process, the micro-encapsulated debris is visually inspected. Micro encapsulation may be conducted in tanks or containers. The performance standard for the micro-encapsulation technology is described under IDAPA 58.01.05.011 {40 CFR Part §268.45, Table 1} titled “Alternative Treatment Standards for Hazardous Debris”. This standard states that “Leachability of contaminants must be reduced”.

C.9 WASTE MANAGEMENT UNITS

Section D provides detailed process information associated with all waste management units. The following sections describe the types of treatment conducted in the various waste management units available at the facility.

C.9.1 Containment Building

This Section provides information for the Containment Building. Further detail is provided in Section D.9. The Containment Building (Stabilization and Debris portions) is designed, and operated to meet the criteria for containment buildings described under IDAPA 58.01.05.008 {40 CFR 264 Subpart DD - Containment Buildings}. Operations occur as follows:

- Physical Treatment, including stabilization; and
- Mechanical Processing, including sorting/size reduction/crushing (Misc. Unit – Subpart X).

The Containment Building is used to store and treat non-bulk and bulk containers with or without free liquids anywhere within the unit, including in the oversized debris bin and/or on the sort floors. Also, non-containerized bulk materials with or without free liquids may be stored and treated in limited amounts on the unit floor. Treatment methods for hazardous waste include the following:

- Stabilization[3];
- Chemical Oxidation;
- Chemical Reduction;
- Neutralization;
- Deactivation;
- Macro Encapsulation;
- Micro Encapsulation;
- Adsorption (clay, carbon, etc.);
- Precipitation;

[3] The term "stabilization" is defined by the EPA under 40 CFR 268.42 as "Stabilization with the following reagents (or waste reagents) or combinations of reagents (1) Portland Cement; or (2) lime/pozzolans (e.g., fly ash and cement kiln dust) – this does not preclude the addition of reagents (e.g., iron salts, silicates, and clays) designed to enhance the set/cure time and/or compressive strength, or to overall reduce the leachability of the metal or organic. USEI uses the term Stabilization in a more generic sense to mean the treatment of a waste material to make it physically and chemically stable. In this sense, it consists of those processes, which make the material conform to applicable LDR treatment standards or other applicable standard(s).

- Bio-remediation;
- Mechanical Processing, including sorting/size reduction/crushing; and
- Decanting.

To facilitate treatment, a crushing system is also located inside the Containment Building as described in D.9. The location of the crusher in the Containment Building is shown on Drawing #D2020-A02, -R07 and -R08. The crushing system is physically located within the Containment Building to provide containment for any material spills or release of fugitive dust emissions, for protection from the weather, and to minimize the potential for release of waste constituents.

Additionally, the Containment Building is used to store and treat non-bulk and bulk containers with or without free liquids anywhere within the unit, including the Mixing Bin Tanks. Also, non-containerized bulk materials with or without free liquids may be stored and treated in limited amounts on the unit floor (e.g. frozen material within load).

C.9.1.1 Truck Unloading Apron #1 and #2

Truck Unloading Aprons #1 & #2, contiguous with the Stabilization Facility, are existing, unenclosed storage, processing, and receiving areas for containers with or without free liquids. The aprons consist of individual reinforced concrete slabs with underlying 80 mil HDPE liners for containment.

C.9.1.2 Truck Unloading Apron #3

Truck Unloading Apron #3, contiguous with the Containment Building, is an existing, unenclosed, subdivided storage, processing, and receiving area for containers with or without free liquids. The apron consists of three (3) curbed, reinforced concrete slabs with underlying 80 mil HDPE primary and secondary liners for containment.

C.9.1.3 Mixing Bin Tanks (Stabilization Portion)

The Stabilization Portion’s stationary Mixing Bin Tanks are internally lined with steel wear plates that do not act as the primary containment. The wear plates protect the primary containment structures during the mixing of wastes, which is performed with an excavator. Each Mixing Bin Tank is provided with a primary barrier and a secondary system equipped with collection sumps. The concrete slab floor area inside the Containment Building is provided with a primary barrier, also equipped with monitoring and collection sumps, that comply with the requirements of IDAPA 58.01.05.008 {40 CFR §264.193(e)(1)(i)}. Secondary and primary volume calculations are provided in Appendix D.2.7. Further detailed information concerning the Containment Building and the mix bin Tanks is found in Section D.9. This system is designed to manage both solid and liquid type waste streams that require treatment prior to landfill disposal.

C.9.1.4 Mixing Bin Tanks (Debris Portion)

The Debris Portion’s stationary Mixing Bin Tanks are constructed of steel and will be placed on top of the existing floor in the containment building. Since the tanks are constructed of steel, wear plates will not be installed in the Mixing Bin Tanks. The Mixing Bin Tanks will provide primary containment. The existing floor of the Debris portion of the Containment Building will provide secondary containment for each Mixing Bin Tank. This is the same surface which provides primary containment for the Containment Building. The Containment Building is provided with a primary barrier and a secondary system equipped with collection sumps. The concrete slab floor area inside the Containment Building is provided with a primary barrier, also equipped with monitoring and collection sumps, that comply with the requirements of IDAPA 58.01.05.008 {40 CFR §264.193(e)(1)(i)}. Primary and secondary volume calculations are provided in Attachment 14a, Tables D-2a, D-2b, and D-2c. Further detailed information concerning the Containment Building and the Mixing Bin Tanks is found in Section D.9. This system is designed to manage both solid and liquid type waste streams that require treatment prior to landfill disposal.

C.9.2 Stabilization Facility

Stabilization in the Stabilization Facility is conducted in Mixing Bins (i.e., containers) (See Section D, Figure D-2 for the Process Flow Diagram). Further information is provided in Section D, Section D.9 and D.10. Empty Mixing Bins are loaded onto one of two parallel tracks located on the South Side of the Stabilization Facility. The Mixing Bins are then pulled towards the Access Ramps where they are loaded with solid, sludge, and liquid wastes via elevated Access Ramps located on both sides of the Stabilization Facility (east and west sides).

After waste has been loaded into the Mixing Bin, the bins continue northward towards the reagent silos where the appropriate amounts of treatment material are added. Reagents are added to the Mixing Bins via a series of bulk material handling systems or a front-end loader, dump truck, or other appropriate equipment. Water is added directly into the mix bin at the mixing areas.
After the required reagents have been introduced to the mix bin(s), the bins are moved to the mixing area on western portion of the facility. Excavators, located on mixing platforms above the mix bins, thoroughly mix the contents of the bins.

After the reagents have been thoroughly mixed, the mix bins are indexed to the sampling area where if appropriate, waste process control samples are collected and analyzed as discussed in Sections C.10, and C.11.4. The Mixing Bins are can then be reprocessed, emptied into another container or pile for additional on and/or off-site treatment or disposal, taken to an appropriate storage area, or taken to the landfill for disposal.

C.9.3 Drum Pads 4 and 5 (CSP #4 & 5)

CSP #4 is an existing, unenclosed, subdivided storage, processing, and receiving area for containers with or without free liquids. It is curbed and constructed of reinforced concrete and sealed with an epoxy coating for containment. Drawing #PRMI-R11 shows the locations, dimensions and designations of the subdivided storage areas used for segregating incompatible wastes; this drawing also shows the locations and design of the containment systems, including slope and drainage information.

CSP #5 is an existing, unenclosed, subdivided storage, processing, and receiving area for containers with or without free liquids. It is curbed and constructed of reinforced concrete and sealed with an epoxy coating for containment. Drawing #PRMI-R11, -C12, and -C13 show the locations, dimensions, and designations of the subdivided storage areas used for segregating incompatible wastes; these drawings also show the locations and design of the containment systems, including slope and drainage information.
Further details for these storage pads are provided in Section D, Section D.1.

C.9.4 Container Storage Area No. 1 (CSA #1)

CSA #1 is an unlined storage pad primarily constructed of native compacted soils. CSA #1 is sloped to the North to Northeast to drainage collection points. Diversion channels are located South and Southwest of the unit to control run-on (Drawing PRMI-R15). Only solid materials are managed in CSA #1.

Solid wastes in non-bulk containers (e.g. bags, boxes and drums, etc.) placed into storage at CSA #1 will be elevated or otherwise protected from contact with potentially accumulated liquid (IDAPA 58.01.05.008 and 40 CFR §264.175(c)). Bulk containers are stored with a minimum of 24 in. between individual containers. Additionally, a minimum of four feet wide aisle is located between every two rows of bulk containers to allow emergency equipment access. A typical storage arrangement for bulk containers in CSA #1 is shown on Drawing # PRMI-R15.

C.9.5 RCRA/PCB Storage Building

The RCRA/PCB Storage Building is an existing, enclosed storage, processing, and receiving area for containers. Part of the building consists of a curbed, welded steel floor for containment within a steel framed building. Drawing #PRMI-R21 and PRMI-R22 show the location, dimensions, and designation of the storage area; these drawings also show the locations and design of the containment systems, including slope and drainage information. The RCRA portion (earthen floor) is for storage of solid wastes that do not contain free liquids. Storage of liquid wastes are permitted within the PCB portion of the building equipped with secondary containment.

C.9.6 Surface Impoundments

A total of four (4) surface impoundments are located at the facility. The Evaporation Pond is utilized to handle onsite or offsite generated liquid wastes, including landfill leachate that may be effectively reduced by evaporation. Three other ponds (Collection Pond Nos. 1, 2, and 3) are utilized to collect surface water runoff and, if necessary, liquids from the Evaporation Pond on a contingency basis. Acceptable wastes are either placed in the appropriate tanks pending transfer to the Evaporation Pond or unloaded directly into the Evaporation Pond.

C.9.7 Waste Water Treatment Tank System

Four (4) above ground tanks are currently used for storage and treatment of RCRA hazardous wastes at the facility designated as Tanks #1, #2, #3 & #4 and are located within secondary containment, adjacent to the southeast corner of CSP #4 as shown on Drawing # PRMI-R11, PRMI-C11, -C12, and -C13. Tank Certifications are provided in Appendix D.2.2.

The four (4) tanks are constructed of 3/8 inch welded carbon steel. Specific components of these tanks are listed in Table D-2.

All (4) tanks are vertical, shell mounted, uniformly structurally supported and anchored on concrete foundations satisfying the requirements of the American Concrete Institute Building Code 318 (ACI 318). Tanks are equipped with either a 16 in. or 24 in. manhole, a conservation breather vent, a liquid level indicator, inlet and outlet valves, and spare valves. Each tank is equipped with a fixed roof and is vented through a closed vent system to a carbon adsorption canister to remove potential volatile organic vapors.

The flow diagram shown on Drawing # 720C-P02, illustrates how the Tanks are integrated into the facility's RCRA operations and provide instrumentation details for each tank. Drawing # 720C-P01 and Appendix D.2.4 provide information on the leachate piping. The tanks are operated under ambient temperature and pressure conditions and are heat traced to prevent freezing in the winter.

Leachate Piping is either placed directly on the ground surface to facilitate regular inspection or consists of double walled pipe. The specification for this piping is included in Appendix D.2.4. The leachate piping system is operated such that it is essentially empty when not in use. The system is designed to drain back towards the leachate risers to prevent the potential for freezing. Pipe culverts have been constructed at all road crossings to protect the pipes from vehicle traffic.

C.10 QUALITY ASSURANCE/QUALITY CONTROL

The following quality assurance/quality control (QA/QC or "quality") information is utilized to ensure adequate quality assurance and quality control during waste management activities. The following documents were utilized during the development of USEI's QA/QC procedures:

1. *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, SW-846*, Third Edition, Final Update I, U.S. EPA, Office of Solid Waste, Washington, DC, July 1992, Section One, as updated

2. Handbook for analytical Quality Control in Water and Wastewater laboratories, EPA 600/4-79-019, March 1979, US Environmental Protection Agency (USEPA), Environmental Monitoring and Support Laboratory (EMSL), Cincinnati, OH.

Quality protocols are applicable to both sampling and analytical techniques. The following sections provide general QA/QC procedures USEI utilizes during the collection, transfer, storage and analysis.

The objective of the Quality Assurance/Quality Control (QA/QC) program is to ensure that operational decisions result in the proper treatment, storage and disposal of the hazardous wastes handled at the facility. An additional aspect of this program is to ensure that hazardous wastes, which are restricted from disposal at the facility, are adequately screened prior to acceptance of waste shipments. The principal components of this program are listed as follows for the routine acceptance, treatment, and disposal of hazardous waste.

- Pre-acceptance review to screen and classify waste;

- Review and cross-check of shipping and manifest documentation for each shipment as it arrives at the facility;

- Second review of pre-acceptance information, classification, and shipping documentation prior to any storage, treatment, or disposal activity;

- Field inspections, item counts, and other physical verification of shipment contents performed independently by technical personnel;

- Sampling performed by trained personnel using accepted procedures;

- Fingerprint analysis performed by qualified technical personnel;

- Comparison of field data, fingerprint data, and pre-acceptance information for consistency prior to QC release of waste for disposal; and

- Treatment determination study of process capabilities for stabilization of hazardous constituents by demonstration and analysis during the pre-acceptance review process.

C.10.1 Sampling QC

Personnel involved in the sampling of waste are given formalized training. This consists of a presentation of the theoretical aspects of random sampling and the practical considerations of sample collection and sampling handling. Documentation is maintained in the employee's personnel file to reflect the nature and content of the training per the requirements of Section H of this Document.

C.10.1.1 Fingerprint Analysis

Fingerprint analysis performed in the routine acceptance of waste shipments provides qualitative confirmation that the waste actually received on-site is consistent with the more rigorous pre-acceptance criteria. For personnel and equipment involved with this analysis, personnel receive training in the types and methods involved in the physical characterization of waste and specific factors of concern. Notations of non-conforming physical characteristics and other fingerprint parameters may be recorded on the ICF and/or other pertinent documentation associated with the processing of the waste for disposal.

C.10.1.2 General Sample Handling

Hazardous waste samples, sample containers, and sampling equipment are handled in a manner that is consistent with the required analytical procedures. Samples are sealed and transported to the laboratory as soon as practical after collection. The seal normally consists of a bottle cap or other closure that prevents spillage. The outside of the sample container is cleaned prior to being removed from the sampling location to limit the potential spread of any contamination. This is accomplished by wiping the sample container with a dry or dampened cloth. In some cases, rinsing with water or other solvents may be appropriate.

C.10.1.3 Sample Identification and Documentation

Hazardous waste samples collected under the requirements of this WAP are currently numbered by one of two systems (or equivalent), depending on whether the samples are from routine waste or non-routine wastes. If the sample is from waste routinely received for disposal, it has an associated Internal Control Form (ICF)/load number assigned. The sample identification number consists of that ICF/load number followed by the ICF item number and a specific container designator.

Non-routine samples (those with no associated ICF number) are consecutively numbered based upon yearly sequential numbers as follows:

03-0001

"03" indicates the calendar year the sample is collected.

"0001" is a consecutive number that progresses upwards until the end of the year.

The following information is placed on all sample labels:

- Essential information;

- Sample Identification Number;
- Date the sample was collected; and
- Initials or name of sample collector.

Additional information (to be provided as requested):

- Generator's name;
- Description of waste, including shipping name, identification numbers, container type, etc.;
- Location of sampling site/grid;
- Waste Stream Identification (WSID) Number; and
- Analysis requested.

Records of all samples collected under the requirements of this WAP are kept by the facility. For all ICF/load related samples, these records include information on physical characteristics (e.g., liquid, solid, etc.), item count, discrepancies/problems, and other related data.

Incoming samples are recorded in the sample logs and/or electronically by the facility. ICF-related samples have a completed WPQ that outlines the required fingerprint parameters and expected results. The specific tracking system is dependent on the current database tracking system, which is periodically updated, as necessary. The above outline provides an example of how a tracking system is organized.

Chain-of-custody procedures are used when deemed necessary to document sample possession from time of collection through transfer to other facilities. Normally, these procedures are used when outside laboratories are utilized and/or there is legal reason to document the chain of possession of the sample. Samples are stored in a secure and controlled location. An example of a chain-of-custody form is shown in Figure C.10.

C.10.1.4 Sample Storage and Preservation

Samples are properly preserved, stored, and analyzed as soon as practical after they are collected. Refrigeration is a part of most sample storage/preservation techniques; however, some sample constituents, such as metal cations, which may precipitate into a salt that will not readily re-dissolve, may be adversely affected by refrigeration.

Chemical preservation is used for specific constituents because of the potential reaction of the preservative with other possible constituents. Where a sample is needed for multiple constituents, several separate sample bottles may be required for proper preservation. For those samples required to be sent to an off-site laboratory, the normal procedure is to contact the off-site laboratory for type of container (e.g. plastic, glass etc.), preservative requirement, required volume, and storage time limitations associated with the analytical method and the requested analysis.

Routine samples for receipt and process control purposes are not usually preserved because analysis is begun shortly after sample collection.

C.10.2 QC for Other Analytical Procedures

The facility maintains a substantial amount of analytical capacity above that required performing routine fingerprint analysis. In order to maintain a high level of confidence in the data generated from the use of the analytical procedures, the QC provisions cited in these procedures are followed as appropriate based on the need for information. For example, if a procedure is run for the purpose of confirmation of analytical information supplied from an outside source, the QC considerations may be relaxed somewhat as opposed to the same procedure run for the precise quantification of a chemical species. The facility may, from time to time, determine the need to incorporate additional analytical procedures for various reasons. As these are adopted for use, appropriate QC provisions are also implemented consistent with the confidence levels associated with the need for additional information.

C.10.3 Additional Laboratory QC Provisions

Additional components of the laboratory QC program are as follows:

- Instrumentation and equipment are maintained in serviceable condition as determined by manufacturers recommendations and by the facility's internally determined need for analytical capability.
- All volumetric glassware is designated as Class "A" as defined by the National Bureau of Standards, if required by the analytical methodology.
- All chemicals and reagents used in any fingerprint test or other analytical procedure are of sufficient purity to be non-interfering with the results desired. In those tests and procedures where minimum purity levels are specified, such as "ACS Reagent Grade", or equivalent are used, as appropriate.

C.10.4 Laboratory and Sampling Quality Assurance Program

The basis for obtaining reliable data consistent with the identified needs of the facility rests with the equipment, procedures, and personnel involved. The methods for maintaining high standards of performance in these areas lie in the detection of deviations from established protocols or the appearance of previously undetected or procedural interference's. In the first case, the assurance of quality is based on observations derived from daily observations and periodic internal compliance audits. In the second case, numerical information is required from the analysis of blanks, spikes, surrogates, and other known quantities. Documentation of the QC activities associated with and required by the sample collection and analyses procedures are maintained.

C.10.4.1 Sampling Program

Sampling procedures are described in Section C.4 of this WAP. The selection of the sample collection device depends on the type of sample, the sample container, the sampling location and the nature and distribution of the waste components. In general, the methodologies used for specific materials correspond to those referenced in IDAPA 58.01.05.005 {40 CFR Part 261, Appendix I}. The selection and use of the sampling device is supervised or performed by a person thoroughly familiar with the sampling requirements. Sampling equipment is constructed of non-reactive materials such as glass, PVC plastic, aluminum, or stainless steel. Care is taken in the selection of the sampling device to prevent contamination of the sample and to ensure compatibility of materials. For example, glass bottles are not used to collect hydrofluoric acid wastes.

Individual container samples that are related may be composited prior to analysis as described in Section C.4.3.

C.10.4.2 Analytical Program

USEI has developed a program of analytical quality practices and procedures to ensure that precision and accuracy are maintained. These programs include the use of control standards, duplicates, spikes, and blanks. Non-company laboratories employed by the company demonstrate quality control practices that are comparable to USEI's practices.

C.11 GENERAL CONSIDERATIONS

In the operation of a hazardous waste management facility a number of issues become apparent, which are not necessarily anticipated in the regulations and may present unique management methods. Below are sections addressing several issues of this nature and other unique situations. It is USEI's intention to address these issues in this forum to provide insight into the technique development.

C.11.1 Disposition of Samples

Samples of waste streams are commonly disposed in the same fashion as the waste stream itself. If, for example, a waste is approved for stabilization and landfilling, the sample may be stabilized (e.g.; in the lab, in containers, or mix bins) and subsequently disposed. Samples received, which are unauthorized for management on-site, are returned to the generator (or representative) or aggregated (under the provisions of IDAPA 58.01.05.006 and 40 CFR §262.34) and sent off-site to an authorized facility for subsequent management. To facilitate sample management, samples approved for the same management processes may be consolidated (e.g.; in tanks or containers) and managed under the provisions of IDAPA 58.01.05.006 {40 CFR §262.34}. Should samples arrive on-site from an identified generator, but without proper waste identification, USEI will attempt to contact the generator to identify the associated waste and appropriate hazardous waste codes, if any. If a sample identity cannot be resolved with a generator, or if the generator of the waste sample cannot be determined, USEI will attempt to identify the generator and send it back or such samples may be managed as on-site generated waste and subject to classification as characteristic wastes (D001 through D043) for the characteristics / contaminants reasonably expected to be in the waste.

C.11.1.1 Frozen Samples

Samples of frozen loads are defrosted prior to analysis (Note: to speed up fingerprinting, samples may be heated under the vent hood). In some cases, it may be necessary to defrost entire loads or, for drum loads, 10% of the load, to facilitate sampling or to inspect for free standing liquids. As an alternative, and if conditions warrant (e.g., anticipated freezing conditions) a sample of waste being delivered may be taken at the point of generation for the purpose of satisfying the requirements of this plan. Such samples will be taken from either the load or place of generation or accumulation. If this procedure is utilized, the load will also be visually inspected on-site for Physical Appearance to check against obvious differences in waste type.

C.11.2 Sampling Safety Precautions

Sampling personnel wear personal protective equipment (PPE) (e.g.; eye, foot, hand, head & respiratory protection & protective clothing), as necessary. Load receipt personnel check the manifest or other shipping or pre-acceptance information to be familiar with the material and ensure necessary precautions are taken. Specific safety precautions are outlined in USEI's Health and Safety Plan.

C.11.3 Remote Project Sampling and/or Analysis

In cases where USEI directs off-site sampling (e.g.; at USEI's Rail Transfer Station) or analysis for the purpose of having that sample or analysis meet the requirements of the USEI provisions (e.g., Fingerprint Testing, etc.), USEI will instruct an on-site representative in the requirements of this WAP or a USEI representative will be at the project site to ensure compliance with the provisions of this WAP including the applicable QA/QC requirements.

C.11.4 Sampling of LDR Waste and CAMU Waste

When waste is treated on-site for the purpose of meeting LDR or CAMU treatment standards or, for LDR or CAMU-eligible waste confirmation testing, samples are taken on a grab sample basis. EPA has promulgated compliance of concentration based treatment standards for all non-wastewaters based on grab samples as stated in IDAPA 58.01.05.011 {40 CFR §268.40(b)}. USEI follows this sampling methodology for waste treated on-site. Any grab sample must pass the treatment standards in order for compliance to be assured. When there is any uncertainty in achievement of treatment standards, the sample should be re-sampled and/or re-analyzed as necessary.

C.11.5 Interim Processing Loads

Following treatment, the treated waste is sent to the landfill for final disposal and “staged” in the landfill while applicable verification testing is performed as described in Section C.6. Up to 50 batches may be staged at any point in time. Staged material will be staged for up to 10 working days.

USEI may submit an extension request to the IDEQ if additional time is needed to verify treatment due to unique verification sampling and analysis requirements (e.g., samples need to be sent offsite for analysis).

C.11.5.1 Re-Sampling of Interim Processing Piles

Wastes treated on or off-site and “staged” at one of the interim processing pile in the landfill that result in a failure of applicable standards (from an initial sample) may need re-sampling for verification analyses. If the re-sampling indicates the waste meets treatment standards the waste may be released for disposal. If re-sampling indicates the material does not meet applicable treatment standards the waste will be redirected for further treatment, as necessary.

C.11.6 Lab Packs

Lab Packs are managed in accordance with IDAPA 58.01.05.008 {40 CFR §264.316}. Lab Packs are not sampled. Lab packs must be packaged in non-leaking inside containers and must be over packed in an open head metal container with less than 110 gallon capacity and surrounded by a sufficient quantity of non-biodegradable sorbent material capable of absorbing the liquid contents of the container. The sorbent material must not be capable of reacting dangerously with, being decomposed by, or being ignited by the contents of the lab pack. Reactive wastes, other than cyanide or sulfide bearing waste (as defined by IDAPA 58.01.05.005 and 40 CFR §261.23(a)(5)) must be treated or rendered non-reactive prior to packaging. Lab pack material is accepted subject to a contents and packaging review. Lab pack materials which are proposed to be treated, stored, or disposed are inventoried, and the inventories are sent to the facility for review. The inventories are reviewed for incompatibility of contained materials, land disposal restrictions, and utilization of appropriate packing materials. Since lab packs contain many small quantities of individual materials, they are not sampled, but are inspected to ensure adequate packing material is present and the drum is at least 90% full (if destined for direct landfilling). If necessary, sorbent material may be added until the lab pack is 90% full.

C.11.7 Management of Residues[4]

Management of waste residues and other miscellaneous equipment or debris originating from on-site management areas or activities may be managed as on-site generated wastes and classified according to their hazardous waste characteristics, if any. However, where an on-site generated waste is derived from one or more wastes, it will be managed in accordance with the approved management conditions for that waste(s) (e.g.; a spill of F002 material may be managed as F002), or if precluded by permit, regulation, or operational conditions, it may be subject to alternative management, as appropriate. Stabilization residues and other treatment residues will carry the waste code(s) and will be managed in the same manner as the last waste stream in the unit. For example, sludge's removed from a stabilization mix bin which last received K061 wastes would carry the K061 code and must meet appropriate treatment standards for K061 before being land disposed on-site, if that were the selected disposal option. Residues from waste treatment units will carry the waste codes and be managed consistent with the waste last managed in the unit. The applicable waste codes and corresponding waste management methods will be based upon the "First In, First Out" principle and the estimated resident time. Residues from truck cleaning, Containment Building, Stabilization Facility, or in other waste management units are managed either with the like materials being managed at those locations or as on-site generated waste. Residues in "RCRA Empty" containers are not subject to this WAP since they are not solid or hazardous wastes per IDAPA 58.01.05.005 {40 CFR §261.7}.

C.11.8 Rejected Load or Rejected Partial-Load, and Re-Manifesting Procedures

Manifest discrepancies are resolved, if possible, by contacting the generator or its representative to obtain the needed information. There are many cases where entire loads or portions of loads may be rejected (e.g., a bulk load contains un-profiled or unacceptable[5] materials). The regulations (IDAPA 58.01.05.008 and 40 CFR Parts 264, Subpart E – *Manifest System, Recordkeeping, and Reporting*) do not give instructions on how materials are rejected or re-manifested. The exact manifesting procedures will be determined considering the variables associated with any particular rejection, but, in general, the following is a summary of the typical considerations associated with rejecting materials.

Two options are available for rejecting some or all of a load. The 1st option includes sending material out on the original manifest noting in Block 19 that the load is being rejected back to the point of origination or the alternate facility designated on the manifest or verbally designated by

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[4] Residues is used to mean solids and liquids contained or generated in sumps, truck & equipment washing, tank cleaning, boiler cleaning, evaporator cleaning, distillation unit cleaning, equipment maintenance, repair, or replacement, pipes, valves, filters, filter media, miscellaneous samples, and personal protective equipment.
[5] The material may be "unacceptable" for many reasons, of which only some are due to permit constraints. The term "unacceptable" is not meant to mean unacceptable due to permit constraints, but to also cover those materials for which the facility has not developed the appropriate management procedures or process in managing the waste and for other causes.

the generator. If the manifest has not already been signed, the original manifest may be utilized by either striking through the original TSDF destination and inserting the new (alternate) destination or by simply noting in block 19 the new destination. If the manifest has been signed, an additional line may be struck through USEI's signature on the manifest.

A 2nd option is to generate a new manifest. This procedure is less preferable since USEI must complete the Generator's section of the manifest and, in this case, language may be inserted in blocks J, K, or 15 indicating USEI is the generator for shipping purposes only and referencing the original manifest. This option is often useful for bulk loads for which a portion is being rejected in containers (e.g.; aerosol cans removed from a bulk load may be sent back to the generator packaged in DOT shipping containers) and for rejecting or forwarding on a portion of a container shipment. In either case, USEI will copy the generator notifications and/or certifications for that shipment and attach a copy to the outgoing manifest(s) rather than altering the notifications and/or certifications made by the generator.

Although not required for entire load rejections, USEI will usually keep a copy of the manifest(s), subsequently generated manifest(s), and notifications and/or certifications. In cases where the waste is being manifested back to the generator, USEI does not need to complete the LDR Notifications or Certifications since the waste is not being sent for land disposal.

C.11.9 Restricted Waste

Certain wastes are restricted from on-site disposal at the facility. Table C.8 provides the list of on-site disposal restricted waste.

C.11.10 Brokerage of Non-Hazardous and Hazardous Waste

Wastes accepted for management may be subsequently sent to an alternate facility for disposal and or other management, if necessary. At times, USEI may elect to send waste to an alternate TSDF due to scheduling, economic, and/or operational complications associated with the waste in question. Alternatively, some waste streams may have a specific technology code (IDAPA 58.01.05.011 {40 CFR §268.40} Treatment Standards) that requires a type of treatment not offered by USEI. Other undefined reasons my result in the decision to send waste offsite for disposal. As a result, these wastes will be brokered for further treatment at an appropriate facility, as necessary. Examples of wastes that may require brokering include:

- Wastes greater than 260 mg/kg total mercury;
- Specific customer requests;
- Flammable liquids;
- Wastes with specific technology codes not offered by USEI;
- Certain wastes regulated under Subpart CC.

Brokered wastes will be managed under the same management methods, procedures and restrictions outlined within this WAP. For example, USEI will utilize appropriate waste determination/characterization, sampling, pre-acceptance, receiving, and storage requirements as outlined in this WAP. Wastes my also be consolidated or bulked as necessary for off-site shipment.

Additionally, material that will be brokered for offsite disposal will be designated as such by placing a red dot on the top of the drum or other visible location. Specific markings for brokered waste will facilitate tracking of brokered material as described in Section D.1.b.

C.11.10.1 Storage of Brokered Waste

Waste that will be brokered for offsite shipment will conform to the same management requirements outlined in this WAP including associated compatibility requirements. Section D.1.b provides more detailed storage requirements.

C.11.11 Non-Hazardous Wastes (NHW)

USEI accepts wastes, which are not hazardous as defined under RCRA or are exempt from RCRA regulations (e.g., household hazardous waste, etc.). USEI utilizes this WAP and the procedures contained herein to review non-hazardous wastes, however, depending on the specific waste, specific sections of this WAP may not be applicable (e.g., manifesting provisions, sampling requirements, LDR verification of treated wastes, etc.).

Each load of NHW arriving for on-site treatment or disposal will be visually inspected in order to verify waste conformance and/or acceptability. If applicable, NHW liquids will be solidified prior to disposal and will follow the requirements of IDAPA 58.01.05.008 {40 CFR §264.314}.

C.11.12 Protectively-Characterized Wastes

Generators occasionally “protectively” (overly)-characterize[6] wastes sent to off-site TSDFs for a variety of reasons (including public relations, legal reasons, financial incentives, lack of characterization experience, or lack of specific analytical information). USEI has analytical resources and technical personnel trained and experienced in proper regulatory/waste classification and who are capable of detecting protective-classification. Examples of protective-characterization include remedial projects where soils are classified according to a specific waste characteristic (e.g., D008 – lead), but where any specific load(s) do not fail the TCLP analysis for the specific waste characteristic as a “protective” measure. USEI, where it possesses specific analytical data, process knowledge, or regulatory knowledge may properly characterize waste during the pre-acceptance or load-arrival process. The primary criteria for re-classifying hazardous waste are analytical data (e.g., TCLP test as described above) unless the re-classification is a result of a regulatory exemption and/or other criteria. Prior to disposal, USEI will complete an appropriate Notification and/or an appropriate LDR Certification, as required.

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[6] “Over-characterization” means the practice of applying waste codes or UHCs to a waste which do not apply and/or to the practice of not applying appropriate LDT Notifications or Certifications.

C.11.13 Standard Profiles

"Standard profiles" may be used for waste streams which are 1) similar in physical or chemical characteristics or 2) generated by similar industries or processes. This profile designation is consistent with EPA's approach of assigning a listed waste code to similar process wastes. All the wastes within a standard profile are usually managed at USEI using the same treatment process.

USEI may develop standard profiles based on information from waste streams targeted for this process. USEI reviews the generator provided information to evaluate whether an individual waste stream is sufficiently similar in physical and/or chemical characteristics to an established standard profile. A specific waste stream may be identified as conforming to an approved standard profile by evaluating the individual waste stream information against the standard profile. The specific waste stream information must fall within the standard profile representative ranges in order to incorporate that waste stream into the standard profile.

Specific candidate waste streams, which, upon review, are identified as conforming to an existing approved standard profile, will be managed under the existing waste management decision specific for that standard profile.

C.11.14 RCRA/PCB Waste

The USEI facility is a fully permitted RCRA and TSCA facility. Often, material is accepted that is both a characteristic/listed RCRA waste and a PCB contaminated TSCA waste. When this occurs, the material is managed as a RCRA waste since the PCB component is managed as a UHC under the RCRA regulations. In this manner, the material is not a PCB waste but a RCRA waste subject to RCRA regulations. If the material in question is not characteristic/listed under RCRA and does have a PCB component (i.e., regulated under TSCA) then the waste will be managed as a TSCA waste as described by USEI's TSCA permit. This distinction provides important guidance as the two sets of regulations are not always the same and it is necessary that the material be managed under clear and consistent regulations.

C.12 CONCLUSION

The aforementioned sampling and analytical quality practices help ensure the data obtained are precise and accurate for the waste stream being sampled. The analytical results are used by facility management to decide whether or not to accept a particular waste and, upon acceptance, to determine the appropriate method of treatment, storage, and disposal. Results are also important to ensure that wastes are managed properly by the facility and that incompatible wastes are not inadvertently combined. The quality of these results is as important as the results themselves. Thus, the quality of the analytical data, the thoroughness and care with which the sampling and analyses are performed and reported, provides an important basis for day-to-day operational decisions.

Appendix C-2:

US Ecology: Wayne, Michigan

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
LANSING

RICK SNYDER
GOVERNOR

DAN WYANT
DIRECTOR

May 4, 2012

Mr. Michael J. Takacs
Regulatory Specialist
EQ The Environmental Quality Company
Wayne Disposal, Inc.
49350 North I-94 Service Drive
Belleville, Michigan 48111

Dear Mr. Takacs:

SUBJECT: Hazardous Waste Management Facility Expansion Operating License (License); Wayne Disposal, Inc. (WDI), Belleville, Michigan; MID 048 090 633

The Department of Environmental Quality (DEQ), Resource Management Division (RMD), has completed its review of the License application from WDI. Based on that review and the results of the public hearing held on March 12, 2012, the DEQ has issued the License to WDI pursuant to Part 111, Hazardous Waste Management, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. The License application review and the public participation procedures were conducted in accordance with Part 111.

Enclosed are copies of the License, Response to Comments, and Notice of Final Decision. The license attachments that were previously provided with the draft License have not changed, so they can be included with this final License. If you have any questions or comments, please contact Mr. Peter Quackenbush, Hazardous Waste Section, RMD, at 517-373-7397; quackenbushp@michigan.gov; or DEQ, P.O. Box 30241, Lansing, Michigan 48909-7741.

Sincerely,

Liane J. Shekter Smith, P.E., Chief
Resource Management Division
517-373-9523

Enclosures
cc: Mr. Scott Maris, EQ The Environmental Quality Company
Ms. DeLores Montgomery/Mr. David Slayton, DEQ
Mr. Michael Busse, DEQ
Mr. Peter Quackenbush/Mr. Joseph Rogers, DEQ
Mr. Leo Parks, DEQ
Operating License File

State of Michigan
Department of Environmental Quality
HAZARDOUS WASTE MANAGEMENT FACILITY EXPANSION OPERATING LICENSE

NAME OF LICENSEE: Wayne Disposal, Inc.

NAME OF FACILITY OWNER: EQ – The Environmental Quality Company

NAME OF FACILITY OPERATOR: Wayne Disposal, Inc.

NAME OF TITLEHOLDER OF LAND: Wayne Disposal, Inc.

FACILITY NAME: Wayne Disposal, Inc.

FACILITY LOCATION: 49350 North I-94 Service Drive
Belleville, Michigan 48111

EPA IDENTIFICATION (ID) NUMBER: MID 048 090 633 EFFECTIVE DATE: May 4, 2012

REAPPLICATION DATE: November 5, 2021 EXPIRATION DATE: May 4, 2022

AUTHORIZED ACTIVITIES

Pursuant to Part 111, Hazardous Waste Management, of Michigan's Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (Act 451), being §§324.11101 to 324.11153 of the Michigan Compiled Laws, and the hazardous waste management administrative rules (hereafter called the "rules") promulgated thereunder, being R 299.9101 *et. seq.* of the Michigan Administrative Code, by the Department of Environmental Quality (DEQ), an operating license (hereafter called the "license") is issued to Wayne Disposal, Inc. (hereafter called the "licensee"), to operate a hazardous waste management facility (hereafter called the "facility") located at latitude 42° 13' 30" N and longitude 83° 31' 00" W. The licensee is authorized to conduct the following hazardous waste management activities:

- ☒ STORAGE
  - ☐ Container
  - ☒ Tank
  - ☐ Waste Pile
  - ☐ Surface Impoundment
  - ☐ Drip Pad
- ☐ TREATMENT
  - ☐ Container
  - ☐ Tank
  - ☐ Surface Impoundment
  - ☐ Incinerator
  - ☐ Other:
- ☒ DISPOSAL
  - ☒ Landfill
  - ☐ Land Application
  - ☐ Surface Impoundment
- ☒ POSTCLOSURE
  - ☐ Tank
  - ☐ Surface Impoundment
  - ☒ Landfill
  - ☐ Waste Pile

APPLICABLE REGULATIONS AND LICENSE APPROVAL

The conditions of this license were developed in accordance with the applicable provisions of the rules, effective March 17, 2008. The licensee shall comply with all terms and conditions of this license. This license consists of the 32 pages of conditions attached hereto (along with those in Attachments 1 through 16) and the applicable regulations contained in R 299.9101 through R 299.11008, as specified in the license. For purposes of compliance with this license, applicable rules are those that are in effect on the date of issuance of this license in accordance with R 299.9521(3)(a).

This license is based on the information in the license application submitted on March 4, 2011, and any subsequent amendments (hereafter referred to as "the application"). Pursuant to R 299.9519(11)(c), the license may be revoked if the licensee fails, in the application or during the license issuance process, to disclose fully all relevant facts or, at any time, misrepresents any relevant facts. As specified in R 299.9519(1), the facility shall be constructed, operated, and maintained in accordance with Part 111 of Act 451, as amended on December 22, 2010; the rules; and this license.

This license is effective on the date of issuance and shall remain in effect for 10 years from the date of issuance, unless revoked pursuant to R 299.9519 or continued in effect as provided by the Michigan Administrative Procedures Act, 1969 PA 306, as amended (Act 306). Pursuant to R 299.9516, this license shall be reviewed by the DEQ 5 years after the date of issuance and shall be modified as necessary in accordance with the provisions of R 299.9519 and R 299.9520.

Issued this 4th day of May, 2012

by ______________________________
Liane J. Shekter Smith, P.E., Chief
Resource Management Division

PART I
STANDARD CONDITIONS

A. TERMINOLOGY AND REFERENCES

Throughout this license, the term "Division" means the Resource Management Division within the DEQ responsible for administering Part 111 of Act 451 and the rules. Throughout this license, "Director" means the Director of the DEQ or the Director's duly authorized designee such as the Division Chief. All of the provisions of Title 40 of the Code of Federal Regulations (CFR) referenced in this license are adopted by reference in R 299.11003.

B. EFFECT OF LICENSE

Except as otherwise provided by law, any treatment, storage, or disposal of hazardous waste not specifically authorized in this license is prohibited. Issuance of this license does not authorize any injury to persons or property, any invasion of other private rights, or any infringement of federal, state, or local law or regulations {R 299.9516(8)}; nor does it obviate the necessity of obtaining such permits or approvals from other units of government as may be required by law. Compliance with the terms of this license does not constitute a warranty or representation of any kind by the DEQ, nor does the DEQ intend that compliance with this license constitutes a defense to any order issued or any action brought under Act 451 or any other applicable state statute or §106(a) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) {Title 42 of the United States Code (U.S.C.) §9606(a)}, the Resource Conservation and Recovery Act of 1976, as amended (RCRA), and its rules, or any other applicable federal statute. The licensee, however, does not represent that it will not argue that compliance with the terms of this license may be a defense to such future regulatory actions. Each attachment to this license is a part of, and is incorporated into, this license and is deemed an enforceable part of the license.

C. SEVERABILITY

The provisions of this license are severable, and if any provision of this license, or the application of any provision of this license to any circumstance, is held invalid, the application of such provision to other circumstances and the remainder of this license shall not be affected thereby.

D. RESPONSIBILITIES

1. The licensee shall comply with Part 111 of Act 451, the rules, and all conditions of this license, except to the extent authorized by the DEQ pursuant to the terms of an emergency operating license. Any license noncompliance, except to the extent authorized by the DEQ pursuant to the terms of an emergency operating license, constitutes a violation of Part 111 of Act 451 and is grounds for enforcement action, license revocation, license modification, or denial of a license renewal application. {R 299.9521(1)(a) and (c) and (3)(a) and (b) and 40 CFR §270.30(a)}

2. If the licensee wishes to continue an activity regulated by this license after the expiration date of this license, the licensee shall submit a complete application for a new license to the Division Chief at least 180 days before this license expires, November 5, 2021, unless an extension is granted pursuant to R 299.9510(5). To the extent the licensee makes a timely and sufficient application for renewal of this license, this license and all conditions herein will remain in effect beyond the license expiration date and shall not expire until a decision on the application is finally made by the DEQ, and if the application is denied or the terms of the new license are limited, until the last day for applying for judicial review of the new license or a later date fixed by order of the reviewing court consistent with §91(2) of Act 306. {R 299.9521(1)(a) and (c) and (3)(a) and 40 CFR §270.30(b)}

3. The licensee shall comply with the conditions specified in R 299.9521(1)(b)(i) to (iii) and 40 CFR §270.30(c) through (k), (l)(2), (3), (5), (7), and (11), and (m). {§§11123(3), 11146(1) and (2), and 11148(1) of Act 451 and R 299.9501(1), R 299.9516, R 299.9519, R 299.9521(1)(a) and (b) and (3)(a) and (b), R 299.9522, and R 299.9525}

4. The licensee shall give notice to the Division Chief as soon as possible prior to any planned physical alterations or additions to the licensed facility.

E. **SUBMITTAL DEADLINES**

When the deadline for submittals required under this license falls on a weekend or legal state holiday, the deadline shall be extended to the next regular business day. This extension does not apply to the deadline for financial mechanisms and associated renewals, replacements, and extensions of financial mechanisms required under this license. The licensee may request extension of the deadlines for submittals required under this license. The licensee shall submit such requests at least five business days prior to the existing deadline for review and approval by the Division Chief. Written extension requests shall include justification for each extension. {R 299.9521(3)(a)}

PART II
GENERAL OPERATING CONDITIONS

A. GENERAL WASTE ANALYSIS

The licensee shall ensure that any waste managed at the facility has been properly characterized pursuant to R 299.9302 and comply with the procedures described in the attached Waste Analysis Plan, Attachment 1, of this license. {R 299.9605(1) and 40 CFR §264.13}

B. SECURITY

The licensee shall comply with the barrier, surveillance, and signage requirements of R 299.9605(1) and 40 CFR §264.14.

C. GENERAL INSPECTION REQUIREMENTS

1. The licensee shall inspect the facility in accordance with the Inspection Schedule, Attachment 2, of this license and comply with the inspection requirements of R 299.9605(1) and 40 CFR §264.15.

2. The licensee shall implement the procedure to ensure compliance with the requirements of R 299.9605(2) regarding transport vehicles and other containers leaving the facility.

D. PERSONNEL TRAINING

The licensee shall comply with the personnel training requirements of R 299.9605 and 40 CFR §264.16. The Personnel Training Program, Attachment 3, of this license shall, at a minimum, cover all items in R 299.9605 and 40 CFR §264.16.

E. PREPAREDNESS AND PREVENTION

The licensee shall comply with the preparedness and prevention requirements of R 299.9606 and 40 CFR Part 264, Subpart C.

F. CONTINGENCY PLAN

The licensee shall comply with the contingency plan requirements of R 299.9607 and 40 CFR Part 264, Subpart D. The Contingency Plan, Attachment 4, of this license, and the prescribed emergency procedures shall be immediately implemented by the licensee whenever there is a fire, explosion, or other release of hazardous waste or hazardous waste constituents that threatens or could threaten human health or the environment, or if the licensee has knowledge that a spill has reached surface water or groundwater.

G. DUTY TO MITIGATE

Upon notification from the Division Chief or his or her designee that an activity at the facility may present an imminent and substantial endangerment to human health or the environment, the licensee shall immediately comply with an order issued by the Division Chief to halt such activity and conduct other activities as required by the Division Chief to eliminate the said endangerment. The licensee shall not resume the halted activity without the prior written approval from the Division Chief. {§11148 of Act 451 and R 299.9521(3)(b)}

H. **MANIFEST SYSTEM**

The licensee shall comply with the manifest requirements of R 299.9304, R 299.9305, and R 299.9608.

I. **RECORD KEEPING AND REPORTING**

1. The licensee shall comply with the written operating record and monthly operating report (EQP 5142 form) requirements of R 299.9609 and 40 CFR §264.73 and Part 264, Appendix I, and R 299.9610(3), respectively. The monthly operating report shall be submitted on EQP 5142 form provided by the Division Chief, or an equivalent form that has been approved by the Division Chief.

2. The licensee shall comply with the biennial report requirements of R 299.9610. {R 299.9521(1)(a) and 40 CFR §270.30(l)(9)}

3. The licensee shall submit the results of all environmental monitoring required by this license and any additional environmental sampling or analysis conducted beyond that required by this license, in the form of an Environmental Monitoring Report to the Division Chief within 60 days after any sample collection. Such increased frequency shall be indicated in the Environmental Monitoring Report. {R 299.9521(1)(a) and R 299.9521(3)(b) and 40 CFR §270.30(l)(4)}

4. The licensee shall provide environmental monitoring information or data that is required pursuant to this license, to an authorized representative of an environmental or emergency response department of the Van Buren Charter Township or Wayne County who requests such information or data and that has jurisdiction over the facility. Such information or data shall be made available on the same day the licensee forwards this information to the Division Chief. {R 299.9521(3)(b)}

5. The licensee shall immediately report to the Division Chief any noncompliance with the license that may endanger human health or the environment by doing both of the following:

   (a) The licensee shall immediately notify the Division Chief at 517-335-2690, if the noncompliance occurs Monday through Friday during the period of 8:00 a.m. to 5:00 p.m., except state holidays, or by calling the DEQ Pollution Emergency Alerting System (PEAS) at 1-800-292-4706 during all other times. This notice shall include the following:

      (i) Information concerning the fire, explosion, release, or discharge of any hazardous waste or hazardous waste constituent that could threaten human health or the environment, that has reached surface water or groundwater, or that may endanger public drinking water supplies or the environment; and

      (ii) A description of the occurrence and its cause, including all of the information outlined in R 299.9607(2)(a)-(i).

   (b) The licensee shall also follow up the verbal notice by providing a written report to the Division Chief within five days of the time the licensee becomes aware of the circumstances. The written report shall contain all of the information in Condition II.I.5.(a)(i)-(ii) of this license along with a description of the noncompliance and its cause; the periods of noncompliance (including exact dates and times); whether the noncompliance has been corrected and, if not, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance and when those activities occurred or will occur. The Division Chief may waive the five-day written notice requirement if the licensee submits a written report containing this information within 15 days of the time the licensee becomes aware of the circumstances.

{R 299.9521(1)(a) and R 299.9607 and 40 CFR §270.30(l)(6)}

6. The licensee shall report all other instances of noncompliance with this license, Part 111 of Act 451, the rules, and any other applicable environmental laws or rules that apply to the licensed facility, at the time monitoring reports required by this license are submitted or within 30 days, whichever is sooner. The reports shall contain the information listed in Condition II.I.5. of this license. {R 299.9521(1)(a) and 40 CFR §270.30(l)(10)}

7. The licensee may make minor modifications to the forms contained in the attachments to this license. The modifications may include changing the format, updating existing references and information, adding necessary information, and changing certification and notification information in accordance with Part 111 of Act 451 and its rules and RCRA and its regulations. The licensee shall submit the modifications to the Division Chief prior to implementing the use of the modified form(s). If the Division Chief does not reject or require revision of the modified form(s) within 14 days of receipt, the licensee shall implement use of the modified form(s) and the form(s) shall be incorporated into this license as a replacement for the existing form(s).

J. **CLOSURE**

The licensee shall comply with the closure requirements of R 299.9613. The licensee shall close the facility in accordance with the Closure Plan, Attachment 5, of this license, all other applicable requirements of this license, and all other applicable laws. {R 299.9613 and 40 CFR Part 264, Subpart G, except 40 CFR §§264.112(d)(1), 264.115, and 264.120}

K. **POSTCLOSURE**

The licensee shall comply with the postclosure monitoring requirements of R 299.9613 and monitor and maintain the facility in accordance with the Postclosure Plan, Attachment 6, of this license. The licensee shall submit a certification of postclosure in accordance with R 299.9613(5). {R 299.9613 and 40 CFR §§264.116 through 264.119}]

L. **FINANCIAL ASSURANCE FOR CLOSURE**

1. On the effective date of this license, the facility closure cost estimate is $8,975,765. The licensee shall keep this estimate current as required under R 299.9702 and 40 CFR §264.142.

2. The licensee shall continuously maintain financial assurance for the current closure cost estimate as required under R 299.9703.

M. **FINANCIAL ASSURANCE FOR POSTCLOSURE**

1. On the effective date of this license, the facility postclosure cost estimate is $9,791,490. The licensee shall keep this estimate current as required under R 299.9702 and 40 CFR §264.144.

2. The licensee shall continuously maintain financial assurance for the current postclosure cost estimate as required under R 299.9703.

N. **FINANCIAL ASSURANCE FOR CORRECTIVE ACTION**

On the effective date of this license, the cost of performing any corrective action at the facility is currently unknown. If at any time during the operation or postclosure of the facility it is determined that corrective action work is needed, then at each phase of the corrective action process as defined in Part VI of this License, the facility must develop and maintain current financial assurance for corrective action as required under R 299.9712 and R 299.9713.

O. **FINANCIAL REPSONSIBILITY FOR LIABILITY COVERAGE**

The licensee shall continuously maintain liability coverage for sudden and accidental occurrences and nonsudden accidental occurrences, as required by R 299.9710.

P. **WASTE MINIMIZATION**

The licensee shall certify, at least annually, that the licensee has a hazardous waste minimization program in place. {R 299.9609(1)(a), 40 CFR §264.73(b)(9) and §3005(h) of RCRA, and 42 U.S.C. §6925(h)}

Q. **LAND DISPOSAL RESTRICTIONS**

The licensee shall comply with all of the requirements of 40 CFR Part 268. {R 299.9627 and 40 CFR Part 268}

R. **AIR EMISSION STANDARDS**

The licensee shall notify the Division Chief of any waste management units that become subject to the requirements of 40 CFR Part 264, Subparts AA, BB, and/or CC within 30 days of the start of the regulated activity.

{R 299.9630, R 299.9631, and R 299.9634 and 40 CFR Part 264, Subparts AA, BB, and CC}

S. **DOCUMENTS TO BE MAINTAINED AT THE FACILITY**

The licensee shall maintain at the facility the following documents and amendments required by this license, until closure/postclosure is completed and certified by an independent registered professional engineer, and the facility is released from financial assurance requirements for closure/postclosure by the Director:

1. Waste Analysis Plan, including Quality Assurance/Quality Control (QA/QC) Plans.
2. Inspection Schedules and records.
3. Personnel Training Program documents and records.
4. Contingency Plan.
5. Closure and Postclosure Plans.
6. Cost estimates for facility closure, postclosure, and copies of related financial assurance documents.
7. Operating record.
8. Site Security Plan.
9. Facility engineering plans and specifications.
10. Record keeping procedures.
11. Environmental monitoring plans, including Sampling and Analysis Plans and QA/QC Plans.
12. Environmental monitoring data and statistical records.

13. Preventative procedures (Personnel Protection Plan).
14. Hazardous waste minimization program certification.
15. Standard Operating Procedures

{R 299.9521(3)(a)}

T. ENGINEERING PLANS AND CONSTRUCTION

1. The licensee shall construct, operate, and maintain the facility in accordance with the Engineering Plans, Attachment 7, of this license, and any modifications to those plans shall be made in accordance with this license.

2. Within 90 days of the effective date of this license, the licensee shall submit engineering plans for the design of the new haul road from the unloading tank to Master Cells (MC) VI F and G for review and approval. Upon approval the plans will become part of Attachment 7.

3. The licensee shall provide quarterly progress reports during construction regarding the engineering plans and specifications approved under this license to the Division Chief. The first report shall be submitted within 90 days of issuance of this license and then every 90 days thereafter until submission of the final as-built plans and construction certification documents. The licensee shall provide documentation regarding completion of the engineering modifications approved under this license, including a report, as-built drawings, equipment specifications, and updated certifications of construction and capability, to the Division Chief for review and approval in accordance with Condition IV.C. of this license. {R 299.9521(3)(b)}

PART III
TANK SYSTEM STORAGE CONDITIONS

A. COVERAGE OF LICENSE

The hazardous waste unloading tank system storage area at the facility shown in Drawings C-100 through C-106 is covered by this license. Any expansion or enlargement beyond the facility boundary or beyond the 1,000 cubic yards tank system storage design capacity requires a new expansion license from the Director. Drawings C-100 through C-106 are incorporated into this license as part of Attachment 7. {R 299.9521(1)(b)}

B. WASTE IDENTIFICATION AND QUANTITY

The licensee may store no more than a total volume of 1,000 cubic yards of the hazardous wastes listed in the Acceptable Wastes Types, Attachment 8, of this license in the tank system identified as Transfer Box in Attachment 7, subject to the terms of this license. {R 299.9521(2)(d)}

C. DESIGN, CONTAINMENT, AND ASSESSMENT OF TANK SYSTEMS

The licensee shall construct, operate, and maintain all tank systems in accordance with the applicable requirements of R 299.9615, 40 CFR §§264.192, 264.193, and 264.194, and in accordance with the attached plans and specifications in Attachment 7 of this license.

D. MANAGEMENT OF TANK SYSTEMS

The licensee shall label and manage the tank systems in accordance with the requirements of R 299.9615 and R 299.9627, 40 CFR §§264.194, 264.196, and 268.50(a)(2)(ii), and R 29.4101 to R 29.4504 pursuant to the provisions of the Fire Prevention Act, 1941 PA 207, as amended, National Fire Protection Association (NFPA) Standard No. 704. The licensee may add non-biodegradable sorbent, cement kiln dust, or lime in the unloading tank to improve the structural consistency of received waste that is not optimum for placement and compaction in the landfill.

E. PROHIBITION ON STORING IGNITABLE OR REACTIVE WASTES OR MATERIALS

The licensee is prohibited from storing ignitable or reactive wastes or materials in tank systems at the facility. {R 299.9521(2)(d) and (3)(b)}]

F. PROHIBITION ON STORAGE OF INCOMPATIBLE WASTES OR MATERIALS

The licensee shall not place incompatible wastes, or incompatible wastes and materials, in the same tank system or place hazardous waste in a tank system that has not been decontaminated and that previously held an incompatible waste or material {R 299.9609 and R 299.9615 and 40 CFR §§264.17(c), 264.73(b)(3), and 264.199}

G. DISPOSITION OF ACCUMULATED LIQUIDS

The licensee shall remove spilled or leaked waste and accumulated precipitation from the tank system within 24 hours of detection and manage it in accordance with the requirements of Part 111 of Act 451 and the rules. {R 299.9521(3)(b) and R 299.9615 and 40 CFR §264.193(c)(4)}

PART IV
LANDFILL DISPOSAL CONDITIONS

A. COVERAGE OF LICENSE

The hazardous waste landfill and related appurtenances (piping, pumps, operation and maintenance buildings, etc.) at the facility shown in General Site Plan Drawing 02 are covered by this license. The capacity of the currently constructed landfill is 10.72 million cubic yards and the proposed additional capacity is 11.73 million cubic yards. Any expansion or enlargement beyond the total design capacity of 22.45 million cubic yards or beyond the area shown in General Site Plan Drawing 02 requires a new expansion license from the Director. General Site Plan Drawing 02 and the attached plans and specifications are incorporated into this license as Attachment 7. {R 299.9521(1)(b)}

B. WASTE IDENTIFICATION AND QUANTITY

1. The licensee, except to the extent prohibited under Condition IV.B.3. below, may dispose a total volume of 22.45 million cubic yards of hazardous and compatible nonhazardous waste in the landfill, subject to the terms of this license. The license shall not dispose of any hazardous waste not listed in Attachment 8 of this license, unless the Division Chief approves the disposal of such waste types through an amendment to this license. {R 299.9521(2)(d)}

2. The licensee, except to the extent prohibited under Condition IV.B.3., below, may dispose of polychlorinated biphenyl (PCB) wastes listed in Attachment 8 of this license. This license constitutes authorization pursuant to Part 147, PCB Compounds, of Act 451 to dispose of PCB wastes. The licensee must also obtain written approval from the U.S. Environmental Protection Agency (U.S. EPA) pursuant to the federal Toxic Substances Control Act (TSCA) prior to disposing of any PCB waste in MCs VI F and G of the landfill.

3. The licensee shall not accept for disposal any hazardous waste not listed in Attachment 8 of this license or any incompatible nonhazardous wastes or materials that meet any of the following criteria {R 299.9521(2)(d)}:

   (a) Ignitable wastes as described in R 299.9212(1). {R 299.9619}

   (b) Reactive wastes as described in R 299.9212(3). {R 299.9619}

   (c) Bulk or noncontainerized liquid waste or waste containing free liquids. {R 299.9619(2) and 40 CFR §264.314(b)}

   (d) Containers holding free liquids. {R 299.9619(5) and 40 CFR §264.314(d)}

   (e) Waste that will:

      (i) Adversely affect the permeability of the clay liner. {R 299.9521(3)(b), R 299.9619, and R 299.9620 and 40 CFR §264.301}

      (ii) Produce a leachate that is incompatible with the clay liner, leachate collection system piping, or the off-site sewer system. {R 299.9521(3)(b), R 299.9619, and R 299.9620(3) and 40 CFR §264.301}

      (iii) Generate gases that will adversely affect the permeability of the clay cap or create a violation of Part 55, Air Pollution Control, of Act 451. {R 299.9602 and R 299.9619(5)(c)}

R 299.9619(5)(c)}

4. The licensee shall provide a written notification to the transportation companies that deliver to the facility that:

   (a) Wastes shipped to the facility must be placed in closed containers or otherwise totally contained or covered during transportation.

   (b) All trucks transporting hazardous waste to or from the facility shall use Rawsonville Road to enter and exit the facility.

   (c) Trucks transporting hazardous waste to or from the facility shall not park or stand on the I-94 Service Drive.

5. All containers on site shall be closed or otherwise totally contained or covered unless they are being sampled and/or visually inspected or in the process of being filled or emptied. {R 299.9521(3)(b)}

C. **DESIGN, CONSTRUCTION, AND RUN-ON, RUNOFF, AND CONTAMINANT CONTROL**

1. The licensee shall construct and maintain a liner system in accordance with the engineering plans and specifications in Attachment 7 of this license and R 299.9619, R 299.9620, R 299.9621, and R 299.9622. {R 299.9619, R 299.9620, R 299.9621, and R 299.9622 and 40 CFR §§264.301 and 264.303}

2. The licensee shall submit a certification for each phase of the construction of MCs VI F and G. No waste shall be placed in a newly-constructed portion of MCs VI F and G until the certification is approved by the Chief of the Hazardous Waste Section.

3. The licensee shall submit post construction documentation to the Division Chief following construction of each phase of the expanded facility pursuant to § 11125 of Part 111 of Act 451, as amended.

3. The licensee shall insure that all uncovered portions of the constructed liners, leak detection systems, and leachate collection systems are adequately protected from vegetation, desiccation, clogging, freeze-thaw effects, weathering, and all other deterioration processes. {R 299.9619 and R 299.9620 and 40 CFR §§264.301 and 264.303}

4. The licensee shall have a licensed professional engineer inspect any portions of the natural or recompacted clay not protected from weathering for more than 90 days and the leachate collection system not protected from clogging and weathering for more than 90 days. If repair is necessary the engineer shall specify repair of any areas in accordance with the approved plans and specifications where he or she determines by visual inspection that desiccation, erosion, clogging, or weathering has occurred to the extent that the design specifications are no longer met. The results of these inspections shall be maintained in accordance with Condition II.I. of this license. {R 299.9619, R 299.9620, R 299.9621, and R 299.9622 and 40 CFR §§264.301 and 264.303}

5. All areas repaired in accordance with Condition IV.C.4. of this license must be recertified by a licensed professional engineer. The licensee shall submit the recertification to the Division Chief. {R 299.9619, R 299.9620, R 299.9621, and R 299.9622 and 40 CFR §§264.301 and 264.303}

6. The licensee shall operate and maintain a run-on control system capable of preventing storm water flow onto the active portions of the landfill during peak discharge from at least a 24-hour, 25-year storm, as specified in the approved Storm Water Management System Evaluation Report and in accordance with the Storm Water Management Standard Operating Procedure (SOP) approved by the Hazardous Waste Section Chief and as depicted in Figures 2A and 2B of that report. {R 299.9604(1)(a)}

7. The licensee shall operate and maintain a runoff management system to collect and control the storm water volume resulting from at least a 24-hour, 100-year storm, as specified in the approved Storm Water Management System Evaluation Report and in accordance with the Storm Water Management SOP approved by the Hazardous Waste Section Chief and as depicted in Figures 2A and 2B of that report. {R 299.9604(1)(a)}

8. The licensee may not install interim and final cover and other structures authorized by the Division Chief in the course of normal landfill operations until receiving:

   (a) A license modification authorizing a change or changes in the storm water runoff management system; or

   (b) Division Chief approval of a closure plan report submitted pursuant to this license that demonstrates that all detectable levels of PCBs in soil and/or sediments have been removed from Area A (Figure 1 of Attachment 11 of this license) and paved areas; that demonstrates that PCBs in soils and/or sediments in Area A have been remediated to meet an approved site specific cleanup criteria established by the licensee pursuant to Part 201, Environmental Remediation, of Act 451 and that all detectable levels of PCBs have been removed from paved areas; or that the untreated discharge of storm water from Area A and paved areas at the facility comply with Part 31, Water Resources Protection, of Act 451. {R 299.9602 and R 299.9604}

9. The licensee shall maintain an effective National Pollutant Discharge Elimination System (NPDES) permit for the storm water discharge that requires the treatment of Area A and Area B (Figure 1 of Attachment 11 of this license) storm water to remove any PCBs prior to discharge to Quirk Drain. The licensee shall notify the Division Chief at least 60 days in advance of any proposal to remove the requirement to treat the Area A and/or Area B storm water to remove any PCBs prior to discharge to Quirk Drain. Concurrently, the licensee shall submit a license modification to the Division Chief establishing alternate systems to prevent PCBs from the Area A and/or Area B watersheds from being discharged uncontrolled to off-site surface waters. Nothing in this license should be construed by the licensee to authorize any violation of Part 31 of Act 451.

10. The licensee shall notify the Division Chief at least 60 days in advance of any proposal to remove any sediment or surface water sampling locations from the Pollution Minimization Plan (PMP) enforceable under the effective NPDES permit. Concurrently, the licensee shall submit a license modification to the Division Chief requesting that the license be revised to incorporate any sampling locations removed from the PMP into the appropriate monitoring programs of this license as a minor modification.

11. The licensee shall expeditiously empty or otherwise manage collection and holding facilities (e.g., tanks or catch basins) associated with run-on and runoff control systems after storms to maintain the design capacity of the system. {R 299.9619 and 40 CFR §264.301(h)}

12. The licensee shall cover or otherwise manage the landfill to control dispersal of particulate matter in accordance with a Fugitive Dust SOP approved by the Hazardous Waste Section Chief. The daily cover shall consist of ConCover 180, at least 15 centimeters of clean soil, or an equivalent other material approved by the Division Chief. {R 299.9619 and 40 CFR §264.301(i)}

13. The licensee shall monitor wind speed and direct the placement of waste in accordance with a Wind Speed SOP approved by the Hazardous Waste Section Chief.

14. The licensee shall operate and maintain a vehicle wash facility. The licensee shall ensure that all vehicles traveling on active portions of the site are cleaned and decontaminated at this facility before leaving the active area. {R 299.9521(3)(b)}

15. The licensee shall operate all vehicles in a manner that will minimize the contamination of internal haul roads in accordance with a Trackout SOP approved by the Hazardous Waste Section Chief. {R 299.9521(3)(b) and R 299.9604(1)(c)}

16. The licensee shall operate and maintain a leachate collection and removal system in accordance with R 299.9619, 40 CFR §264.301(a)(2), and the plans and specifications in Attachment 7 of this license. The leachate captured by this system shall be treated as necessary and discharged to the municipal sewer system in accordance with the applicable pretreatment standards. The licensee shall request a minor modification in accordance with R 299.9519 for any equipment replacement or upgrading with functionally equivalent elements of the system that is not being performed as part of routine maintenance of the system.

17. The licensee shall operate and maintain a contact water collection and removal system in accordance with the plans and specifications in Attachment 7 of this license. The contact water captured by this system shall be treated as necessary and discharged to the municipal sewer system in accordance with the applicable pretreatment standards. The licensee shall request a minor modification in accordance with R 299.9519 for any equipment replacement or upgrading with functionally equivalent elements of the system that is not being performed as part of routine maintenance of the system.

18. The licensee shall operate and maintain the leachate and contact water collection and removal systems in MC VI-ESE in accordance with a 6E-SE Leachate and Contact Water System SOP approved by the Hazardous Waste Section Chief.

19. The licensee shall conduct all construction and maintenance activities in accordance with an Earthwork Clearance SOP approved by the Hazardous Waste Section Chief.

20. The licensee shall maintain the leak detection and collection system (LDCRS) in accordance with a LDCRS Riser Maintenance SOP approved by the Hazardous Waste Section Chief.

21. With the initiation of construction on each new phase of MCs VI F and G, or more frequently if necessary, the licensee shall evaluate each of the following SOPs to determine if they require revisions to reflect the current landfill operation; Stormwater Management, Fugitive Dust, Wind Speed, Trackout, Contact Water System, LDCRS Riser Maintenance, and Earthwork Clearance. If revision of any of the SOPs is required they shall be submitted within 60 days of the initiation of that construction to the Hazardous Waste Section Chief for approval.

D. **WASTE PLACEMENT**

1. The licensee shall ensure that the placement of all hazardous waste in the landfill is conducted in accordance with 40 CFR §§264.17(b), 264.313, 264.315, and 264.316. If containers of hazardous waste are crushed at the facility, the containers shall be crushed only inside the active landfill cell. {R 299.9521(2)(d) and (3)(b) and R 299.9619}

2. The licensee shall record the contents, quantity, and location of each daily waste deposit and place this documentation in the operating record. This information shall be recorded on a map or diagram of the landfill and shall include cross references to specific manifest document numbers, if the waste was accompanied by a manifest. {R 299.9609 and R 299.9619 and 40 CFR §§264.73(b)(2) and 264.309}

3. After waste placement reaches the grade of the perimeter of the active landfill cell, the licensee shall annually survey and record the elevations of waste in the cell to insure that final grades as shown in Drawing 7 in Attachment 7 of this license are not exceeded. The results of the survey shall be submitted to the Division Chief within 30 days of completion of the survey. {R 299.9521(1)(b) and (3)(a)}

4. The licensee shall only place macroencapsulated waste in the landfill in accordance with "special burial" procedures approved in writing by the Division Chief.

E. **CLOSURE**

1. The licensee shall complete closure in accordance with the engineering plans and specifications and the construction quality assurance plan in the approved Closure Plan, Attachment 5, of this license. {R 299.9613 and R 299.9619(1) and (5) and 40 CFR §264.310}

2. The licensee shall notify Division, Southeast Michigan District staff, and Lansing Hazardous Waste Section staff, at least one week in advance of key events, to enable staff to be present to observe and/or take samples during the final cover placement activities. Key events include test fill construction, placement of clay liner, placement and seaming of synthetic liner, and placement of drainage media and topsoil. {R 299.9521(1)(a) and (3)(a) and 40 CFR §270.30(i)}

3. The licensee shall construct the clay component of the final cover by using the same materials, equipment, and methods used in constructing the test fill. If the materials, equipment, or methods change significantly, a new test fill shall be constructed. {R 299.9521(3)(a) and (b), R 299.9619(5), R 299.9620, and R 299.9621}

4. After completion of the final cover, the licensee shall survey the benchmarks and final cover once every two years. A contour map of the final cover shall be submitted to the Division within 30 days of the completion of the survey. {R 299.9619 and 40 CFR §264.310(b)(1), (5), and (6)}

F. **ADDITIONAL REPORTING**

The licensee shall submit an annual inspection and maintenance summary report to the Division by March 1st of each year during the active life of the landfill and the postclosure care period. The annual inspection and maintenance report shall include a summary of all maintenance activities performed by the licensee to maintain the integrity of the active landfill and the final cover of closed cells such as mowing, fertilization, and liming and a copy of the associated inspection logs.

{R 299.9521(2)(a) and (b) and 40 CFR §270.31}

PART V
ENVIRONMENTAL MONITORING CONDITIONS

A. GROUNDWATER MONITORING PROGRAM

1. The licensee shall conduct a detection monitoring program in the glacial sand and bedrock aquifers for primary, secondary, tertiary, and field monitoring parameters. Under this program, the licensee shall operate and maintain a groundwater monitoring system in accordance with the Groundwater Monitoring Program Sampling and Analysis Plan (GWMP SAP), Attachment 9, of this license. {R 299.9611(2)(a) and (b), R 299.9612, and R 299.9629 and 40 CFR Part 264, Subpart F, excluding 40 CFR §§264.94(a)(2) and (3), 264.94(b) and (c), 264.100, and 264.101}

2. With the initiation of construction on each new phase of MCs VI F and G, or more frequently if necessary, the licensee shall evaluate the monitoring locations specified in the GWMP SAP to determine if any additional monitoring wells are required to be installed or any existing monitoring wells need to be decommissioned. If revision of the GWMP SAP is required it shall be submitted within 60 days of the initiation of that construction to the Hazardous Waste Section Chief for approval as a minor license modification.

3. All new monitoring wells shall be installed and constructed in accordance with American Society of Testing and Materials (ASTM) standard D5092-90 or a plan approved by the Director. Any monitoring well that must be decommissioned shall be done in accordance with ASTM standard D5299-92 or a plan approved by the Director. {R 299.9612(1)(b)}

4. Water removed from each monitoring well shall be managed as specified in Section VI of Attachment 9 of this license. {R 299.9521(3)(b)}

5. The licensee shall submit an annual groundwater report to the Division Chief no later than March 1st of each year for the previous calendar year's activities. At a minimum, the report shall include the following information:

   (a) A narrative summary of the previous calendar year's sampling events, including sampling event dates, the identification of any significant problems with respect to GWMP SAP procedures, a summary of newly-installed and/or decommissioned monitoring wells, and copies of field log sheets.

   (b) A determination of the groundwater flow rate and direction in the monitored zones (drift aquifer, and bedrock aquifer), including the preparation of a groundwater level contour map from this data.

   (c) A summary evaluation of groundwater quality data results, including narrative, tabular, and graphical summaries of results and trends of primary, secondary, and tertiary parameters, and a summary of current background concentrations of applicable parameters.

   (d) A presentation of the statistical analysis of the data and the identification of any statistically significant increases (and/or pH decreases) pursuant to Condition V.A.7 of this license.

   (e) An analysis and discussion of laboratory and field related QA/QC information. This shall include results of equipment, field, and trip blanks and a discussion and evaluation of the adequacy of the data with respect to the GWMP SAP specifications and requirements.

{R 299.9521(3)(b) and R 299.9612(1) and 40 CFR, §264.97(j)}

6. The licensee shall establish background groundwater quality values at monitoring wells as specified in Section 3.0 of Attachment L of Attachment 9 of this license. {R 299.9612(1)(c), (d), and (e) and 40 CFR §264.97(a) and (g)}

7. Within 60 days after each sampling of each monitoring well, the licensee shall determine if a statistically significant increase (or change in pH) has occurred compared to background levels for each primary and secondary parameter listed in Attachment H of Attachment 9 of this license. For the primary parameters, any occurrence above the laboratory detection limit(s) for the parameters shall be considered statistically significant. {R 299.9612(1)(c) and (e) and 40 CFR §264.97(h) and (i)}

8. If a statistically significant increase (or change in pH) is detected for any primary or secondary parameter, the licensee shall notify the Division, Hazardous Waste Section, Permit and Corrective Action Unit, by telephone within one working day and arrange a resampling as soon as possible to confirm if a statistically significant increase (or change in pH) exists. Resampling must include not less than four replicate samples at the affected well(s) for the parameter(s) in question. For the primary and any other nonnaturally occurring parameters, a statistically significant increase shall be confirmed if at least two of the four resample results are detected above the laboratory detection limit(s) for the parameter(s), or if at least one of the resample results is detected at five times the laboratory detection limit. For the naturally occurring secondary parameters, a statistically significant increase shall be confirmed using the average concentration of the four confirmation samples as the analytical result in the statistical procedures specified in Attachment L of Attachment 9 of this license. {R 299.9612 and 40 CFR §264.97(g)}

9. If the licensee determines pursuant to Conditions V.A.7. and V.A.8. of this license that a statistically significant increase has been confirmed for any primary parameter, the licensee shall address the increase in accordance with the requirements specified in R 299.9612 and 40 CFR §264.98(f) and (g). Additionally, the licensee shall:

   (a) Within 1 working day, notify the Division Chief or the appropriate Division Supervisor, or if unavailable, the DEQ Pollution Emergency Alerting System (PEAS) at 1-800-292-4706.

   (b) Immediately take steps to determine the cause of the contamination and eliminate the source of discharge.

   (c) Prior to a license modification requiring a compliance monitoring and corrective action, the licensee shall provide the Division Chief, or his or her designee, with weekly telephone updates and written reports every two weeks regarding the progress to date in determining the cause of contamination and eliminating the discharge. The written report shall include the results of all samples from environmental monitoring conducted by the licensee. {R 299.9521(3)(b)}

   (d) Within 90 days after the confirmation of a statistically significant increase, submit to the Division Chief an application for a license modification to establish a compliance monitoring or corrective action meeting the requirements of R 299.9612 and 40 CFR §264.98(g)(4).

(e) Within 180 days after the determination, submit to the Division Chief a detailed description of corrective actions that shall achieve compliance with applicable laws and rules, including a schedule of implementation. Corrective action shall also meet the requirements of R 299.9629 and include a plan for a groundwater monitoring program that shall demonstrate the effectiveness of the corrective action. Such a groundwater monitoring program may be based on a compliance monitoring program developed to meet the requirements of 40 CFR §264.99.

(f) If the licensee determines pursuant to Conditions V.A.7. and V.A.8. of this license that a statistically significant increase in primary parameters has been confirmed in groundwater, the licensee may demonstrate that a source other than the licensed facility or an error in sampling, analysis, or evaluation solely caused the identification of a statistically significant increase. While the licensee may make a demonstration under this condition in addition to, or in lieu of, submitting a license modification application and implementing corrective action within the time specified in Conditions V.A.9.(d) and V.A.9.(e) of this license, the licensee is not relieved of the requirement to submit a license modification application and implement corrective action within the time specified, unless the DEQ finds that the demonstration made under this condition successfully shows that a source other than the licensed facility caused the statistically significant increase or that the statistically significant increase resulted from an error in sampling, analysis, or evaluation. In making a demonstration under this condition, the licensee shall:

(i) Notify the Division Chief in writing within 7 days of determining a statistically significant increase pursuant to Condition V.A.9. of this license that it intends to make a demonstration under this condition.

(ii) Within 60 days after determining that a statistically significant increase has occurred pursuant to Conditions V.A.7. and V.A.8. of this license, submit a report to the Division Chief that demonstrates a source other than the licensed facility solely caused the statistically significant increase, or that the statistically significant increase was caused by an error in sampling, analysis, or evaluation.

(iii) Continue to monitor groundwater in compliance with this license.

10. If the licensee determines pursuant to Conditions V.A.7. and V.A.8. of this license that a statistically significant increase (or change in pH) has occurred for any secondary parameter, the licensee shall address the increase (or change in pH) in accordance with the requirements specified in R 299.9612. Additionally, the licensee shall:

(a) Immediately take steps to determine the cause of contamination and eliminate the source of the discharge.

(b) Within 60 days after the determination, submit to the Division Chief a detailed report that explains the chronology of events, investigative methods, all laboratory analyses, calculations, field activities, and findings related to this determination.

(c) The licensee may demonstrate that a source other than the licensed facility or an error in sampling, analysis, or evaluation solely caused the identification of a statistically significant increase. In making a demonstration under this condition, the licensee shall:

(i) Notify the Division Chief in writing within 7 days of determining a statistically significant increase pursuant to Condition V.A.9. of this license that it intends to make a demonstration under this condition.

(ii) Within 60 days after determining that a statistically significant increase has occurred pursuant to Conditions V.A.9. and V.A.8. of this license, submit a report to the Division Chief that demonstrates a source other than the licensed facility solely caused the statistically significant increase, or that the statistically significant increase was caused by an error in sampling, analysis, or evaluation.

(iii) Continue to monitor groundwater in compliance with this license.

11. In the event that the Division Chief determines from the findings of Conditions V.A.7 and V.A.8 of this license that a statistically significant increase (or change in pH) in hazardous constituents has occurred in the groundwater, and the Director finds, in accordance with § 11148 of Act 451, that the increase (or change in pH) may present an imminent and substantial hazard to the health of persons or to the natural resources, or is endangering or causing damage to public health or the environment, the licensee shall immediately comply with an order issued by the Director pursuant to § 11148(1) of Act 451 to cease waste receipt, storage, and treatment at the affected units and conduct other activities as required by the Director to eliminate the said endangerment. {R 299.9612(1)(g)}

12. The licensee shall report all groundwater detection monitoring and hydraulic monitoring results as required by Condition II.I.3 of this license. This information shall be signed and certified in accordance with Condition I.D.3. of this license.

B. **AMBIENT AIR MONITORING PROGRAM**

1. The licensee shall conduct ambient air monitoring in accordance with the program specified in the Ambient Air Monitoring Program Sampling and Analysis Plan, Attachment 10, of this license. {R 299.9611(2)(c)}

2. The licensee shall report ambient air monitoring results as required by Condition II.I.3. of this license. This information shall be signed and certified in accordance with Condition I.D.3. of this license.

C. **SOIL MONITORING PROGRAM**

1. The licensee shall conduct a semiannual corrective action soil monitoring program for PCBs in Area A and a detection soil monitoring program for PCBs in Area B as specified in the Soil Monitoring Program Sampling and Analysis Plan (SM SAP), Attachment 11, of this license.

2. With the initiation of construction on each new phase of MCs VI F and G, or more frequently if necessary, the licensee shall evaluate the soil monitoring locations specified in the SM SAP to determine if any additional soil monitoring locations are required to be added or removed. If revision of the SM SAP is required it shall be submitted within 60 days of the initiation of that construction to the Hazardous Waste Section Chief for approval as a minor license modification. {R 299.9611(2)(d)}

3. Within 60 days of each soil sampling event, the licensee shall determine if an apparent threshold limit exceedance (ATLE) for PCBs has occurred as specified in Section 7.0 of

3. If an ATLE for PCBs is detected, the licensee shall verbally notify the Division, Hazardous Waste Section, Permit and Corrective Action Unit, within 1 working day and collect verification samples within 7 working days to determine if a confirmed threshold limit exceedance (CTLE) for PCBs has occurred as specified in Section 8.0 of Attachment 11 of this license.

4. If it is determined that a CTLE for PCBs has occurred pursuant to Conditions V.C.3. and V.C.4. of this license, the licensee shall:

   (a) Take immediate steps to eliminate the source of the contamination and prevent further releases.

   (b) Within 1 working day after the determination, verbally notify the Division, Hazardous Waste Section, Permit and Corrective Action Unit.

   (c) Within 5 days after the determination, submit a written report to the Division, Hazardous Waste Section, Permit and Corrective Action Unit, that includes the findings from the resampling and a map showing the proposed locations for collecting delineation phase samples as specified in Section 8.0 of Attachment 11 of the license.

   (d) Within 14 days after the determination, collect the first phase of delineation samples to determine the extent of the areas exceeding the CTLE as specified in Section 8.0 of Attachment 11 of this license.

   (e) Within 14 days after receiving the delineation phase sampling results, evaluate the data and submit a plan to remove soils/sediments and to determine the source(s) or expected source(s) of the PCBs to the Division, Hazardous Waste Section, Permit and Corrective Action Unit, as specified in Section 8.0 of Attachment 11 of this License.

   (f) Contaminated soils/sediments shall be properly characterized and managed as waste in accordance with Part 3 of the Part 111 Rules, and cleanup to the levels specified in Section 7.0 of Attachment 11 of this License shall be verified by soil sampling. Any nonhazardous soils/sediments containing 5 parts per million (ppm) or less of PCBs shall be disposed of at a licensed solid waste disposal facility or in a WDI licensed hazardous waste cell. Any soils/sediments containing more than 5 ppm of PCBs or that are hazardous waste shall be disposed of at a licensed hazardous waste facility. Any soil/sediments containing more than 50 ppm of PCBs shall be disposed at a TSCA authorized facility. The waste characterization records shall be maintained for a minimum of 3 years from the date of disposal. The licensee shall maintain a log at the facility for any soil/sediments that are disposed of in the WDI hazardous waste disposal cell providing the date and amount excavated, the date and location within the cell where they were disposed, and sufficient information to locate the waste characterization data maintained by the licensee.

   (g) Within 60 calendar days after determining that a CTLE has occurred, implement the plan required in Condition V.C.5(e) and submit a final report to the Division, Hazardous Waste Section, Permit and Corrective Action Unit that includes:

      (i) The chronology of events.

      (ii) Investigative methods.

(iii) All laboratory analyses.

(iv) Calculations.

(v) Field activities related to the determination.

(vi) The corrective measures/remedies.

5. The licensee shall report all soil monitoring results as required by Condition II.I.3 of this license. This information shall be signed and certified in accordance with Condition I.D.3. of this license.

D. **SURFACE WATER MONITORING PROGRAM**

1. The licensee shall conduct a quarterly surface water detection monitoring program as described in the Surface Water Monitoring Program Sampling and Analysis Plan (SW SAP), Attachment 12, of this license.

2. With the initiation of construction on each new phase of MCs VI F and G, or more frequently if necessary, the licensee shall evaluate the surface water monitoring locations specified in the SW SAP to determine if any additional surface water monitoring locations are required to be added or removed. If revision of the SW SAP is required it shall be submitted within 60 days of the initiation of that construction to the Hazardous Waste Section Chief for approval as a minor license modification. {R 299.9611(5)}

3. Within 60 days of each sampling event, the licensee shall determine if an apparent statistically significant increase (ASSI) has occurred as specified in Section 7.0 of Attachment 12 of this license.

4. Duplicate samples shall be collected at each sampling location for volatile organics, PCBs, and metals. Initially, the licensee is required to analyze only one of the two samples. The licensee shall hold the duplicate sample pending the results of the initial sample. The duplicate sample for PCBs shall be extracted when it arrives at the laboratory and the extract held in case a confirmation analysis is required. If a statistically significant increase is detected in a monitoring parameter(s), the duplicate sample/sample extract shall be analyzed for confirmation purposes.

5. If an ASSI is detected, the licensee shall verbally notify the Division, Hazardous Waste Section, Permit and Corrective Action Unit, within one working day and determine if a confirmed statistically significant increase (CSSI) has occurred as specified in Section 8.0 of Attachment 12 of this license.

6. Within 30 days of a determination that a CSSI has occurred pursuant to Conditions V.D.3. and V.D.5. of this license, the licensee shall determine whether a discharge of hazardous waste and/or hazardous waste constituents to off-site surface waters is occurring, determine the source, and take immediate steps to eliminate and prevent any such discharge. If a discharge of PCBs to off-site surface water occurs the licensee shall implement the Contingency Plan, Attachment 4, of this license, unless the discharge is specifically authorized by and is in compliance with the effective NPDES permit for the facility.

7. Within 60 days of a determination that a CSSI has occurred pursuant to Conditions V.D.3. and V.D.5. of this license, the licensee shall submit a written report to the Division Chief documenting the investigation, response, and any proposed actions to prevent future releases.

8. The licensee shall report surface water monitoring results as required by Condition II.I.3. of this license. This information shall be signed and certified in accordance with Condition I.D.3. of this license.

{R 299.9521(3)(a) and (b) and R 299.9611(5)}

E. **LEACHATE MONITORING PROGRAM**

1. With the construction on each new phase of MCs VI F and G, the licensee shall include additional leachate monitoring locations as defined in the Leachate Monitoring Program Sampling and Analysis Plan (LMP SAP) as new cells are certified and approved for disposal by the Hazardous Waste Section Chief. The revision of the LMP SAP shall be submitted at the time of the construction certification to the Hazardous Waste Section Chief for approval as a minor license modification.

2. The licensee shall measure the leachate level in each collection sump on a weekly basis and verify that the leachate pump and flow meter are operating properly during that field event. The procedures for conducting the inspection are specified in Section 3.0 of the LMP SAP, Attachment 13, of this license.

3. The licensee shall inspect the leachate collection sumps on a weekly basis for deterioration and/or damage and monitor the total monthly volume of leachate pumped from each collection sump and record this information on the operating record for the facility. {R 299.9609(1)(b) and R 299.9619(4)(c)(iii)}

4. The licensee shall jet out the leachate collection system through the leachate clean-out pipes once every two years, or more frequently if needed, to minimize blockage that could cause leachate to build up on the base of the disposal cells.

5. The licensee shall conduct an annual leachate monitoring program on each of the constructed and certified leachate collection sumps within MCs V, VI, and VII as described in the LMP SAP, Attachment 13, of this license.

    (a) Samples shall be collected in accordance with the procedures specified in the LMP SAP, Attachment 13, of this license, and they shall be analyzed for the parameters listed on Figure 7 of Attachment 13 of this license.

    (b) In addition to monitoring the leachate for the parameters identified in Condition V.E.5.(a), above, the licensee shall collect annual samples from two of the constructed and certified sump locations in MCs V, VI, and VII and analyze the samples for a modified 40 CFR Appendix IX parameters specified in Figure 8 of the Attachment 13 of this license. Following completion of the initial approximately 8-year cycle, the Appendix IX sampling shall continue on this schedule for each open cell.

    (c) If, based on the results of the modified Appendix IX monitoring required by Condition V.E.5.(b), it is determined that the leachate contains organic constituents other than those that are routinely monitored under Condition V.E.5.(a) of this license, the licensee shall submit a written report to the Division stating whether or not the parameter should be added to the leachate program. If, upon review of the report, the Division determines that the parameter is present in significant concentrations in the leachate and/or may pose a serious environmental hazard due to the nature of the constituent, the licensee shall be required to add the parameter to the annual leachate monitoring list, and it shall become a routine leachate indicator. In addition, any such parameters shall also be added to the groundwater, lysimeter, surface water, and leak detection monitoring programs as specified in Condition V.E.6.(b), below.

6. The licensee shall submit an annual leachate monitoring report to the Division by March 1st of each year during the active life of the landfill and the postclosure care period.

   (a) The annual leachate monitoring report shall be signed and certified in accordance with Condition I.D.3. of this license.

   (b) During the active life of the landfill, the annual leachate monitoring report shall summarize the results of the leachate analytical data that was collected at the facility and recommend any refinements deemed necessary to the leachate and the groundwater and leak detection/lysimeter monitoring programs. If the licensee determines that organic chemicals are newly present or present at increased concentrations in the leachate and a determination is made to add the parameter(s) to the leachate monitoring program, the parameters shall also be added to the groundwater and the leak detection monitoring programs, and they shall be sampled on at least an annual basis.

   (c) During the active life of the landfill and during the postclosure care period, the annual leachate monitoring report shall include:

      (i) Leachate volume calculations.

      (ii) A graphical presentation of the monthly and yearly quantities of leachate being generated and pumped from each leachate sump at the landfill.

      (iii) A graphical comparison between leachate quantities pumped/generated at each leachate sump during the reported year and the leachate quantities pumped/generated from previous years.

      (iv) Reasons for increases/decreases in leachate quantities at each leachate sump. If there is an increase in leachate quantities, the source shall be indicated in the leachate monitoring report.

7. The licensee shall report leachate monitoring results as required by Condition II.I.3. of this license. This information shall be signed and certified in accordance with Condition I.D.3. of this license.

{R 299.9521(3)(a) and (b) and R 299.9611(5)}

F. LEAK DETECTION SYSTEM MONITORING PROGRAM

1. With the construction on each new phase of MCs VI F and G, the licensee shall include additional leak detection monitoring locations as defined in the Leak Detection Monitoring Program Sampling and Analysis Plan (LDMP SAP) as new cells are certified and approved for disposal by the Hazardous Waste Section Chief. The revision of the LDMP SAP shall be submitted at the time of the construction certification to the Hazardous Waste Section Chief for approval as a minor license modification..

2. The licensee shall conduct a quarterly leak detection monitoring program as specified in the LDMP SAP, Attachment 14, of this license. In addition, the licensee shall:

   (a) Inspect each of the constructed and certified leak detection system sumps in MC VI on a weekly basis to confirm that the pump system is operating properly and that there is no evidence of damage or tampering that could allow waste or waste constituents to have entered the system. Information from this inspection shall be reported on the weekly/after storm inspection form required by Condition II.C.1. of this license.

   (b) Record the volume of liquid withdrawn from each of the constructed and certified leak detection system sumps in MC VI on a weekly frequency and analyze in the field the liquid from each of the leak detection system sumps in MC VI on a monthly frequency for pH and specific conductivity. This information shall be reported on the form that is included as Attachment C of Attachment 14 of this license.

   (c) If any sump yields volume measurements above the maximum expected volume, calculated as per Section 7.1 in Attachment 14 of this license, or conductance values exceed the mean plus three standard deviations, as calculated from the last eight conductance values, samples shall be collected from the affected sump and analyzed as soon as practicable for the full list of quarterly parameters specified in Condition V.F.3. of this license.

3. The licensee shall collect samples from the constructed and certified sump locations in MC VI on a quarterly basis and analyze the samples for the parameters listed in Attachment E of Attachment 14 of this license.

4. The background statistical value for the organic monitoring parameters is defined as the reported detection limit specified in Attachment E of Attachment 14 of this license.

5. If additional parameters must be added to the leak detection monitoring program in accordance with Condition V.E.5.(c) of this license, the licensee must provide written notification to the Division Chief requesting modification to the program. If background has not already been established for these additional parameters, the notification must include a proposed plan to determine background for these constituents on an accelerated schedule.

6. The licensee shall provide written notification to the Division Chief requesting any changes that need to be made to the approved LDMP SAP, Attachment 14, of this license and obtain written approval prior to implementation.

7. The licensee shall, within 60 calendar days of the sampling, report in writing to the Division Chief the laboratory data and the results from the statistical evaluation performed in accordance with Attachment 14 of this license.

8. If a statistically significant increase is detected in any of the monitored parameters, the licensee shall immediately notify the Division that this situation has occurred and arrange for a resampling as soon as possible to confirm if the statistical increase exists. If adequate water can be obtained from the system, confirmation samples shall be collected in quadruplicate.

9. If the licensee confirms that a statistically significant increase in a monitored parameter has occurred, the following actions must be taken:

   a. Immediately notify the Director by calling the Division Chief or the Division Southeast Michigan District Supervisor, in accordance with Condition II.I.5. of this license.

b. Provide follow-up notification to the Division Chief in writing within 5 calendar days of the telephone call in accordance with Condition II.I.6.(b) of this license.

c. Begin immediate action to implement the current Contingency Plan, as appropriate.

d. Determine, within 30 calendar days of notification, whether a failure in the liner system has occurred.

e. Provide the Division Chief, or his or her designee, with weekly telephone updates and written reports every two weeks regarding the progress to date in determining the cause of contamination and the results of all samples from environmental monitoring conducted by the licensee.

10. If the determinations made pursuant to Condition V.F.9.(d) of this license indicate a release of contaminants from the MC VI primary liner system, the licensee shall do either of the following:

a. Begin immediate action to repair failures in the liner system or otherwise correct the problem and demonstrate to the Division Chief within 72 hours that the action being taken will contain the release of contaminants and maintain the capability of the system to detect contaminants that may enter the leak detection system. The licensee shall complete the repair and corrective activities pursuant to a schedule approved by the Division Chief and shall obtain the certification of a registered professional engineer that, to the best of his or her knowledge or opinion, the remedial actions have been completed. If the Division Chief determines that the failure cannot be corrected on a schedule that insures the protection of human health and the environment, the licensee shall comply with Condition V.F.10.(b) of this license.

b. Cease placing waste into the affected area in MC VI and take action to prevent the migration of hazardous waste and hazardous waste constituents from the area on a schedule approved by the Division Chief, and propose a plan to address any environmental damages that may have occurred as a result of the failure.

11. If the licensee determines pursuant to Conditions V.F.8. and V.F.9. of this license that a statistically significant increase in hazardous constituents has occurred in the leak detection system, it may demonstrate that a source other than the licensed facility caused the increase or that the increase resulted from error in sampling, analysis, or evaluation. In making a demonstration under this condition, the licensee shall:

a. Notify the Division Chief within 7 days of the determination that it intends to make a demonstration under this condition.

b. Within 90 days of the determination, submit a report to the Division Chief that demonstrates that a source other than the licensed facility solely caused the increase or that the increase was caused by error in sampling, analysis, or evaluation. The report shall be signed and certified in accordance with Condition I.D.3. of this license.

c. Continue to monitor the leak detection system in compliance with this license.

12. The licensee shall report leak detection monitoring results as required by Condition II.I.3. of this license. In addition to these requirements, the licensee shall provide the Division Chief with a written annual report by March 1st of each year summarizing the data and the monitoring program results from the previous calendar year. The annual report shall include graphical

presentations summarizing volume pumped from each leak detection system sump per month and volume pumped from the leak detection system versus volume pumped from the leachate collection system. The annual report shall reference and be part of the annual leachate monitoring report required in Condition V.E.6. of this license. All monitoring reports shall be signed and certified in accordance with the requirements in Condition I.D.3. of this license.

13. The licensee shall report leak detection monitoring results as required by Condition II.I.3. of this license. This information shall be signed and certified in accordance with Condition I.D.3. of this license.

{R 299.9521(3)(a) and (b) and R 299.9611(5)}

G. **LYSIMETER MONITORING PROGRAM**

1. The licensee shall conduct a semiannual detection monitoring program as specified in the Lysimeter Monitoring Program Sampling and Analysis Plan (LM SAP), Attachment 15, of this license.

2. The background statistical value for the organic monitoring parameters is defined as the reported detection limit specified in Figure 3 of Attachment 15 of this license.

3. If additional parameters must be added to the lysimeter monitoring program in accordance with Condition V.E.5.(c) of this license, the licensee must provide written notification to the Division Chief requesting modification to the program. If background has not already been established for these additional parameters, the notification must include a proposed plan to determine background for these constituents on an accelerated schedule.

4. The licensee shall provide written notification to the Division Chief requesting any changes that need to be made to the approved LM SAP, Attachment 15, of this license and obtain written approval prior to implementation.

5. The licensee shall, within 60 calendar days of the sampling, report in writing to the Division Chief the laboratory data and the results from the statistical evaluation performed in accordance with Attachment 15 of this license.

6. If a statistically significant increase is detected in any of the monitored parameters, the licensee shall immediately notify the Division that this situation has occurred and arrange for a resampling as soon as possible to confirm if the statistical increase exists. If adequate water can be obtained from the system, confirmation samples shall be collected in quadruplicate.

7. If the licensee confirms that a statistically significant increase in a monitored parameter has occurred, the following actions must be taken:

   (a) Immediately notify the Director by calling the Division Chief or the Division Southeast Michigan District Supervisor, in accordance with Condition II.I.5. of this license.

   (b) Provide follow-up notification to the Division Chief in writing within 5 calendar days of the telephone call in accordance with Condition II.I.5.(b) of this license.

   (c) Begin immediate action to implement the current Contingency Plan, as appropriate.

   (d) Determine, within 30 calendar days of notification, whether a failure in the liner system has occurred.

(e) Provide the Division Chief, or his or her designee, with weekly telephone updates and written reports every two weeks regarding the progress to date in determining the cause of contamination and the results of all samples from environmental monitoring conducted by the licensee.

8. If the determinations made pursuant to Condition V.G.7.(d) of this license indicate a release of contaminants from MCs V or VII, the licensee shall do the following:

   Begin immediate action to repair or otherwise correct the problem and demonstrate to the Division Chief within 72 hours that the action being taken will correct the release of contaminants and clean up contaminants that may have leaked from the system. The licensee shall complete the repair and cleanup activities pursuant to a schedule approved by the Division Chief and shall obtain the certification of a registered professional engineer that, to the best of his or her knowledge or opinion, the remedial actions have been completed.

9. If the licensee determines pursuant to Conditions V.G.7. and V.G.8. of this license that a statistically significant increase in hazardous constituents has occurred in the lysimeter monitoring program, it may demonstrate that a source other than the licensed facility caused the increase or that the increase resulted from error in sampling, analysis, or evaluation. In making a demonstration under this condition, the licensee shall:

   (a) Notify the Division Chief within 7 days of the determination that it intends to make a demonstration under this condition.

   (b) Within 90 days of the determination, submit a report to the Division Chief that demonstrates that a source other than the licensed facility solely caused the increase or that the increase was caused by error in sampling, analysis, or evaluation. The report shall be signed and certified in accordance with Condition I.D.3. of this license.

   (c) Continue to monitor the lysimeter system in compliance with this license.

10. The licensee shall report lysimeter monitoring results as required by Condition II.I.3 of this license. In addition to these requirements, the licensee shall provide the Division Chief with a written annual report by March 1st of each year summarizing the data and the monitoring program results from the previous calendar year. The annual report shall reference and be part of the annual leachate monitoring report required in Condition V.E.6. of this license. All monitoring reports shall be signed and certified in accordance with the requirements in Condition I.D.3. of this license.

11. The licensee shall report lysimeter monitoring results as required by Condition II.I.3 of this license. This information shall be signed and certified in accordance with Condition I.D.3. of this license.

{R 299.9521(3)(a) and (b) and R 299.9611(5)}

H. **SEDIMENTATION BASIN MONITORING PROGRAM**

1. The licensee shall conduct an annual sedimentation basin monitoring program for the north sedimentation basin (NSB), south sedimentation basin (SSB), and the northwest sedimentation basin (NWSB) as specified in the Sedimentation Basin Monitoring Program Sampling and Analysis Plan (SB SAP), Attachment 16, of this license.

2. Within 60 days of each sampling, the licensee shall determine if an ASSI has occurred as specified in Section 7.0 of Attachment 16 of this license.

3. If an ASSI is detected, the licensee shall verbally notify the Division, Hazardous Waste Section, Permit and Corrective Action Unit, within one working day and collect verification samples within seven working days to determine if a CSSI has occurred as specified in Attachment 16 of this license.

4. If the licensee determines pursuant to Conditions V.H.2. and V.H.3. of this license that a CSSI has occurred, the licensee shall:

   (a) Take immediate steps to eliminate the source of the contamination and prevent further releases.

   (b) Within 1 working day after the determination, verbally notify the Division, Hazardous Waste Section, Permit and Corrective Action Unit.

   (c) Within 5 calendar days after the determination, submit written notification of the CSSI to the Division, Hazardous Waste Section, Permit and Corrective Action Unit. The notification shall be signed and certified in accordance with Condition I.D.3. of this license.

   (d) In addition, within 30 days after the determination, implement the response actions defined in Section 8.0 of Attachment 16 of this license depending upon the CSSI location and parameter.

5. The licensee shall report sedimentation basin monitoring results as required by Condition II.I.3. of this license and as specified in Section 9.0. of Attachment 16 of this license. This information shall be signed and certified in accordance with Condition I.D.3. of this license.

{R 299.9521(3)(a) and (b) and R 299.9611(5)}

PART VI
CORRECTIVE ACTION CONDITIONS

A. CORRECTIVE ACTION AT THE FACILITY

1. The licensee shall implement corrective action for all releases of a contaminant from any waste management unit (WMU) at the facility, regardless of when the contaminant may have been placed in or released from the WMU. For the purposes of this license, the term "corrective action" means an action determined by the Division Chief to be necessary to protect the public health, safety, welfare, or the environment, and includes, but is not limited to, investigation, evaluation, cleanup, removal, remediation, monitoring, containment, isolation, treatment, storage, management, temporary relocation of people, and provision of alternative water supplies, or any corrective action allowed under Title II of the federal Solid Waste Disposal Act, PL 89-272, as amended, or regulations promulgated pursuant to that act. For the purposes of this license, the process outlined in Part 111 of Act 451 and the environmental protection standards adopted in R 299.9629 shall be used to satisfy the corrective action obligations under this license. {§§11102 and 11115a of Act 451 and R 299.9629}

2. To the extent that a release of a hazardous substance, as defined in §20101(t) of Act 451, that is not also a contaminant, as defined in §11102(2) of Act 451, is discovered while performing corrective action under this license, the licensee shall take concurrent actions as necessary to address the Part 201 of Act 451 remedial obligations for that release. {R 299.9521(3)(b)}

B. CORRECTIVE ACTION BEYOND THE FACILITY BOUNDARY

The licensee shall implement corrective action beyond the facility in accordance with §11115a of Act 451 and R 299.9629(2).

C. IDENTIFICATION OF WASTE MANAGEMENT UNITS

The WMUs at the facility are identified below and shown in Drawing 1 in Attachment 7 of this license.

1. The following WMU, identified in the Draft Report on RCRA Facility Investigation Release Assessment for Wayne Disposal Site # 1 Landfill, October 7, 1992, requires further corrective action at this time that includes, at a minimum, further investigation to determine if a release of a contaminant has occurred and, if a release has occurred, the nature and extent of the release.

   (a) WMU 1 — Site # 1 Landfill

2. The following WMUs, identified in the RCRA Corrective Action Plan RFI Phase 1 Environmental Monitoring Report for Wayne Disposal Site # 2 Landfill, July 17, 1990, do not require corrective action at this time based on the design of the units and available information that indicates that no known or suspected releases of contaminants from the units have occurred.

   (b) WMU 2 — Site # 2 Landfill

{§§11102 and 11115a of Act 451 and R 299.9521(3)(b) and R 299.9629}

3. Within 30 days of discovery of a new WMU or a release of a contaminant from a new WMU, the licensee shall provide written notification to the Division Chief. The written notification shall include all of the following information:

   (a) The location of the unit on the facility topographic map.

   (b) The designation of the type of unit.

   (c) The general dimensions and structural description, including any available drawings of the unit.

   (d) The date the unit was operated.

   (e) Specification of all waste(s) that have been managed in the unit.

   (f) All available information pertaining to any release of a contaminant from the unit.

4. Based on a review of all of the information provided in Condition VI.C.3. of this license, the Division Chief may require corrective action for the newly-identified WMU. The licensee shall submit a written remedial investigation (RI) Work Plan to the Division Chief within 60 days of written notification by the Division Chief that corrective action for the unit is required.

{§§11102 and 11115a of Act 451 and R 299.9504(1), R 299.9508(1)(b), and R 299.9629 and 40 CFR §270.14(d)}

D. **CORRECTIVE ACTION INVESTIGATION**

Within 60 days of the licensee's receipt of the Division's comments on the review of the Draft Report on Corrective Action Investigation (CAI) Release Assessment for Wayne Disposal Site # 1 Landfill, October 7, 1992, which was submitted to the U.S. EPA, the licensee shall submit a CAI Work Plan to conduct additional investigation to determine if a release of a contaminant(s) from of the WMU 1 identified in Condition VI.C. of this license has occurred and, if a release(s) has occurred, evaluate the nature and extent of the release(s). The licensee shall submit a written CAI Work Plan, CAI Final Report documenting compliance with the approved CAI Work Plan and supporting further corrective action at the facility, and CAI progress reports to the Division Chief for review and approval in accordance with Condition VI.K. of this license. The Division Chief will approve, modify and approve, or provide a Notice of Deficiency (NOD) for the CAI Work Plan and CAI Final Report. Upon approval, the CAI Work Plan and CAI Final Report become enforceable conditions of this license. {§§11102 and 11115a of Act 451 and R 299.9629}

E. **INTERIM MEASURES**

The licensee shall conduct interim measures (IM) at the facility, if determined necessary by the licensee or the Division Chief, to clean up or remove a released contaminant or to take other actions, prior to the implementation of a remedial action, as may be necessary to prevent, minimize, or mitigate injury to the public health, safety, or welfare, or to the environment. The licensee shall submit a written IM Work Plan, IM Final Report documenting compliance with the approved IM Work Plan and supporting further corrective action at the facility, and IM progress reports to the Division Chief for review and approval in accordance with Condition VI.K. of this license. The Division Chief will approve, modify and approve, or provide an NOD for the IM Work Plan and IM Final Report. Upon approval, the IM Work Plan and IM Final Report become enforceable conditions of this license.

{§§11102 and 11115a of Act 451 and R 299.9629}

F. **DETERMINATION OF NO FURTHER ACTION**

1. The licensee shall continue corrective action measures to the extent necessary to ensure that the applicable environmental protection standards established under Part 201 of Act 451, as adopted in Part 111 of Act 451, are met, if the limits are not less stringent than allowed pursuant to the provisions of RCRA.

2. Based on the results of the CAI and other relevant information, the licensee shall submit a written request for a license minor modification to the Division Chief if the licensee wishes to terminate corrective action for a specific WMU identified in Condition VI.C. of this license. The licensee must demonstrate that there have been no releases of a contaminant(s) from the WMU and that the WMU does not pose a threat to public health, safety, welfare, or the environment.

3. Based on the results of the CAI and other relevant information, the licensee shall submit a written request for a license major modification to the Division Chief if the licensee wishes to terminate facility-wide corrective action. The licensee must conclusively demonstrate that there have been no releases of a contaminant(s) from any of the WMUs at the facility and that none of the WMUs pose a threat to public health, safety, welfare, or the environment.

4. If, based upon a review of the licensee's request for a license modification pursuant to Condition VI.F.2. or VI.F.3. of this license, the results of the completed CAI, and other relevant information, the Division Chief determines that the releases or suspected releases of a contaminant(s) do not exist and that the WMU(s) do not pose a threat to public health, safety, welfare, or the environment, the Division Chief will approve the requested modification.

5. A determination of no further action shall not preclude the Division Chief from requiring continued or periodic monitoring of air, soil, groundwater, or surface water, if necessary to protect public health, safety, welfare, or the environment, when facility-specific circumstances indicate that potential or actual releases of a contaminant(s) may occur.

6. A determination of no further action shall not preclude the Division Chief from requiring further corrective action at a later date, if new information or subsequent analysis indicates that a release or potential release of a contaminant(s) from a WMU at the facility may pose a threat to public health, safety, welfare, or the environment. The Division Chief will initiate the necessary license modifications if further corrective action is required at a later date.

{§§11102 and 11115a of Act 451 and R 299.9629(2)}

G. **CORRECTIVE MEASURES STUDY**

If the Division Chief determines, based on the results of the CAI and other relevant information, that remedial activities are necessary, the Division Chief will notify the licensee in writing that a Corrective Measures Study (CMS) is required. If required by the Division Chief, the licensee shall conduct a CMS to develop and evaluate the corrective measures alternative(s) necessary to address the release(s) of a contaminant(s) or hazardous substances and the WMU(s) that are identified in the approved CAI Final Report as requiring final remedial activities. The licensee shall submit a written CMS Work Plan, a CMS Final Report documenting compliance with the approved CMS Work Plan and supporting further corrective action at the facility, and CMS progress reports to the Division Chief for review and approval in accordance with Condition VI.K. of this license. The Division Chief will approve, modify and approve, or provide an NOD for the CMS Work Plan and CMS Final Report. Upon approval, the CMS Work Plan and CMS Final Report become enforceable conditions of this license {§§11102 and 11115a of Act 451 and R 299.9629}

H. **CORRECTIVE MEASURES IMPLEMENTATION**

1. The licensee shall conduct final corrective measures based on the CMS Final Report approved by the Division Chief. The licensee shall submit a written Corrective Measures Implementation (CMI) Work Plan to the Division Chief for review and approval. The licensee shall also submit a written CMI Final Report documenting the compliance with the approved CMI Work Plan and providing justification that the corrective actions may cease, and CMI progress reports to the Division Chief for review and approval in accordance with Condition VI.K. of this license. The Division Chief will approve, modify and approve, or provide an NOD for the CMI Work Plan and CMI Final Report. Upon approval, the CMI Work Plan and CMI Final Report become enforceable conditions of this license.

2. The Division will provide notice of its draft decision on the CMI Work Plan to persons on the facility mailing list and an opportunity for a public hearing.

3. The licensee shall implement the approved CMI Work Plan within 60 days of receipt of the Division Chief's written approval of the CMI Work Plan.

{§§11102 and 11115a of Act 451 and R 299.9629}

I. **CORRECTIVE ACTION MANAGEMENT UNITS**

If applicable, the licensee shall comply with the requirements of R 299.9635 in order to designate an area at the facility as a corrective action management unit for implementation of response activities. {R 299.9521(3)(a)}

J. **TEMPORARY UNITS**

If applicable, the licensee shall comply with the requirements of R 299.9636 in order to designate tank or container storage units used for the treatment or storage of remediation wastes as temporary units for implementation of response activities. {R 299.9521(3)(a)}

K. **SUMMARY OF CORRECTIVE ACTION SUBMITTALS**

The licensee shall submit the required corrective action documents in accordance with Conditions II.N., VI.D., VI.E., VI.G., and VI.H. of this license and the schedule below.

CORRECTIVE ACTION DOCUMENT	SUBMITTAL DEADLINE
Written notification of a new release of a contaminant from an existing WMU, a new WMU, or a release of a contaminant from a new WMU	Within 30 days of discovery
CAI Work Plan for a newly-identified release of a contaminant from an existing WMU, a new WMU, or a release of a contaminant from a new WMU	Within 60 days of receipt of written notification that response activity is required
CAI Work Plan for existing WMU 1	Within 60 days of approval of the Draft Report on RCRA Facility Investigation Release Assessment for Wayne Disposal Site # 1 Landfill,
Revised CAI Work Plan for WMU 1	Within 45 days of receipt of CAI Work Plan NOD
CAI progress reports	Within 30 days of initiation of the CAI and every 30 days thereafter
CAI Final Report for WMUs and contaminant releases	Within 60 days of completion of CAI
Revised CAI Final Report for WMUs and contaminant releases	Within 45 days of receipt of CAI Final Report NOD
IM Work Plan for WMUs and contaminant releases	Within 60 days of receipt of notification that IM Work Plan is required
Revised IM Work Plan for WMUs and contaminant releases	Within 30 days of receipt of IM Work Plan NOD
IM progress reports	Within 30 days of initiation of the IM and every 30 days thereafter
IM Final Report for WMUs and contaminant releases	Within 60 days of completion of the IM
Revised IM Work Plan for WMUs and contaminant releases	Within 45 days of receipt of IM Final Report NOD
CMS Work Plan for WMUs and contaminant releases	Within 60 days of receipt of notification that CMS is required
Revised CMS Work Plan for WMUs and contaminant releases	Within 45 days of receipt of CMS Work Plan NOD
CMS progress reports	Within 30 days of initiation of the CMS and every 30 days thereafter

CORRECTIVE ACTION DOCUMENT	SUBMITTAL DEADLINE
CMS Final Report for WMUs and contaminant releases	Within 60 days of completion of the CMS
Revised CMS Final Report for WMUs and contaminant releases	Within 45 days of receipt of CMS Final Report NOD
CMI for WMUs and contaminant releases	Within 90 days of approval of the CMS Final Report
Revised CMI for WMUs and contaminant releases	Within 45 days of receipt of CMI NOD
CMI progress reports	Within 60 days of implementation of the CMI and every 30 days thereafter, unless otherwise approved
Completion Report for remediated WMUs and contaminant releases	Within 60 days of the remedial actions have been completed and cleanup criteria have been met
Revised Completion Report for WMUs and contaminant releases	Within 45 days of receipt of Completion Report NOD

L. **CORRECTIVE ACTION DOCUMENTS RETENTION**

The licensee shall maintain all corrective action documents required by this license at the facility. The documents shall be maintained for the operating life of the facility or until the facility is released from financial assurance requirements for corrective action by the Director, whichever is longer. The licensee shall offer such documents to the Division Chief prior to discarding those documents. {§§11102 and 11115a of Act 451 and R 299.9521(3)(b) and R 299.9629}

Attachment 1

Waste Analysis Plan

WASTE ANALYSIS PLAN

40 CFR 264.13b & c

AND

MI ACT 451 R504(1)c

Wayne Disposal Inc. (WDI) & Michigan Disposal Waste Treatment Plant (MDWTP)
49350-North I-94 Service Drive
Belleville, Michigan 48111

USEPA ID No. MID 048 090 633 (WDI)
USEPA ID No. MID 000 724 831 (MDWTP)

WAP – Table of Contents

1.0 INTRODUCTION

The purpose of this Waste Analysis Plan (WAP) is to identify and document the overall operational procedures, analytical techniques, and the necessary sampling methodologies which are undertaken for hazardous wastes that are received by the **Michigan Disposal Waste Treatment Plant (MDWTP)** for treatment and/or storage and Wayne Disposal, Inc (WDI) for disposal as required by Part 111 of Act 451 of the Public Acts of 1994, the Natural Resources and Environmental Protection Act (NREPA), Administrative Rule 299.9504(1)(c).

Per 40 CFR 264.73, the required information will be kept as part of the operating record.

The forms referenced within this WAP are typical forms currently used by the facility. These forms will periodically require updating based upon changes in regulations, customer needs, operations, or as company policy dictates.

2.0 FACILITY DESCRIPTION

2.1 Description of General Processes

Wayne Disposal, Inc. (WDI)

The Wayne Disposal Site #2 Hazardous Waste Landfill (WDI) operations include the landfill disposal of hazardous and non-hazardous wastes permitted by the MDEQ under the facility operating license and the USEPA under a Resource Conservation and Recovery Act (RCRA) permit (MID 048 090 633).

The specific routine operations and work areas include:

- Waste receiving and Quality Control (QC);
- Waste unloading;
- Container staging; and
- Hazardous waste landfill and related appurtenances (pipings, pumps, operation and maintenance, truck wheel wash buildings located within the area bounded by North Interstate 94 (I-94) Service Drive and Willow Run Airport).

The landfill is currently permitted with a design capacity of 11,000,000 cubic yards (cy) of in-place waste.

The requirements for operations in these areas are defined in and regulated by the operating license and permit. Non-hazardous wastes are managed in accordance with Part 115. The Wayne Disposal Site #2 Hazardous Waste Landfill (WDI) - MID 048 090 633) is co-located at the same site as the Michigan Disposal Waste Treatment Plant (MDWTP) – MID 000 724 831. The WDI operations are supported by the MDWTP office/laboratory and waste receiving, storage, and treatment operations located near the entrance to the facility. These operations assist to control and evaluate shipments received for conformance with pre-approval information regarding the specific properties, treatment, and documentation requirements. The WDI waste analysis records are maintained at the receiving building and laboratory areas.

Michigan Disposal Waste Treatment Plant (MDWTP)

The MDWTP operations include receiving, storage, and treatment of hazardous wastes permitted by the MDEQ under the facility operating license and the USEPA under a Resource Conservation and Recovery Act (RCRA) permit (MID 000 724 831). The routine operations and work areas include:

- Waste receiving and Quality Control (QC);
- Waste loading and unloading;
- Reagent unloading and tank storage;
- Waste storage in tanks;
- Waste treatment in tanks;
- Container staging/storage; and
- Shipment of wastes off-site to treatment, storage, and disposal facilities (TSDFs).

Non-hazardous wastes are managed in accordance with the Solid Waste Processing and Transfer Facility Operating License issued under Part 115 of Act 451 of 1994, the Natural Resources and Environmental Protection Act (NREPA).

2.2 Waste Identification and Classification

The waste types acceptable for treatment and storage at MDWTP or disposal at WDI are defined in Appendix A of this WAP.

In addition, at WDI the following waste types **NOT ACCEPTABLE** for disposal:

- Ignitable wastes as described in R299.9212(1);
- Reactive wastes as described in R299.9212(3);
- Bulk or non-containerized liquid waste or waste containing free liquids;
- Containers holding free liquids, including laboratory packs;
- Wastes which will:
    a. Adversely affect the permeability of the clay liner;
    b. Produce a leachate that is incompatible with the synthetic liner, leachate collection system (LCS), discharge piping, and the off-site sewer system;
    c. Generate gases which will adversely affect the permeability of the clay cap; and
    d. Create a violation of 1975 PA 348 and rules promulgated thereunder;
- Waste which are banned from landfilling by regulations promulgated under 40 Code of Federal Regulations (CFR) Part 268 unless the wastes meet the applicable Land Disposal Restriction (LDR) treatment standards or a variance has been obtained from the USEPA.

2.3 Description of Waste Management Units

Wayne Disposal, Inc. (WDI)

The Wayne Disposal Site #2 Hazardous Waste Landfill includes a permitted hazardous waste landfill with primary and secondary liner systems, a leachate collection and removal system, and a leak detection, collection and removal system. The landfill operations also include run-on, run-off, and contaminant control systems including a vehicle wash facility and other landfill-related appurtenances and support buildings. When placed in the landfill, containers are at least 90-percent full or crushed, shredded, or similarly reduced in volume before burial in the landfill.

Michigan Disposal Waste Treatment Plant (MDWTP)

The MDWTP is a liquid and solid hazardous waste storage and treatment facility. Containerized wastes may be staged/stored on-site before and after treatment in one of the following areas:

- East Container Staging Area (ECSA)
- North Container Storage Area (NCSA)
- East and West Loading/Unloading Bays
- Southeast Container Storage Area (SECSA)

Wastes are placed directly into the waste treatment tanks, and mixed, with modifiers for deactivation, neutralization, chemical oxidation, and chemical reduction or stabilization reagents, as required for the specific wastes being treated. The facility currently uses a backhoe shear attachment to size solid containers. Prior to being sized over and into a treatment tank the containers are staged on the paved floor in front of the treatment tanks.

Liquid hazardous wastes to be treated in the pozzolanic stabilization process may be stored in four, 20,000-gallon, vertical storage tanks (16 through 19) or placed directly into treatment tanks A – H (formerly tanks 7A, 7B, 8A, 8B, 9A, 9B, 10A and 10B respectively). Liquid reagents are stored in two, 20,000-gallon vertical tanks (25 and 27).

Dry flowable bulk solid hazardous wastes may be stored in three 100 cubic yard (CY) silos (2, 3 and 6). Lime kiln flue dust, cement kiln flue dust, lime and fly ash are also used for stabilization and may be stored in all six silos (1 through 6). The dusts are fed from the silos to the closest pugmill and treatment tank at a controlled rate to effect treatment of liquid and solid wastes. Other reagents, such as ferrous sulfate, may be added directly to the tanks in bag, container, or bulk quantities.

Hazardous waste and non-hazardous waste are stored and treated in treatment tanks A, B, C, D, E, F, G and H (formerly treatment tanks 7A, 7B, 8A, 8B, 9A, 9B, 10A and 10B respectively) and Pugmills 14 and 15. Treatment consists of blending the wastes and treatment reagents in the storage/treatment tanks.

Tanks will be decontaminated if changed from the storage/treatment of listed wastes to characteristic wastes. Decontamination consists of water washing and/or dry decontaminating the tank. The rinse waters and/or dry decontamination material is directed to a listed batch tank (containing a compatible waste). The decontamination step is noted on the Batch Ticket for the tank receiving the rinse waters and/or dry decontamination material.

Containerized hazardous waste and non-hazardous wastes are staged/stored on concrete pads at the East Container Staging Area (ECSA), North Container Storage Area (NCSA), Southeast Container Storage Area (SECSA) and inside the bays the East and West Treatment Buildings at MDWTP prior to placement in one of the tanks. Drainage trenches/sumps are constructed within the NCSA and ECSA to contain and control liquid runoff. Containers are handled by removing the tops or bungs and emptying the contents with a vacuum truck or directly into one of the treatment tanks using a forklift, or pump.

The following wastes are stored in closed containers (such as drums) and/or in tarped bulk (such as roll-off boxes or trailers):	NCSA	ECSA	SECSA (see Section 2.d.1 of the Container Storage Attachment)	East and/or West Bays Temp Storage (< 8 hrs) -
Untreated hazardous waste	Yes	Yes	Yes	Yes
Untreated solid hazardous waste bulked into roll-offs boxes or trailers (see Section 3.5)	Yes	No	No	Yes
Treated hazardous waste awaiting analytical results	Yes	No	No	Yes
Decharacterized waste awaiting analytical results	Yes	No	No	Yes
Decharacterized waste with analytical data demonstrating compliance with LDRs	Yes	Yes	Yes	Yes

3.0 OPERATIONAL PROCEDURES

3.1 Pre-Approval Procedures

3.1.1 Generator-Supplied Information – MDWTP/WDI

The pre-approval process is a waste evaluation procedure that takes place prior to receiving hazardous and non-hazardous wastes at the MDWTP for storage or treatment and WDI for disposal. The initial step of the waste stream approval process is a review of the waste characterization as prepared by the generator.

The facility requires that the generator characterize their waste stream, in order to comply with 40 CFR Parts 261 and 268.

For the purposes of compliance with 40 CFR Part 268 or if the waste is not listed in Subpart D of 40 CFR Part 261 (R299.9213), per 40 CFR 262.11, the generators must determine whether their waste is identified in Subpart C of 40 CFR Part 261 (R299.9212) by either:

- Testing the waste according to the methods set forth in Subpart C (of 40 CFR Part 261) or according to an equivalent method approved by the Director of the MDEQ; or
- Applying knowledge of the hazard characteristic in light of the materials or processes used. Material Safety Data Sheets (MSDS) of products in combination with information provided by the generator on the GWCR are acceptable to properly characterize the waste stream.

The generator must complete a Generator Waste Characterization Report (GWCR) or equivalent form. The facility will accept other forms of documentation of waste characterization than the GWCR as long as all pertinent information is included. GWCRs are supplied to the generators in hard copy or online at www.eqonline.com. The elements of the GWCR include:

- Generator name, address, and telephone number;
- USEPA ID Number;
- Description of Generating Process;
- USEPA and/or Michigan Hazardous Waste Codes;
- Hazardous & Toxicity Characteristics;

- Actual &/or Potential Constituents;
- Fingerprint parameters as described in this WAP; and
- Generator's Written or Electronic Signature or a signed statement from the generator giving permission to a 3rd party to act on their behalf.

The GWCR, with the supporting analytical data where required, forms the basis of information upon which the facility determines if the waste can be accepted for disposal at WDI or storage, transshipment and treatment at MDWTP. Waste streams are also reviewed with respect to the Land Disposal Restrictions (LDR) requirements in 40 CFR Part 268. The analytical data, waste type, process description, waste chemical and physical characteristics, or a representative sample provide the facility with sufficient information to decide if the waste can be accepted or if additional data is required before a decision can be reached. If the generator does not provide sufficient information, the generator or their representative is contacted and requested to provide further information before the approval process will continue.

3.1.2 Special Conditions –MDWTP/WDI

Exceptions for the requirement of a sample of waste for acceptance at the facility (WDI/MDWTP) include the following waste types:

- Articles, equipment, clothing (such as personal protective equipment (PPE)) contaminated with chemicals;
- Empty containers which once held waste, commercial chemical products, or chemicals (small tanks, containers, bags, boxes, liners, cans, pails, etc.). Containers are considered "empty" according to the criteria specified in R299.9207;
- Asbestos-containing waste from cleaning or demolition activities that is properly bagged/containerized;
- Spent activated carbon, filters from inside tanks, ion-exchange resins, molecular sieves, filters/ cartridges;
- Hazardous contaminated debris and demolition wastes (40 CFR 268);

- Chemical-containing devices/articles, such as cathode ray tubes (CRTs), fluorescent lights, batteries;
- Discarded, off-specification, or out-dated commercial products. A MSDS will be provided or made available for review;
- Wastes from food or animal processing;
- Animal feces
- Selected wastes from medical, veterinarian, taxidermy, or mortuary facilities;
- Septage or sewer treatment plant sludge from domestic users; and
- Tanks (whole or cut);
- Equipment, machinery, pumps, piping, etc.; and
- Waste streams approved by MDEQ on a case-by-case basis.

For wastes from which no samples will be taken prior to disposal, a visual inspection will be performed to determine if the waste resembles the description provided in the approval. Double contained asbestos waste <u>will not be opened</u> for visual inspection. However, during the pre-approval process, the generator must verify that the asbestos contains no free liquids and it is so stipulated on the GWCR for that waste stream.

3.1.3 Special Wastes

3.1.3.1 Source Material, NORM or TENORM – MDWTP/WDI

Waste streams containing NORM, TENORM, and exempted radioactive material may be managed at the facility (MDWTP/WDI) provided the following steps are taken:

1. During the facility pre-approval process, obtain a radiochemical analysis and/or other appropriate radiological information on each (NORM, TENORM, and exempted radioactive material) proposed waste stream as well as any other information required by this WAP including the WCR. No material classified as low-level radioactive waste pursuant to Title 42 of the United States Code, Chapter 23, Development and Control of Atomic Energy, Section 2021b, Definitions, is allowed at the site.

2. The radiochemical analysis and appropriate information are evaluated to determine if they can be accepted at the site. All material accepted at the site shall be in at least one of the following categories:

State of Michigan regulated materials

a. Exempt concentrations: IRR Rule 65
b. Exempt quantities: IRR Rule 74(1)
c. NORM: The DNRE's *Cleanup and Disposal Guidelines for Sites Contaminated with Radium-226* (EQC 1602)
d. Other material as specifically approved.

Note: For the purposes of interpreting the State of Michigan's *Ionizing Radiation Rules (IRR) Governing Radioactive Material,* refer to the definitions contained in IRR Rules 3 thru 20.

U.S. Nuclear Regulatory Commission (NRC) regulated materials

a. Exempt concentrations: 10 CFR parts 30.14 and 40.13
b. Exempt quantities: 10 CFR part 30.18
c. Specific exemptions: 10 CFR parts 20.2005, 30.11, 30.15, 30.16, 30.19, 30.20, 30.21, and 40.14

Note: For the purposes of interpreting title 10 of the U.S. Code of Regulations (10 CFR), refer to the definitions contained in 10 CFR parts 20.1003, 30.4, and 40.4.

Disclaimer: This in no way represents approval or authorization for receipt of NRC regulated material. If you have questions about radioactive material regulated by the NRC, contact the NRC regional office at 630-829-9500.

3. A sample is obtained from the generator, if appropriate, to determine if the level of radioactivity, based on a gamma radiation reading, will be above Site 2's background limit. The reading will be recorded for that (NORM, TENORM, and exempted radioactive material) EQ waste stream.

4. WDI and/or MDWTP may approve for receipt each (NORM, TENORM, and exempted radioactive material) proposed waste stream that meets the above criteria.

5. A (NORM, TENORM, and exempted radioactive material) waste stream may not be received by the facility (WDI and/or MDWTP) until steps 1-4, above, have been followed.

Questions about radioactive material regulated by the State of Michigan should be directed to the DEQ.

3.1.3.2 Asbestos Waste Containing PCBs and/or RCRA Hazardous Waste - WDI

Asbestos containing waste that also contains PCBs and/or is also a RCRA hazardous waste is exempt from the requirement of a sample of waste for review and acceptance and visual inspection at the facility if all of the following conditions are met:

- The waste contains ≥ 1% asbestos;
- The waste is properly bagged/containerized;
- Bulk asbestos waste will be handled in such a manner as to not cause any visual emissions;
- The generator verifies that the asbestos containing waste contains no free liquids and it is so stipulated on the approval.

3.1.4 Generator Waste Characterization Report (GWCR) Review – MDWTP/WDI

After the generator-supplied information is received, trained personnel (which may include, but is not limited to, the Laboratory Manager, Technical Support Manager, Approvals staff and facility (Operations Management & Supervisors or their designee) review the information then determine if additional information or analyses are required.

"Trained personnel" refers to those persons authorized to do a task based on the ISO Job Descriptions maintained on-site. These ISO Job Descriptions are considered living documents will be updated as needed and maintained at the facility and can be reviewed upon request at the facility.

Representative samples of waste may be provided by the generator, may be subject to the fingerprint analysis (see Sections 4.0, 5.0 and Table 3), except where noted in Section 3.1.2. Supplemental analysis (indicated with a "O" in Table 3) may also be performed at the direction of trained personnel based upon the available information provided by the generator, USEPA, or Michigan hazardous waste numbers and the facility's operating requirements.

If, during the review, trained personnel determine that the waste characteristics do not conform to the information provided on the GWCR, the generator or their representative is notified in order to attempt to resolve the discrepancy. If the inconsistency is not resolved, the waste will be rejected and not approved.

3.1.5 Treatment, Storage, and Disposal Approval – MDWTP/WDI

When it is determined that a waste stream can be safely handled at the facility in accordance with the operating license requirements, it is assigned a unique approval number. An approval letter is sent to the generator, serving as notification that the waste as represented may be shipped to the facility, and that the facility has the appropriate permit(s) to accept the waste. All approval files are maintained in the facility operating record in a paper or other archival form. Approval files with no shipments before expiration will not be kept in the facility operating record.

Section 4 details the testing procedures and criteria utilized by trained personnel to evaluate waste as part of the pre-approval process. Once the generator has received the approval to ship, the generator or their representative arranges for transportation and delivery by a licensed waste transporter.

3.1.6 Waste Approval Re-Evaluation – MDWTP/WDI

The facility requires that the GWCR, supporting information, and/or documentation be updated whenever any one of the following occur:

- There has been a change in the process generating the waste;
- Inspection of a waste shipment reveals that the waste does not meet the description/classification of the current approval record for the waste; or
- One year has passed since the last approval of the waste.

3.2. Incoming Load Pre-Acceptance Procedures

The procedures for incoming wastes are designed to assure that loads received for treatment and/or storage have been previously approved for acceptance, and are representative and consistent with the information submitted with the GWCR.

3.2.1 Inbound Load Procedure – MDWTP/WDI

When a shipment of waste arrives at the facility, the following step-wise procedure is followed:

- The driver proceeds to the inbound scale where the weight and truck number are recorded. The driver then proceeds to the sampling station (for containerized loads, this step may be omitted);
- The driver presents the manifest and any other shipping documents to trained personnel in the Receiving Building; and
- Trained personnel examine the manifest and other shipping documents, for manifests discrepancies, completeness and to ensure that the shipment was intended for treatment and/or storage at MDWTP and/or disposal at WDI.

3.2.2 Waste Inspection and Sampling

After reviewing the documents and determining that the waste stream has been approved, trained personnel check the computer or manual records for any notes or special handling instructions for the shipment and create a Post-Inspection Form (PIF). For bulk shipments, the sampler visually examines the load, pulls a sample, and submits the sample for testing.

For container loads, the driver is given a copy of each manifest and corresponding lab worksheet, PIF and drum log. For MDWTP, the vehicle is directed to the container truck dock where the containers are removed from the vehicle and placed into the staging/storage area(s). Trained personnel visually examine the load, pull a sample, and then submit the samples for testing. All waste streams are sampled as described under "Sampling Methodologies" in Section 6.0.

For WDI, container loads are delivered to the container unloading area at the waste transfer box. Here each container is opened, inspected and sampled in accordance with a standard operating procedure for non-bulk waste unloading. At least 10% of the containers must be sampled. The containers can only be left in the unloading area for the time it takes to clear or reject the load for disposal.

3.2.3 TSDF Evaluation and Approval

Trained personnel conduct the analytical tests and required observations specified for the particular waste stream as described in Section 5.1. If the results of the pre-acceptance fingerprint testing and observations agree with the pre-approval screening data, the waste load is approved for receipt. If the results fall outside the profiled range of variability, the procedures in Section 3.3.1 – Off- Specification and Rejected Load Procedures are followed.

For bulk shipments, the designated treatment and/or storage location is stamped on the PIF, it is handed to the driver, and then the vehicle is directed to the assigned tank located at the MDWTP East or West Treatment Buildings. For container loads, the PIF is handed to the driver at the Receiving Building, then the vehicle is directed to MDWTP and the load can be accepted.

3.2.4 Off-Site Inspection and Sampling - WDI

For some projects, it may be necessary to conduct the weight measurement (or volume estimate), waste inspection (section 3.2.2) and/or fingerprinting tests (section 3.2.3) at an off-site location, such as the site of generation. These activities must be performed by properly trained (by EQ) personnel using the methods and forms in the WAP. The results of the inspection and testing must be transmitted to the Receiving Department prior to the waste being accepted by WDI (i.e. with the waste shipment or before). For these projects, a description of the off-site testing must be submitted to MDEQ for review and approval prior to the start of the project. The description must include a summary of the project, how the sampling/testing will be conducted, post sampling waste security measures (if necessary) and a discussion of the paperwork flow.

3.3 Procedure for Unloaded Trucks – MDWTP/WDI

After unloading, vehicles are directed through the Truck Wash. Containerized loads wait in the holding area until cleared to leave. Bulk shipments proceed to the outbound scale. The driver returns the completed PIF to the Receiving Building and the outbound weight and truck number are recorded.

The manifest is signed, dated, disassembled, and the driver is given the "Transporter" copy. Remaining copies of the manifest are placed in a holding file for later distribution according to the instruction on the manifest form. In the event an electronic manifest is used, the established electronic manifest procedures are followed.

3.3.1 Off-Specification and Rejected Load Procedures – MDWTP/WDI

The facility will follow 40 CFR 264, Subpart E in determining if a significant discrepancy exists.

Discrepancies that do not fall within these criteria are considered to be "minor" and are not subject to a re-characterization review unless the facility has reason to believe that the variation is a continuing deviation and that a particular waste stream is indeed different from the waste approved. Significant inconsistencies in waste type, as defined in 40 CFR 264 Subpart E, result in re-characterization if the inconsistency cannot be reconciled with the generator or the facility has reason to believe that the waste composition has changed.

If a significant discrepancy is revealed during the incoming load procedure, the generator or their representative is contacted to resolve the problem. If the discrepancy is reconciled, the load may be received and the details of the reconciliation are recorded. If the discrepancy is not resolved, the shipment is rejected per 40 CFR 264, Subpart E. The appropriate manifest documents are then returned to the driver.

3.4. Storage - MDWTP

Stored containerized liquid and solid wastes are segregated following USDOT segregation and separation requirements (see Table 1). Liquid wastes, which are transferred from containers, portable tanks or tank trucks, may be transferred to storage tanks prior to subsequent treatment.

Prior to wastes being placed in any storage unit, facility (MDWTP) personnel will determine the compatibility of the waste with the storage unit materials of construction and with wastes already stored therein. The evaluation is based upon vendor/engineering data, materials of construction, and knowledge of the waste and its characteristics from the GWCR. If such data are not available, compatibility testing will be performed prior to storage.

3.4.1 Container Storage - MDWTP

Containerized wastes in storage are segregated according to 49 CFR Subpart C—Segregation and Separation Chart of Hazardous Materials segregation rules. (See Table 1) Based on the hazard assessment of the waste, the containerized waste is organized into segregated storage areas within the NCSA, ECSA, SECSA and the East and West Loading/Unloading Bays.

3.4.2 Tank Storage - MDWTP

Wastes to be stored in tanks will undergo the fingerprint analyses, including a waste compatibility test. Additional testing will be based on the targeted treatment or disposal requirements.

Liquid wastes, delivered in bulk form by tank trucks or decanted from containers or portable tanks, are placed in bulk storage tanks or directly into treatment/storage tanks prior to treatment.

3.4.3 Lab Compatibility Test - MDWTP

Prior to transferring any wastes into a storage tank, the compatibility of the waste, with the material already in the tank, will be determined by mixing in a "mock tank" a waste sample from the tank with samples of waste to be added to the tank. Following the preliminary screening and compatibility testing, specific storage and process compatibility will be determined. The current version of the Work Plan for the Lab Compatibility Test is maintained on-site. The parameters used to determine compatibility are briefly outlined below

- Gas Evolution - Materials that upon mixing, appear to liberate significant amounts of vapors, fumes, or mists, will not be combined.
- Heat Generation - Materials that, upon mixing, would generate excessive amounts of heat will not be combined.
- Adverse Reactions - Materials that, upon mixing, result in the formation of a large amount of sludge, or solidify or gel may not be combined if this causes a removal or subsequent handling problem.

When a bulk shipment is to be unloaded into a tank, a representative sample will be collected from the tank into which the waste is to be unloaded. The sample will be evaluated for the compatibility characteristics listed above. If it is determined that the mixture is incompatible, the waste will not be placed into that receiving tank. If the waste is determined to be incompatible with the tank materials of construction or with the tank contents, the procedure will be repeated, as needed, until a compatible tank is available. If no compatible tank is available, the load may be rejected and returned to the generator or transshipped off-site to another TSDF.

3.5 Waste Bulking and/or Consolidation - MDWTP

Wastes that are bulked and mixed, (excluding empty containers, site generated debris or closed and intact containers of non-hazardous waste), are subjected to the same compatibility and waste code evaluations as applied to wastes that are mixed in the treatment tanks. The following includes a list of items that may be bulked or consolidated.

- Empty Containers – as defined in Part 111, under Specific Conditions and are bulked in a roll-off container.
- Site Generated Debris – includes articles, equipment, clothing (such as personal protection equipment); ringbolts and rings from containers; pallets and pieces of pallets, etc., which are bulked in a roll-off container.
- Closed and intact containers of non-hazardous waste –non-hazardous solid waste in which all openings on the containers are closed.
- Liquid or solid hazardous waste containers being consolidated into larger or fewer containers (not for treatment at MDWTP)
    - I. Containers may need to be combined into larger or fuller containers (such as prior to transshipment)
    - II. If Roll-off containers or trailers will be used for consolidation, a liner will be utilized when bulking listed hazardous waste to prevent contamination from listed wastes to characteristic wastes.
    - III. All of the waste consolidated into a different container will only be done in the NCSA, the East Bay or West Bay.
    - IV. <u>Compatibility</u> - Waste to be consolidated will be from the same waste stream or will be evaluated to ensure that the waste being consolidated is compatible. If not from the same waste stream, samples will be added to a mock tank for compatibility prior to being consolidated.

V. The following waste streams will not be consolidated: reactives, ignitables, cyanides, incompatibles and odorous.

- Solid (non-liquid) hazardous waste containers being bulked into a batch for treatment at MDWTP

    I. All of the waste bulked into a roll-off or trailer will only be done in the NCSA, the East Bay or West Bay.

    II. The roll-off or trailer will utilize a liner when bulking listed hazardous waste to prevent contamination from listed wastes to characteristic wastes.

    III. The containerized waste to be bulked in a roll-off or trailer will be pre-assigned to batch.

    IV. <u>Compatibility</u> - Samples from the containers will be added to a mock tank for compatibility prior to being bulked into a roll-off or trailer.

    V. After all of the containers assigned to that batch are bulked, the batch in the roll-off or trailer will be transferred to an assigned storage/treatment tank for treatment.

    VI. The following waste streams will not be bulked: reactives, ignitables, cyanides, incompatibles and odorous.

3.6 Procedures for Ignitable, Reactive, and Incompatible Wastes

The facility (WDI/MDWTP) utilizes waste characterization data provided by the generator as well as analytical screening and testing procedures to obtain information regarding waste ignitability, reactivity, or incompatibility prior to treatment and/or storage. MDWTP also evaluates this information relative to waste compatibility with the facility equipment and treatment processes. Containerized wastes are segregated for storage following the DOT Segregation Chart (See Table 1 of the WAP). Wastes that are incompatible will not be stored adjacent to each other.

MDWTP does not accept for treatment ignitable wastes having a flashpoint less than 90°F. Ignitability data for wastes is obtained through process knowledge and/or performing flashpoint or ignitability screening tests, as described in Section 4. Ignitable wastes with a flash point less than 90°F may be received and subsequently transshipped. Containers accepted at MDWTP for transshipment are uniquely marked so that they can easily visually identified as a transship waste stream.

MDWTP does not accept for treatment wastes exhibiting the characteristic of reactivity. D003 (deactivated) waste may be accepted for treatment. Reactive wastes identified in R299.9212(3)(b-e) may be received for storage in the NCSA and subsequently transshipped. Reactive wastes identified in R299.9212(3)(a, f, g, h) are prohibited. MDWTP evaluates potential reactivity characteristics through the use of process knowledge and for potential cyanide (CN) or sulfide-containing wastes, through analysis for total, amenable and reactive CN, and reactive sulfide. To evaluate the potential for incompatibility of wastes with the facility equipment, treatment processes, or with other wastes upon mixing/blending, MDWTP uses process knowledge, and compatibility testing described in Sections 3.4.1 – Container Storage, 3.4.2 – Tank Storage and 3.4.3 – Lab Compatibility Test. If the review of the waste characterization data and/or compatibility testing indicates a potential for incompatibility and unacceptability at the MDWTP, the wastes will be either rejected and returned to the generator or transferred to another permitted TSDF capable of managing the waste in accordance with the procedure outlined in Section 3.3.1 – Off-Specification and Rejected Load Procedures.

The Vertical Liquid Tanks are equipped with combination pressure relief valves/flash arrestors on top and high temperature cut-off valves at the bottom. These tanks are constructed and located in compliance with NFPA Chapter 30 regulations for flammable liquids, or in the vicinity of loading flammable liquids.

Wastes received in containers will be staged and stored in accordance with DOT Separation Requirements. Containers remain closed during storage except for during sampling. In addition to being physically separated from incompatible waste, containerized ignitable waste will not be stored within 50 feet of the property line, and will be stored in such a manner as to prevent fires or explosions. Reactive wastes received for transship to another facility will be physically separated from incompatible wastes and stored in a manner as to prevent fires, explosions, or release of toxic fumes, dusts, or gases that could threaten human health.

Smoking is allowed at the facility (MDWTP/WDI) only at a few designated areas. Maintenance work done at MDWTP follows the same standards described above for operation work. Hot Work Permit will be granted in advance and air monitoring testing will go on to prevent a flammable atmosphere before any operation goes underway.

3.7 Waste Treatment Technologies - MDWTP

3.7.1 Chemical Stabilization - MDWTP

The facility (MDWTP) treats wastes that require treatment to comply with the LDRs through chemical stabilization using a pozzolanic-type process incorporating CKD, lime, and other select reagents. Certain wastes may require more than one type of treatment, including neutralization, deactivation, chemical oxidation, and/or chemical reduction using reagents such as lime, oxidizing or reducing agents, to convert selected waste constituents into a physical or chemical form that is less soluble, less hazardous and/or more suitable for subsequent stabilization.

3.7.2 Chemical Oxidation - MDWTP

Hazardous wastes containing organic constituents above the LDR levels are chemically oxidized at the facility (MDWTP). The chemical oxidation process is described below and detailed in Figure 2. Chemical oxidation is also discussed as one of the Best Demonstrated Available Technologies (BDAT) for managing organic contaminated waste in 40 CFR 268.42 and Appendix VI.

Oxidation is the process in which an atom or compound acquires electrons (the oxidizing agent or oxidant) and reduction is the process in which an atom or compound loses electrons (the reducing agent or reducant). The two processes always occur simultaneously with one compound acting as the oxidant and the other the reductant.

For the treatment of hazardous organic containing waste, the facility (MDWTP) typically uses a sodium hypochlorite solution as the oxidizing agent. While sodium hypochlorite is the predominant oxidant used, the facility (MDWTP) may occasionally use other oxidizing agents, including but not limited to hydrogen peroxide and potassium permanganate. In the oxidation process, electrons are stripped from the organic molecules to the extent that the carbon-to-carbon bonds are broken and carbon dioxide, sodium chloride and water are formed. Organic compounds are destroyed in this mildly exothermic reaction.

The amount of oxidant used in the treatment is determined by trained personnel and is a function of 1) the concentration of all organics in the waste, or 2) the treatability study run on the waste, and/or 3) the trained personnel's previous experience with the waste. Batches treated by chemical oxidation must be solidified by chemical stabilization before landfilling and must also be determined to pass the LDR standards as described in Section 3.8.

3.7.3 Treatability Studies (see Table 2, Table 3 & Section 4) - MDWTP

The pre-approval analyses for specific wastes to be treated to meet the applicable LDR(s) are specified in Table 3 and Section 4 – Waste Analysis Parameters. A bench-scale treatability study is performed to verify acceptability with the facility (MDWTP) treatment process and the treatment "recipe" required to meet the applicable treatment standards. The treated waste samples are analyzed as specified in Table 2, Table 3 and Section 4.

These pre-approval treatability studies are used to adjust the treatment processes for specific waste types and batches. Example treatment approaches for typical hazardous waste types are presented on Figures 1 through 4.

These treatment operations may combine several wastes or shipments from various generators to facilitate operational efficiency and utilization of available processing capacity. Batch treatment of multiple wastes and/or shipments will be based on chemical compatibility, USEPA hazardous waste numbers, and treatment requirements.

Post-treatment analyses, includes the TCLP and, where applicable, specific constituent analyses are performed on each batch of hazardous waste prior to landfill disposal. This post-treatment analysis is used to demonstrate that the treatment residue meets the LDRs. (See Table 2 and Table 3)

The facility (MDWTP) conducts treatability testing to ensure that wastes can be treated to the required LDR levels prior to acceptance of the waste. Examples of possible triggers for a treatability study are listed below:

- The waste type not previously treated at MDWTP
- The waste is generated by a process not previously treated at MDWTP
- The waste has levels of constituents outside the range normally treated at MDWTP
- The waste codes or constituents not previously treated at MDWTP

Tables 2 and 3 are provided to assist in guiding the chemists and technicians in determining if a treatability test is needed.

The treatability test involves simply mixing waste and treatment reagents in a ratio developed by the laboratory. Measured volumes of the waste are mixed with the treatment agents. Mixing is designed to emulate retention time in the pugmill mixer and mixing time per unit of waste in the treatment tanks. After mixing, a sample of the waste is collected for analysis for the constituents of concern. A treatability report is then prepared showing the after treatment concentrations of the constituents of concern. This report is placed into the waste stream technical approval file prior to acceptance of the waste.

To successfully treat certain waste streams, a modification of the standard process may be required. Modified treatments are first verified in the laboratory, and then implemented at the plant once the waste is received. Modified treatments are considered Confidential Business Information. It is important to note that all treatments are verified through actual post treatment analysis of treatment residue, prior to disposal of the waste.

3.7.4 Mixing, Blending, & Commingling of Wastes for Treatment - MDWTP

As part of the treatment and storage process, various individual waste streams are mixed, blended, and/or commingled. The blending operations are conducted by the facility (MDWTP) Operations personnel under the direction and careful supervision of the facility's laboratory and treatment chemists.

3.7.5 Authorization to Mix or Blend - MDWTP

See Section 3.4.3, "Lab Compatibility" for a detailed discussion.

3.8 Land Disposal Restrictions (LDRs)

3.8.1 Waste Not Subject to the LDRs - MDWTP

The MDWTP stabilization process will also be utilized to treat wastes not subject to the LDRs, to solidify free liquids and render the waste more suitable for handling and landfill disposal.

The post-treatment analyses will include a visual observation, to ensure no free liquid is present. A paint filter test may be performed on selected loads when determined necessary by visual inspection.

3.8.2 Wastes Meeting the LDRs

Wastes that are certified, through analysis, to meet the LDRs specified in 40 CFR 268 may be directly landfilled at WDI or another off-site TSDF. The LDR certification and notification, and analytical documentation will be provided for each waste stream disposed of at WDI or shipped to another TSDF. Per 40 CFR 264.73, the required information will be kept as part of the operating record.

3.8.3 Wastes Requiring Treatment & LDRs - MDWTP

Wastes requiring deactivation, chemical oxidation, chemical reduction, and/or stabilization at the facility (MDWTP) will be treated in batch operations. Each batch may contain multiple USEPA hazardous waste numbers and treatment standards. The treated batches will be held in the treatment/storage tanks or in roll-off boxes or trailers while testing is performed prior to disposal (see Section 2.3). Treatment batch residues will be sampled and analyzed to determine whether the batch meets the applicable treatment standards defined in 40 CFR 268. Treatment batch residues, resulting from the treatment operations that exceed the applicable LDRs, will be reevaluated. Options include re-testing after additional cure time, retreating on-site until the LDRs are achieved or sent off-site for further treatment to meet the LDRs. Any off-site shipments will be accompanied by the LDR notification, a manifest, and data for the waste for the off-site TSDF in accordance with 40 CFR 268.7(a)(1).

Treatment residues that meet the applicable LDRs, will be disposed at WDI or another TSDF. The LDR certification, notification and analytical documentation will be provided for each waste disposed of at WDI or shipments to another TSDF. Per 40 CFR 264,73, the required information will be kept as part of the operating record.

3.8.4 Characteristic Wastes & LDRs

Characteristic wastes, which are batch-treated separately from listed wastes, may be disposed of in a solid waste/Subtitle D landfill, if it is determined that the LDRs have been achieved and the treatment residue no longer exhibits the characteristics of hazardous waste and all applicable underlying hazardous constituents (UHCs), have been treated in accordance with the Universal Treatment Standards (UTS) at 40 CFR 268.

3.8.5 Hazardous Debris & LDRs

As stated in 40 CFR 268.45, Hazardous debris (>60mm) must be treated prior to land disposal, unless the debris is no longer contaminated with hazardous waste or the debris is treated to the waste-specific treatment standards specified in 40 CFR 268.45 using technologies identified in Table 1 of 268.45. MDWTP will ensure that debris requiring treatment to the waste specific treatment standards is treated to those standards or that the technology standard is met. MDWTP anticipates receiving hazardous debris that may be contaminated with any code or codes identified in Appendix A of the WAP.

Characteristic ignitable or corrosive hazardous debris will be deactivated at MDWTP during the micro-encapsulation process prior to landfill disposal. If immobilization, such as micro-encapsulation or macro-encapsulation, is used in a treatment train, it will be the last treatment technology applied. This requirement also will apply to debris contaminated with two or more contaminants subject to treatment. Hazardous debris will be treated for each contaminant, subject to treatment as specified by 40 CFR 268.45(b) for toxicity characteristic debris and debris contaminated with listed wastes. CN reactive debris will not be accepted by MDWTP.

MDWTP uses the micro- and macro-encapsulation immobilization technologies listed in 40 CFR 268.45 to achieve the performance standard of reduced leachability of the hazardous contaminants, in the case of micro-encapsulation, and completely encapsulates debris with a material(s) that is resistant to degradation by the debris and its contaminants and the material into which it may come into contact after placement (leachate, other waste, microbes), in the case of macro-encapsulation.

Treated hazardous debris will be managed as specified in 40 CFR 268.45. When treating debris in accordance with the alternative treatment standards for debris, the MDWTP uses only the immobilization technologies of micro and macro-encapsulation. Hazardous debris contaminated with listed or characteristic waste that is treated by micro or macro-encapsulation at the MDWTP are properly disposed in licensed Subtitle C landfills and are accompanied by an LDR notification and certification form in accordance with 40 CFR 268.7(b)(5). Treatment of debris using one of the technology specific immobilization treatment standards at 40 CFR 268.45, constitutes compliance with the LDRs and no testing after treatment is required prior to disposal.

3.9 Macro-encapsulation

3.9.1 Description of the Macro-encapsulation Unit

The macro-encapsulation unit is made of approximately one-inch thick polyethylene using an injection molding process to create a rigid, one-piece "tub" that fits within a roll-off or is self-supporting. The macro-encapsulation units can be manufactured in any size but are most commonly manufactured to fit within a 20-yard roll-off. To seal the unit, a sheet of the same polyethylene in approximately the same thickness is screwed onto the lip of the tub using approximately 120 self-tapping screws. Screwing the down the lid provides a watertight seal that may be augmented with caulking or glue.

Debris placed within the macro-encapsulation units are jacketed within the polyethylene in an inert, durable, watertight material that will substantially reduce surface exposure to potential leaching media. The inert polyethylene material will completely encapsulate the debris and is resistant to degradation by the debris and debris contaminants managed by MDWTP and the wastes, leachate, or microbes with which it will contact once landfilled in a licensed hazardous waste cell.

3.9.2 Description of the Macro-encapsulation Process

Macro-encapsulation will be performed as follows:

1) Debris will be placed into one of the treatment tanks, Tanks A – H (formerly tanks 7A, 7B, 8A, 8B, 9A, 9B, 10A, 10B), or directly into a macro-encapsulation unit.
2) In the treatment tank, the debris is mixed, as needed, with an inert, finely divided material to fill the void spaces when encapsulated and to provide cushioning material. The inert filler includes cement kiln dust, sand, solidified non-hazardous waste, waste treated to the LDRs, or other non-biodegradable sorbent or fixation media. Fill material is also added directly to the macro-encapsulation units.
3) The debris is lifted from the tank with a backhoe and placed into a macro-encapsulation unit or is placed directly into the unit. As with dump trailers and dump trucks currently loaded with treated waste within MDWTP, the macroencapsulation units are also loaded within MDWTP.
4) The lid is screwed into place on the macroencapsulation unit.
5) Macroencapsulation approvals will specify "special burial" in the licensed hazardous waste cell. The special burial designation will ensure that the macroencapsulation units are carefully placed in the cell to ensure that they are not ruptured during placement or after placement. For macroencapsulated debris shipped to other permitted TSDF, guidance will be provided, to extent needed so that the macroencapsulation unit can be unloaded without rupturing.

3.9.3 Macro-encapsulation Capacity

Macro-encapsulation treatment capacity is a function of available tank space. Macro-encapsulation of hazardous debris will be counted against the permitted treatment capacity of the MDWTP on a daily basis as are all other hazardous wastes treated in the tanks. All permitted tank treatment methods, including micro- and macro-encapsulation, are performed within the state license and federal permit capacity limitations as stipulated in Section A-1 of this application.

4.0 WASTE ANALYSIS PARAMETERS

4.1 Criteria for Parameter Selection and Rationale – MDWTP/WDI

The parameters selected for analysis of wastes managed by the facility and the rationale for their selection is based on the physical/chemical characteristics of the waste, the regulatory and operating license requirements for treatment and/or storage of the waste at MDWTP or disposal at WDI, the information and analytical data supplied to the facility by the waste generator and the process control data necessary to manage the waste by the MDWTP's treatment and/or storage operations or disposal at WDI. The waste analysis used by the facility to manage wastes for treatment and/or storage include the following:

4.1.1 Fingerprint Analyses – MDWTP/WDI

These analyses may be performed on generator samples for pre-approval of the waste for management at the facility and are also performed on samples of each waste load prior to load acceptance, except for those listed in section 3.1.2. These analyses may also be performed if the generator or the facility determines that there is a change in the process generating the waste. The fingerprint analyses include screening procedures to provide data regarding the general physical and chemical characteristics of the waste. Table 3 indicates which tests will be used and under which conditions.

4.1.2 Supplemental Analyses (indicated with a "O" in Table 3) – MDWTP/WDI

These analyses are generally waste-specific based on the physical/chemical characteristics of the waste, the USEPA or Michigan hazardous waste number (determined by the generator), the process generating the waste, treatment, storage, or disposal process control requirements, and regulatory treatment requirements (such as the LDR or facility operating license conditions).

These analyses may be performed to supplement the generator-supplied information regarding the waste and the fingerprint analyses and include standard analytical USEPA and/or American Society for Testing and Materials (ASTM) methods.

Waste characterization data is provided by the generator using the GWCR, as described in Section 3.1.1. The generator data and analyses provide the facility with the information needed to properly manage a waste and ensure that the waste shipment received matches the identity and characteristics of the waste approved and designated on the accompanying Hazardous Waste Manifest (manifest) or shipping papers.

4.2 Analytical Parameter Descriptions – MDWTP/WDI
(Pre-Approval/Re-Approval, Pre-Acceptance & Post-Treatment)

The analytical parameters used to manage wastes for treatment, storage and disposal include the fingerprint analyses or supplemental analyses (if necessary) are described below. Table 3 indicates which tests will be used and under which conditions.

Color	This procedure evaluates the color of waste samples/information presented for pre-approval and compares the color of incoming loads of waste.
Consistency	A comparison of the incoming wastes consistency of originally approved material. Consistency descriptors are as follows: Dust, Solid, Semi-Solid, Sludge, Liquid and debris.
Compatibility Test	The procedures will be followed as outlined in the current version of the Work Plan for the Lab Compatibility Test that is maintained on-site.
Cyanide	A determination that the waste does not meet the criteria set forth in 40 CFR 261.23(a)(5). The test method to be used is the Total and Amenable Cyanide Method 9010, found in SW-846 or Method 7.3.3.2 for Reactive CN. Untreated waste containing more than 250 ppm of reactive or releasable CN is not accepted for treatment but may be stored in containers and transshipped.

Flashpoint / Ignitability	Used to determine the flash point of a liquid to verify approval under limits of acceptable only above 90°F flashpoint. **Test Methods for Liquids:** a. Setaflash Closed Cup Tester - American Society for Testing and Materials (ASTM) Standard D-3278-78 b. Pensky-Martin Closed Cup Tester - ASTM D-93-79 or D-93-80 **Test Methods for Sludges / Solids:** 5 plus or minus (≠) 1 grams of waste is placed in a small container. Ignition is attempted with a match for 5 seconds. If ignition occurs and the waste burns vigorously and persistently, the waste is not acceptable for treatment but may be stored prior to transshipment.
Hexavalent Chromium	The waste is screened using either a Hach® type chromate test kit or equivalent, or USEPA Method 7196. This method is used to screen for the presence or absence of hexavalent chromium (Cr^{+6}).
Hydrogen Sulfide	A test to determine if the specific rate of release of hydrogen sulfide in waste is above 500 ppm upon contact with an aqueous acid. (SW-846, Section 7.3.4.2).
Odor (Incidental)	Potentially problematic odors detected in the routine laboratory handling of a sample may result in rejection of the load unless the waste can be managed in such a way as to minimize odor emissions.
Oxidizer	No method for the oxidizer screen was provided in USEPA SW-846. The procedure used is as follows: Potassium iodide starch (KI) indicator paper is used to determine the presence of organic peroxides or other oxygen donors in aqueous wastes. A sample is considered an oxidizer if a reaction occurs when the addition of concentrated sulfuric acid produces orange gas (NOX). A SOP called "Screening of Possible Oxidizers (as defined by 40 CFR 173.151)" is used by the facility laboratory in performing this test. The current version of this SOP is maintained on-site.
Paint Filter Test	This method (USEPA 9095) may be used to determine if free liquid is present in a waste, if this is not apparent by visual inspection.
PCBs	This method (SW-846 8082) is used to detect Polychlorinated Biphenyls (PCBs). PCB analysis will be conducted on all wastes that contain oily residue, or are suspected of containing PCBs. Oily residue is defined as waste streams containing over 50 percent oil, no matter the origin.
pH	A comparison of the pH of the incoming waste with the pH range of the originally approved material is performed. pH methods used include SW-846 9040B, 9041A, 9045C.

Radiation Screen	A sample is passed near the detector window of a geiger counter, and the reading of the meter is noted and compared to the background reading. (See Section 3.1.3 Special Wastes; Section 3.1.3.1 Source Material, NORM or TENORM)
Reactivity - Water	A determination that the waste does not react violently with water during processing. In the course of this test water reactivity is addressed. The test method is as follows: Approximately ten milliliters (mls) or equal volume of waste is mixed rapidly with approximately ten mls of water solution in a beaker, the waste is compatible with the process if no incompatible waste reaction occurs as defined in 40 Code of Federal Regulations (CFR) 264, Appendix B, paragraph 1. The testing materials are identified water reactivity.
Reactivity – Acid	Standard Method 2310 (current Edition) is used to measure the acid content in waste in either mg/L (for aqueous samples) or mg/kg (for solid samples). Acidity is determined by potentiometric titration.
Suspended Solids	Is used to determine suspended solid content of aqueous wastes or sludge for the purpose of determining wastewater or non-wastewater categories under 40 CFR Part 268. This is performed using generator-provided information / analysis or from data obtained from the preparation of TCLP extracts (Method 1311).
TCLP	A Toxicity Characteristic Leachate Procedure (TCLP) test is used to determine if a solid waste meets or exceeds the maximum concentrations extractable of contaminants listed in 40 CFR 261.24, Table I. The test methods to be used are described in 40 CFR Part 261, Appendix II, Method 1311. Equivalent methods must be approved by the Director. (See Section 3.0)
Total Metals	A test to determine the total metal (i.e., constituent concentration in waste) content of wastes (USEPA SW-846 Methods 6000, 7000).
VOCs	This SW-846 (USEPA) analytical method (8260, 8021B or 8015BA) is used to determine the total concentration of volatile organic compounds (VOCs) in waste matrices. Only the constituents identified for a particular waste stream are analyzed.

40 CFR Part 261, Appendix VII	The hazardous constituents for which a waste is listed. The Appendix VII constituents are presumed to be present by facility personnel, and the waste handled accordingly. Specific information on a particular waste stream is normally supplied by the generator, based either on analysis or from the 40 CFR 261 background documents, which describe the basis of listing in accordance with 264.13(a)(2). If analysis is performed by the facility (on-site or by contract laboratory), one of the methods listed below is used, depending on the constituent of interest. These methods are provided in US EPA's "Test Methods for Evaluating Solid Waste," SW-846 (current Update). - Total Semi Volatiles (8100, 8060, 8270) - Total Volatiles (8260, 8021, 8015) - Total Metals (6000,6010,7000 series) - Total Herbicides (8151A) - Total Pesticides (8081)

4.3 Receiving - MDWTP/WDI

The analytical parameters used for pre-acceptance may include fingerprint and/or supplemental analyses for each incoming shipment of wastes arriving at the facility are indicated in Table 3. Supplemental analyses performed, is a function of the designated USEPA or Michigan hazardous waste numbers and waste characteristics. The analytical parameters performed for receiving incoming shipments of waste -are indicated in Table 3 except as noted in Section 3.1.2.

4.4 Post-Treatment - MDWTP

The analytical parameters that are used for post-treatment may include fingerprint and/or supplemental analyses. These parameters are defined by the waste codes and UHC associated with the waste in process and are summarized in Tables 2 and 3. Post treatment testing will not be performed on micro or macro-encapsulated debris.

5.0 ANALYTICAL TEST METHODOLOGIES

5.1 Fingerprint Parameters and Methods – MDWTP/WDI

The "fingerprint" parameters include screening procedures and test methods that have been developed within the waste management industry to provide a general identification of specific physical and chemical characteristics of wastes handled. These parameters are presented in Table 3 and are described above in Section 4.2.

5.2 Supplemental Parameters and Methods (indicated with a "O" in Table 3) – MDWTP/WDI

The additional parameters include commonly accepted standard analytical methods developed by the USEPA, ASTM, or as a standard waste management industry procedure. These parameters, presented in Table 3 and described above in Section 4, are used, as necessary, for additional characterization of the waste and determination of specific properties and/or constituents to ensure proper treatment, and/or storage in accordance with current regulations and the operating license.

Fingerprint analysis and additional analyses (if necessary) are used to ensure that restricted wastes are not accepted by the facility and that incompatible wastes are not commingled. Specific analyses may be used for various waste matrices.

5.3 Laboratory Capabilities – MDWTP/WDI

An analytical laboratory is maintained on-site for the purpose of conducting the analytical procedures associated with this WAP to evaluate, approve, and monitor the characteristics of waste received from their customers and managed by the facility. The laboratory utilizes modern analytical equipment and facilities in the analysis of waste samples. In addition, trained chemists are employed (individuals that possess educational and/or work experience qualifications necessary to be proficient in performing waste analysis) who utilize standardized procedures for maintaining quality assurance (QA) and quality control (QC) requirements associated with the analytical procedures.

The laboratory is currently capable of performing the fingerprint analyses, as described in this WAP, as well as standard USEPA and ASTM methodologies for analyses of a variety of parameters in the following general categories:

1) Water quality parameters/inorganics, non-metallics;
2) RCRA hazardous waste characteristics;
3) Organic Constituents:
    (a) VOCs;
    (b) Semi-VOCs;
    (c) Pesticides, herbicides; and
    (d) PCBs.
4) Metals.

The Laboratory's capabilities may be subject to change as necessitated by regulations, operating requirements, or advances in analytical methodologies and equipment.

5.4 Quality Control/Quality Assurance – MDWTP/WDI

The Laboratories maintain a Laboratory Quality Assurance Program (LQAP) to insure the accuracy, precision, and reliability of the laboratory results produced for our customers, or at the request of regulatory or accrediting bodies. Management, administrative, statistical, investigative, preventive, and corrective techniques are employed to maximize the reliability of the analytical data.

This LQAP establishes the policies and procedures regarding:

- Glassware preparation;
- Reagents, solvents, gases, and standards;
- Samples and sampling;
- Instrument calibration procedures;
- Analytical procedures;
- QC checks;
- Data handling and reporting;
- Preventative maintenance;
- Corrective actions;
- Orientation and training;
- Performance and system audits; and
- Subcontracted laboratories.

The Laboratory uses standard analytical procedures developed by the USEPA and ASTM. The Laboratory equipment maintained on-site is calibrated within acceptable limits, according to USEPA and ASTM or the manufacturer specifications prior to use. The Laboratory instruments are periodically inspected, maintained, and serviced according to manufacturer specifications. Reference standards and QC samples (i.e., checks, spikes, laboratory blanks, duplicates, and splits) are used to determine the accuracy and precision of procedures, instruments, and operators. Quality assurance/quality control (QA/QC) data is recorded with the test results. Records of all pertinent laboratory calibration, analytical, and QC activities and data are maintained by the laboratory.

The laboratory QA/QC procedures used by the facility assist in assuring that the data obtained are precise, accurate, and representative of the waste stream analyzed.

The analytical QA/QC procedures follow the method-specific requirements specified in "Test Methods for Evaluating Solid Waste: Physical Chemical Methods," SW-846, where applicable.

6.0 SAMPLING METHODOLOGIES

6.1 General Methodologies

Each incoming shipment of non-hazardous and hazardous waste is inspected and sampled, except those listed in section 3.1.2, to ensure that the waste received for matches the waste reviewed during the pre-approval process. The sampling techniques described herein are performed in accordance with the techniques outlined in USEPA's SW-846.

6.2 Sampling Program and Equipment

USEPA SW-846 will be followed, whenever possible, when choosing sampling equipment and methodologies. If a method is not provided in USEPA SW-846, then a different method will be used as outlined in Section 4.2. The person sampling is trained in the selection and use of the sampling device and is thoroughly familiar with the sampling requirements.

Sampling equipment is constructed of non-reactive materials such as glass, polyvinyl chloride (PVC) plastic, aluminum, or stainless steel. Care is taken in the selection of the sampler to prevent cross-contamination of the sample and to ensure compatibility of materials.

Sampling is performed for each waste in a manner that ensures the samples are as representative as possible under the conditions of the sampling event. All bulk and containerized hazardous waste loads will be sampled prior to acceptance, except for waste specified in Section 3.1.2. All samples must be appropriately labeled. The following information is included on the label:

Type of Sample	**Label Requirements:**
Bulk Loads	Transporter Name Truck #
Container Loads	Waste Code Manifest # Approval # Drum # and/or barcode
Treatment Tanks	Batch ID # Date Time Sampler

Observations or unusual conditions during sampling are noted as comments on the label. No chain-of-custody (COC) form is used with samples on-site, since the samples are relinquished directly to the on-site Laboratory. A COC will accompany any sample being sent to an off-site Laboratory.

6.3 Specific Sampling Procedures

6.3.1 Containerized Waste – MDWTP/WDI

Each incoming stream of waste in containers (non-hazardous/hazardous) will be sampled, except those listed in section 3.1.2, and the parameters according to Table 3 performed on each sample.

The containers are labeled with an EQ identification label, which numbers each container per manifest line item. Alternately, the numbers will be spray painted on each container. Once numbered, the containers to be sampled will be determined using www.random.org or an equivalent method listed in SW-846. Each hazardous waste stream will be sampled at 10-percent of the total number of containers.

The separate samples collected will be composited by waste stream in the facility laboratory to form a single sample for analysis. Individual samples that are visually dissimilar will not be composited.

Samples will be collected from containers by utilizing the sampling equipment recommended by the USEPA in USEPA, SW-846 and Section 6.2. Facility personnel will usually utilize container thieves or coliwasas to sample aqueous waste (MWTP only) and trier or scoops to sample granular or solid, sludge matrices (MDWTP/WDI).

6.3.2 Bulk Waste – MDWTP/WDI

Each incoming stream of waste received at the facility in a bulk form, except those listed in Section 3.1.2 will have a sample collected and analyzed for the fingerprint parameters in Table 3. Samples will be collected from each vehicle. A clean carbon steel, stainless steel auger or disposable PVC trier will be utilized to collect solid samples. Bulk aqueous tankers will be grab sampled utilizing a thief or coliwasa-type sampler to collect the sample from varying depths for analysis.

6.3.3 Treatment/Storage Tanks - MDWTP

Treated, stabilized waste will be sampled from the MDWTP treatment tanks in order to verify that the waste meets the LDRs prior to land disposal with the exception of microencapsulated and macroencapsulated debris. Samples of treated, stabilized waste will be collected from random vertical and horizontal locations.

A grab sample will be collected from a random vertical and horizontal location using a backhoe to reach the selected sampling point, collecting the sample from the backhoe bucket with a disposable scoop or cup. The sample is then taken to the laboratory for analysis. The location from which the random grab sample is taken will be marked in a grid in the Batch packet.

6.3.4 Transshipped Wastes - MDWTP

Any waste to be transshipped off-site to other permitted TSDF's will be received under a valid MDWTP approval and management will comply with this WAP.

6.3.5 Waste Materials Utilized as Treatment Reagents - MDWTP

MDWTP will obtain a chemical assay of waste materials such as lime or cement kiln dust (CKD) from the material source/vendor for evaluation prior to approval for use at MDWTP.

6.4 Equipment Decontamination

All equipment used in the collection of waste samples will either be disposable (e.g., scoops or container thieves) or sufficiently cleaned to remove observable contamination prior to sampling.

6.5 Sample Preservation and Storage

- Hazardous waste samples are generally not amenable to preservation;
- Samples for volatile organics are refrigerated at 4-degrees Celsius (°C) until analyzed and must be analyzed within seven days;
- Samples for semi-volatiles, if necessary, must be extracted within seven days and analyzed within 40 days;
- Aqueous samples for total organic carbon (TOC) analyses are refrigerated at 4°C until analysis and aliquots for metals analysis are preserved by the addition of HNO_3 to pH <2; and
- Samples are stored in the laboratory refrigeration unit.

6.6 Quality Control/Quality Assurance

Sampling QA/QC policies are found in the QA/QC manual, which is maintained by the Laboratory.

6.7 Health and Safety Protocols

During sampling and laboratory-related activities, personnel will utilize precaution to reduce the potential for incidents, injuries, or accidents. The facility has established a Hazardous Waste Operations (HAZWOPER) Facility Health and Safety Plan (HSP) in accordance with Michigan Occupational Safety and Health Administration (MIOSHA) Act 154 and R325.52129 for operations at TSDFs.

Facility personnel are HAZWOPER trained in accordance with the provisions of R325.52129(8) and follow health and safety (H&S) requirements, including PPE requirements specified in the facilities' standard operating procedures (SOPs).

REFERENCES

American Society for Testing and Materials, "Annual Book of ASTM Standards."

United States Environmental Protection Agency, "Test Methods for Evaluating Solid Waste: Physical Chemical Methods." SW-846, Third Edition, September 1986 as amended by Update I, (July, 1992), II (September 1994), IIA (August 1993), IIB (January 1995), III (June, 1997)

United States Environmental Protection Agency, Office of Solid Waste and Emergency Response, April 1994, "Waste Analysis at Facilities that Generate, Treat, Store, and Dispose of Hazardous Waste;" A Guidance Manual.

Standard Methods for the Evaluation of Water and Waste Water, 18th Edition

Note: For Industry Standards see the QA/QC Program Manual.

TABLE 1 - SEGREGATION AND SEPARATION CHART OF HAZARDOUS MATERIALS

CLASS OR DIVISION		2.1	2.2	3	4.1	4.3	5.1	5.2	6.1*	8A	8B	9
Non-Flammable Gases	2.1	C	C	C	C	C	C	C	C	C	C	C
Non-Toxic, Non-Flammable Gases	2.2	C	C	C	C	C	C	C	C	C	C	C
Flammable Liquids	3	C	C	C	C	C	X	C	C	C	C	C
Flammable Solids	4.1	C	C	C	C	C	C	C	C	X	X	C
Dangerous when wet materials	4.3	C	C	C	C	C	C	C	C	X	X	C
Oxidizers	5.1	C	C	X	C	C	C	C	C	X	X	C
Organic Peroxides	5.2	C	C	C	C	C	C	C	C	X	X	C
Poisonous Liquids (NOT PG I, Zone A materials)	6.1*	C	C	C	C	C	C	C	C	C	C	C
Corrosive Liquids-Acids	8A	C	C	C	X	X	X	X	C	C	X	C
Corrosive Liquids-Bases	8B	C	C	C	X	X	X	X	C	X	C	C
Other Regulated Materials and Non-Hazardous Wastes	9	C	C	C	C	C	C	C	C	C	C	C

Notes:

- ✓ This chart is from the USDOT Segregation and Separation Chart of Hazardous Materials, 49 CFR Subpart C (177.848) & additionally segregates the corrosive wastes into acids and bases.
- ✓ Acids have a pH $\leq$ 2.0 and bases have a pH $\geq$ 12.5.

* = Other than Poisonous Liquids PG I, Zone A will not receive wastes with Class 1, or Division 2.3, 4.2, 6.1 PG I, Zone A Hazardous Material classifications.

C = Compatible
X = Non-Compatible

TABLE 2 – PROCESS LOGIC

TARGET CONSTITUENTS	TYPICAL WASTE CODES	TREATMENT TRAIN	POST- TREATMENT PARAMETERS
Arsenic	D004	STABL	TCLP Metals
Barium	D005	STABL	TCLP Metals
Cadmium	D006	STABL	TCLP Metals
Chromium (Hexavalent)	D007 (Cr+6)	CHRED fb STABL	TCLP Metals
Lead	D008	STABL	TCLP Metals
Mercury	D009	STABL	TCLP Metals
Selenium	D010	CHRED fb STABL	TCLP Metals
Silver	D011	STABL	TCLP Metals
Nickel	F006-F009, F011, F012	STABL	TCLP Metals
Low [CN-] with Metals and Cr+6	F006, F007 F008, F009 F011, F012 F019	CHOXD fb CHRED fb STABL	T-CN A-CN TCLP Metals
Low [CN-] No Metals/ Organics	F010	CHOXD	T-CN A-CN TCLP Metals
Metals, Zinc	K061	STABL	TCLP Metals
Ignitable Low TOC Subcategory <10% TOX	D001	DEACT/CHOXD fb STABL	Ignitability
Ignitable High TOC Compressed Gases Strong Oxidizers Ignitable Solids	D001	Transshipment	NA
Oxidizers (No Strong Oxidizers Except for Transshipment)	D001	DEACT/CHRED fb STABL	Ignitability
Corrosives With Metals, Organics	D002/ICR	DEACT/NEUT fb CHOXD fb CHRED fb STABL	PH* TCLP Metals Total Organics
Low [ ] Organics	F001 – F005	CHOXD fb STABL	Total Organics
Low [ ] Organics	D018 – D043	CHOXD fb STABL	Total Organics
Hazardous Waste Debris	All Codes & Contaminants Subject to Treatment	MICRO	NA
Hazardous Waste Debris	All Codes & Contaminants Subject to Treatment	MACRO	NA
Non-Hazardous Waste	-	STABL for Free Liquids	Visual Inspection

NOTES:

- ✓ Verify treatment process conditions, sequence, reagents and dosage rates with Trained MDWTP Personnel prior to processing any wastes (Refer to batch sheet.)
- ✓ All hazardous wastes must meet LDRs prior to disposal.
- ✓ The post-treatment analyses will also include a visual observation, to ensure no free liquid is present.

ABBREVIATIONS & SYMBOLS

A-CN = Amenable Cyanide
CHOXD = Chemical Oxidation
CHRED = Chemical Reduction
DEACT = Deactivation
fb = followed by
MICRO = Microencapsulation
MACRO = Macroencapsulation
NEUT = Neutralization
STABL = Stabilization
TCLP = Toxicity Characteristic Leaching Procedure
T-CN = Total Cyanide
< = Less than
> = Greater than
[ ] = Concentration

TABLE 3 – ANALYTICAL PARAMETERS & TESTING METHODS

PARAMETER	ANALYTICAL METHOD (1)	PRE-APPROVAL	PRE-ACCEPTANCE	POST-TREATMENT
Color	See Section 4.2	R	R	
Consistency	See Section 4.2	R	R	
Ignitability	See Section 4.2	R	R	
pH	See Section 4.2	R	R	
Radiation Screen	See Section 4.2	R	R	
Reactivity – Water	See Section 4.2	R	R	
Cyanide (Spot Test)	See Section 4.2	R	O	
Odor	See Section 4.2	R	O	
Sulfide (Spot Test)	See Section 4.2	R	O	
Compatibility Test	See compatibility work plan	O	R	
Cyanide (Reactive)	See Section 4.2	O	O	
Flash Point	See Section 4.2	O	O	
Hexavalent Chromium	See Section 4.2	O	O	
Oxidizer	See Section 4.2	O	O	
PCBs	See Section 4.2	O	O	
Reactivity – Acid	See Section 4.2	O	O	
Hydrogen Sulfide (Reactive)	See Section 4.2	O	O	
Total Organic Carbon - TOX	See Section 4.2	O	O	
Paint Filter Test (1)	See Section 4.2	O	O	M
Cyanide (Total)	See Section 4.2	O	O	M
Cyanide (Amenable)	See Section 4.2	O	O	M
TCLP	See Section 4.2	O	O	M
40 CFR 261 Appendix VII Constituents:	See Section 4.2	O	O	M
- Total Semi-Volatiles	See Section 4.2	O	O	M
- Total Volatiles	See Section 4.2	O	O	M
- Total Metals	See Section 4.2	O	O	M
- Total Herbicides	See Section 4.2	O	O	M
- Total Pesticides	See Section 4.2	O	O	M

NOTES:

(1) =	Visual inspection to ensure no free liquids are present prior to disposal is performed on each load. Paint filter tests are performed on selected loads if deemed necessary by visual inspection.
PCBs =	Polychlorinated Biphenyls
TCLP =	Toxicity Characteristic Leaching Procedure
R =	Required analysis
M =	Mandated to meet treatment standards
O =	Optional (or if no designation indicates the analysis is optional)

FIGURE 1

TECHNOLOGY NAME
Deactivation (DEACT)

APPLICABLE WASTE TYPES
Wastes exhibiting the characteristics of Ignitability, Corrosivity, or Reactivity such as D001, D002, and D003 hazardous waste numbers.

PRE-TREATMENT REQUIREMENTS
Waste Specific

CRITICAL DESIGN PARAMETERS
- Dependent on which characteristic is exhibited.
- Deactivation technologies include those recommended in 40CFR Part 268 Appendix VI.

WASTE CHARACTERISTICS AFFECTING PERFORMANCE

- STATE - solid, liquid, or sludge
- ALKALINITY, ACIDITY, AND pH
- FLASH POINT
- CONCENTRATION OF OTHER CONSTITUENTS PRESENT.
- DEACTIVATION BY-PRODUCTS.

NOTE: MDWTP DOES NOT ACCEPT REACTIVE WASTES

UNDERLYING PRINCIPLE OF OPERATION

The treatment standard for many subcategories of characteristic hazardous D001, D002, and D003 wastes remove the characteristic of Ignitability, Corrosivity, or Reactivity. EPA has determined that many technologies such as those listed below, when used alone or in combination can achieve the treatment standard. Example deactivation technologies include:

Stabilization (STABL)
Neutralization (NEUTR)

FIGURE 2

TECHNOLOGY NAME

Chemical Oxidation (CHOXD)

APPLICABLE WASTE TYPES

Wastes containing organics, organo-metallics, cyanides, or sulfides. Oxidize arsenic to insoluble form in waste waters or inorganic sludges from metal plating/finishing. Typical hazardous waste numbers include F006, F007, F008, F009, F011, F012, F010, F019, F001-F005, D018-D043.

PRE-TREATMENT REQUIREMENTS

Frequently requires raising pH to alkaline range.

CRITICAL DESIGN PARAMETERS

- Oxidation/reduction potential.
- Residence time.
- Amount and type of oxidizing agent - add excess and monitor ORP.
- Degree of mixing.
- pH - optimize (moderately alkaline ~10-11.5).
- Oxidation temperature.
- Amount and type of any catalyst.
- TOC may be used as surrogate parameter for organics.

WASTE CHARACTERISTICS AFFECTING PERFORMANCE

- CONCENTRATION OF OTHER OXIDIZABLE COMPOUNDS. Increases demand in reagent; high sulfide may require additional reagent.
- CONCENTRATION OF METAL SALTS (especially Pb and Ag) Can cause excess consumption of reagent. Metal-cyanide complexes are more difficult to oxidize.

UNDERLYING PRINCIPLE OF OPERATION

The basic principle of chemical oxidation is that inorganic cyanides, selected dissolved organic compounds and sulfides can be chemically oxidized to yield carbon dioxide, nitrogen, water, salts, simple organic acids and in the case of sulfides, sulfates. Typical oxidants and reactions using sodium hypochlorite are:

Cyanide

$CN^- + NaOCl$ --- $OCN^- + NaCl$

$2OCN^- + 3NaOCl$ --- $CO_3^{-2} + CO_2 + N_2 + 3NaCl$

Phenol

$C_6H_5OH + 14NaOCl$ --- $6CO_2 + 3H_2O + 14NaCl$

Sulfide

$S^{-2} + 4NaOCl$ --- $SO_4^{-2} + 4NaCl$

FIGURE 3

TECHNOLOGY NAME
Chemical Reduction (CHRED)

APPLICABLE WASTE TYPES
Reduce hexavalent chromium and selenate ions. Treat oxidizing wastes containing reducible organics, inorganic oxidizers from plating, metal finishing, chromium pigments, mining, ore processing, or chemical manufacturing. Typical hazardous waste numbers include D007, D010, F006-F009, F011, F012, and F019.

PRE-TREATMENT REQUIREMENTS
Frequently requires lowering pH to acidic range.

CRITICAL DESIGN PARAMETERS
- Oxidation/reduction potential.
- Residence time.
- Amount and type of reducing agent - add excess and monitor ORP.
- Degree of mixing
- pH - usually at lower pH; <4.
- Reduction temperature.

WASTE CHARACTERISTICS AFFECTING PERFORMANCE

- CONCENTRATION OF OTHER REDUCIBLE COMPOUNDS. Increases demand in reagent. If TOC or inorganic oxidizer concentration is high, may not be applicable technology.
- CONCENTRATION OF OIL AND GREASE. Causes monitoring problems/fouling. If high, may not be applicable technology.

UNDERLYING PRINCIPLE OF OPERATION

The basic principle of chemical reduction is to reduce the valence of oxidizers and other constituents such as metals through oxidation-reduction reactions. Reducing agents such as ferrous sulfate or sodium sulfite are used to reduce specific constituents such as hexavalent chromium:

$$H_2(Cr^{+6})_2O_7+3Na_2SO_3+3H_2SO_4 \text{ ---- } (Cr^{+3})_2(SO_4)_3+3Na_2SO_4+4H_20$$

FIGURE 4

TECHNOLOGY NAME

Stabilization (STABL) / Microencapsulation (MICRO)

APPLICABLE WASTE TYPES

Wastes and hazardous debris containing leachable metals, high filterable solids content, low total organic content,

and low oil and grease content. These include residuals from treatment of electroplating waste waters, characteristic and listed metal wastes.

Typical hazardous waste numbers include D004-D011, F006-F009, F011, F012, F019, K061, F001-F005, and D018-D043.

PRE-TREATMENT REQUIREMENTS

- May require reducing or oxidizing metals to lower solubility states.
- May require reducing oil and grease or organic content.

CRITICAL DESIGN PARAMETERS

- Amount and type of stabilizing agent and additives.
- Degree of mixing.
- Residence time.
- Temperature and humidity
- Form of metals
- Oxidation state.
- Solubility.

WASTE CHARACTERISTICS AFFECTING PERFORMANCE

- CONCENTRATION OF FINE PARTICLES.

Very FINE particles (<No. 200 mesh) may weaken chemical bonds and increase leachability.

- CONCENTRATION OF OIL AND GREASE.

High OIL AND grease content coat particles, weaken chemical bonding, and increase leachability.

- CONCENTRATION OF ORGANIC COMPOUNDS.

High ORGANIC content (TOC) and organic compounds can inhibit curing and increase leachability.

- CONCENTRATION OF SULFATE AND CHLORIDE COMPOUNDS.

High sulfate or chloride content may interfere with chemical reactions, weaken bond strength, affect cure time, strength, and increase leachability.

- SOLUBILITY OF METAL COMPOUNDS. Metals should be present in most insoluble form.

UNDERLYING PRINCIPLE OF OPERATION

The basic principle of operation for stabilization is that leachable metals and low levels of selected organics are immobilized by the addition of stabilization reagents. The leachability is reduced by the formation of a lattice structure and/or chemical bonds that bind the contaminants into a solid matrix thereby limiting the concentrations of contaminants that can be leached when water contacts the waste material. Stabilization of metals is most effective when the metal is in its least soluble state. Typical stabilization reagents include Portland cement, lime and cement kiln dust. Micro encapsulation involves stabilization of hazardous debris such that the leachability of hazardous contaminants are reduced.

APPENDIX A

MDWTP - MID 000724831
Waste Types Acceptable for Storage, Treatment &/or Transshipment

Special Notes Regarding Permitted Waste Types (see Section 3.7)
The following Waste Code List includes all United States Environmental Protection Agency (USEPA) and Michigan Department of Environmental Quality (MDEQ) hazardous waste codes, with the following exceptions:

Ignitability –
Waste accepted for Treatment - Flash point of all wastes shall be > (greater than) = 90 °F.

Waste accepted for Storage and Transshipment - Flash point of all wastes shall be > (greater than), < (less than), or = 90 °F. Containers accepted at MDWTP for transshipment are uniquely marked so that they can easily visually identified as a transship waste stream.

Reactive wastes - (D003, K027, K044, K047, K161, and K045)
D003 (deactivated) waste may be accepted for storage, treatment and/or transshipment. These D003 deactivated waste (that may retain the code) will only be received as certified treatment residues, contaminated soil, contaminated debris, or spill residues that do not exhibit the characteristic of reactivity.

Reactive wastes identified in R299.9212 (3)(b-e) may be received for storage in the NCSA will be uniquely marked and subsequently transshipped. Reactive wastes identified in R299.9212 (3)(a, f, g, h) are prohibited.

Dioxin-containing wastes - (F020-F023, F026-F028, K043, and K099)
Dioxin-containing wastes shall not be accepted.

LDR –
Any waste codes that have a Land Disposal Restriction (LDR) technology-based treatment standard, other than Deactivation (DEACT), Chemical Reduction (CHRED), Chemical Oxidation (CHOXD), or Stabilization (STABL) cannot currently be treated by the facility, except as certified treatment residues. Hazardous waste debris may be treated as a waste stream or by micro-encapsulation or macro-encapsulation.

Attachment 2

Inspection Schedule

<u>GENERAL INSPECTION SCHEDULE</u>

40 CFR 264.15b

AND

NREPA 451, Part 111 R504(1)c

WAYNE DISPOSAL SITE #2 LANDFILL

GENERAL INSPECTION SCHEDULE

.40 CFR 270.14(b)(5) and MI Act 64 R504(1)c

Purpose:

The employees designated by the Owner or Operator as the Inspector(s) will inspect the facility for malfunctions and deterioration, operator errors, and discharges which may be causing -- or may lead to -- (1) release of hazardous waste constituents to the environment or (2) a threat to human health. The Inspector conducts these inspections often enough to identify problems in time to correct them before they harm human health or the environment.

Inspection Categories:

The Operator has developed and the Inspector follows a written schedule for inspecting:

1) Monitoring equipment;

2) Safety and emergency equipment;

3) Security devices; and

4) Operating and structural equipment important to preventing, detecting, or responding to environmental or human health hazards.

The inspection schedule is kept at the facility. The inspections are to be conducted at the times indicated below:

1. Annual - May of each year.
2. Quarterly - May, August, November, February.
3. Weekly - Monday or Tuesday of each week.
4. Daily - Each day the facility is handling hazardous waste.
5. After Storm - Within 24 hours following 0.5" precipitation.

Inspection Frequency:

The frequency of inspection is based on the rate of possible deterioration of the equipment and the probability of an environmental or human health incident if the deterioration, or malfunction, or any operator error goes undetected between inspections.

Inspection Requirements for Waste Handling Areas:

As applicable to the facility, the inspection schedule meets the following requirements:

Areas subject to spills: (40 CFR 264.15) Areas subject to spills, such as loading and unloading areas, are inspected daily when in use.

Inspection Requirements for Landfills:

As applicable to the facility, the inspection schedule meets the following requirements for all landfill units storing hazardous wastes:

In accordance with 40 CFR 264.303(b), while a landfill is in operation, it must be inspected weekly and after storms to detect evidence of any of the following:

(1) Deterioration, malfunctions or improper operation of run-on and run-off control systems. These systems are designed to control the volume of water from a 24-hour, 100 year storm. Associated collection and holding facilities must be emptied after storms to maintain design capacity of the system;

(2) Proper functioning of wind dispersal control systems;

(3) The presence of leachate in and proper functioning of leachate collection and removal systems. The design of each sump and removal system must provide a method for measuring and recording the volume of liquids present in the sump and of liquids removed. Ensure that leachate depth over the liner does not exceed 30 cm. (one foot).

In accordance with 40 CFR 264.303(c), a landfill with a leak detection system must:

(1) Record the amount of liquids removed from each leak detection system sump at least once a week during the active life and closure period.

(2)After the final cover is installed, the amount of liquids removed from each leak detection sump must be recorded at least monthly. If the liquid level in the sump stays below the pump operating level for two consecutive months, the amount of liquids in the sumps must be recorded at least quarterly. If the liquid level in the sump stays below the pump operating level for two consecutive quarters, the amount of liquids in the sumps must be recorded at least semiannually. If at any time during the post-closure operating period the pump operating level is exceeded at units on quarterly or semiannual recording schedules, the owner or operator must return to monthly recording of amounts of liquids removed from each sump until the level again stays below the pump operating level for two consecutive months.

Inspection Records:

The Inspector records inspections in an Inspection Log or Summary by compiling all completed Inspection Report forms into a binder kept on-site. These records are kept for at least three years from the date of inspection. These records, at a minimum, include the date and time of the inspection, the name of the inspector, a notation of the observations made, and the date and nature of any repairs or other remedial actions.

The following Inspection Report Forms are currently in use at the facility:

1) Daily Inspection Report (Form LOM-FM-002-BEL)
2) Weekly / After Storm Inspection Report (Form LOM-FM-003-BEL)
3) Quarterly / Annual Post-Closure Inspection Report (Form LOM-FM-008-BEL)
4) Quarterly/Annual Inspection Report (Form LOM-FM-006-BEL)
5) Storm Water SOP Inspection Form (Form LOM-FM-009-BEL)
6) Weekly Inspection Checklist for Leachate Collection System (Form QES-FM-005-BEL)

7) Waste Transfer Tank Inspection Report (LOM-FM-XXX-BEL)

These Inspection Report forms list and describe items to be examined at a specific frequency. On the notes on each form (bottom or reverse side of the form), the inspection items and acceptable or unacceptable conditions for each inspection item are identified. Some parts of each report form may not be applicable during the course of an inspection. For example, the weekly report includes a number of specific items that must be evaluated only in the event of a storm. If no storm has occurred the status of that item would be not applicable (N/A).

In addition to the inspection forms, the following SOPs are in place that include operating, inspection and training requirements:

1) Standard Operating Procedure for Storm Water Management (LOM-OP-011-BEL)
2) Standard Operating Procedure for Track-out Management (LOM-OP-012-BEL)
3) Standard Operating Procedure for Fugitive Dust Management (LOM-OP-009-BEL)
4) Standard Operating Procedure for Wind Speed Monitoring (LOM-OP-013-BEL)
5) Earthwork Clearance Permit (ECP) Procedure (LOM-OP-003-BEL)
6) LDCRS Riser Maintenance Procedure (LOM-OP-010-BEL)

These SOPs in some cases have associated forms and instructions for record keeping. The SOPs may also refer to the stand alone forms listed above.

Groundwater monitoring equipment will be inspected during sampling events, which may not coincide with this schedule. When this occurs the information is recorded on the Quarterly / Annual Inspection Report form closest in time to the actual inspection.

A revised or improved version of any Inspection Report form may be implemented upon proper administrative change notification to Michigan Department of Environmental Quality, Waste & Hazardous Materials Division.

Inspection Response and Corrective Action:

The Operator remedies any deterioration or malfunction of equipment or structures, which the inspection reveals on a schedule which ensures that the problem does not lead to an environmental or human health hazard. Where a hazard is imminent or has already occurred, remedial action is taken immediately.

If an unacceptable condition is detected, the Inspector reports it to the facility manager in charge at that time. The facility manager assigns responsibility for corrective action and a deadline by which corrective action has to be taken on the condition.

On subsequent daily inspections, the Inspector monitors the condition until the situation is completely rectified. Once it is rectified, the Inspector notes the date and time that the correction was made on all previous Reports mentioning the defect.

WAYNE DISPOSAL, INC. SITE #2
ACTIVE HAZARDOUS WASTE LANDFILL OPERATIONS
DAILY INSPECTION REPORT

Item	Description	Yes	No	If "No" is checked, state required corrective action	Completed
1	Daily cover properly applied to new waste at end of work day and to previously covered areas where re-cover necessary due to weathering? Integrity of daily cover acceptable in all areas?[1]				
2	Perimeter fence, gates and locks intact and secure?[2]				
3	No spilled or tracked waste in area around transfer station?[3]				
4	After-Hours Waste Transfer Log is up to date?				
5	Wind speed monitoring equipment is on and properly functioning?				
6	Wind Speed Monitoring Equipment Downtime Log is up to date?				
7	Wind speed sensor is no more than 10 ft below the elevation at which waste is currently being placed in the landfill, is located on the southwest slope of Master Cell VI, and is approximately vertical?				
8	Is each Radio / Telephone operational: Security, Receiving, Lab, MDWTP Spotter's Shack & WDI Spotter's Shack				
9	Is the Wheel Wash Operational?				
10	Is the Wash Building equipped for decontamination of material?				
11	Is the Landfill Fire Extinguisher present and charged?				
12	Is the Sweeper or Water Truck operational?				
13	Is the South Sedimentation Basin gate valve operational?				
14	Is there sufficient silt fencing equipment available on site?				
15	Is there sufficient spill absorbent materials available on site (1 pallet minimum)				

Signature of operator responsible for Item 1: ______________________

Operating date: ______________________

Date and time cover application completed for specified operating date: ______________________

____

Signature of Inspector for Items 2-7 (Landfill Manager or designated alternate): ______________________

Date of inspection for Items 2-7: ______________________

Time of inspection for items 2-7: ______________________

[1]Daily cover is ConCover or 6 inches of soil. ConCover application in accordance with manufacturer's specification and of sufficient thickness and coverage to control dust emissions. New waste covered at end of each day. Previously covered waste that is becoming exposed due to weathering of cover material must be re-covered to required specification.

[2]Inspect for vandalism, deterioration, or damage that could result in unauthorized entry to the active disposal area. Verify gates are locked.

[3]Inspect for proper housekeeping around the truck transfer area (sweeping and shoveling of any waste material that may have fallen from truck bed onto the ground surface). Site personnel shall also follow the Track-out Management SOP (LOM-OP-012-BEL) and the Bulk Waste Unloading SOP (LOM-OP-001-BEL) to minimize or eliminate spillage/track-out.

WAYNE DISPOSAL, INC. SITE #2
ACTIVE HAZARDOUS WASTE LANDFILL OPERATIONS
WEEKLY AND AFTER-STORM INSPECTION REPORT

Description	Yes	No	If "No", Explain. State Corrective Action.
Is this a WEEKLY inspection?			If yes, complete ENTIRE FORM
Is this an AFTER-STORM inspection?			If yes, complete ONLY Sections C & D

A. Leachate and Contact Water Collection Systems			**Section A Inspected By:** ______ **Date:** ______
Leachate collection sump riser covers present and properly seated (if applicable)?			
Condition of leachate collection sump risers acceptable?			
Leachate depths in each collection sump in compliance?			
Pumps functioning properly?			
Condition of flow meters acceptable?			
Secondary containment monitoring sumps for leachate and contact water force mains free of liquid?			

B. Leak Detection, Collection, and Removal System			**Section B Inspected By:** ______ **Date:** ______
Sump riser caps present and properly seated?			
Condition of sump risers acceptable?			
No evidence of tampering?			
Is the top of the riser and sample port protected from direct contact with waste?			
Motor controller condition acceptable? Protected from weathering?			

C. Storm Water Structural Controls			**Section C Inspected By:** ______ **Date:** ______
Contact water pumps and pump controls are properly functioning?			
Contact water high level alarms are functional?			
Contact water loss of power alarms are functional?			
Backup batteries for contact water alarm systems have proper voltage?			
Contact water is contained in the cell by separator berms and condition of berms is acceptable?			

D. Dike and Interim Cover Systems			**Section D Inspected By:** ______ **Date:** ______
Interim cover free of signs of erosion which could leave waste exposed?			
Condition of perimeter dike acceptable? Able to prevent run-on into cell and runoff out of cell?			
Is the perimeter free of signs of waste outside of the active cell?			
Is the visual boundary around the active cell in tact?			

Specify Type of Inspection

Check yes for the appropriate type of inspection (i.e. a weekly or an after-storm inspection).

For weekly Inspections, complete all sections.

If it is an after-storm inspection, complete Sections C & D only.

A. Leachate and Contact Water Collection Systems

Top cover is required only if riser rim is low enough to be a fall hazard. If present, verify that cover is properly seated.

Inspect aboveground exterior and visible interior portions of risers for damage, stress (buckling) and deterioration.

Measure depth to leachate in each collection sump. If leachate head is non-compliant, immediately notify the Landfill Manager (or designee).

Inspect flow meters for damage or malfunction. Report meter readings to Landfill Manager (or designee).

Check for liquid in the secondary containment monitoring sumps for both the leachate and contact water force mains. If liquid is present, determine whether it is condensate, groundwater or leachate/contact water. If condensate, no action required. If groundwater, there is a leak in the secondary pipe. If leachate or contact water, there is a leak in the primary pipe. Any leaks must be reported to the Landfill Manager immediately and repaired.

B. Leak Detection, Collection, and Removal System

Caps required at all times to prevent contaminants from entering the sumps. Check that caps are present and properly seated.

Inspect aboveground exterior of sump risers for damage, buckling and deterioration.

Note if there is any evidence of tampering that could introduce contamination into the sump.

Waste must not be in contact with the sample port or in the vicinity of the riser opening.

If present, the pump control box must be closed and protected from weathering. If not in use the controller should be moved indoors.

C. Storm Water Structural Controls

Inspect containment berms for damage and wear that could result in failure to contain runoff either due to leakage, permeation, spillage over, or slope failure. Immediately report to the Landfill Manager (or designee) erosion, soil displacement, equipment-induced damage, cracks, wet soil during dry weather, etc.

D. Dike and Interim Cover Systems

Inspect interim cover soil for erosion which could lead to waste exposure.

Inspect the perimeter dike for erosion and vehicle/equipment damage that could weaken the dike and/or allow runon into the cell or runoff out of the cell. Report any exposed geosynthetics. Report tire rutting which may have damaged underlying geosynthetics.

Inspect the perimeter of the active cell for debris that has blown outside of containment. Collect immediately and return to landfill.

Verify visual boundary around the active cell is intact.

WAYNE DISPOSAL, INC. SITE #2 CELLS V, VII, AND IX
QUARTERLY/ANNUAL POST-CLOSURE INSPECTION CHECKLIST

Month (Feb, May, Aug, or Nov) and Year: ______________________

Names of Inspectors: ______________________

Inspection Dates	Inspection Item	TRUE	FALSE***
	Security System		
Feb/May/Aug/Nov (Quarterly)	Gates and Perimeter fence secure and intact		
Feb/May/Aug/Nov (Quarterly)	All warning signs present and legible		
	Clay Dike and Perimeter Dewatering Tile System		
Feb/May/Aug/Nov (Quarterly)	No surface evidence of damage / deterioration		
Feb/May/Aug/Nov (Quarterly)	Free-flowing conditions exist at both discharge outlets		
May Only (Annual)	No damage / deterioration or evidence of tile blockage in manholes. Water levels and flow conditions in manholes acceptable.		
	Final Cover System		
Feb/May/Aug/Nov (Quarterly)	No significant erosion		
Feb/May/Aug/Nov (Quarterly)	No settling or water ponding		
Feb/May/Aug/Nov (Quarterly)	Cover properly vegetated		
Feb/May/Aug/Nov (Quarterly)	No rodent holes		
Feb/May/Aug/Nov (Quarterly)	Cover drain pipes intact, no flow obstructions		
Feb/May/Aug/Nov (Quarterly)	No evidence of leachate seeps (if seeps observed, immediate corrective action required)		
	Leachate Collection System		
Feb/May/Aug/Nov (Quarterly)	Standpipes/manholes/covers present, secure, and undamaged		
Feb/May/Aug/Nov (Quarterly)	Water column in each subcell collection sump acceptable		
Feb/May/Aug/Nov (Quarterly)	Pump systems (electrical, meters, pumps, piping) operational and undamaged		
Feb/May/Aug/Nov (Quarterly)	No surface evidence of damage to leachate discharge lines		
Feb/May/Aug/Nov (Quarterly)	No liquid in leachate force main secondary containment monitoring sumps		
	Monitoring Wells		
May and Nov Only (Semi-annual)	Well security devices present and undamaged		
May and Nov Only (Semi-annual)	Aboveground portion of well casings intact, properly seated, and undamaged.		
May and Nov Only (Semi-annual)	Grout seal and concrete pad a base of wells intact, no evidence of water infiltration		
May and Nov Only (Semi-annual)	No ponded water around well heads		
May and Nov Only (Semi-annual)	Conditions of lysimeters acceptable (MC V and VII only)		
	Gas Venting System (Cells V and VII only)		
Feb/May/Aug/Nov (Quarterly)	Vent pipes undamaged and properly seated in cell covers		
Feb/May/Aug/Nov (Quarterly)	Positive pressure exists at vent outlets.		
	Benchmarks		
May Only (Annual)	Monuments undisturbed. Manholes centered over monuments.		

*** If "false" is entered for any inspection item, list the required corrective action in the Maintenance Log.

WAYNE DISPOSAL SITE #2 LANDFILL QUARTERLY / ANNUAL INSPECTION REPORT			Quarterly ☐ Annual ☐		Date/Time: ______ Inspector: ______	
INTERVAL	DESCRIPTION	LOCATION	ACCEPTABLE?		CORRECTIVE ACTION (Who, What)	COMPLETED (When)
			Yes	No		
	I. Monitoring Equipment					
	Groundwater					
Quarterly	Monitor Well -- Security					
Quarterly	Monitor Well -- Integrity					
Quarterly	Pump System -- Integrity					
	II. Structures/Appurtenances					
	Perimeter Edge Drain					
Annually	Manhole Covers -- Security					
Annually	Manhole Covers -- Integrity					
Annually	Manhole Sections -- Integrity					
Annually	Sumps -- Integrity					

INSPECTION CRITERIA

I. Monitoring Equipment

Groundwater

Inspect individual well security devices (caps, covers, locks) for malfunctions, deterioration, vandalism, or damage.
Inspect observable portion of well casing for deterioration or damage such as cracks, casing alignment (damage from vehicle contact), insect, or animal infestation.
Check grout at base of casing for proper seal to prevent surface water infiltration down on the side of the casing.
Inspect/operate pump and pump control unit for damage deterioration and malfunction.

Perimeter Edge Drain

Verify manhole covers are in-place and are not damaged or have deteriorated to a point that would allow for accidental entry.
Inspect above ground portion and interior for evidence of damage or deterioration such as cracking or spauling that would lead to sediment infiltration.
Inspect sump for excessive sediment build-up that could result in flow blockage. Inspect for line blockage, i.e., water accumulating above pipe elevation.

WEEKLY INSPECTION CHECKLIST FOR LEACHATE COLLECTION SYSTEM
WAYNE DISPOSAL, INC. SITE #2 HAZARDOUS WASTE LANDFILL MASTER CELLS

Inspector: ____________________

Date: ____________________

Cell	Meter Reading	Meter Advance?		Compliance Depth to Leachate (ft)	Actual Depth to Leachate (ft)	Level in Complaince?		Pump Functioning?		Meter Functioning?	
		Y	N			Y	N	Y	N	Y	N
V-A				68.8							
V-B				62.5							
V-C				55.9							
V-E				61.2							
VI-AS				127.0							
VI-AN				128.3							
VI-B				135.2							
VI-C				102.1							
VI-D				130.9							
VI-ENE											
VI-ENW				80.0							
VI-ESW				26.0							
VI-ESE				37.0							
VI-CONTACT											
VII-A				37.5							
VII-BN				49.3							
VII-BS				51.8							
VII-C				46.2							

Comments/Action Taken ____________________

Note: Report items needing immediate attention to the Site Manager
Inspection sheet current as of 9/18/08 change to compliance levels DTL (MC-VI)

WAYNE DISPOSAL SITE #2 LANDFILL
WASTE TRANSFER TANK INSPECTION REPORT

Daily ☐ Weekly ☐ Annual ☐

Date: ______________________
Time: ______________________
Inspector: ______________________

INTERVAL	DESCRIPTION	ACCEPTABLE?		CORRECTIVE ACTION (Who, What)	COMPLETED (When)
		Yes	No		
Daily	Cement Floor				
	Steel Walls				
	Sump				
Weekly	Leak Detection Observation Well				
	Run-on Control				
	Retaining Wall				
	Integrity of Contact Water Piping				
Annually	Cement Thickness				
	Steel Thickness				

INSPECTION CRITERIA

Daily

Cement Floor - Check for cracks, gaps, or damage to integrity of concrete surface.
Steel Walls - Check for damage to steel, loose bolts, and displacement along seams.
Sump - Check for water in sump. If water present, pump to contact water pond.

Weekly

Leak Detection Observation Well - Check for presence of water in leak detection well with electronic sounding device.
Run-on Control - Check curbs, gutters, speed bumps, and asphalt surface for damage or obstructions.
Retaining Wall - Check for erosion of earth or displacement of seams.
Integrity of Contact Water Piping - Check for water discharge within the contact water sump at the transition of the double-contained HDPE conveyance piping to the primary pump discharge pipe.

Annual

Cement Floor Thickness - Survey floor to determine how much wear has occurred, at 4-inches of wear the surface should be repaired.
Steel Thickness - Measure thickness to determine degree of degradation. Replace if less than two-thirds of the original plate thickness.

Training and Amendment of Inspection Checklists and SOPs:

All of the inspection checklists included in this section cannot be revised without the revisions being submitted to and approved by the MDEQ. This also holds for many of the SOPs listed in this document. Each SOP will contain a requirement for regulatory approval if necessary. The checklists and SOPs need to be reviewed to determine if modification is warranted any time there a new disposal area is constructed or any major change is made to the site infrastructure that are subject to inspection. When modifications to any checklist or SOP are made and approved, training of relevant personnel must be conducted before implementation

Attachment 3

Personnel Training Program

SITE 2 (MDWTP/WDI) PERSONNEL TRAINING PROGRAM

PERSONNEL TRAINING FOR SAFE FACILITY OPERATION AND MAINTENANCE

40 CFR 270.14(b)(12), 40 CFR 264.16, and Part 111

CORPORATE OBJECTIVES TARGET SAFETY AND COMPLIANCE

EQ completes all required compliance training for associates in a timely manner. In order to accomplish this a comprehensive training plan is followed which encompasses safety, compliance with environmental standards, and job-specific training such as adherence to the waste analysis plan (WAP). One module found within this training plan is the training required under RCRA for persons who work at a hazardous waste facility. The requirements in 40 CFR 264.16 state that workers will be given a baseline awareness of potential hazards at the facility and how to respond to an incident involving the release of waste following the site Contingency Plan. This training program, the RCRA Contingency Plan and Emergency Response Procedures is described below.

THE RCRA CONTINGENCY PLAN AND EMERGENCY RESPONSE PROCEDURES

This section provides an outline of both introductory and continuing training programs provided by the facility owners and operators to prepare persons to operate or maintain the Hazardous Waste Management facility in a safe manner as required to demonstrate compliance with 40 CFR 264.16. The title of this training program is RCRA Contingency Plan and Emergency Response Procedures. This training is designed to meet actual job tasks in accordance with RCRA regulatory requirements in 40 CFR 264.16(a)(3).

GENERAL METHOD AND CONTENT OF TRAINING

Facility personnel shall successfully complete a program of classroom instruction and on-the-job training that teaches them to perform their duties in a way that ensures the facility's compliance with the requirements of this part. The curriculum includes all the elements to fulfill both introductory and continuing training that will be given to each person filling a position related to hazardous waste management at the facility. An associate who is trained in hazardous waste management procedures, normally the Regulatory or Health & Safety Representative, directs this training.

Each manager is responsible for identifying the initial and continuing training needs of his/her employees to ensure facility compliance with RCRA. This information is communicated to the Regulatory or Health & Safety Representative who registers the employee into training classes. The manager also provides instruction on job-related standard operating procedures and other on-the-job training. This program includes instruction, which teaches facility personnel hazardous waste management procedures, including contingency plan implementation relevant to the position in which they are employed.

A. TRAINING CURRICULUM:

The training program is designed to ensure that facility personnel are able to respond effectively to emergencies by familiarizing them with emergency procedures, emergency equipment, emergency systems including;

(i) Procedures for using, inspecting, repairing, and replacing facility emergency and monitoring equipment;

(ii) Communications or alarm systems;

(iii) Responses to fires or explosions;

(iv) Responses to spill incidents; and

(v) Shutdown of operations

B.TRAINING TIMING AND FREQUENCY

Each affected person completes the program within six months after the effective date of these regulations or six months after the date of their employment or assignment to a facility, or to a new position at a facility, which ever is later. Employees hired after the effective date of these regulations must not work in unsupervised positions until they have completed the training requirements of the RCRA Contingency Plan and Emergency Response Procedures.

C. ANNUAL REVIEW

All facility personnel take part in an annual RCRA Contingency Plan and Emergency Response Procedures review.

D. DOCUMENTATION AND RECORD KEEPING:

The owner or operator maintains the following documents and records at the facility:

(1) Job Title and Employee List:

The job title for each position at the facility related to waste management, and the name of each employee filling each job; - per 40 CFR 264.16(d)(1)

(2) Job Description:

A written job description is provided for each position is listed above. This description may be consistent in its degree of specificity with descriptions for other similar positions in the same company location or bargaining unit, u must include the requisite skill, education, or other qualifications, and duties of employees assigned to each position; - per 40 CFR 264.16(d)(2) –

(3) Training Requirements:

A written description of the type and amount of both introductory and continuing training that will be given to each person filling a position listed; - per 40 CFR 266.16(d)(3)

(4) Records;

Records that document the RCRA Contingency Plan and Emergency Response Procedure training or job experience has to be given to, and completed by, facility personnel; - per 40 CFR 264.16(d)(4)

E. RECORD MANAGEMENT

Training records on current personnel are kept until closure of the facility. Training records on former employees are kept for at least three years from the date the employee last worked at the facility. Such records are maintained on-site.

Personnel training records may accompany personnel transferred within the same company to another facility.

Attachment 4

Contingency Plan

EQ -- THE ENVIRONMENTAL QUALITY COMPANY

PRESENTS

RCRA CONTINGENCY PLAN

AND

EMERGENCY PROCEDURES

FOR

MICHIGAN DISPOSAL WASTE TREATMENT PLANT

&

WAYNE DISPOSAL, INC. SITE #2

AT

BELLEVILLE, MICHIGAN

As revised February 2011
(Discard all previous versions)

RCRA CONTINGENCY PLAN PURPOSE

"Contingency Plan" means document that sets out an organized, planned, and coordinated course of action to be followed in case of a fire, explosion, or release of hazardous waste or hazardous waste constituents that could threaten human health or the environment." (R299.9102(p), 40 CFR 260.10)

The contingency plan has been designed to minimize hazards to human health or the environment from fires, explosions, or any unplanned sudden or non-sudden release of hazardous waste or hazardous waste constituents to air, soil, or surface water.

The provisions of the plan are to be carried out immediately whenever there is a fire, explosion, or release of hazardous waste or hazardous waste constituents which could threaten human health or the environment(40 CFR 264.51(b))

TABLE OF CONTENTS

A1. Description of Operations - Michigan Disposal Waste Treatment Plant (MDWTP)

The MDWTP operations include receiving, storage, and treatment of hazardous wastes permitted by the MDEQ under the facility operating license and the USEPA under a Resource Conservation and Recovery Act (RCRA) permit (MID 000 724 831).

The specific routine operations and work areas for MDWTP include:

- Waste receiving & quality control(QC)
- Waste loading/unloading
- Reagent unloading & tank storage
- Waste storage in tanks
- Waste treatment in tanks
- Container staging & storage and
- Shipment of waste off-site to permitted treatment, storage, and disposal facilities (TSDFs)

The requirements for operations in these areas are defined in and regulated by the facility operating license.

Waste Identification and Classification - MDWTP

The waste types acceptable for treatment and storage at the facility are defined in Part 111 of Michigan's Natural Resources and Environmental Protection Act, 1994 PA 451 (Act 451) and 40 CFR regulations at part 261. The wastes acceptable for treatment listed in Appendix A of MDWTP's WAP.

Description of Waste Management Units - MDWTP

The MDWTP facility is a liquid and solid hazardous & non-hazardous waste storage and treatment facility. Containerized wastes may be stored on-site before and after treatment in one of five hazardous waste storage areas: the North Container Storage Area (NCSA), the East Container

Storage Area (ECSA), the Southeast Container Storage Area (SECSA) and the East and West Treatment Building Bays. The facility is equipped with pollution control systems for particulate, odor, and emission control.

Liquid hazardous wastes to be treated in the pozzolanic stabilization process may be stored in four, 20,000 gallon and vertical storage tanks (T-16 through T-19). Liquid reagents are stored in two, 15,000 gallon vertical tanks (T-25 and T-27).

Hazardous Waste dust may be stored in three 100 cubic yard (cy) silos of the plant. Lime kiln flue dust, cement kiln flue dust, and lime are also used for stabilization and may be used in all six silos (T-1 through T-6). The dusts are fed from the silos to the closest pugmill and treatment tank at a controlled rate to effect treatment of liquid and solid wastes. Other reagents, such as ferrous sulfate, may be added directly to the tanks in bag or bulk quantities.

Listed and characteristic hazardous wastes are stored and treated in sludge receiving tanks, sludge storage tanks, and pugmills on the west side of the plant and similarly stored and treated on the east side of the plant. In both cases, treatment consists of blending the waste in sludge feed tanks prior to treatment in the pugmills or mixing and treatment directly in the sludge storage/treatment tanks. Other chemical reagents may be selectively added in drum or bulk quantities.

Containerized hazardous waste and non-hazardous wastes are staged and stored on concrete pads at the NCSA, ECSA, SECSA and the East and West Treatment Building Bays. Drainage trenches constructed within the containment areas contain and control liquid runoff. Drums are transported from the pad into the plant using a barrel forklift. Then they are opened by carefully removing the tops or bungs and immediately emptying the contents with a vacuum truck or pouring contents directly into the sludge boxes or treatment tanks using the barrel forklift. The empty drums are placed into a roll-off box or other similar container for subsequent disposal.

The disposal operations are supported and directed from the office/lab and waste receiving site located near the entrance to the facility. These support operations assist to control and evaluate shipments received for conformance with pre-approval information regarding the specific properties, treatment, and documentation requirements. The facility waste characterization and analysis records are maintained on-site.

A2. Description of Operations - Wayne Disposal, Inc. Site #2 (WDI)

The WDI operations include the landfill disposal of hazardous and non-hazardous wastes permitted by the MDEQ under the facility operating license USEPA under a Resource Conservation and Recovery Act (RCRA) permit (MID 048 090 633).

The specific routine operations and work areas for WDI include:

- Waste receiving and quality control
- Waste unloading
- Hazardous waste landfill and related appurtenances (piping, pumps, operation and maintenance, truck wheel wash buildings located within the area bounded by North Interstate 94 (I-94) Service Drive and Willow Run Airport)

Work areas are shown in Figure 4.

The landfill is currently permitted with a design capacity of 11,000,000 cubic yards (cy) of in-place waste. The requirements for operations in these areas are defined in and regulated by the Hazardous Waste Treatment, Storage and Disposal Facility operating license. Non-hazardous wastes are managed in accordance with the facility's Part 115 of Michigan's Natural Resources and Environmental Protection Act, 1994 PA 451 (Act 451). The WDI landfill is-located at the same site as the MDWTP treatment and storage facility (MID 000 724 831). The WDI landfill disposal operations are supported by the MDWTP office/lab and waste receiving, storage, and treatment operations located near the entrance of the facility. These operations assist to control and evaluate shipments received for conformance with pre-approval information regarding the specific properties, treatment, and documentation requirements. The WDI facility waste analysis records are maintained on-site.

Waste Identification and Classification - WDI

The waste types acceptable for treatment and storage at the facility are defined in Parts 111 and 115 of Michigan's Natural Resources and Environmental Protection Act, 1994 PA 451 (Act 451) and 40

CFR Regulations at Part 261. Acceptable hazardous waste codes are identified in Section 8 of the Hazardous Waste Treatment, Storage and Disposal Facility Operating License.

The facility (WDI) license has specific restrictions regarding the following waste types NOT ACCEPTABLE for disposal:

- Ignitable wastes as described in Michigan Act 451 rule R 299.9212
- Reactive wastes as described in Michigan Act 451 rule R 299.9212
- Bulk or noncontainerized liquid waste or waste containing free liquids
- Containers holding free liquids, including laboratory packs
- Wastes which are banned from landfilling by regulations promulgated under 40 Code of Federal Regulations (CFR) Part 268 unless the wastes meet the applicable Land Disposal Restriction (LDR) treatment standards or a variance has been obtained from the USEPA
- Waste which will:
  (1) Adversely affect the permeability of the clay liner.
  (2) Produce a leachate that is incompatible with the clay liner, leachate collection system piping, or the off-site sewer system.
  (3) Generate gases that will adversely affect the permeability of the clay cap or create a violation of the air pollution control requirements of Part 55 of Act 451.

<u>Description of Waste Management Units - WDI</u>

The WDI facility includes a permitted hazardous waste landfill with primary and secondary liner systems, a leachate collection and removal system, and a leak detection, collection and removal system. The landfill operations also include run-on, run-off, and contaminant control systems including a vehicle wash facility and other landfill-related appurtenances and support buildings. When placed in the landfill, containers are at least 90% full or crushed, shredded, or similarly reduced in volume before burial in the landfill. The waste management units are identified in Figure 4.

PLAN SCOPE (264.52)

264.52(a). Emergency Response Actions--All Personnel

All MDWTP and WDI personnel are instructed to respond, in case of emergency, as follows:

1. Alert the shift supervisor or the emergency coodinator of the hazard(s).
2. If any persons in the immediate area are potentially endangered, advise them to leave immediately.
3. If any person has been seriously injured call 911 for EMT support.
4. Contact the Emergency Coordinator(s) in person, as necessary, by radio or phone (See Section 264.52(d), page 15 for the list of Emergency Coordinators).
5. Indicate nature of emergency and stand by to receive instructions from Emergency Coordinator or evacuate.
6. Shut down, as necessary, all processing and ancillary equipment per manufacturers instructions, associated with the incident.

The Emergency Coordinator will direct actions of all facility personnel to:

1. Identify hazards and assess extent of potential harm to human health or the environment.
2. Notify, as necessary, the appropriate Emergency Response Contacts listed in this Plan.
3. Respond in cooperation with outside agencies to minimize hazards.
4. Follow up response actions with required reports (verbal and written). This includes internal incident reports and providing information to regulatory staff to prepare the incident report(s).

If there is a fire, explosion, or other release of hazardous waste or hazardous waste constituents that could threaten human health or the environment, or a spill that reached surface water or ground water, then immediately notify the DEQ's pollution emergency altering system (PEAS) - telephone number

800-292-4706 if after hours, and the DEQ directly if between 8-5. The notification shall include all of the following information:

(a) The name and telephone number of the person who is reporting the incident.

(b) The name, address, telephone number, and EPA Identification No. of the facility.

(c) The name, address, and telephone number of the owner or operator.

(d) The date, time, and type of incident.

(e) The name and quantity of the material or materials involved and released.

(f) The extent of injuries, if any.

(g) The estimated quantity and disposition of recovered material that resulted from the incident.

(h) An assessment of actual or potential hazards to human health or the environment.

(i) The immediate response action taken.

264.52(b). Emergency Response Planning

This RCRA Contingency Plan is a part of the overall effort at the facility to predict, prevent, and properly respond to incidents. The RCRA Contingency Plan satisfies RCRA requirements for responses to emergencies involving hazardous waste.

264.52(c). Arrangements with Emergency Response Agencies

(a) The following are arrangements agreed to by local fire departments, police, hospitals, contractors, state and local emergency response teams to coordinate emergency services.

1) Local police, fire departments, and emergency response teams are made familiar with the layout of the facility (by independent review of copy of this contingency plan and upon response by ER contact and tours of the facility), properties of hazardous waste handled at the facility and associated hazards, places where facility personnel would normally be working, entrances to and roads inside the facility, and possible evacuation routes.

2) The Primary emergency authority of the local police and fire department is set forth by state and local law or ordinance. The Van Buren Fire Department is deemed the primary emergency contact for situations related to this site's operations. The Van Buren Fire Department will make other emergency team contacts at their discretion, usually asking for the assistance of the Van Buren Police Department/Michigan State Police. This, of course does not preclude MDWTP and WDI personnel from exercising the option of contacting additional emergency units depending on the circumstances (A list of Emergency Response Contacts is provided in this section). Any others providing support to the primary emergency authority will follow the direction of the local police and fire departments.

3) All necessary support by emergency response teams, emergency response contractors, and equipment suppliers has been documented in this Plan.

4) Information to familiarize hospital staff with the properties of wastes involved in an injuries, incident, or illness resulting from fires, explosions, or releases will be provided at the time of response to an incident.

5) EQ is continuing to work with the Van Buren Township (VBT) Fire Department to further develop and maintain emergency response activities (i.e. joint training, periodic drills and evacuation planning with local emergency response agencies) and better communication.

(b) No state and local authorities have declined to enter into such arrangements; if such refusal occurs it would be documented.

264.52(c). Emergency Response Agency and Regulatory Contacts

Agency	Contact #	Emerg. #
Ambulance Services		
1. Huron Valley Ambulance Service, Inc. 2215 Hogback Road Ann Arbor, MI 48105 Contact: Mr. Dale Berry, Executive Director	(734) 971-4733	(734) 994-4111
Emergency Medical Services		
1. St. Joseph Mercy Hospital 5301 E. Huron River Drive Ann Arbor, MI 48106 Contact: Dr. John McCabe, MD - Emergency Room	(734) 712-3456	(734) 712-3000
2. Midwest Health Center, P.C. 9301 Middlebelt Road Romulus, MI 48174 Contact: Dr. R.T. Nolta, MD FACPM		(734) 941-1000
3. Concentra Medical Center 11700 Metro Airport Center Drive Romulus, MI 48174 Contact: Mr.Mark Weiner, MD, Medical Director		(734) 955-7000
Poison Information		
1. Poison Control Center Children's Hospital of Michigan Harper Professional Office Building 4160 John R, Suite #616 Detroit, MI 48201 Contact: Dr. Suzanne White, Medical Director	(313) 745-5335	(800) 222-1222

Agency		Contact #	Emerg. #
Fire Departments			
1.	Van Buren Township Fire Department 46425 Tyler Road Belleville, MI 48111	(734) 699-8930	911
2.	Willow Run Airport Fire Department P.O. Box 801 Ypsilanti, MI 48198 Contact: Mr. Tim Hoeft, Fire Chief	(734) 485-6660	Metro Dispatch (734) 942-3600 Control Tower: (734) 480-9247
3.	Ypsilanti Township Fire Department 222 South Ford Boulevard Ypsilanti, MI 48198	(734) 544-4225	(734) 544-4224
Police Departments			
1.	Van Buren Township Police Department 46425 Tyler Road Belleville, MI 48111 Contact: Mr. Gerald Champagne, Public Safety Director	(734) 699-8930	911
2.	Taylor - State Police Post 12111 Telegraph Road Taylor, MI 48180 Contact: First Lieutenant Lynne Huggins	(734) 287-5000	911
State and Federal Emergency Reporting			
1.	State of Michigan: Pollution Hotline	(800) 292-4706	
2.	Federal: National Response Center	(800) 424-8802	

Agency	Contact #	Emerg. #
Van Buren Township Government		
1. Van Buren Township 46425 Tyler Road Belleville, MI 48111	(734) 699-8900	911
Special Agencies		
1. Western Wayne County Hazardous Incident Response Team (H.I.R.T) 14910 Farmington Rd Livonia, MI 48154 Note: Hazmat Team may only be activated by an on-scene Fire Department Officer.	(734) 466-2431	911
2. Sara Title III Local Emergency Planning Committee Wayne County Emergency Management Office of Wayne County Executives 10250 Middlebelt Road Detroit, MI 48242 Contact: Mr. Mark Sparks, Director of Emergency Management	(734) 942-5289	(734) 942-3600

264.52(d). On-Site Emergency Coordinator Contacts

The Emergency Coordinators are listed below in the order in which they will assume responsibility.

264.52(d). Emergency Coordinators for MDWTP & WDI Facilities

Emergency Coordinators		Site phone number: (734) 699-6201	
Primary:			
	Kerry Durnen Director of Operations	Office: Cellular: Home:	(734) 699-6265 (734) 576-0189 (734) 439-1690
	Tom Caswell Operations Mgr	Office: Cellular: Home:	(734) 699-6213 (734) 576-0420 (248) 573-5113
Alternates:			
	Tony Patrick Plant Supervisor	Office: Cell: Home:	(734) 699-6226 (734) 576-0382 (734) 865-5983
	Paul Haratyk Plant Supervisor	Office: Pager: Cell: Home:	(734) 699-6214 (800) 250-4182 (734) 576-0142 (734) 844-1128
	Michael L. Porath Operations Manager	Office: Cell: Home:	(734) 699-6239 (734) 576-0179 (517) 423-6996
	Ken Weber WWTP Mgr	Office: Cell: Home:	(734) 699-6280 (734) 576-0153 (734) 464-0310

264.52(e). Emergency and Decontamination Equipment

The Health and Safety Manager ensures that the Emergency and Decontamination Equipment on-site is maintained. Locations of emergency and decontamination equipment are shown in Figures 1, 2 and 3. Some of this equipment may be serviced and/or monitored by an outside contractor. Routine training is provided to appropriate EQ Personnel on the operation and use of certain emergency equipment.

264.52(f). <u>Evacuation Plan Clearing Immediate Area</u>

If any employee in the active hazardous waste treatment area or waste reception area encounters an emergency situation which they believe to present an imminent threat to human health or the environment, the individual employee is authorized to leave the area immediately and tell others to leave the area immediately.

Any available route away from the hazard may be used either on foot or by vehicle. The employee should proceed out the main gate to the service drive or out Denton Road to the service drive and notify security to contact the Emergency Coordinator. If security has been disabled use radio or first available phone to contact the Emergency Coordinator.

<u>Evacuation of Entire Facility</u>

Evacuation Signal: If in the opinion of the Emergency Coordinator a general evacuation of the entire site is warranted, he will notify all persons on-site by radio and PA systems. All employees work under supervision of a supervisor in public address system range or direct radio contact with the Emergency Coordinators. Evacuation notice will be given verbally to these employees.

Primary Evacuation Route:

Upon receiving the evacuation order by radio, all employees, including persons in the non-hazardous areas, must immediately proceed out Denton Road to the service drive and congregate at that point. The security guards' list of persons on-site will be used for roll call.

Alternate Evacuation Route:

If wind direction and location of hazard blocks the Denton Road gate, the employees must exit the main gate to service drive and congregate east of the entrance. The security guards' list of persons on-site will be used for roll call.

Return to Site:

Employees should not return to the site until instructed to do so by the Emergency Coordinator, or until a general all clear signal is given over the radio/PA system.

264.53. Plan Distribution

1. On-Site Copy Locations: Official Copies of the Contingency plan can be found in the following locations on-site:
   a) MDWTP/WDI Spotter's Shed
   b) Guard Office
   c) Safety Office
   d) Administrative Building
   e) Receiving Building
   f) Lunchroom/Training Center
2. Off-Site Copy Locations: Official Copies of the Contingency Plan have been sent to the following agencies off-site:
   a) EQ Main Office (Wayne, MI)
   b) Each of the Emergency Response Contacts with addresses listed in section 264.52(c) of this plan.

264.54. Plan Revision

The contingency plan must be reviewed, and immediately amended, if necessary, whenever:

(a) The facility permit is revised;

(b) The plan fails in an emergency;

(c) The facility changes - in its design, construction, operation, maintenance, or other circumstances - in a way that materially increases the potential for fires, explosions, or releases of hazardous waste or hazardous waste constituents, or changes the response necessary in an emergency;

(d) The list of Emergency Coordinators changes; or

(e) The list of emergency equipment changes.

The Emergency Coordinator(s) will coordinate with the Quality Environmental Health & Safety Department (QEHS) to initiate an update of the Contingency Plan whenever it becomes outdated.

Whenever the Contingency Plan is modified, the Emergency Coordinator(s) must provide the emergency response agencies with a copy of the modified plan. Send these copies with a letter of transmittal, by certified mail, with instructions to destroy all previous copies.

264.55. Responsibility, Qualifications and Authority of Emergency Coordinator

At all times there is at least one employee, either on the facility premises or on call and within reasonable travel distance of the facility, with the responsibility for coordinating all emergency response measures. These personnel are known as on-site Emergency Coordinator(s). They must be fully qualified for this responsibility and be knowledgeable of this Contingency Plan, the facility's operations and activities, and how these operations and activities are impacted by RCRA obligations." They must also be knowledgeable of the location and characteristics of waste handled, the location of all records within the facility, and the facility layout.

The Emergency Coordinator must be contacted immediately in the occurrence of any situation that may result in potential or actual threats to human health or the environment. The Emergency Coordinator must implement this plan whenever there is a fire, explosion, or release of hazardous waste or hazardous waste constituents that could threaten human health or the environment. The Emergency Coordinator is authorized to commit any necessary resources of the company that may be needed to carry out this Contingency Plan.

264.56. Emergency Response Procedures by the Emergency Coordinator

264.56(a). At Tine of Incident

Whenever there is an imminent or actual emergency situation, the Emergency Coordinator (or his designee) immediately:

(1) Activates internal communication systems (Radio/ PA System) to notify all facility personnel; and

(2) Notifies appropriate state or local agencies with designated response roles if their help is needed.

264.56(b). In the Event of Release, Fire or Explosion

The Emergency Coordinator must coordinate with QEHS to immediately identify the character, exact source, amount and extent of any released materials. They may do this by observation and/or review of the facility records or manifests, and if necessary, by chemical analysis.

264.56(c). Assessment of Possible Hazards

The Emergency Coordinator must assess possible hazards to human health or the environment that may result from the release, fire, or explosion. This assessment must consider both direct and indirect effects of the release, fire, or explosion (e.g., the effects of any toxic, irritating, or asphyxiating gases that are generated, or the effects of any hazardous surface water run-off from water or chemical agents used to control fire and heat-induced explosions). Should the release, fire or explosion present a significant **off-site** risk, SOP QES-OP-010-BEL (an MDNRE approved SOP) must be implemented to provide a timely assessment of off-site risk.

Sudden Release (Spill) Control, Containment, Cleanup, and Disposal

In the event of a spill or release which could threaten human health or the environment, the following steps should be taken:

1. Contact the Emergency Coordinator for instructions.

2. The Emergency Coordinator shall give directions to:

a) Isolate the area of the spill to prevent contact with any personnel.

b) Determine whether the spilled material may enter or is entering the sedimentation basin, and if the potential exists, the discharge point from the sedimentation basin to the Quirk Drain must be closed.

c) Determine the characteristics of the spilled waste for any special handling requirements. If feasible and safe, stop the release at the source of the flow by overpacking or uprighting containers, using valves, shut off switches, patches, lids or other mechanical devices. Drains or sumps may be sealed using visqueen and a weight such as a bag of absorbent.

d) Vacuum any available spilled waste with the vacuum truck. Any remaining residue should be contained with absorbents and shoveled into containers in preparation for disposal. Solid wastes may be front-end loaded into containers or waste hauling vehicles.

e) If the spill occurred in a paved area, the pavement should be cleaned with water and detergent solution, under high pressure and then rinsed twice with clean water, being sure to collect all spent cleaning and rinsing solutions with the vacuum truck. After the spill has been cleaned up, the spill area will be inspected for cracks, fissures or any other imperfection that might allow the spilled material to reach the subsoil. In the event that any cracks or fissures are found, three one-inch holes will be drilled through the concrete. The holes will be along the cracks or fissures and spaced to represent the area. A thin wall tube will be pounded at least six inches into the soil. The soil collected in the tube will be analyzed for the spilled constituents. If hazardous levels of spill constituents are detected, the concrete in the area should be removed and the area remediated as though the spill had occurred in an unpaved area. When completed, the new replacement concrete should include water stop. If hazardous levels of spill constituents are not detected, the holes should be filled with Emanco T-430 or equivalent in accordance with manufacturer's instructions.

f) In the event the spill occurs in an unpaved area, all visible contamination should be removed. At least six inches of "clean" soils surrounding the contaminated area should also be removed. Samples should then be taken for chemical analysis to confirm the absence of any contaminants from the spilled waste.

g) Containers of Hazardous Waste are properly labeled and marked and managed in generation accumulation areas. They are properly characterized and disposed of at a properly licensed waste management facility. A properly completed manifest is used if transport of liquids or hazardous waste to an off site destination is necessary.

3. The Emergency Coordinator shall assist QEHS in the preparation of the appropriate reports described below.

264.56(d). Notification of Regional Authorities If the Emergency Coordinator determines the facility has had a release, fire, or explosion which could threaten human health or the environment outside the facility, he will report such findings and act as follows:

1. If the Emergency Coordinator suspects that the evacuation of surrounding local areas is advisable, he will inform Van Buren Fire Department, or Van Buren Police Department or MI State Police and assist the appropriate officials in deciding whether evacuation is necessary and, if so, assist in determining what areas should be evacuated. According to R 299.9607 and 40 CFR 264.56(d), the decision making authority to evacuate the local areas belongs to the appropriate local authorities (i.e. Van Buren Township) based on the EQ's assessment of the release.
2. In the event of fire, the Emergency Coordinator gives special consideration to potential impact of smoke or fumes on I-94 freeway traffic.

3. If there is a fire, explosion, or other release of hazardous waste that could threaten human health or the environment, or a spill that reached surface water or ground water, the Emergency Coordinator will immediately notify the DEQ's pollution emergency alerting system (PEAS) - telephone number 800-292-4706. The notification shall include all of the following information:

(a) The name and telephone number of the person who is reporting the incident;

(b) The name, address, telephone number, and EPA Identification No. of the facility;

(c) The name, address, and telephone number of the owner or operator;

(d) The date, time, and type of incident;

(e) The name and quantity of the material or materials involved and released;

(f) The extent of injuries, if any;

(g) The estimated quantity and disposition of recovered material that resulted from the incident, if any;

(h) An assessment of actual or potential hazards to human health or the environment;

(i) The immediate response action taken.

If any threat to human health or to the environment extends **off-site**, the Emergency Coordinator will also contact the National Response Center (800-424-8802) and report the following:

1. Name and phone number of reporter;
2. Name and address of facility;
3. Time and type of incident;
4. Name and quantity of material involved, to the extent known;
5. The extent of injuries, if any;
6. Possible hazards to human health or the environment outside the facility.

264.56(e). Preventing the Spread of Hazards

During an emergency, the Emergency Coordinator must take all reasonable measures necessary to ensure that fires, explosions, and releases do not occur, recur, or spread to other hazardous waste at the facility. These measures must include, where applicable, stopping processes and operations, collecting and containing released waste, and removing or isolating containers.

264.56(f). Response to Fire, Explosion or Release

If the facility stops operations in response to a fire, explosion, or release, the Emergency Coordinator must monitor for leaks, pressure buildup, gas generation, or ruptures in valves, pipes or other equipment, whenever this is appropriate.

264.56(g). Provision for treatment, storage, and disposal of waste generated in emergencies

Immediately after an emergency, the Emergency Coordinator must provide for treating, storing, or disposing of recovered waste, contaminated soil or surface water, or any other material that results from a release, fire, or explosion at the facility.

[Comment: Unless the owner or operator can demonstrate, in accordance with Section 261.3(c) or (d) of 40 CFR, that the recovered material is not a hazardous waste, the owner or operator becomes a generator of hazardous waste and must manage it in accordance with all applicable requirements of Parts 262, 263, and 264 of 40 CFR.]

264.56(h). Prevention of and Preparation for future incidents

The Emergency Coordinator must ensure that, in the affected area(s) of the facility:

(1) No waste that may be incompatible with the released material is treated, stored, or disposed of until cleanup procedures are completed; and

(2) All emergency equipment listed in the contingency plan is cleaned and fit for its intended use before operations are resumed in the affected area(s) of the facility.

(3) EQ is continuing to work with the Van Buren Township (VBT) Fire Department to further develop and maintain emergency response activities (i.e. joint training, periodic drills and evacuation planning with local emergency response agencies) and better communication.

264.56(i). Notification of Compliance with section 264.56(h)

Notification must be given to the Regional Administrator, and appropriate state and local authorities, that the facility has taken the necessary steps to prevent and prepare for future incidents (as described in 40 CFR 264.56(h)) before operations are resumed in the affected area(s) of the facility.

264.56(j). Post Emergency Documentation and Reporting

Documentation:

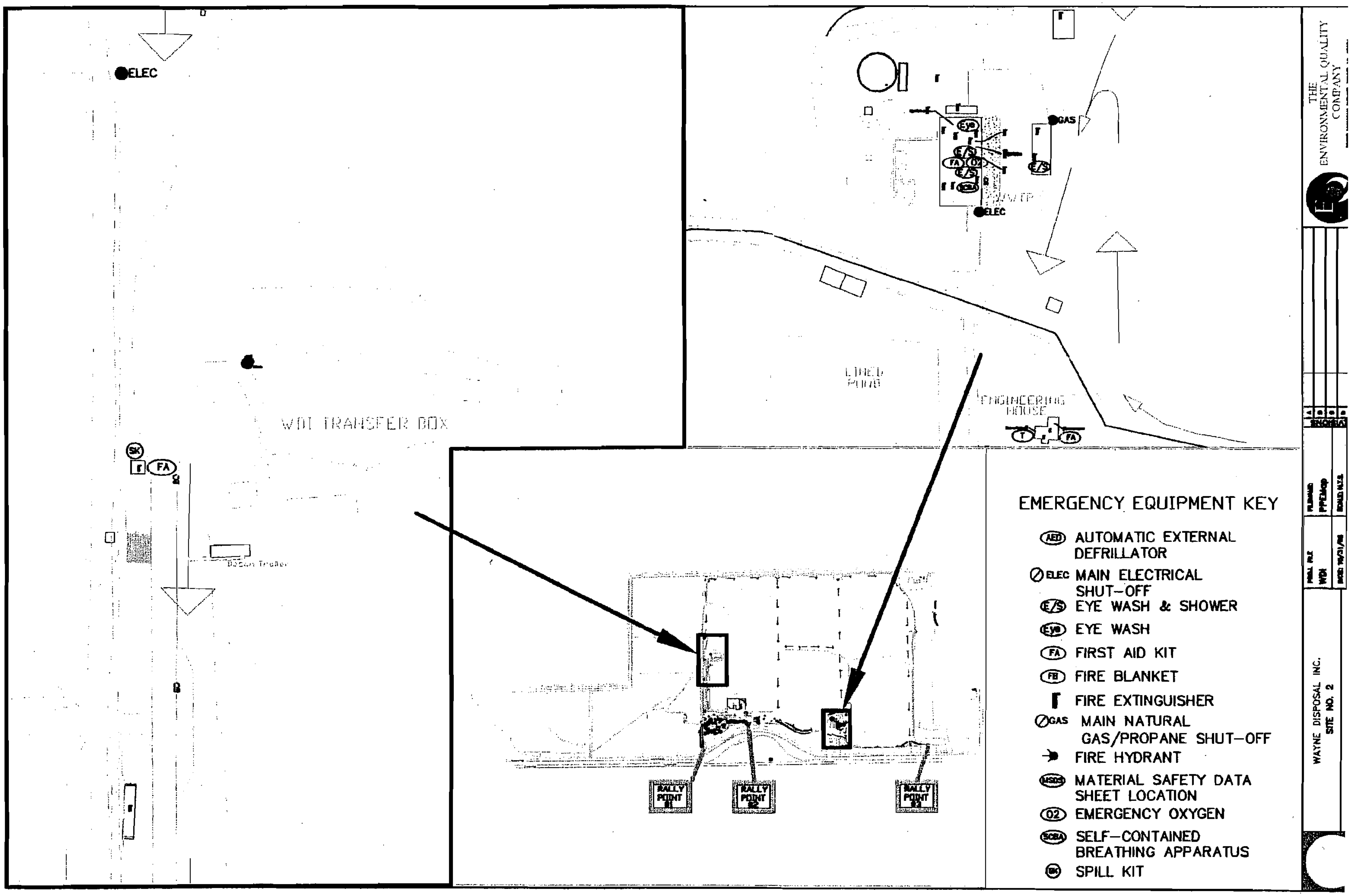
The Emergency Coordinator will note in the Operating Record the time, date, and details of any incident that requires implementing the Contingency Plan. The Operating Record is maintained at the Wayne Disposal, Inc. Site No. 2 facility in Belleville, Michigan.

Reporting:

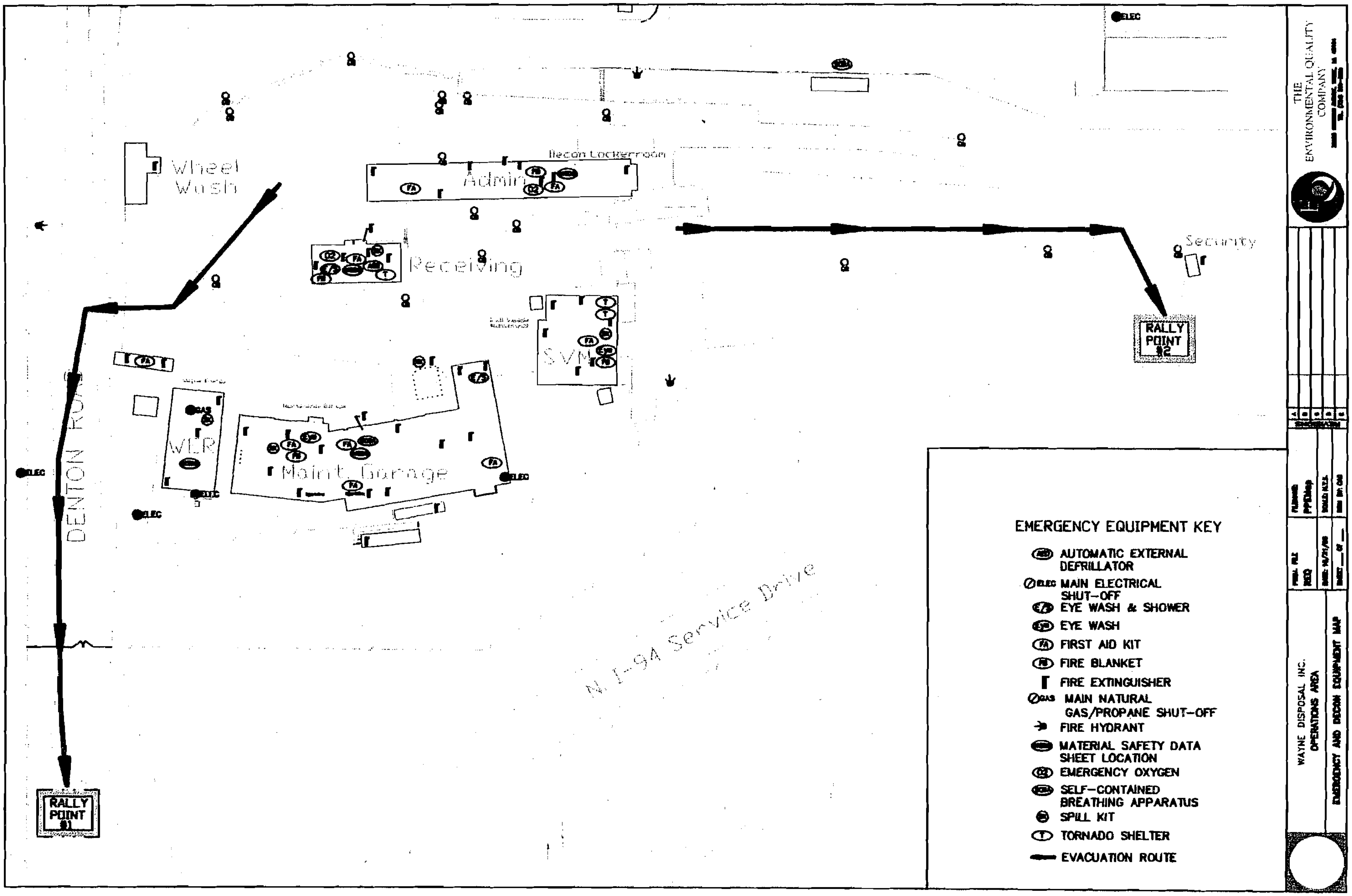
Within **15 days** of any situation requiring implementation of the Contingency Plan, the Emergency Coordinator shall prepare a report to be submitted to the Regional Administrator (EPA) and DEQ District Supervisor, Waste Management Division, SE Michigan District (Warren). At a minimum, the report shall detail the following:

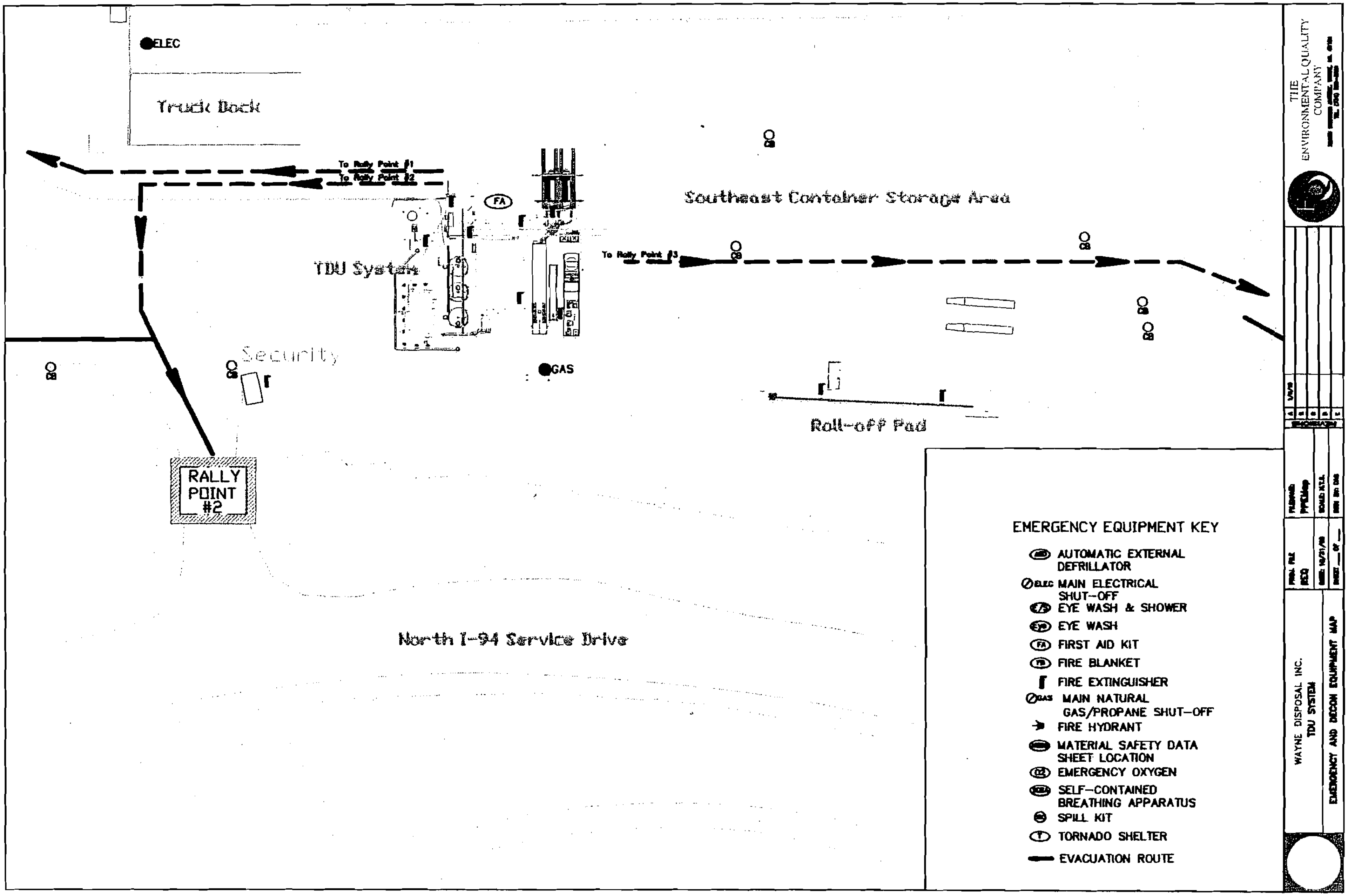
1. Name, address and phone number of the operator;
2. Name, address, and telephone number of the facility;
3. Date, time, and type of incident (e.g. fire, explosion);

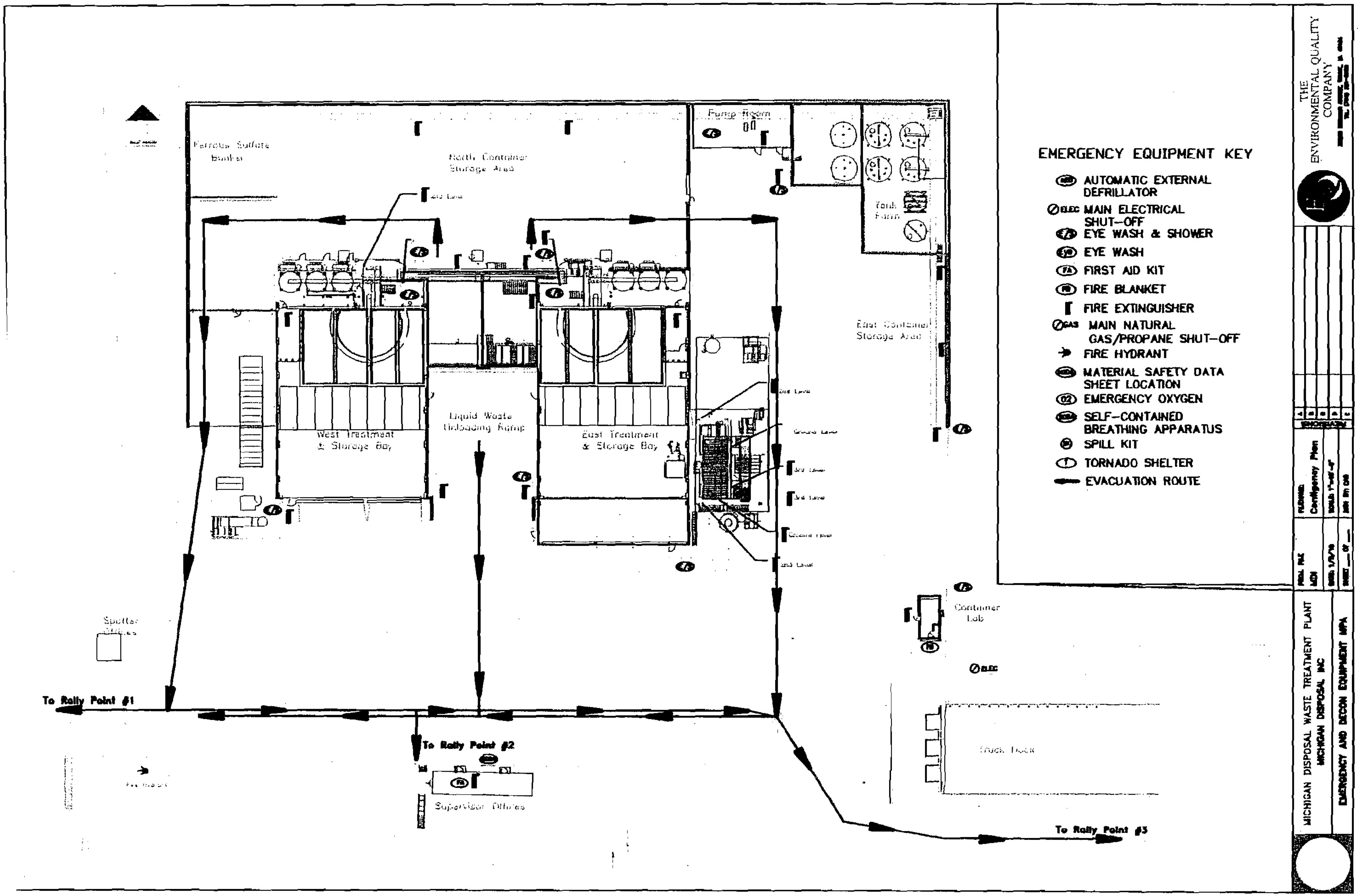
4. Name and quantity of material(s) involved;
5. The extent of injuries, if any;
6. An assessment of actual or potential hazards to human health or the environment, where this is applicable; and
7. Estimated quantity and disposition of recovered material that resulted from the incident.



ELEC
WDI TRANSFER BOX
SK
FA
ELEC
GAS
Eye
E/S
FA
O2
SCBA
ELEC
LINED POND
ENGINEERING HOUSE
T
FA
RALLY POINT #1
RALLY POINT #2
RALLY POINT #3
EMERGENCY EQUIPMENT KEY
AED AUTOMATIC EXTERNAL DEFRILLATOR
ELEC MAIN ELECTRICAL SHUT-OFF
E/S EYE WASH & SHOWER
EYE EYE WASH
FA FIRST AID KIT
FB FIRE BLANKET
FIRE EXTINGUISHER
GAS MAIN NATURAL GAS/PROPANE SHUT-OFF
FIRE HYDRANT
MSDS MATERIAL SAFETY DATA SHEET LOCATION
O2 EMERGENCY OXYGEN
SCBA SELF-CONTAINED BREATHING APPARATUS
SK SPILL KIT
THE ENVIRONMENTAL QUALITY COMPANY
WAYNE DISPOSAL INC. SITE NO. 2


Wheel Wash
Admin
Decon Lockerroom
Receiving
Security
RALLY POINT #2
SVM
WLR
Maint. Garage
DENTON ROAD
N. I-94 Service Drive
RALLY POINT #1
ELEC
GAS
EMERGENCY EQUIPMENT KEY
AUTOMATIC EXTERNAL DEFRILLATOR
MAIN ELECTRICAL SHUT-OFF
EYE WASH & SHOWER
EYE WASH
FIRST AID KIT
FIRE BLANKET
FIRE EXTINGUISHER
MAIN NATURAL GAS/PROPANE SHUT-OFF
FIRE HYDRANT
MATERIAL SAFETY DATA SHEET LOCATION
EMERGENCY OXYGEN
SELF-CONTAINED BREATHING APPARATUS
SPILL KIT
TORNADO SHELTER
EVACUATION ROUTE
THE ENVIRONMENTAL QUALITY COMPANY
WAYNE DISPOSAL INC.
OPERATIONS AREA
EMERGENCY AND DECON EQUIPMENT MAP


ELEC
Truck Dock
To Rally Point #1
To Rally Point #2
FA
TDU System
To Rally Point #3
Southeast Container Storage Area
Security
GAS
Roll-off Pad
RALLY POINT #2
North I-94 Service Drive
EMERGENCY EQUIPMENT KEY
AUTOMATIC EXTERNAL DEFRILLATOR
MAIN ELECTRICAL SHUT-OFF
EYE WASH & SHOWER
EYE WASH
FIRST AID KIT
FIRE BLANKET
FIRE EXTINGUISHER
MAIN NATURAL GAS/PROPANE SHUT-OFF
FIRE HYDRANT
MATERIAL SAFETY DATA SHEET LOCATION
EMERGENCY OXYGEN
SELF-CONTAINED BREATHING APPARATUS
SPILL KIT
TORNADO SHELTER
EVACUATION ROUTE
THE ENVIRONMENTAL QUALITY COMPANY
WAYNE DISPOSAL INC.
TDU SYSTEM
EMERGENCY AND DECON EQUIPMENT MAP



Ferrous Sulfate Bunker
North Container Storage Area
Pump Room
Tank Farm
East Container Storage Area
West Treatment & Storage Bay
Liquid Waste Unloading Ramp
East Treatment & Storage Bay
Container Lab
Truck Dock
Supervisor Offices
To Rally Point #1
To Rally Point #2
To Rally Point #3
EMERGENCY EQUIPMENT KEY
AUTOMATIC EXTERNAL DEFRILLATOR
MAIN ELECTRICAL SHUT-OFF
EYE WASH & SHOWER
EYE WASH
FIRST AID KIT
FIRE BLANKET
FIRE EXTINGUISHER
MAIN NATURAL GAS/PROPANE SHUT-OFF
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MATERIAL SAFETY DATA SHEET LOCATION
EMERGENCY OXYGEN
SELF-CONTAINED BREATHING APPARATUS
SPILL KIT
TORNADO SHELTER
EVACUATION ROUTE
THE ENVIRONMENTAL QUALITY COMPANY
MICHIGAN DISPOSAL WASTE TREATMENT PLANT
MICHIGAN DISPOSAL, INC
EMERGENCY AND DECON EQUIPMENT MPA
Contingency Plan

Appendix A--Letters of Transmittal of Contingency Plan

WDI

WAYNE DISPOSAL, INC.

October 6, 2011

Dr. John McCabe
St. Joseph Mercy Hospital
5301 E. Huron River Drive
Ann Arbor, MI 48106

Re: Contingency Plan
Wayne Disposal, Inc.

Dear Dr. McCabe:

As a listed member of an Emergency Response Agency enclosed please find an updated Contingency Plan for Wayne Disposal, Inc.'s Hazardous Waste Facility in Belleville, Michigan. The updated plan is being sent to all listed Emergency Response Agencies to ensure that up to date information is contained in all files.

Please dispose of any earlier copies of this plan that you may possess and if you have any questions please contact me at (734) 699-6286.

Sincerely,

Michael J. Takacs
Environmental Manager

enclosures

WAYNE DISPOSAL, INC.

October 6, 2011

Dr. Mark Weiner, MD
Concentra Medical Center
11700 Metro Airport Center Drive
Romulus, MI 48174

Re: Contingency Plan
Wayne Disposal, Inc.

Dear Dr. Weiner:

As a listed member of an Emergency Response Agency enclosed please find an updated Contingency Plan for Wayne Disposal, Inc.'s Hazardous Waste Facility in Belleville, Michigan. The updated plan is being sent to all listed Emergency Response Agencies to ensure that up to date information is contained in all files.

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Sincerely,

Michael J. Takacs
Environmental Manager

enclosures

WDI

WAYNE DISPOSAL, INC.

October 6, 2011

Dr. R.T. Nolta, MD FACPM
Midwest Health Center, P.C.
9301 Middlebelt Road
Romulus, MI 48174

Re: Contingency Plan
Wayne Disposal, Inc.

Dear Dr. Nolta:

As a listed member of an Emergency Response Agency enclosed please find an updated Contingency Plan for Wayne Disposal, Inc.'s Hazardous Waste Facility in Belleville, Michigan. The updated plan is being sent to all listed Emergency Response Agencies to ensure that up to date information is contained in all files.

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Sincerely,

Michael J. Takacs
Environmental Manager

enclosures

WAYNE DISPOSAL, INC.

October 6, 2011

Dr. Suzanne White
Poison Control Center
Children's Hospital of Michigan
Harper Professional Office Building
4160 John R, Suite #616
Detroit, MI 48201

Re: Contingency Plan
Wayne Disposal, Inc.

Dear Dr. Weiner:

As a listed member of an Emergency Response Agency enclosed please find an updated Contingency Plan for Wayne Disposal, Inc.'s Hazardous Waste Facility in Belleville, Michigan. The updated plan is being sent to all listed Emergency Response Agencies to ensure that up to date information is contained in all files.

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Sincerely,

Michael J. Takacs
Environmental Manager

enclosures

WAYNE DISPOSAL, INC.

October 6, 2011

Mr. Dale Berry, Executive Director
Huron Valley Ambulance Service, Inc.
2215 Hogback Road.
Ann Arbor, MI 48105

Re: Contingency Plan
Wayne Disposal, Inc.

Dear Mr. Berry:

As a listed member of an Emergency Response Agency enclosed please find an updated Contingency Plan for Wayne Disposal, Inc.'s Hazardous Waste Facility in Belleville, Michigan. The updated plan is being sent to all listed Emergency Response Agencies to ensure that up to date information is contained in all files.

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Sincerely,

Michael J. Takacs
Environmental Manager

enclosures

WAYNE DISPOSAL, INC.

October 6, 2011

Public Safety Director
Van Buren Township Police Department
46425 Tyler Road
Belleville, MI 48111

Re: Contingency Plan
Wayne Disposal, Inc.

Dear Director McClanahan:

As a listed member of an Emergency Response Agency enclosed please find an updated Contingency Plan for Wayne Disposal, Inc.'s Hazardous Waste Facility in Belleville, Michigan. The updated plan is being sent to all listed Emergency Response Agencies to ensure that up to date information is contained in all files.

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Sincerely,

Michael J. Takacs
Environmental Manager

enclosures

WAYNE DISPOSAL, INC.

October 6, 2011

Van Buren Township Fire Department
46425 Tyler Road
Belleville, MI 48111

Re: Contingency Plan
Wayne Disposal, Inc.

Dear Chief Loyer:

As a listed member of an Emergency Response Agency enclosed please find an updated Contingency Plan for Wayne Disposal, Inc.'s Hazardous Waste Facility in Belleville, Michigan. The updated plan is being sent to all listed Emergency Response Agencies to ensure that up to date information is contained in all files.

Please dispose of any earlier copies of this plan that you may possess and if you have any questions please contact me at (734) 699-6286.

Sincerely,

Michael J. Takacs

Michael J. Takacs
Environmental Manager

enclosures

WDI

WAYNE DISPOSAL, INC.

October 6, 2011

Mr. Mark Sparks, Director of Emergency Management
Wayne County Emergency Management
Office of Wayne County Executives
10250 Middlebelt Road
Detroit, MI 48242

Re: Contingency Plan
Wayne Disposal, Inc.

Dear Mr. Sparks:

As a listed member of an Emergency Response Agency enclosed please find an updated Contingency Plan for Wayne Disposal, Inc.'s Hazardous Waste Facility in Belleville, Michigan. The updated plan is being sent to all listed Emergency Response Agencies to ensure that up to date information is contained in all files.

Please dispose of any earlier copies of this plan that you may possess and if you have any questions please contact me at (734) 699-6286.

Sincerely,

Michael J. Takacs
Environmental Manager

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WAYNE DISPOSAL, INC.

October 6, 2011

Western Wayne County Hazardous
Incident Response Team
14910 Farmington Road
Livonia, MI 48154

Re: Contingency Plan
Wayne Disposal, Inc.

To Whom It May Concern:

As a listed member of an Emergency Response Agency enclosed please find an updated Contingency Plan for Wayne Disposal, Inc.'s Hazardous Waste Facility in Belleville, Michigan. The updated plan is being sent to all listed Emergency Response Agencies to ensure that up to date information is contained in all files.

Please dispose of any earlier copies of this plan that you may possess and if you have any questions please contact me at (734) 699-6286.

Sincerely,

Michael J. Takacs
Environmental Manager

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WDI

WAYNE DISPOSAL, INC.

October 6, 2011

First Lieutenant Lynne Huggins
Taylor State Police Post
12111 Telegraph Road
Taylor, MI 48180

Re: Contingency Plan
Wayne Disposal, Inc.

Dear First Lieutenant Huggins:

As a listed member of an Emergency Response Agency enclosed please find an updated Contingency Plan for Wayne Disposal, Inc.'s Hazardous Waste Facility in Belleville, Michigan. The updated plan is being sent to all listed Emergency Response Agencies to ensure that up to date information is contained in all files.

Please dispose of any earlier copies of this plan that you may possess and if you have any questions please contact me at (734) 699-6286.

Sincerely,

Michael J. Takacs
Environmental Manager

enclosures

WDI

WAYNE DISPOSAL, INC.

October 6, 2011

Ypsilanti Township Fire Department
222 South Ford Boulevard
Ypsilanti, MI 48198

Re: Contingency Plan
Wayne Disposal, Inc.

To Whom it May Concern:

As a listed member of an Emergency Response Agency enclosed please find an updated Contingency Plan for Wayne Disposal, Inc.'s Hazardous Waste Facility in Belleville, Michigan. The updated plan is being sent to all listed Emergency Response Agencies to ensure that up to date information is contained in all files.

Please dispose of any earlier copies of this plan that you may possess and if you have any questions please contact me at (734) 699-6286.

Sincerely,

Michael J. Takacs

Michael J. Takacs
Environmental Manager

enclosures

WAYNE DISPOSAL, INC.

October 6, 2011

Mr. Tim Hoeft, Fire Chief
Willow Run Airport Fire Department
PO Box 801
Ypsilanti, MI 48198

Re: Contingency Plan
Wayne Disposal, Inc.

Dear Hoeft:

As a listed member of an Emergency Response Agency enclosed please find an updated Contingency Plan for Wayne Disposal, Inc.'s Hazardous Waste Facility in Belleville, Michigan. The updated plan is being sent to all listed Emergency Response Agencies to ensure that up to date information is contained in all files.

Please dispose of any earlier copies of this plan that you may possess and if you have any questions please contact me at (734) 699-6286.

Sincerely,

Michael J. Takacs
Environmental Manager

enclosures

Attachment 5

Closure Plan

CLOSURE PLAN

40 CFR 270.14b (13) & PART 111, R504(1)c

CLOSURE PLAN

40 CFR 270.14(b)(13)
Part 111 R504(1)c
TABLE OF CONTENTS

CLOSURE PLAN

40 CFR 270.14(b)(13)

I. INTRODUCTION

A. Facility Conditions

Originally Wayne Disposal, Inc. Site #2 was a 427 acre facility with approximately 360 acres available for co-disposal of both hazardous and non-hazardous waste via landfill.

Wayne Disposal Site#2 Landfill has set aside Master Cells (MC) V, VI and VII for hazardous waste disposal. The hazardous waste boundary which circumscribes MC V, VI and VII contains 120 acres of which 105.6 are actual disposal area. Since the Fall of 1982, the co-disposal of hazardous and non-hazardous waste has been discontinued, with the remaining capacity in MCs V, VI, and VII reserved for hazardous waste.

All hazardous waste cells have leachate collection and removal systems. MC V and MC VII have been closed with multilayer final cover systems. This closure plan was developed to describe closure activities for cells VI-AS through VI-E. Cells VI-F and VI-G, which have not been constructed, must be incorporated into this Plan incrementally as each phase is constructed and licensed. Updates to the closure plan must include an updated sampling plan based on the configuration of the landfill licensed at the time. The updated closure plan and closure cost estimate must be submitted to MDEQ along with the construction certification for each phase. Financial assurance must also be adjusted at this time.

The base of the existing portions of the disposal area, as licensed under Michigan Natural Resources and Environmental Protection Act, (Act 451) of 1994, consist of clay soils with an average permeability of less than 5 X 10^{-8} cm/sec, underlain in most areas by varying thickness of CL-ML or ML soil with permeabilities in the 10^{-6} to 10^{-7} range, followed by a water bearing sand formation.

B. Scope

This document is the Closure Plan for the cells of the Wayne Disposal, Inc. Site #2, Van Buren Township, Michigan, EPA facility ID number MID048090633. It is organized to address 40 CFR Subpart G: Closure and Post-closure, and 40 CFR 264.310: Closure and Post-closure Care for Landfills.

The plan describes activities related to construction of the cover system, decontamination of remaining facility areas and equipment, and long term monitoring, inspection and maintenance activities required during post-closure. The plan is intended to satisfy the requirements for closure of the cells in accordance with State and Federal regulations.

II. CLOSURE PERFORMANCE STANDARD (40 CFR 264.111)

The Closure Plan for the cells is designed to ensure that after closure, minimum maintenance and controls will be required. The plan is also designed to minimize or eliminate threats to human health and the environment by preventing release of hazardous waste or hazardous waste constituents into the ground, groundwater, surface water, or air.

III. CLOSURE PLAN ACTIVITIES (40 CFR 264.112 (b))

The Closure Plan for the cells requires that completed areas be finished with final cover, topsoil, and vegetative growth. The Closure Plan minimizes the need for further maintenance. This reduces the potential for contamination and allows a monitoring record to be established before post-closure monitoring begins. The plan identifies the steps that will be necessary to close the cells at the facility.

IV. SITE PREPARATION (40 CFR 264.112 (b))

The cells to be closed will be prepared for clay capping by shaping and grading to meet the desired subgrade profile. The existing clay dike will be located before grading and shaping. The dike will serve as the baseline and starting point for constructing the clay cap. Surveyors will place corner stakes to mark the dike initially. All subsequent field stakes will be placed by Wayne Disposal, Inc. Site #2. Wayne Disposal, Inc. Site #2 will shape and grade an area capable of being capped with the FML foundation layer.

V. FINAL COVER (40 CFR 264.310 (a))

A. Purpose

The purposes for the final cover are (1) to provide long-term minimization of percolation from precipitation into the waste, (2) to function with a minimum level of maintenance, (3) to promote drainage while minimizing erosion, (4) to maintain integrity in the event of limited settlement of the waste surface, and (5) to achieve a permeability less than or equal to the bottom liner system or natural subsoils present.

B. Design Elements

The final cover system must consist of the following elements as approved by the Michigan Department of Environmental Quality (MDEQ), Waste and Hazardous Materials Division on June 4, 2004:

1. A leveling layer over the waste shall be installed per the Engineering Plans and Report on Basis of Design for Master Cell VI Cover Design Modification (11/20/02, with comment response of 4/27/04). This layer shall be installed above the surface of the waste consisting of a minimum of 12-inches of silt, clayey silt, or silty clay with a classification of ML, CL-ML, or CL as determined by ASTM Method D2487-83. This layer shall be installed in general accordance with section VI.A. of this plan;
2. A geosynthetic clay layer (GCL), placed directly over the leveling layer, consisting of a layer of sodium bentonite encapsulated between two geotextiles at least one of which shall be non-woven, and shall meet the requirements of Table 7.1 of the approved Engineering Plans and Report on Basis of Design for Master Cell VI Cover Design Modification. The lower and upper geotextiles should be either stitch bonded or needle punched together to provide stability. The manufacturers recommended overlap distance shall be marked on the GCL;
3. A 40-mil thick high density polyethylene (HDPE), very low density polyethylene (VLDPE), or linear low density polyethylene (LLDPE) flexible membrane liner (FML) installed per section VI C;
4. A double-bonded geocomposite drainage layer as specified in section VI D. of this plan;
5. A general soils layer, placed directly over the drainage blanket layer, consisting of a minimum of 30 inches of soil as described in section VI E. of this plan;
6. A layer of topsoil, placed directly over the compacted clay layer, consisting of a minimum of 6 inches of loamy sand as described in section VI F. of this plan;

7. A vegetative crop to be established per section VI G. of this plan.

C. Final Contours - Erosion Prevention (40 CFR 264.310 (b)(5))

The final contours of the constructed final cover will result in slopes between 4% and 25% and must conform to the topography for Master Cell VI as shown on Sheet 7 of the Engineering Plans for Design Modification, November 2002. Deviations from the elevations are permitted to the extent they are necessitated by complying with the thickness requirements stipulated for the clay liner, general soils and topsoil in sections VI B., VI E. and VI F. of this plan.

D. Gas Vents

At the time of closure Wayne Disposal, Inc. will develop a procedure to ensure that landfill cell(s) to be final capped will be evaluated to determine if a landfill gas collection system should be installed. Should the evaluation indicate that a landfill gas collection system is required; Wayne Disposal, Inc. will submit the evaluation and an updated landfill gas system design for MDEQ approval. However, if the evaluation indicates that the landfill gas collection system is not necessary the passive gas vents, as currently approved in the Design Modification, will be installed at the appropriate locations.

VI. CONSTRUCTION SPECIFICATIONS FOR FINAL COVER OF MASTER CELL VI

A. Construction of Intermediate Cover Layer

1. The layer upon which the geosynthetic clay liner is to be placed must consist of a minimum of 12-inches of compacted silt, clayey silt, or silty clay with an ASTM Method D2487-83 classification of ML, CL-ML or CL.

2. The CQAC or WDI will confirm the slope and correct elevations for the leveling layer surface by survey at a rate of at least once per half-acre over the entire master cell area. This survey, combined with a previous survey of top of waste elevations, will be used to confirm the thickness of the leveling layer and to determine if additional leveling osils are required. Alternatively, the required thickness of the leveling layer will be confirmed by soil borings conducted on a frequency of at least one per half-acre of final cover to be constructed. The thickness of the leveling layer shall not be less than one (1) foot.
3. The CQAC will confirm the classification of the leveling layer. A sample will be taken for every 25,000 cubic yards placed or change in borrow soil character and classified by the USCS (ASTM D2487). Additionally, the sample will be tested for gain size distribution by sieve analysis and hydrometer (ASTM D4222), and for Atterberg Limits (ASTM D4318). A test result not meeting those requirements will be reported immediately to the CQA officer.
4. The leveling layer will be smooth drum rolled in the presence of the CQAC to identify areas of excessive deflection and to prepare the surface for placmement of the GCL.

B. Installation of Geosynthetic Clay Liner (GCL)

1. The CQAC and the geosynthetics installer shall visually inspect the finished leveling layer surface and document unsuitable conditions such as soft or wet spots, large clay clods, and sharp rocks or other objects that could puncture or otherwise damage the GCL.
2. The geosynthetics installer shall supply and install the GCL in accordance with Section 7 of the approved CQA Plan.

C. Synthetic Liner

1. Introduction

The top of the geosynthetic clay liner (GCL) serves as the foundation for the synthetic liner and will be finished to the required elevations.

The synthetic liner will be a 40 mil (minimum) HDPE, VLDPE, or LLDPE.

The 40 mil (minimum) synthetic liner is placed upon the foundation materials. The individual sections of synthetic liner are welded together to form one continuous liner. During the installation of the synthetic liner, the seams will be tested with non-destructive methods.

2. Pre-Testing

Test seams shall be made on fragment pieces of geomembrane liner to verify that seaming conditions are adequate. Test seams shall also be made at the beginning of each seaming period, at the Inspector's discretion, and at least once each 4 hours, for each piece of seaming apparatus used that day.

The test seam sample shall be at least 2 feet long by 1 foot wide with the seam centered lengthwise. Two specimens 1 inch wide shall be cut from opposite ends of the test seam by the Contractor. These specimens shall be field tested by the contractor for shear and peel strength using a tensometer. If a test seam fails, the test shall be repeated in its entirety. If the additional test seam fails, the seaming apparatus or seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full test seams are achieved.

3. Non-Destructive Seam Testing

The Contractor shall non-destructively test all field seams over their full length using a vacuum test unit. Continuity of testing shall be done as the seaming work progresses, not at the completion of all field seaming.

a. Air Vacuum Testing Process Equipment

- A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge.
- A steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections.
- A rubber pressure/vacuum hose with fittings and connections.
- An air pressurized solution spraying apparatus.
- A soapy solution.

b. Air Vacuum Testing Procedure

- Energize the vacuum pump and reduce the tank pressure to approximately -5 psi (gauge pressure).
- Wet a strip of geomembrane approximately 12 inches by 96 inches with the soapy solution.
- Place the box over the wetted area and compress.
- Close the bleed valve and open the vacuum valve.

- Ensure that a leak tight seal is created between the FML and neoprene gasket.
- Examine the geomembrane through the viewing window for the presence of soap bubbles.
- If no bubble(s) appear after a leak tight seal is formed, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 inches overlap and repeat the process.
- All areas where soap bubbles appear shall be marked and repaired and then retested.

The following procedures shall apply to situations where seams cannot be non-destructively tested, as determined by the Inspector:

- All such seams shall be cap-stripped with the same geomembrane where possible.
- If the cap strip is accessible to testing equipment, the seam shall be non-destructively tested.
- If the cap strip seam is not accessible for testing, the seaming and cap-stripping operations shall be observed by the Inspector for uniformity and completeness.

4. <u>Destructive Seam Testing</u>

a. <u>Location and Frequency</u>

The Contractor shall conduct a minimum of one destructive test per 500 feet of seam length. The Contractor shall not be informed in advance of the locations where the seam samples will be taken.

b. Sampling Procedure

Samples shall be cut by the Contractor at times and locations designated by the Inspector as the seaming progresses in order to obtain test results prior to completion of liner installation. The Inspector must witness the procurement of all field test samples and the Contractor shall mark all samples with that location and sample number. The Contractor shall also record in written form the date, time, location, sample number, ambient temperature, number of seaming unit, name of seamer, welding apparatus temperatures and pressures, and pass or fail description, and attach a copy of each sample portion.

All holes in the geomembrane resulting from obtaining the seam samples shall be immediately repaired in accordance with repair procedures. The integrity of the new seams in the repaired area shall be tested.

c. Size and Disposition of Samples

The samples shall be 12 inches wide by 24 inches long with the seam centered lengthwise. The sample shall be cut into two equal length pieces, half to be retained by the Contractor and the other half to be given to the Owner's Representative for archive storage and/or independent testing

d. Field Testing

The Contractor shall cut five 1-inch wide replicate specimens from his sample and these shall be tested by the Contractor. The Contractor shall test the five specimens from the seam sample for seam shear and peel, in accordance with the specified material tests and procedures. To be acceptable, four out of the five replicate test results must pass the material specification requirements. The results of these tests shall be provided to the Inspector by the conclusion of the second work day following the procurement of the field seam sample.

e. Independent Laboratory Testing

The Owner's Representative will require the Inspector to package and ship at least two seam samples received from the Installer to an independent laboratory for determination of seam shear and peel. Four of five specimens per sample must pass the material specifications requirements for the installation to be acceptable.

5. Procedures In The Event Of Destructive Test Failure

The following procedures shall apply whenever a sample fails the field destructive test. The Contractor shall have two options:

(a) The Installer can reconstruct the seam between the failed location and any passed test location.

(b) The Installer can retrace the welding path to an intermediate location (at 10 feet minimum from the location of the failed test) and take a small sample for an additional field test. If this additional sample passes the test, then the seam is reconstructed between that location and the original failed location. If this sample fails, then the process is repeated.

The Installer shall determine the length of seam failure to the satisfaction of the Inspector by additional tests or assume the seam is unacceptable between the two successful test locations, which bracket the test failure.

Over the length of seam failure, the Installer shall either cut out the old seam, reposition the panel and reseam or add a cap strip, as approved by the Inspector.

After reseaming or placement of the cap strip, one additional destructive test shall be taken within the reseamed area, and if test results are not acceptable, this process shall be repeated until the reseamed length is judged satisfactory by the Inspector.

In any case, all acceptable seams must be bounded by two passed test locations (i.e., the above procedures shall be followed in both directions from the original failed location), and one successful test must be obtained within the reconstructed area.

The Inspector shall document all actions taken in conjunction with destructive test failures.

Patches shall be round or oval in shape, made of the same geomembrane, and extend a minimum of 6 inches beyond the edge of defects.

Patches shall be applied using approved methods only. Small patches (less than 6 inches in least dimension) will require a cooling period after extruded welding half of the patch to prevent a burn through the liner before welding the second half of the patch.

6. Defects And Repairs

a. Identification

All seams and non-seam areas of the geomembrane shall be inspected by the Inspector for identification of defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter. Because light reflected by the geomembrane helps detect defects, the surface of the geomembrane shall be clean at the time of inspection. The geomembrane surface shall be brushed, blown or washed by the Installer if the amount of dust or mud inhibits inspection.

b. Evaluation

Each suspect location in seam and non-seam areas shall be non-destructively tested. Each location which fails the non-destructive testing will be marked by the Contractor.

Where extrudate surface drifting occurs beyond 25 percent of the seam width, the affected seam length will be cap stripped as required by the Inspector. Reseaming over an existing seam will not be permitted, as it may be conducive to capillary leakage.

c. Repair Procedures

- Defective seams shall be restarted/re-seamed.
- Small holes shall be repaired by extrusion cap welding. If the hole is larger than ¼ inch, it must be patched.
- Blisters, larger holes, undispersed raw materials, and contamination by foreign matter shall be repaired by patches.

Surfaces of FML, which are to be patched, shall be abraded and cleaned no more than one hour prior to the repair.

7. Restart/Re-seaming Procedures

Restart of the extrusion welding process shall be achieved by grinding the existing seam and rewelding a new seam 2 inches from the termination of the previous seam and commencing at the start of grinding.

Re-seaming for the fusion welding process shall be achieved by cutting out the existing seam and welding in a replacement strip or if possible, cut the sheet next to the failed seam, move the panel over and seam with a single seam.

a. Verification of Repairs

Each repair shall be non-destructively tested using the methods described. Repairs which pass the non-destructive test shall be taken as an indication of an adequate repair. Failed tests shall indicate that the repair shall be redone and retested until a passing test results.

b. Record of the Results

Daily documentation of all non-destructive and destructive testing shall be provided to the Inspector by the Installer.. This documentation shall identify all seams which initially failed the test and include evidence that these seams were repaired and retested successfully.

D. Construction of the FML Protection/Drainage Blanket Layer

1. The drainage layer must be a double-bonded geocomposite with a transmissivity of at least 1×10^{-5} m^2/sec when tested at a gradient of 25% under a normal load of 1,000 lbs/ft^2.
2. The perimeter drain pipe must consist of 4 inch diameter corrugated perforated pipe and 4 inch diameter non-perforated outlet pipe placed as shown in Sheet 13 of the Engineering Plans.
3. The perimeter drain pipe must be wrapped with geotextile filter material possessing an equivalent opening size of #70 standard sieve.
4. The double-bonded geocomposite comprising the layer must be placed on the FML in a manner that does not damage it or the drainage pipe system.
5. Initial double-bonded geocomposite placement must be done by placing the material at the toe of the lined slope and pushing the material up the side slope with appropriate equipment.

6. The full design thickness of the double-bonded geocomposite layer must be maintained when spreading the material and for any construction traffic on the layer.

7. Wayne Disposal, Inc. Site #2 must obtain direct layer thickness measurements at a rate of at least once per every half acre verify conformance with design requirements.

E. Construction of General Soil Layer

1. A layer of general soils a minimum of 30 inches in thickness must be placed over the granular material described in section VI D. of this plan.

2. General soils will consist primarily of inorganic soil constituents free of stumps, large roots, and other deleterious materials.

3. General soils shall not be compacted and shall be placed in such a manner as to cause minimum disturbance to the granular layer.

4. No frozen soil may be used in any lift, nor may any soil be placed on frozen base.

5. Wayne Disposal, Inc. Site #2 must obtain direct layer thickness measurements at a rate of at least once per every half-acre to verify conformance with design requirements.

F. Topsoil Specifications

- A layer of topsoil at least 6 inches thick after grading must be placed over the general soil layer described in section VI E of this plan.

- The topsoil must be a loamy sand, and confirmed by grain size analyses conducted according to ASTM Method D 422-63 at least once per 3,000 cubic yards to be placed.
- The top ½ inch of the topsoil layer must be loosely packed to provide an acceptable seed bed.
- Wayne Disposal, Inc. Site #2 must obtain direct measurements of topsoil thickness at the rate of at least once per half-acre to verify conformance with F1.

G. Vegetative Cover Specifications

1. The topsoil described in VI F. must be fertilized with 12-12-12 N-P-K at the rate which provides approximately 240 pounds per acre of total available nutrients, i.e. 80 pounds. per acre of available nitrogen, phosphoric acid, and potash, or an equivalent.
2. The following seed mix must be sown into the topsoil:

Seed	Percent by Weight
a. perennial rye	20 to 30
b. common creeping red fescue	20 to 30
c. common Kentucky bluegrass	5 to 10
d. Kentucky 31 tall fescue	100 to (a+b+c)

3. The seed mix must have a germination rate of at least 80%.
4. The seed mix must be applied at the rate of not less than 100 pounds per acre.
5. The seedbed must be rolled during or immediately after seed application unless a hydroseeding method is used to apply the seed.

6. Straw mulch/hay must be applied to the seedbed at the even rate of not less than 1.5 tons per acre in a manner that will minimize subsequent displacement by wind.

VII. <u>FINAL COVER DESIGN BASIS</u> (40 CFR 270.21(e))

The following is an evaluation of the proposed final cover to be used for the disposal cells in the hazardous waste management area at Wayne Disposal, Inc. Site #2. This evaluation is required under provision of 40 CFR 270.14(b)(13) and 270.21(e). Provisions relating to the cover requirements are included in 40 CFR 264.310(a). The proposed final cover is evaluated herein with respect to its ability to 1) provide long-term minimization of percolation into the landfilled waste, 2) function with a minimum of maintenance, 3) promote drainage while minimizing erosion, and 4) maintain integrity despite settlement of the landfilled waste surface. Additionally, 40 CFR 264.310 (a) requires that the cover possess a permeability less than or equal to the permeability of the leachate containment system at the base of the landfill.

A. <u>Description of Design</u>

The proposed cover system, exclusive of the vegetative cover, is presented in Sheet 10 (Liner and Final Cover System Details) of the Engineering Plans. The proposed cover consists of six elements. From the ground surface downward, these are 1) a minimum of 6 inches of topsoil, 2) a minimum of 30 inches of general soil, 3) a drainage layer consisting of a double-bonded geocomposite material, 4) a flexible membrane liner 40 mils in thickness, 5) a geosynthetic clay liner (GCL), and 6) a leveling layer consisting of at least 12-inches of compacted silt, clayey silt, or silty clay possessing a Unified Soil Classification of ML, CL-ML, or CL. The proposed surface slopes will range generally from 4 to 15 percent. The proposed vegetative cover will include a mixture of rye, fescue and bluegrass.

Additionally, it is proposed that the drainage blanket layer placed above the flexible membrane liner will be drained at the master cell boundaries and at diversion berms located along the slope of the final cover. The geocomposite will daylight in the various diversion berms along the slope and that water will be conveyed to the associated spillway to the perimeter. The lowest slope section of geocomposite will daylight at the perimeter toe drain which will allow the water to be conveyed through the peastone to the perimeter surface water ditches. See Sheets 11 and 12 of the Engineering Plans.

B. <u>Function of System Components</u>

The function to be served by the topsoil is self evident. It will provide the medium for vegetative root establishment and nourishment. The vegetative cover which will be supported by the topsoil will be essential to minimize soil erosion. The general soils will provide protection for the deeper FML and will provide soil moisture storage for support of the vegetative cover. The geocomposite drainage blanket will serve to transmit water which has percolated through the general soil layer off the landfill cells into the surrounding surface drainage ditches. The FML will serve to interrupt downward percolating moisture so that the drainage blanket can transmit the moisture off the cell cover. The geosynthetic clay liner (GCL) beneath the FML will serve as a barrier layer to minimize percolation and serve as a compacted, stable bedding on which to place the FML. Lastly, the underlying fine-grained soil layer will provide a stable base for geosynthetics placement.

C. <u>Minimization of Percolation</u> (40 CFR 264.310(a)(1))

Percolation of precipitation into the landfill is minimized by three components of the proposed cover system. The general soil just beneath the topsoil will provide soil moisture storage for the vegetative cover. This general fill will therefore minimize the percolation of moisture into the drainage blanket beneath it. The FML which will lie beneath the drainage blanket will maximize runoff and serve to prevent the vertical migration of moisture which reaches the drainage blanket from above. Similarly, the geosynthetic clay liner will serve as an additional barrier to prevent the vertical migration of moisture. This system therefore combines the beneficial, low permeability aspects inherent in both the FML and the GCL.

Hence, the proposed cover system should provide for short and long term minimization of percolation. As will be discussed later, this conclusion is dependent upon proper installation and construction techniques, the establishment of the vegetative cover, and the diligent application of a long term inspection and maintenance program.

D. <u>Maintenance</u> (40 CFR 264.310 (a)(2))

The proposed system will require regular maintenance only insofar as the vegetative cover is concerned. Proposed maintenance of the vegetative cover will be performed to minimize the establishment of native, undesirable species such as deep rooted, woody plants. Other potential efforts might include occasional mowing, fertilization, or even reseeding if determined to be necessary as described below.

Maintenance efforts will generally be limited to careful, periodic inspections (condition surveys) and repair of any problems identified during these inspections. Proposed inspections will specifically be directed toward the identification of: invasion by undesirable plant species; deterioration of the vegetative cover; areas of surface erosion; soft, or unstable areas of the cover; damage to the dikes; obstructions, erosion or deterioration of the surface drainage ditches; obstructions or damage to the discharge pipes for the drainage layer; burrowing by animals; or surface disturbance due to unwarranted vehicle traffic.

Detection of problems such as those presented above will require remedial efforts. The proposed remedial efforts will be undertaken to bring the cover back to the original designed condition insofar as possible.

E. Drainage and Erosion (40 CFR 264.310(a)(3))

Generally uniform slopes are planned for the proposed cover system. These slopes will range from approximately 4 percent to 25 percent. Slopes should be no less than 3 percent in order to minimize the impact of surface irregularities. The use of FML beneath the general soil and topsoil will promote runoff. Control and discharge of any runoff through ditches is described elsewhere in the permit application of which this report is a part.

Establishment and maintenance of a vegetative cover will serve to minimize erosion due to both runoff and wind. It is proposed that this vegetative cover will consist of a hardy grass mixture which will require a minimum of effort to maintain in full, thick growth on the entire cover surface. Deep rooted woody plants will not be used and their future establishment will be discouraged through a long term inspection and maintenance program. As previously discussed, placement of topsoil for the establishment of the vegetative cover is planned.

The universal soil loss equation has been applied to the proposed cover system. The analysis is presented in Appendix A of the Engineering Report on Basis of Design, MCVI Design Modification, March 2001. The analysis resulted in an estimate of soil erosion due to rainfall runoff of less than 2 tons per acre per year.

F. <u>Cover Integrity During Settlement</u> (40 CFR 264.310 (a)(4))

A large portion of the fill settlement will occur before cell closure. Nevertheless, the analysis attached herein provides an estimate that the maximum post-closure settlement of the final cover should be approximately 8 to 15 feet. This settlement will be greatest beneath the highest portions of the cover surface. Hence, some surface slopes may be reduced to approximately 3%. The cover will be inspected during the condition surveys discussed above to detect areas where the uniform surface grade may be disrupted, possibly impending surface drainage. Such a condition will be corrected by placing additional compacted clay fill (after stripping the topsoil) on the cover to restore the original grade insofar as necessary to reestablish proper drainage. Subsequent replacement of the topsoil and revegetation in the affected area will be undertaken.

The proposed cover system will have much more capability to maintain integrity during fill settlement than covers consisting of only compacted soil. This is because FML materials can withstand extensive elongation or strain (up to 700%) in comparison with soil materials. Nevertheless, it is intended that local differential settlements will be minimized by compaction during waste placement and prevention of major voids within the fill. It is anticipated that recommendations by the FML manufacturer will be followed regarding the provisions for sufficient excess material (slack) during placement of the FML.

The proposed final cover system is expected to accommodate settling and subsidence in a manner such that cover integrity is maintained, as required by 40 CFR 264.310 (a)(4).

G. <u>Cover Permeability</u> (40 CFR 264.310 (a)(5))

The use of membrane for one component of the cover system, if constructed properly, effectively reduces the potential leakage through the cover to a negligible level. As stated previously, 40 CFR 264.310 (a) requires that the cover possess a permeability less than or equal to the permeability of the leachate containment system at the base of the landfill. Since a synthetic membrane is proposed for use in both cases, the permeability of each can be considered roughly equivalent, as suggested in 40 CFR 264 Preamble (47 FR 32314). Further, the effective "leakage" rate through any barrier is related to the hydraulic gradient. The drainage blanket above the cover membrane and the leachate collection system on the base liner should both effectively reduce hydraulic gradients through the membranes to a negligible level.

The use of a flexible, synthetic membrane as one component of the cover system, if manufactured and installed properly, should effectively reduce the potential leakage through the cover system to a negligible level. There is a scarcity of hydraulic conductivity data for synthetic membrane materials. Gas transmission rates (specifically water vapor transmission rates) through these membrane materials nevertheless suggest that such materials possess equivalent hydraulic conductivities 4 or more orders of magnitude less than that of compacted clay soils. Therefore, polymeric membranes can be expected to be the controlling factors in liner or covers system permeability. Regardless of their hydraulic conductivities relative to each other, the polymeric membranes should effectively reduce the direct transmission of fluid through the cover and liner systems to a negligible level. Because of the low conductivity in these membranes, the prevention of membrane defects during manufacturing and installation is of relatively greater concern than direct fluid transmission through the polymeric materials. Hence, the quality control/assurance measures to be taken on this project will concentrate upon minimizing these defects.

H. Freeze-Thaw Effects (R299.9619(5)(a)(ii))

With regard to the potential depth of seasonal frost penetration and its effects upon the final cover, the proposed cover is expected to function as designed to provide long-term minimization of percolation with a minimum of maintenance. The expected depth of frost penetration in the region where the subject facility is located may be approximately 25 to 42 inches. The synthetic membrane and GCL layers in the cover system are both below this depth. Hence, neither will be directly subjected to seasonal frost.

The principal frost-heave effect which frost penetration may have upon a near-surface soil layer is through the formation of ice lenses. These lenses are caused by the tendency for capillarity to draw available moisture to the freezing front. Hence, ice lenses usually form parallel to this freezing front, i.e., horizontally. The direct effects of these lenses are generally horizontal zones of soil separation or increased porosity.

In order for these ice lenses to form, however, three conditions are necessary. These are a supply of moisture, freezing temperatures and a frost susceptible soil. With regard to the former, the moisture supply must generally be below the freezing front because moisture above this front will either be frozen and unavailable for capillary attraction or will be present because of thawing, i.e. freezing temperatures will not be present to create ice lenses.

The proposed cover system is designed with the purpose of eliminating the underlying supply of moisture available for ice lens formulation, thereby eliminating one of the fundamental, necessary conditions described above. As presented, the drainage blanket below the general soil layer will have more than sufficient capacity to transmit percolation off the cell in question. In addition, the geomembrane will serve as an effective barrier to upward moisture migration from the underlying soil and/or waste. Hence, the freezing front in the proposed final cover will be denied the moisture necessary for ice lens formation.

The proposed final cover which is expected to function as designed according to the requirements of 40 CFR 265.310 (a) and provide long-term minimization of percolation with a minimum of maintenance.

VIII. <u>EQUIPMENT DECONTAMINATION</u> (40 CFR 264.112 (a)(4))

All equipment used during the closure activity to install the leveling layer cover soils or other equipment that is in contact with hazardous waste will be thoroughly cleaned before being allowed to leave the facility. The cleaning will be conducted at the facility vehicle wash building using pressurized water. All equipment will be washed until visibly clean.

All wash water will be handled consistent with current wastewater discharge permits or transported to an appropriate hazardous waste treatment facility.

IX. DISPOSAL OR DECONTAMINATION OF EQUIPMENT, STRUCTURES, SOILS (40 CFR 264.114)

A. Access Road

This closure plan is intended to assess the impact that site operations may have had on the soils adjacent to the on-site haul/access roads. This plan is written to address the access roads currently utilized for waste operations. Should new access routes open to accommodate changes in operations, provisions in this plan must be expanded to include the new roads. These areas are not expected to be areas of significant contamination, as waste is only transported, not actively handled, on the road. Impact to soils around the access road would be limited to those caused by fugitive dust, small spills, etc. Metals and/or PCBs are the primary potential contaminants of concern. The sampling and data evaluation described in this plan will either be performed by Wayne Disposal, Inc. Site #2 staff or by a consultant retained by Wayne Disposal, Inc. Site #2. Analyses will be conducted by a qualified contract laboratory.

The first step in the closure of the access roads will be to wash the pavement to remove soil and dust. The transport road from the North I-94 Service Drive, through the reception area and to the Northwest corner of Master Cell VI will be thoroughly washed and swept with a wet vacuum sweeper. These paved roads will remain intact for post-closure activity access. The second step will be to sample soils adjacent to the paved roads. The procedures used to sample, analyze and evaluate soil data are described below.

Sampling Locations - The sampling locations have been chosen to identify the chemical characteristics of the surface soils in the shoulders of the on-site haul/access roads. There is approximately 2000 feet of roadway from the entrance to the waste unloading area at the northeast corner of Master Cell VI. The total length of roadway will be divided in 10 segments of approximately 200 foot intervals. Out of each 200 foot segment, three soil samples will bè collected from the shoulder of the roadway. At least one sample will be collected from each side of the roadway in each segment. On the side where one sample is collected, the sample will be collected in the approximate mid-point of segment. On the side where two samples are collected, the segment will be divided in half with one sample collected in each half of the segment. The proposed approximate sampling locations are shown on Figure 1.

Sampling Method - The upper 6 inches of the soil surface will be sampled using a small stainless steel trowel or shovel. Large stones (greater than 1 inch in diameter) and vegetative matter will be removed by hand at the time of sampling. The shovel will be carefully cleaned between each sampling location with a mild detergent followed by a distilled water rinse. All soil samples will be individually placed in specially prepared glass containers. These containers will be obtained from the laboratory and will remain unopened until used in the field. Each container will be marked with the sample number, date, and time immediately after receiving its sample. Each sample will be temporarily stored in the field in an iced cooler until the sample can be placed into an on-site refrigerator. All collected samples will be stored in a secure location until transfer/transport to the laboratory. A Chain-of Custody form will be maintained for all samples obtained under the monitoring program. The form will, at a minimum, identify the sample number, sampling location, date, time, sampling individual, and amount/type of sample. A record of the sample handling and shipment, including the transfer of custody from one individual and organization to another, will also be maintained on the form. Signatures of each individual directly involved in the chain-of-custody will complete the form.

Sample Analysis - Each soil sample collected will be analyzed for the metals, Total PCB, volatile and semi-volatile organic parameters listed on Table 1. Analyses will be performed using the procedures outlined on Table 1. Target reporting limits are also listed on the table. If the laboratory is unable to meet the target detection limits, rationale must be provided to MDEQ. Results will be reported on a dry weight basis in units of mg/kg. The analyses will be conducted in accordance with standard laboratory QA/QC protocols.

Data Evaluation - The volatile, semi-volatile organics and metals data from each of the samples will be compared to the Part 201 Generic Cleanup Criteria (GCC) to determine if any standard has been exceeded. Data will be compared with residential or commercial & industrial risk-based clean-up standards or whatever standards are in use at the time of closure depending on which standards are appropriate for the future land use at the facility. If the applicable Part 201GCC standard is exceeded for any metal, WDI can, at its discretion, demonstrate that the concentration is within the normal background concentration for soils at the site. If WDI elects to make this demonstration, a plan will be submitted to MDEQ that outlines the strategy for collecting and analyzing native background samples and for establishing a statistically valid range for background concentrations. If the concentrations are found to be within native background ranges, then no corrective action will be required. PCB analysis results will be compared to a non-detect standard and will be remediated to meet that standard at the time of landfill closure.

If the applicable standards for Volatile and semi-volatile compounds are exceeded and a site-specific background demonstration is either not successful or not possible, WDI will submit a plan to mitigate the contaminated area to MDEQ. The plan shall include a description of the apparent extent of the problem, a proposed remedy, and methods for demonstrating clean closure.

TABLE 1. SOIL MONITORING PARAMETERS

Parameter	Analytical Method	MDEQ Target Detection Limit (mg/kg)
Metals		
Arsenic	7061	0.5
Antimony	7041	N.A.
Barium	6010/6020	1.0
Cadmium	6010/6020	0.5
Cobalt	6010/6020	5.0
Chromium(total)	6010/6020	2.0
Copper	6010/6020	1.0
Iron	6010/6020	2.5
Lead	6010/6020	1.0
Mercury	7470	0.1
Molybdenum	6010/6020	5.0
Nickel	6010/6020	5.0
Selenium	7741	0.5
Silver	6010/6020	0.25
Thallium	6010/6020	N.A.
Vanadium	6010/6020	1.0
Zinc	6010/6020	1.0

Volatile Organic Parameters (analyzed by method 8260)

Parameter	TMDL	Parameter	TMDL
Acteone	0.05	1,2-Dichloropropane	0.005
Bromodichloromethane	0.005	1,3-Dichloropropane	N.A.
Bromoform	0.005	1,1,2,2-Tetrachloroethane	0.005
Carbon Tetrachloride	0.005	Tetrachloroethane	N.A.
Chlorobenzene	0.005	Tetrachloroethene	0.005
2-Chloroethylvinyl Ether	N.A.	1,1,2-Trichloroethane	0.005
Chloroform	0.005	1,1,1-Trichloroethane	0.005
Chloromethane	0.010	Trichloroethene	0.005
Dibromodifluoromethane	N.A.	Trichlorofluoromethane	0.010
1,2 Dichlorobenzene	0.005	Vinyl Chloride	0.010
1,3 Dichlorobenzene	0.005	Methylene Chloride	0.010
1,4 Dichlorobenzene	0.005	Methyl Ethyl Ketone	0.010
Dichlorodifluoromethane	0.010	Benzene	0.005
1,1-Dichloroethane	0.005	Ethylbenzene	0.005
1,2-Dichloroethane	0.005	Toluene	0.005
1,1-Dichloroethene	0.005	Xylenes	0.010
1,2-Dichloroethene	0.005		

Parameter	Analytical Method	MDEQ Target Detection Limit (mg/kg)
Total PCBs	8082	0.5

Semi-Volatile Organic Compounds (analyzed by method 8270)

Parameter	TMDL	Parameter	TMDL
Acenapthene	0.100	Hexachlorobenzene	0.100
Acenapthylene	0.100	Hexachlorobutadiene	0.200
Anthracene	0.100	Hexachlorocyclopentadiene	0.200
Benzidene	N.A.	Hexachloroethane	0.100
Benzo(a)anthracene	0.100	Indeno (1,2,3-cd) pyrene	0.500
Benzo(b)fluoranthene	0.200	Isophorone	0.100
Benzo(k)fluoranthene	0.200	2-Methylnapthalene	N.A.
Benzo(ghi)perylene	0.500	Napthalene	0.100
Benzoic Acid	N.A.	2-Nitroaniline	N.A.
Benzo(a)pyrene	0.200	3-Nitroaniline	N.A.
Benzyl alcohol	N.A.	4-Nitroaniline	N.A.
Bis (2-chloroethoxy) methane	0.200	Nitrobenzene	0.200
Bis (2-chloroethyl) ether	0.100	N-Nitrosodiphenylamine	0.500
Bis (2)chloroisopropyl) ether	0.100	N-Nitroso-di-n-propylamine	0.200
Bis (2-ethylhexyl) phthalate	0.200	Phenanathrene	0.100
4-Bromo phenyl ether	0.200	Pyrene	0.100
Butyl benzyl phthalate	0.100	1,2,4-Trichlorobenzene	0.200
4-Chloroaniline	N.A.	4-Chloro-3-methylphenol	N.A.
2-chloronapthene	0.200	2-Chlorophenol	N.A.
4-Chlorophenyl phenyl ether	0.100	2,4-Dichlorophenol	N.A.
Chrysene	0.100	2,4-Dimethylphenol	N.A.
Dibenz (a,h) anthracene	0.500	4,6-Dinitro-2-methylphenol	N.A.
Dibenzofuran	N.A.	2,4-Dinitrophenol	N.A.
Di-n-butyl phthalate	0.100	2-Methylphenol	N.A.
1,2-Dichlorobenzene	0.100	4-Methylphenol	N.A.
1,3-Dichlorobenzene	0.100	2-Nitrophenol	N.A.
1,4-Dichlorobenzene	0.100	4-Nitrophenol	N.A.
3,3'-Dichlorobenzene	N.A.	Pentachlorophenol	N.A.
Diethyl pthalate	0.100	Phenol	N.A.
Dimethyl pthalate	0.200	2,4,5-Trichlorophenol	N.A.
2,4-Dinitrotoluene	0.500	2,4,6-Trichlorophenol	N.A.
2,6-Dinitrotoluene	0.500		
Di-n-octyl phthalate	0.200		
Fluoranthene	0.100		
Fluorene	0.100		

Note: MDEQ target detection limits may not be attainable. At the time of closure; the analytical methods listed above, the detection limits, and provisions to use alternate detection limits must be negotiated with MDEQ based upon regulatory criteria in place at the time of closure. (N.A.) indicates no MDEQ target MDL for soils is available at this time.

B. <u>Vehicle Wheel Wash</u>

In the event that Michigan Disposal Waste Treatment Plant ceases operations at the same time or prior to final closure of the Wayne Disposal, Inc. Site #2, the wheel wash building will be spray washed until visibly clean. Wash water will be handled as stated in Section VIII above. Solids retained in the holding tank will be buried in the landfill. The structure and the cleaned equipment would remain on site pending a determination on its disposition.

After the wheel wash building has been spray washed until visibly clean, the building's holding tank and floor will be inspected at closure for cracks and other signs of deterioration. If there are visible impacts to the holding tank and/or floor that could potentially breach the containment of the building, then soil sampling shall be conducted. Soil sampling should be performed in accordance with current MDEQ guidance at the time of closure for VOCs, SVOCs, PCBs and metals similar to that provided in the discussion in Section IX.A of this closure plan. Field QA/QC procedures for these sample activities will be in accordance with the Soil Monitoring SAP previously approved by the MDEQ.

If Michigan Disposal Waste Treatment Plant continues hazardous waste activities after closure of the Wayne Disposal, Inc. Site #2 operation, cleaning of the wheel wash building and disposal of cleaning residues will be the responsibility of Michigan Disposal Waste Treatment Plant.

C. Lined Pond

In the event that Michigan Disposal Waste Treatment Plant ceases operations at the same time or prior to final closure of the Wayne Disposal, Inc. Site #2, the lined pond will be spray washed until visibly clean. Wash water will be handled as stated in Section VIII above. Solids retained in the lined pond will be buried in the landfill.

After the lined pond has been spray washed until visibly clean, the geosynthetic liner will be inspected for rips, tears, holes and other signs of deterioration. If there are visible impacts to the geosynthetics liner that could potentially breach the containment of the lined pond, then soil sampling shall be conducted. Soil sampling should be performed in accordance with current MDEQ guidance at the time of closure for VOCs, SVOCs, PCBs and metals similar to that provided in the discussion in Section IX.A of this closure plan

If Michigan Disposal Waste Treatment Plant continues hazardous waste activities after closure of the Wayne Disposal, Inc. Site #2 operation, cleaning of the lined pond and disposal of cleaning residues will be the responsibility of Michigan Disposal Waste Treatment Plant.

D. Area A Soils

At the time of closure, WDI will make a final assessment of the level of metals and PCBs in the soil within Area A. Also, ten percent (10%) of the soil samples analyzed for the Area A characterization will be analyzed for the same expanded parameter list as along the roadway (metals, PCBs, VOCs, and SVOCs). Area A is a section of WDI defined in the WDI Soil and Sediment Sampling and Analysis Plan approved by the Waste and Hazardous Materials Division of the Michigan Department of Environmental Quality (WHMD/MDEQ). Area A includes, among other areas, the shoulder of the haul road leading to the WDI transfer station, and sediment in the on-site surface water ditches and storm sewers. The purpose of this final assessment is to determine if there are areas where analytical concentrations exceed applicable cleanup criteria. The cleanup criteria will be non-detect concentrations, or statutory equivalent at the time of closure.

The sample location plan will be prepared in accordance with the relevant guidance at the time of closure and in consideration of historical soil monitoring data collected in accordance with the Soil and Sediment Sampling and Analysis Plan, which may provide data from which to develop a biased sampling strategy.

On-site areas exceeding applicable cleanup criteria will be remediated by removing the top six inches of soil and disposing of the soil on site in a licensed landfill before the final cell is closed. After removal, the area will be sampled again to ensure applicable cleanup criteria are no longer exceeded. If analytical concentrations are found that exceed applicable cleanup criteria, another six inches will be removed and so on until analytical concentrations are verified below the applicable cleanup criteria. Then, clean soils will replace the soil that was removed and the clean backfill revegetated.

The following assumptions were made in preparing the cost estimate for sampling, analysis and remediation:

1. At the time of closure Area A will be 141 acres including the shoulder of the haul road leading to the WDI transfer station.
2. A biased sampling program will be developed resulting in an estimated 150 samples.
3. Assessment and Verification samples for Area A will be analyzed for PCBs and metals, with ten percent (10%) also being analyzed for VOCs and SVOCs.

   Remediation of Area A will consist of excavating one acre, six inches deep, 807 bank cubic yards – about 1,290 tons.

E. Waste Transfer Box Decommission

This closure plan is intended to assess the impact that site operations may have had on the soils adjacent to the on-site waste transfer box. This plan is written to address the waste transfer box utilized for waste operations in a position outside the limits of the hazardous waste landfill boundary. Should alternate waste transfer box positions open to accommodate changes in operations, provisions in this plan must be expanded to include the new positions. Impact to soils around the waste transfer box positions would be limited to those caused by fugitive dust, small spills, etc. Metals, VOCs, SVOCs, and PCBs are the primary potential contaminants of concern. The sampling and data evaluation described in this plan will either be performed by Wayne Disposal, Inc. Site #2 staff or by a consultant retained by Wayne Disposal, Inc. Site #2. Analyses will be conducted by a qualified contract laboratory.

The first step in the closure of the waste transfer box will be demolition of the steel clad concrete walls and concrete floor of the receiving slab, and the demolition and removal of the tipping slab/access ramp. The soils, aggregate, and geosynthetics installed as part of the secondary containment structures for the receiving slab and access corridor between the waste transfer box and the landfill would be removed and disposed as part of the decommissioning of the waste transfer box. The secondary containment structure material will be cleaned of any visible liquids and the materials will be separated from the leachate collection system of Master Cell 6B at the anchor trench tie-in point. The remaining access pavement will be washed in a manner consistent with the wheel wash activities to remove soil and dust. The paved roads will remain intact for post-closure activity access. All demolition materials will be transported to the final active area of the hazardous waste landfill for disposal immediately prior to the landfill's final closure activities.

The second step will be to sample soils immediately adjacent to the paved surface and at a single point below the geomembrane of the secondary containment system. The procedures used to sample, analyze and evaluate soil data are described below and are similar in nature to the above referenced process for the paved roadway surfaces.

Sampling Locations - The sampling locations have been chosen to identify the chemical characteristics of the surface soils in the immediate vicinity of the waste transfer box. There is approximately 20,000 square feet of roadway from the tipping slab ramp to the actual waste transfer and unloading area. The proposed sampling locations would be along the east side of the tipping slab ramp at a point halfway between the roadway grade break to the actual push wall of the waste transfer box and just off the pavement. A second sample would be collected from the soils beneath the receiving slab of the waste transfer box after removal of the secondary containment geomembrane. The sample location will be beneath the collection sump and any additional samples would be collected, as necessary, wherever a potential crack or other breach was identified by inspection of the containment structures (floor and walls). These samples would only require collection and analysis if contaminated liquids were detected within the receiving slab secondary monitoring sump during the useful life of the structure.

Sampling Method - The upper 6 inches of the soil surface will be sampled using a small stainless steel trowel or shovel. Large stones (greater than 1 inch in diameter) and vegetative matter will be removed by hand at the time of sampling. The shovel will be carefully cleaned between each sampling location with a mild detergent followed by a distilled water rinse. All soil samples will be individually placed in specially prepared glass containers. These containers will be obtained from the laboratory and will remain unopened until used in the field. Each container will be marked with the sample number, date, and time immediately after receiving its sample. Each sample will be temporarily stored in the field in an iced cooler until the sample can be placed into an on-site refrigerator. All collected samples will be stored in a secure location until transfer/transport to the laboratory. A Chain-of Custody form will be maintained for all samples obtained under the monitoring program. The form will, at a minimum, identify the sample number, sampling location, date, time, sampling individual, and amount/type of sample. A record of the sample handling and shipment, including the transfer of custody from one individual and organization to another, will also be maintained on the form. Signatures of each individual directly involved in the chain-of-custody will complete the form. Field QA/QC procedures for these sample activities will be in accordance with the Soil Monitoring SAP previously approved by the MDEQ.

Sample Analysis - Each soil sample collected will be analyzed for the metals, the Total PCB, volatile and semi-volatile organic parameters listed on Table 1. Analyses will be performed using the procedures outlined on Table 1. Target reporting limits are also listed on the table. If the laboratory is unable to meet the target detection limits, rationale must be provided to MDEQ. Results will be reported on a dry weight basis in units of mg/kg. The analyses will be conducted in accordance with standard laboratory QA/QC protocols.

Data Evaluation - The volatile, semi-volatile organics and metals data from each of the samples will be compared to the Part 201 Generic Cleanup Criteria (GCC) to determine if any standard has been exceeded. Data will be compared with residential or commercial & industrial risk-based clean-up standards or whatever standards are in use at the time of closure depending on which standards are appropriate for the future land use at the facility. If the applicable Part 201GCC standard is exceeded for any metal, WDI can, at its discretion, demonstrate that the concentration is within the normal background concentration for soils at the site. If WDI elects to make this demonstration, a plan will be submitted to MDEQ that outlines the strategy for collecting and analyzing native background samples and for establishing a statistically valid range for background concentrations. If the concentrations are found to be within native background ranges, then no corrective action will be required. PCB analysis results will be compared to a non-detect standard and will be remediated to meet that standard at the time of landfill closure.

If the applicable standards for Volatile and semi-volatile compounds are exceeded and a site-specific background demonstration is either not successful or not possible, WDI will submit a plan to mitigate the contaminated area to MDEQ. The plan shall include a description of the apparent extent of the problem, a proposed remedy, and methods for demonstrating clean closure.

X. <u>MAXIMUM INVENTORY OF WASTES</u> (40 CFR 264 112(b)(3))

Waste is not stockpiled at the facility for future disposal. Waste is brought to the facility only after construction of the cell in which it is to be disposed is completed. No storage or treatment occurs at the facility.

The total volume of waste that will be placed in the cells will vary according to the size of the cells. All wastes placed in the landfill are recorded in the operating log.

XI. GROUNDWATER MONITORING, RUN-OFF CONTROL (40 CFR 264.112(b)(5))

1. Groundwater monitoring, in accordance with the permit, outlined for the active facility life will be continued through partial and final closure activities.

2. Leachate collection systems will be monitored and maintained as required during the active life of the facility, including the closure period.

3. Control of run-on and run-off will be monitored and maintained as required during the active life of the facility, including the closure period.

XII. GAS VENTING SYSTEM (R299.9619(3)(c))

The gas venting system is designed to prevent the accumulation of gas generated in closed cells. Details of the gas venting system are shown on Sheet 10 of the Engineering Plans for Design Modification, November 2002. These details show that the installation does not effect the permeability of the final cover system. Gases, if generated, can be collected and discharged through this system. If required under Part 111, gas emissions will be monitored, collected and treated.

XIII. ESTIMATED DATES OF CLOSURE ACTIVITY (40 CFR 264.112 (b)(7))

H.W. Unit	Type of Closure	Anticipated Closure Date
MC V	Partial	Closed
MC VII	Partial	Closed

*Closure schedule may change depending on usage rate.

XIV. ANTICIPATED FINAL/PARTIAL CLOSURE SCHEDULE (40 CFR 264.112(b)(6))

Activity	Time Required
1. Receive of Final Volume of Hazardous Waste	N/A
2. Decontaminate Haul Road, Area A, and demolition of the Waste Transfer Box	45 Days
3. Survey Benchmarks	Concurrent with #2 above
4. Construct Intermediate Cover	30 Days
5. Install Gas Vent System	Concurrent with #4 above
6. Decontamination of Equipment	5 Days
7. Construct Leveling Layer and Install GCL	108 Days
8. Install FML	54 Days
9. Construct Drainage Layer	54 Days
10. Construct General Soils Layer	54 Days
11. Place Top Soil	54 Days
12. Apply Vegetative Cover	27 Days
13. Complete Fence-Barrier around Perimeter of Hazardous Waste Management Area	27 Days
14. Complete and Submit Closure Certification	108 Days
TOTAL TIME	**566 Days**

XV. EXTENSION FOR CLOSURE TIME (40 CFR 264.113 (b))

It is anticipated that partial/final closure activities will exceed 180 days due to the substantial size of Master Cell VI and the uncertainty of the seasonal date when the final volumes of hazardous waste are received and the impact of that date on the sequencing of construction related closure activities. Therefore, the closure schedule assumes less than ideal conditions (see Section XIII). We therefore request an extension of the 180-day closure period. Steps necessary to prevent threats to human health and the environment from the unclosed but terminated hazardous waste management unit, including compliance with all applicable permit requirements, will be taken.

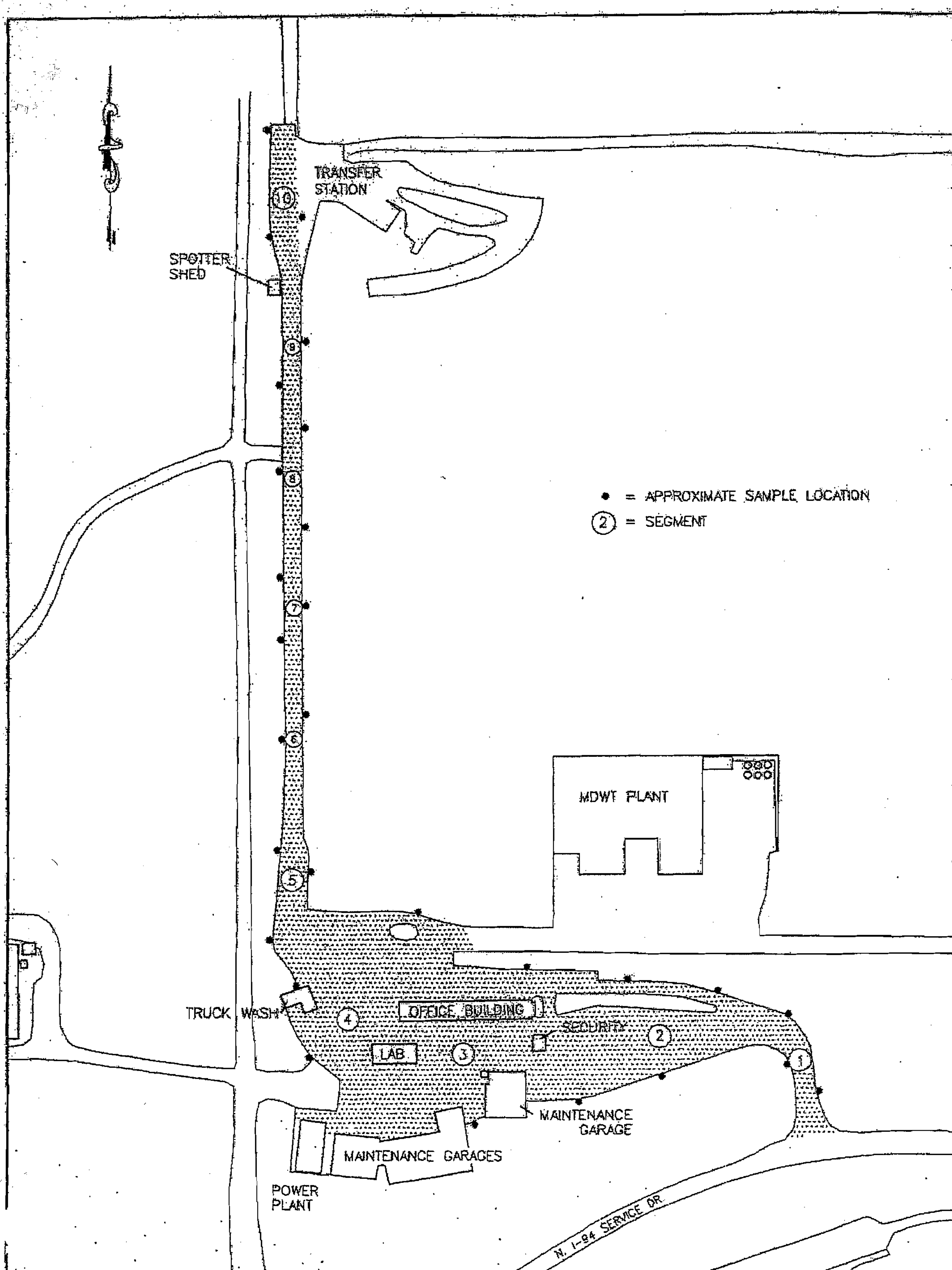
XVI. <u>CERTIFICATION OF CLOSURE</u> (40 CFR 264.115)

Within 60 days of the completion of final closure, certification will be submitted to the MDEQ Director by Wayne Disposal, Inc. Site #2 and an independent registered professional engineer that closure was completed in accordance with the specifications of this plan and Part 111 Rule 613 (3) and (4).

XVII. <u>CLOSURE COST ESTIMATE</u> (40 CFR 264.142, 264.112 (b)(2))

The closure cost estimate and associated information as presented is submitted in accordance with the requirements of 40 CFR 220.14 (b)(15), 264.142 and 264.143. These costs have been previously submitted and are updated each year using the Gross Nation Product (GNP) inflation factor and are presented in Section 39 "Financial Mechanism".

As identified in Section XIV, partial closure of Master Cell V and Master Cell VII is complete and final closure of Master Cell VI is expected in June 2015. Therefore the closure cost estimate includes the closure cost of MC VI, comprising 60.4 acres, and the final facility closure costs; i.e., haul road decontamination, Area A soil remediation, decommissioning of the Waste Transfer Box, and completion of hazardous boundary fencing, etc.



THE ENVIRONMENTAL QUALITY COMPANY	LOCATION: WAYNE DISPOSAL SITE NO. 2		TITLE: CLOSURE PLAN FIGURE 1
	SCALE: 1" = 200'.	DATE: 1/31/96 by J.C.D.	FILENAME: WDITSCA1

ORIGINAL

Attachment 6

Post Closure Plan

POST-CLOSURE PLAN

40 CFR 264.117(a)(1), 40 CFR 270.14(b)(13)

PART 111, R504(1)c

POST-CLOSURE PLAN

40 CFR 264.117(a)(1), 40 CFR 270.14(b)(13)
PART 111, R504(1)c

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SECTION | PAGE

POST-CLOSURE PLAN

40 CFR 264.117, 40 CFR 270.14(b)(13), PART 111, R504(1)c

1.0 GENERAL INFORMATION

This Post-closure Plan is prepared pursuant to requirements under 40 CFR Part 264.117 and 40 CFR 270.14(b)(13). This plan addresses those activities necessary for the proper management of the facility during the 30-year post-closure period (40 CFR Part 264.117(a)(1)]. Should the post closure plan need to be revised, an amendment to the plan shall be requested according to the provisions of 40 CFR 264.118(d).

The primary areas of responsibility include monitoring, inspection, and maintenance activities and their frequencies. During post-closure, damaged or malfunctioning equipment or structures will be repaired or replaced as necessary to maintain the facility in proper condition.

Included in this Permit Application is the post-closure cost estimate, which details the expenses associated with the management and execution of the post-closure plan. In accordance with 40 CFR part 264.118(b)(3), the person to contact regarding Wayne Disposal Site #2 Landfill during the post-closure care period is:

David Lusk
Wayne Disposal, Inc.
Phone:(734) 329-8000
36255 Michigan Avenue
Wayne, MI 48184

In accordance with 40 CFR Part 264.120, no later than 60 days after the completion of the 30-year post-closure care period, Wayne Disposal Site #2 Landfill will submit to the MDEQ, by registered mail, a certification that the post-closure care activities were performed in accordance with this plan.

In accordance with 40 CFR Part 264.119(a), no later than 60 days after the certification of closure of each hazardous waste cell, WDI will submit to the MDEQ and Van Buren Township a record of the type, location, and quantity of hazardous waste disposed of within each cell.

2.0 INSPECTION ACTIVITIES AND FREQUENCIES

The post-closure inspections will be conducted using a grid system across the entire surface (final cover) of the landfill in order to discretize the area into specific regions. The approach will be conducted such that each master cell will be inspected and recorded on the Post Closure Inspection Checklist individually. The quarterly (1st & 3rd quarter) and the semi-annual (2nd quarter) inspections will be conducted on a quadrant grid system for each master cell. The annual inspection will be conducted on a 200 foot grid system (see attached Post-closure Inspection Grid Plan). Please refer to the attached Post-closure Inspection Report following this document for further information and inspection frequencies. When an identified problem is documented on the Post-Closure Inspection Report it shall be listed on the Maintenance Log Form. The purpose of this Maintenance Log Form is to track the items through completion of the repairs and to allow for a historical evaluation of any recurring items and locations.

The clay dikes and the perimeter dewatering tile system will be inspected for any surface evidence of deterioration or damage during each of the quarterly (1st and 3rd quarters), the semi-annual (2nd quarter), and the annual inspections. The two discharge points for the dewatering system will also be observed during each of these inspections to confirm that free-flowing conditions exist at the outlets. During each annual inspection, the manholes along the dewatering tile will be opened and the interiors inspected from the ground surface for evidence of deterioration, damage or tile blockage.

3.0 MAINTENANCE ACTIVITIES

In accordance with 40 CFR Part 264.118(b)(2) and 40 CFR Part 265.310(b), the following maintenance activities have been identified.

Security System

Signs will be replaced as they become illegible or if lost due to vandalism. In the event of fence or gate damage, those sections affecting site security will be repaired or replaced immediately.

Final Cover System

Periodic inspections are performed (refer to Subsection 2 of this Plan) to determine if and when additional maintenance is needed. Inspections of the final cover are specifically directed toward the identification of the following:

- Invasion of undesirable plant species
- Deterioration of vegetative cover
- Areas of surface erosion

- Soft or unstable areas of the cover
- Damage to the dikes
- Obstructions, erosion, or deterioration of the surface water drainage ditches
- Obstructions or damage to the discharge pipes for the drainage layer
- Burrowing by animals
- Surface disturbance due to unwarranted vehicle traffic

Detection of problems such as those presented above requires remedial efforts. The remedial efforts, including fertilizing and reseeding, are undertaken to bring the cover back to the original designed condition, as necessary. Documentation of these inspections is provided as shown in the Post-Closure Inspection Form following this document.

Erosion washouts will be repaired as soon as possible after detection. When cap integrity is in question, repair activities will begin immediately. Restoration of the vegetative cover will be performed during or at the end of the growing season.

In the event of localized subsidence that results in the ponding of surface water, repairs will involve building up the subsided area with soil to provide adequate surface water run-off. Based upon recommendations by the MDEQ; areas of localized subsidence must be evaluated prior to automatic application of surface soils to restore surface drainage. For relatively small areas of localized subsidence (i.e. no greater than 50 feet laterally and/or no greater than 12 inches vertically) soils may be added without notification to the MDEQ. However, larger areas must be evaluated and/or investigated, and shall require submittal of a Work Plan for WHMD approval prior to initiation of maintenance activities.

The vegetative cover is mowed to promote vegetative growth and surface water drainage, and to help improve the site's aesthetics. Vegetative cover that is lost or destroyed due to weathering is replaced in order to control erosion.

The maintenance of the vegetative cover also includes the elimination of undesirable trees or brush growth over the capped areas when apparent. Burrowing animals will be removed or exterminated immediately after being identified. In accordance with 40 CFR Part 264.310(a)(2), the Wayne Disposal Site #2 Landfill final cover functions with a minimum of maintenance.

Clay Dikes & Perimeter Dewatering Tile System

Periodic inspections of the clay dikes and the alignment of the perimeter dewatering tile systems are specifically directed toward the identification of the following:

- Deterioration of vegetative cover over the dikes
- Invasion of the dikes by deep-rooted, woody vegetation species
- Areas of dike surface erosion
- Soft or unstable conditions on dikes or along the tile system alignment
- Disturbance or damage to dikes or tile system manholes
- Blockage of the dewatering tile system outlets
- Excess fluid levels or non-flowing conditions in the dewatering tile system manholes

Vegetative deterioration or surface erosion on the clay dikes will be restored as soon as possible after detection. Vegetation restoration will be performed during or at the end of the growing season. When dike integrity is in question, repair activities will begin immediately.

Blockage at either outlet of the dewatering tile system will be cleared immediately after detection. Damage or disturbance of the concrete manholes on the dewatering tile system will be repaired as soon as possible after detection. Fluid levels in the concrete manholes which indicate partial or full blockage of the dewatering tile system will require jetting or cleaning of the blocked portion of the system as soon as possible after detection. Any surface evidence of collapse in the dewatering tile system will require investigation by sewer camera, open excavation, or other means. If partial or complete collapse has occurred, the affected portion of the system will be repaired and/or replaced as soon as possible after detection.

Leachate Collection System

The primary anticipated maintenance concerns will be pump operations. Should damage or failure occur to this system, repair or replacement of the defective equipment will be performed promptly.

The leachate collection piping will also be maintained by jetting or cleaning out the pipes interior as necessary.

Leak Detection, Collection, and Removal System

The primary anticipated maintenance concerns will be pump operations. Should damage or failure occur to this system, repair or replacement of the defective equipment will be performed promptly. Damaged surface pipes will also be repaired.

Drainage Structures

Ditches that have been damaged due to erosion will be properly repaired. Sediment buildup will be removed where necessary to allow free gravity drainage to the sedimentation basin. Removal of sediment buildup in the sedimentation basins will also be performed as needed to maintain adequate capacity for design flow conditions. The edge drain system may require occasional maintenance via sump clean-out & power-jetting to assure flow & reduce the hydraulic head against perimeter dikes to less than 5 feet of head.

Gas Venting System

Damaged gas venting risers will be repaired or replaced promptly after notification of needed repair. Dislodged gas venting risers will be reset.

Monitoring Wells

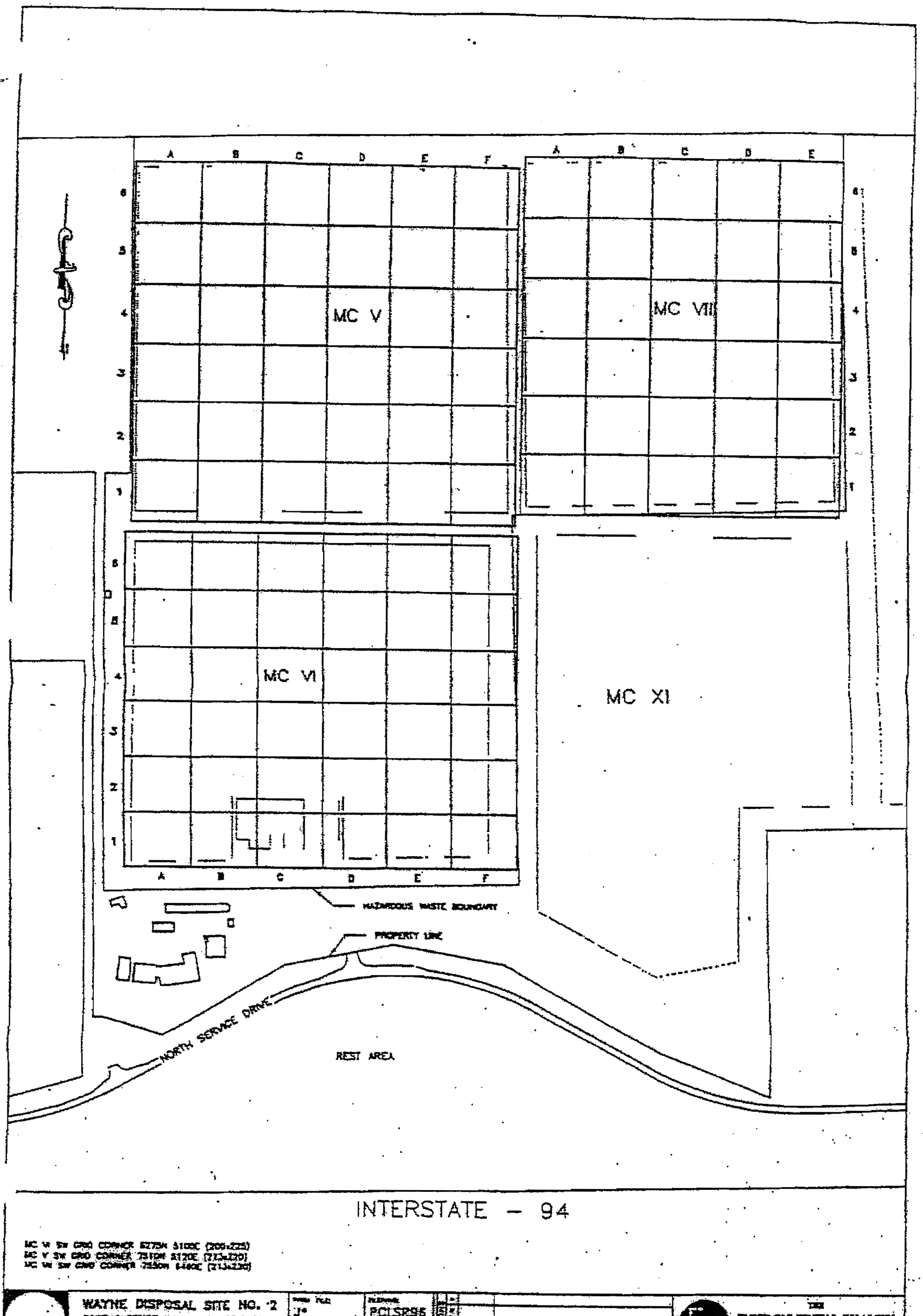
The primary anticipated maintenance concerns will be pump operation, security, and casing integrity. Should damage occur to the pumps, they will be repaired or replaced promptly. If damage is done to the locking system or the well casing, it will also be repaired.

Benchmarks

Should the benchmarks be removed or dislodged entirely, they will be reset or re-established at the original location and elevation.

4.0 MONITORING ACTIVITIES

In accordance with 40 CFR Part 264.310(b)(2). during the post-closure care period, the leachate collection and removal system will continue to be operated until leachate is no longer detected. In accordance with 40 CFR Part 264.310(b)(3), the groundwater monitoring system will be maintained and monitored throughout the post-closure period. The leak detection systems will also be maintained and monitored throughout the post-closure period. Refer to the environmental monitoring sections contained within this Permit Application for additional information regarding monitoring.



MC V
MC VII
MC VI
MC XI
A B C D E F
HAZARDOUS WASTE BOUNDARY
PROPERTY LINE
NORTH SERVICE DRIVE
REST AREA
INTERSTATE — 94
WAYNE DISPOSAL SITE NO. 2
PCLSR95

Attachment 7

Engineering Plans

WAYNE DISPOSAL, INC. SITE NO. 2
MASTER CELL VI-F&G

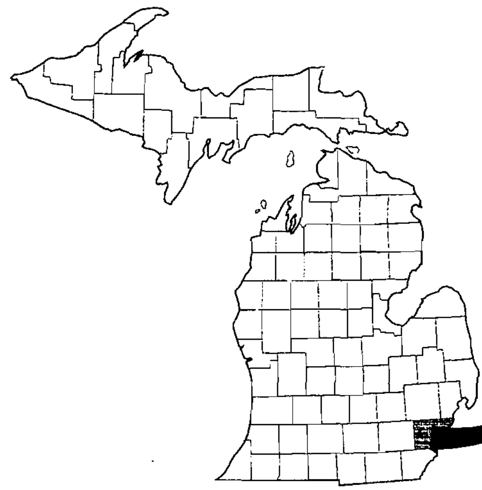
VAN BUREN TOWNSHIP, WAYNE COUNTY, MICHIGAN

NTH PROJECT NO. 13-060921-03

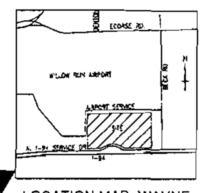
FEBRUARY 2011
REVISED: SEPTEMBER 2011

OWNER:
Wayne Disposal, Inc.
49350 N. I-94 Service Drive
Belleville, Michigan 48111

ENGINEER:
NTH Consultants, LTD.
41780 Six Mile Road
Northville, Michigan 48168



MICHIGAN
APPROX. SCALE: 1"=50 MILES



LOCATION MAP- WAYNE COUNTY
NO SCALE

SHEET INDEX

NTH Consultants, L
Infrastructure Engineering an
Environmental Services

Northville, MI	248.553.(
Detroit, MI	313.237.3
Lansing, MI	517.484.(
Grand Rapids, MI	616.957.3
Exton, PA	610.524.2
Lehigh Valley, PA	484.893.7
Cleveland, OH	216.334.4
Indianapolis, IN	317.735.3

REVISIONS

REV	DESCRIPTION	DATE
A	[illegible]	[illegible]
B	[illegible]	[illegible]

PROJECT NAME:
MASTER CELL VI F&G

PROJECT LOCATION:
WAYNE DISPOSAL, INC
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO.: 13-060921-03	CAD FILE NAME: 13060921-(
DESIGNED BY: JHL	INCEP DATE: 11/12/08
DRAWN BY: ORL	DRAWING SCALE: NONE
CHECKED BY: ISS	SUBMITTED DATE: 9/23/11

SHEET TITLE:
TITLE SHEET

SHEET REFERENCE NUMBER:
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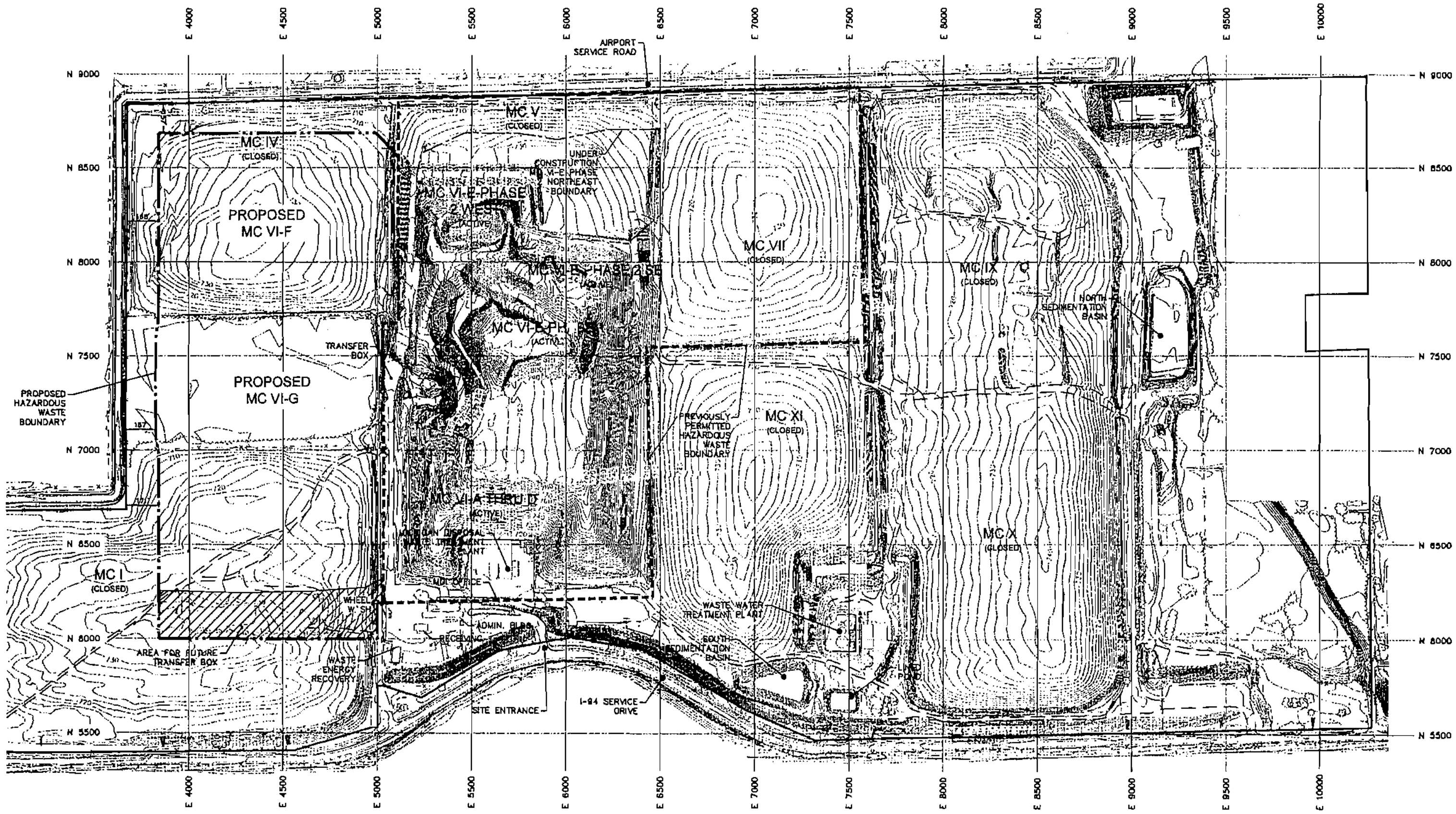
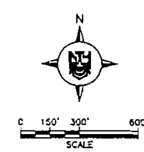


NOTE:

THE BASE MAP WAS CREATED USING AN AERIAL SURVEY TAKEN IN 2001 BY AIR-LAND SURVEY AND PROVIDED BY WDI, A SURVEY BY MCLLC IN OCTOBER 2007, AND A GROUND SURVEY BY WDI IN OCTOBER 2008.



LEGEND

······	EXISTING CONTOUR (2 FT INTERVAL)
▬ ▬ ▬ ▬	PREVIOUSLY PERMITTED HAZARDOUS WASTE BOUNDARY
= = = =	EXISTING SITE ROAD
———	PROPERTY BOUNDARY
—— • • ——	PROPOSED HAZARDOUS WASTE BOUNDARY

NTH Consultants, I

Infrastructure Engineering
Environmental Services

Northville, MI	248 55
Detroit, MI	313.23
Lansing, MI	517 48
Grand Rapids, MI	616 95
Exton, PA	610 52
Lehigh Valley, PA	484 89
Cleveland, OH	216 33
Indianapolis, IN	317.73

REVISIONS

REV	DESCRIPTION	DA

PROJECT NAME

MASTER CELL VI F&G

PROJECT LOCATION

WAYNE DISPOSAL, IN
SITE NO. 2
BELLEVILLE, MICHIGA

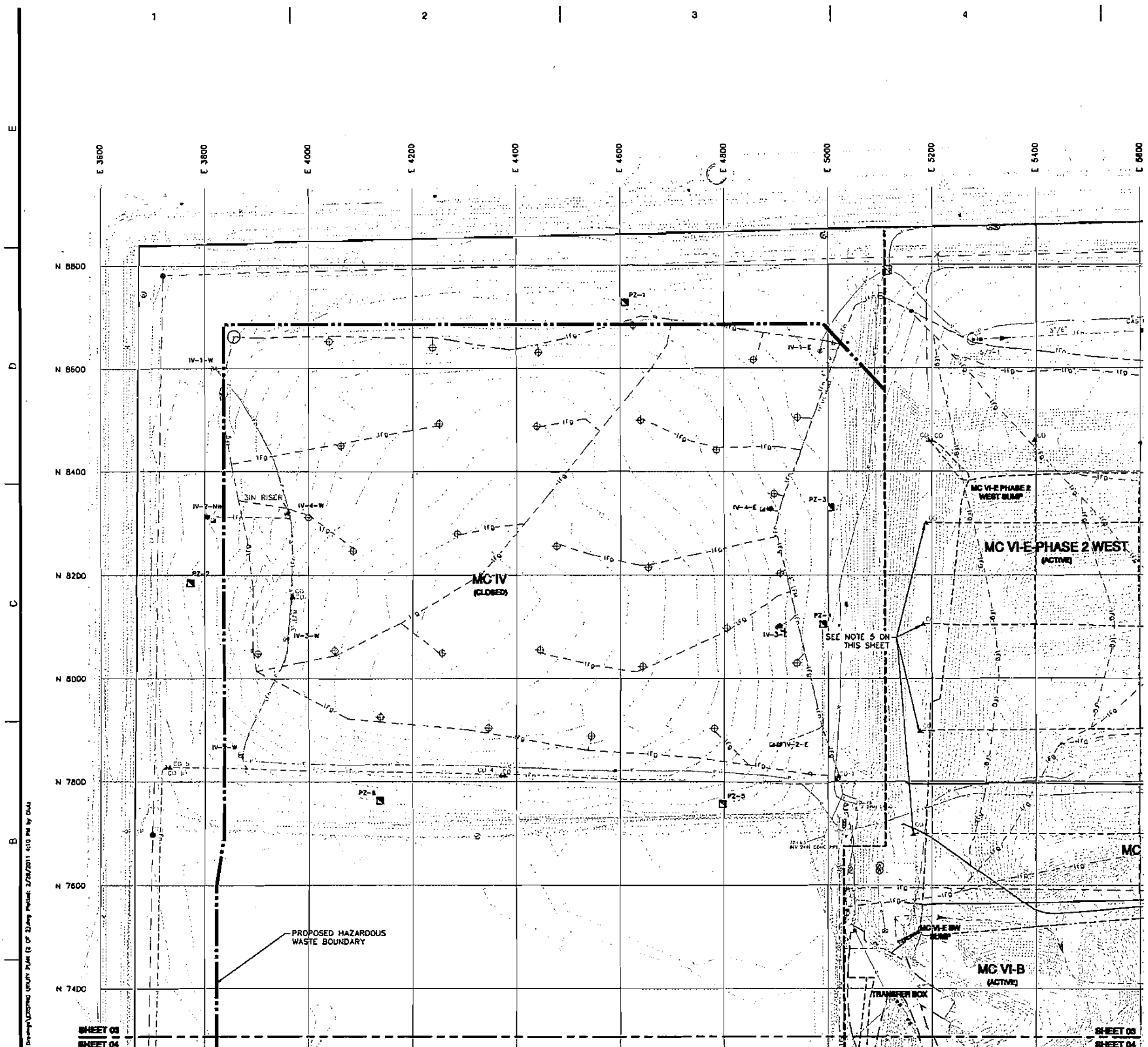
NTH PROJECT NO.: 13-080921-03	CAD FILE NA GENERAL
DESIGNED BY: JHL	INCEP DATE 11/12/08
DRAWN BY: ORL	DRAWING AS SHOW
CHECKED BY: ISS	SUBMITTED 9/23/11

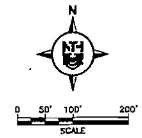
SHEET TITLE:

GENERAL SITE PLAN

SHEET REFERENCE NUMBER:

02





LEGEND

710	EXISTING CONTOUR (2 FT INTERVAL)
	PROPERTY BOUNDARY
	LEACHATE FORCEMAIN
	STORM WATER COLLECTION SYSTEM
	CULVERT
	LANDFILL GAS PIPE
	PERIMETER EDGE DRAIN
	BURIED ELECTRICAL LINE
	SURFACE ELECTRICAL LINE
	OVERHEAD ELECTRICAL LINE
	LEACHATE COLLECTION LINE
	PROPOSED HAZARDOUS WASTE BOUNDARY
	HAZARDOUS WASTE BOUNDARY
	CLEANOUT
	LANDFILL GAS WELL
	LANDFILL GAS HEADER VALVE
	LANDFILL GAS CONDENSATE TRAP
	GAS VENT
	PIEZOMETER
	LEACHATE EXTRACTION WELL
	LEACHATE RISER
	ELECTRICAL UTILITY BOX
	UTILITY POLE
	MONITORING WELL
	TREE
	VEGETATION
	FENCE
	AIR MONITOR STATION

NOTES:

1. THE BASE MAP WAS CREATED USING AN AERIAL SURVEY TAKEN IN 2001 BY AIR-LAND SURVEY AND PROVIDED BY WDI, A SURVEY BY MCLLC IN OCTOBER 2007, AND A GROUND SURVEY BY WDI IN OCTOBER 2008.
2. THE UTILITY BASE MAP WAS PROVIDED BY MCLLC.
3. EXISTING UTILITIES (SUCH AS PIEZOMETERS, WELLS, GAS PIPING, LEACHATE FORCEMAIN, ELECTRICAL LINES, AND CLEANOUTS, ETC.) LOCATED INSIDE THE HAZARDOUS WASTE BOUNDARY ARE TO BE ABANDONED DURING CONSTRUCTION UNLESS MARKED TO REMAIN.
4. REFER TO CTI & ASSOCIATES DRAWING IN APPENDIX K OF THE BASIS OF DESIGN REPORT FOR MC I AND MC IV PROPOSED GAS MANAGEMENT SYSTEM.
5. IF CLEANOUTS ARE TO BE ABANDONED, CUT CLEANOUT FLUSH WITH SURFACE AND FUSION WELD HDPE END CAP TO END.

NTH Consultants, Ltd.
Infrastructure Engineering and Environmental Services

Northville, MI	248.553.0300
Detroit, MI	313.237.3900
Lansing, MI	517.484.6900
Grand Rapids, MI	616.957.3600
Exton, PA	610.524.2300
Lehigh Valley, PA	484.893.1440
Cleveland, OH	216.334.4010
Indianapolis, IN	317.735.7649

REVISIONS

REV	DESCRIPTION	DATE	BY

PROJECT NAME:
MASTER CELL VI F&G

PROJECT LOCATION:
WAYNE DISPOSAL, INC.
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO.: 13-060921-03	CAD FILE NAME: EXISTING UTILITY PLAN (2 OF 2)
DESIGNED BY: DRL	INCEP DATE: 11/12/08
DRAWN BY: DRL	DRAWING SCALE: AS SHOWN
CHECKED BY: RDM	SUBMITTED DATE: 2/28/11

SHEET TITLE:
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(1 OF 2)

SHEET REFERENCE NUMBER:
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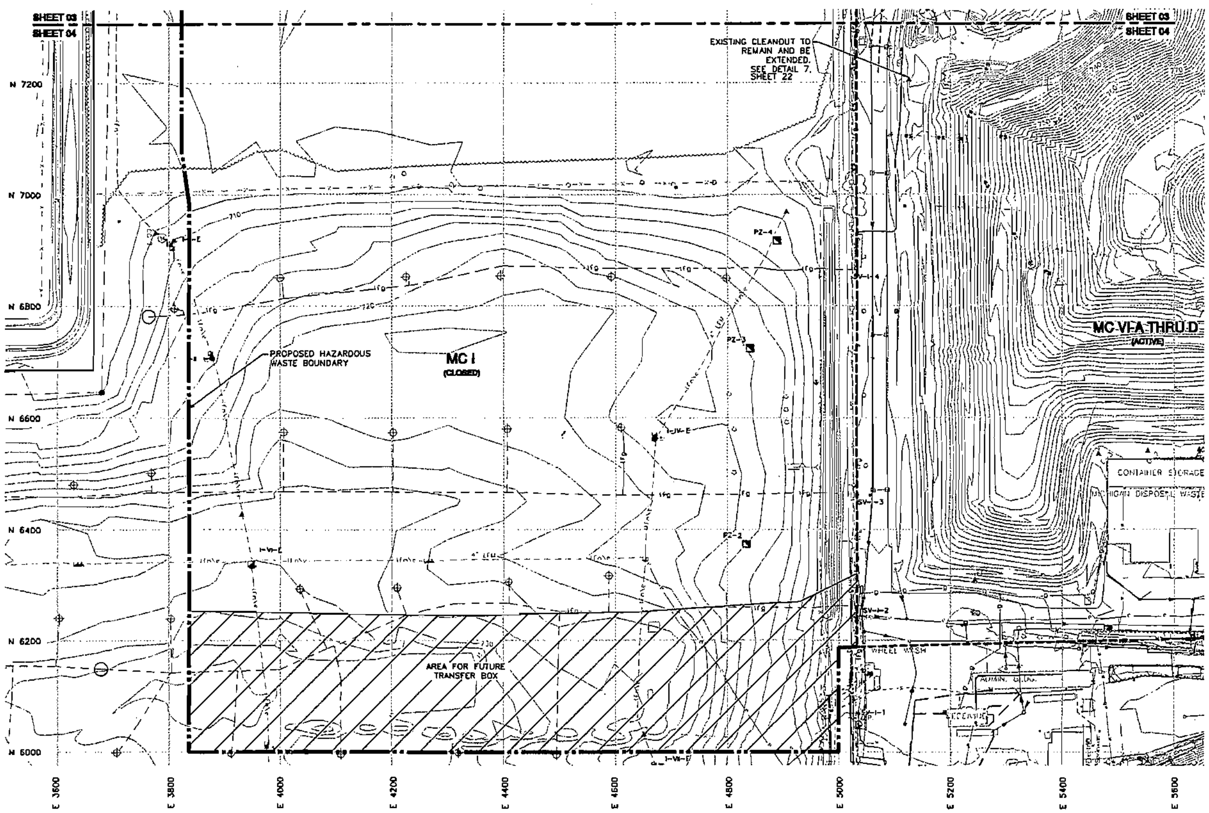
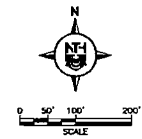




LEGEND

710	EXISTING CONTOUR (2 FT INTERVAL)
	PROPERTY BOUNDARY
	LEACHATE FORCEMAIN
	STORM WATER COLLECTION SYSTEM
	CULVERT
	LANDFILL GAS PIPE
	PERIMETER EDGE DRAIN
	BURIED ELECTRICAL LINE
	SURFACE ELECTRICAL LINE
	OVERHEAD ELECTRICAL LINE
	GAS LINE
	WATER LINE
	SANITARY SEWER LINE
	PROPOSED HAZARDOUS WASTE BOUNDARY
	HAZARDOUS WASTE BOUNDARY
CO	CLEANOUT
	LANDFILL GAS WELL
	LANDFILL GAS HEADER VALVE
	LANDFILL GAS CONDENSATE TRAP
	GAS VENT
	PIEZOMETER
	STORM STRUCTURE
	LEACHATE EXTRACTION WELL
	LEACHATE RISER
	ELECTRICAL UTILITY BOX
	VALVE VAULT
	UTILITY POLE
	MONITORING WELL
	TREE
	VEGETATION
	FENCE

NOTES:

1. THE BASE MAP WAS CREATED USING AN AERIAL SURVEY TAKEN IN 2001 BY AIR-LAND SURVEY AND PROVIDED BY WDI, A SURVEY BY MCLLC IN OCTOBER 2007, AND A GROUND SURVEY BY WDI IN OCTOBER 2008.
2. THE UTILITY BASE MAP WAS PROVIDED BY MCLLC.
3. EXISTING UTILITIES (SUCH AS PIEZOMETERS, WELLS, GAS PIPING, LEACHATE FORCEMAIN, ELECTRICAL LINES, AND CLEANOUTS, ETC.) LOCATED INSIDE THE HAZARDOUS WASTE BOUNDARY ARE TO BE ABANDONED DURING CONSTRUCTION UNLESS MARKED TO REMAIN.
4. REFER TO CTI & ASSOCIATES DRAWING IN APPENDIX K OF THE BASIS OF DESIGN REPORT FOR MC I AND MC IV PROPOSED GAS MANAGEMENT SYSTEM.

NTH Consultants, Ltd.
Infrastructure Engineering and Environmental Services

Northville, MI	248.553.6300
Detroit, MI	313.237.3900
Lansing, MI	517.484.6900
Grand Rapids, MI	616.957.3690
Exton, PA	610.524.2300
Lehigh Valley, PA	484.893.1410
Cleveland, OH	216.334.4040
Indianapolis, IN	317.735.7640

REVISIONS

REV	DESCRIPTION	DATE	BY

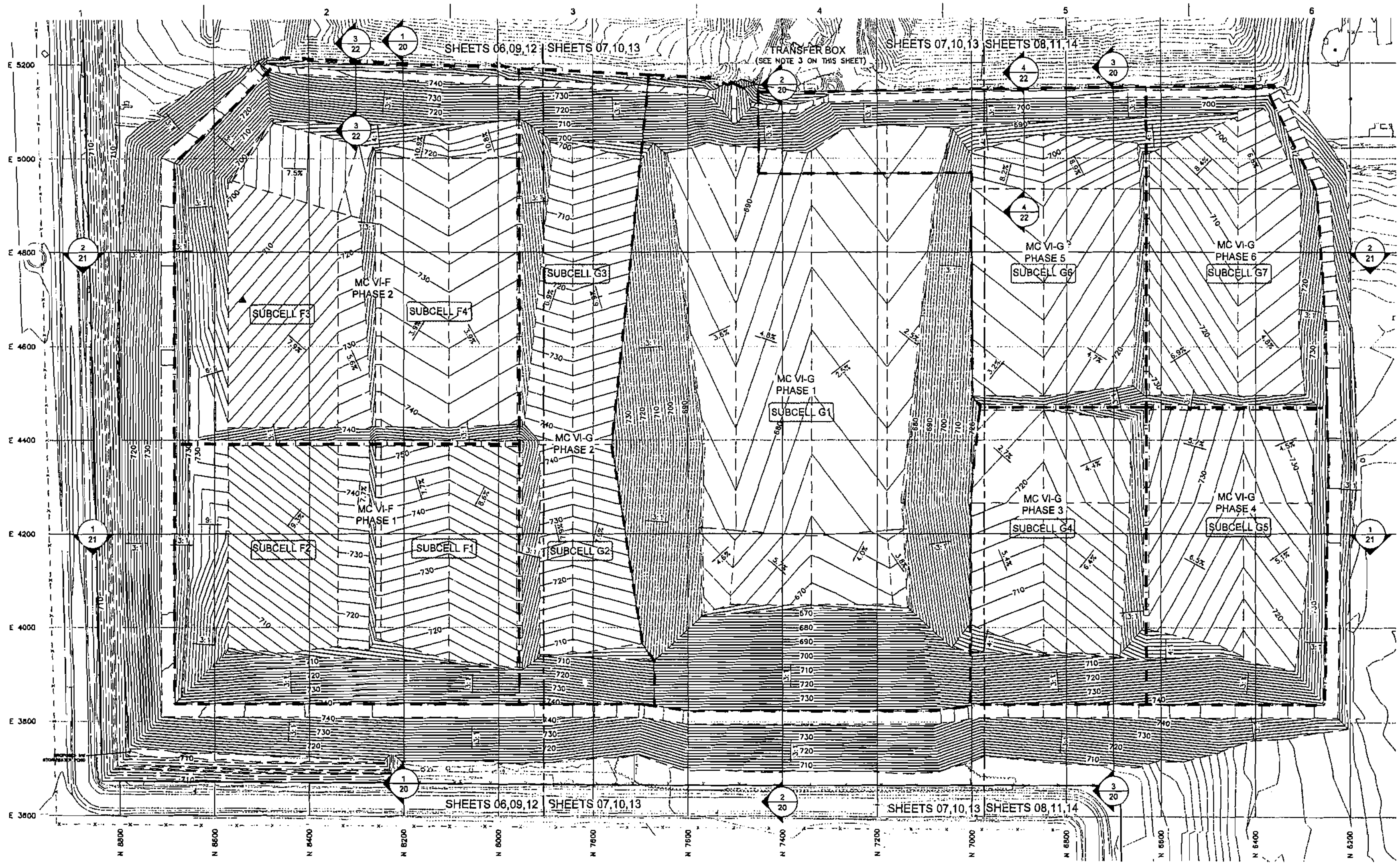
PROJECT NAME:
MASTER CELL VI F&G

PROJECT LOCATION:
WAYNE DISPOSAL, INC.
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO.: 13-080921-03	CAD FILE NAME: [illegible]
DESIGNED BY: DRL	INCEP DATE: 11/12/08
DRAWN BY: DRL	DRAWING SCALE: AS SHOWN
CHECKED BY: RBM	SUBMITTED DATE: 2/20/11

SHEET TITLE:
EXISTING UTILITY PLAN
(2 OF 2)

SHEET REFERENCE NUMBER:
04



PHASE DESIGNATION	PHASE FOOTPRINT AREA (AC.)	PHASE INCREMENTAL VOLUME (C.Y.)
MC VI-F PHASE 1	9.3	812,000
MC VI-F PHASE 2	12.9	1,865,000
MC VI-G PHASE 1	19.9	2,370,000
MC VI-G PHASE 2	7.2	773,000
MC VI-G PHASE 3	5.3	700,000
MC VI-G PHASE 4	3.5	490,000
MC VI-G PHASE 5	7.4	3,600,000
MC VI-G PHASE 6	5.5	1,120,000
TOTAL	73.0	11,730,000

NOTES:

1. THE BASE MAP WAS CREATED USING AN AERIAL SURVEY TAKEN IN 2001 BY AIR-LAND SURVEY AND PROVIDED BY WDI, A SURVEY BY MCLLC IN OCTOBER 2007, AND A GROUND SURVEY BY WDI IN OCTOBER 2008.
2. PHASING SHOWN HERE IS FOR WDI PLANNING PURPOSES ONLY AND MAY CHANGE BASED ON WDI NEEDS WITHOUT MDEQ APPROVAL.
3. THE TRANSFER BOX WILL BE MOVED TO VARIOUS LOCATIONS BASED ON CELL DEVELOPMENT AND FILLING OPERATIONS. SEE TRANSFER BOX DETAIL ON SHEETS 26 AND 27.
2. A MINIMUM OF 5 YEARS PRIOR TO CONSTRUCTING MC VI-G PHASES 3 TO 6, WDI SHALL INVESTIGATE THE DIKE LOCATIONS AND NEED FOR DEWATERING FOR THE EXISTING MC I TO CONFIRM THE ASSUMPTIONS USED IN THE DESIGN. WDI SHALL INFORM THE MDEQ OF THE RESULTS OF THIS INVESTIGATION AND REVISE THE DESIGN, IF NECESSARY. THE REVISED DESIGN SHALL BE APPROVED BY THE MDEQ PRIOR TO CONSTRUCTION OF MC VI-G PHASES 3 TO 6. B

0 50' 100' 200'
SCALE

LEGEND

- 710 EXISTING CONTOUR (2 FT INTERVAL)
- PROPERTY BOUNDARY
- PROPOSED GRADE BREAK
- 710 PROPOSED TOP OF PRIMARY LINER CONTOUR (2 FT INTERVAL)
- 710 PROPOSED NW STORMWATER POND CONTOUR (2 FT INTERVAL)
- PROPOSED PHASE BOUNDARY

NTH Consultants,
Infrastructure Engineering
Environmental Services

Northville, MI	248.55
Detroit, MI	313.23
Lansing, MI	517.48
Grand Rapids, MI	616.96
Exton, PA	610.52
Lehigh Valley, PA	484.80
Cleveland, OH	216.33
Indianapolis, IN	317.73

REVISIONS

REV	DESCRIPTION	DA
A	PHASING DESIGNATIONS	6/16
B	PER MDEQ COMMENTS	6/2

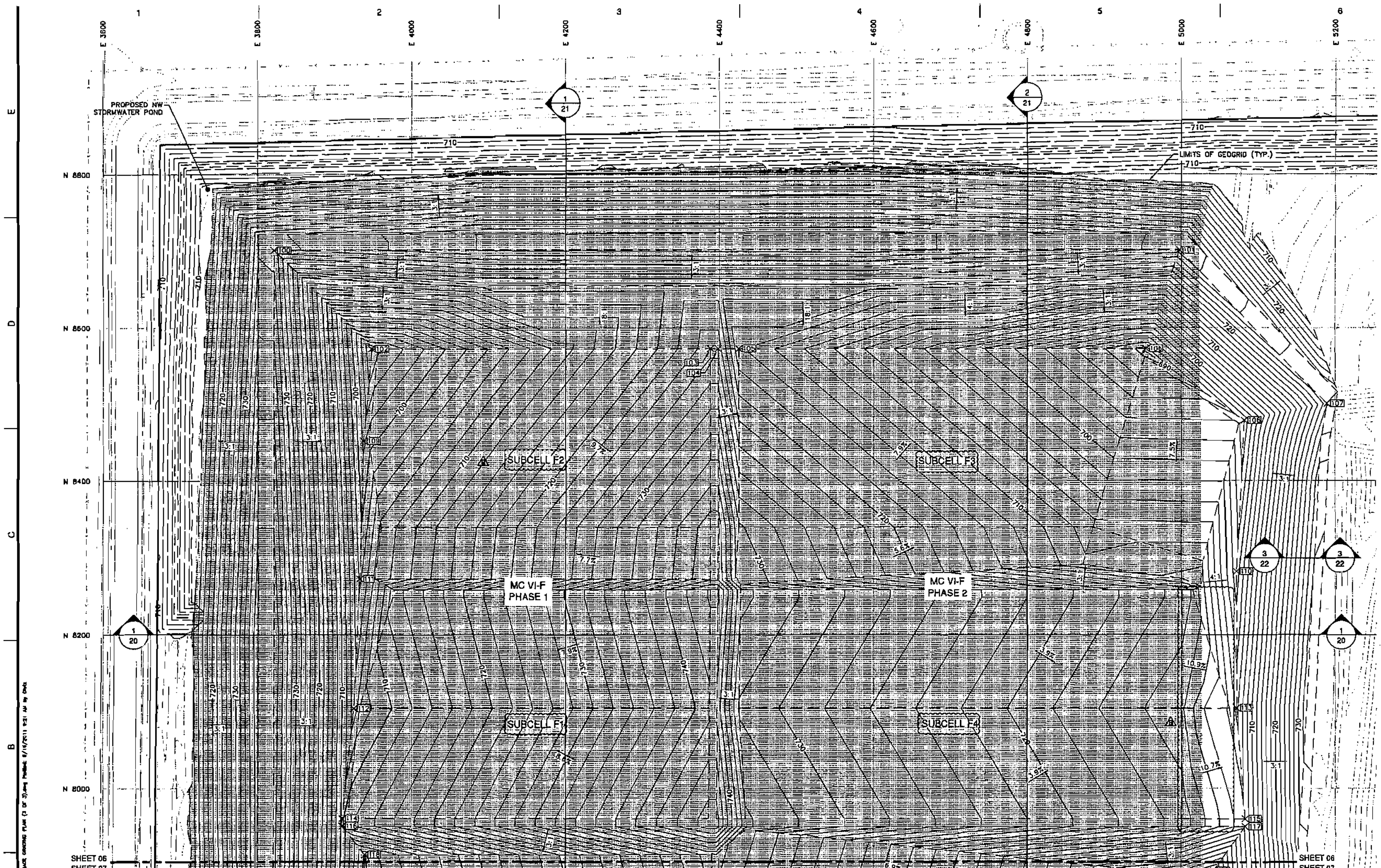
PROJECT NAME
MASTER CELL VI F&G

PROJECT LOCATION
WAYNE DISPOSAL, IN
SITE NO. 2
BELLEVILLE, MICHIGA

NTH PROJECT NO.: 13-060821-03	CAD FILE NA
DESIGNED BY: JHL	INCEP DATE: 11/12/08
DRAWN BY: DRL	DRAWING SC AS SHOW
CHECKED BY: ISS	SUBMITTED: 8/23/11

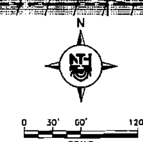
SHEET TITLE:
CONSTRUCTION PHAS
PLAN

SHEET REFERENCE NUMBER:
05



SUBGRADE PERIMETER DIKE COORDINATES			
Point No.	Northing	Easting	Elevation (ft)
100	8701.30	3821.03	731.39
101	8701.30	4997.59	731.01
102	8572.66	3948.14	691.65
103	8572.66	4388.34	725.25
104	8572.66	4398.34	725.25
105	8572.66	4425.01	716.36
106	8572.66	4954.00	689.27
107	8500.75	5189.52	725.83
108	8478.81	5082.20	694.48
109	8451.97	3937.75	697.50
110	8282.53	5072.20	698.88

SUBGRADE PERIMETER DIKE COORDINATES			
Point No.	Northing	Easting	Elevation (ft)
111	8272.51	3932.99	701.60
112	8104.36	3924.94	704.97
113	8104.36	5072.27	703.43
114	7961.05	3909.78	709.54
115	7960.73	5083.24	706.44
116	7951.05	3909.68	709.54
117	7950.73	5083.24	706.44
118	7913.92	3939.16	700.65
119	7893.05	5042.32	691.59
120	7842.73	3938.19	697.92
121	7842.73	5038.07	689.67



LEGEND

- EXISTING CONTOUR (2 FT INTERVAL)
- PROPERTY BOUNDARY
- PROPOSED GRADE BREAK
- 710 — PROPOSED TOP OF SUBGRADE CONTOUR (2 FT INTERVAL)
- 710 — PROPOSED NW STORMWATER POND CONTOUR (2 FT INTERVAL)
- AREA TO BE COVERED BY GEOGRID
- 100 — PROPOSED DIKE COORDINATE POINT NO.
- 3:1 — PROPOSED SLOPE

NOTE:

THE BASE MAP WAS CREATED USING AN AERIAL SURVEY TAKEN IN 2001 BY AIR-LAND SURVEY AND PROVIDED BY WDI, A SURVEY BY MCLLC IN OCTOBER 2007, AND A GROUND SURVEY BY WDI IN OCTOBER 2008.

NTH Consultants, Ltd.
Infrastructure Engineering and Environmental Services

Northville, MI	248.553.6300
Detroit, MI	313.237.3900
Lansing, MI	517.484.6900
Grand Rapids, MI	616.957.3680
Exton, PA	610.524.2300
Lehigh Valley, PA	484.893.1440
Cleveland, OH	216.334.4040
Indianapolis, IN	317.735.7649

REVISIONS

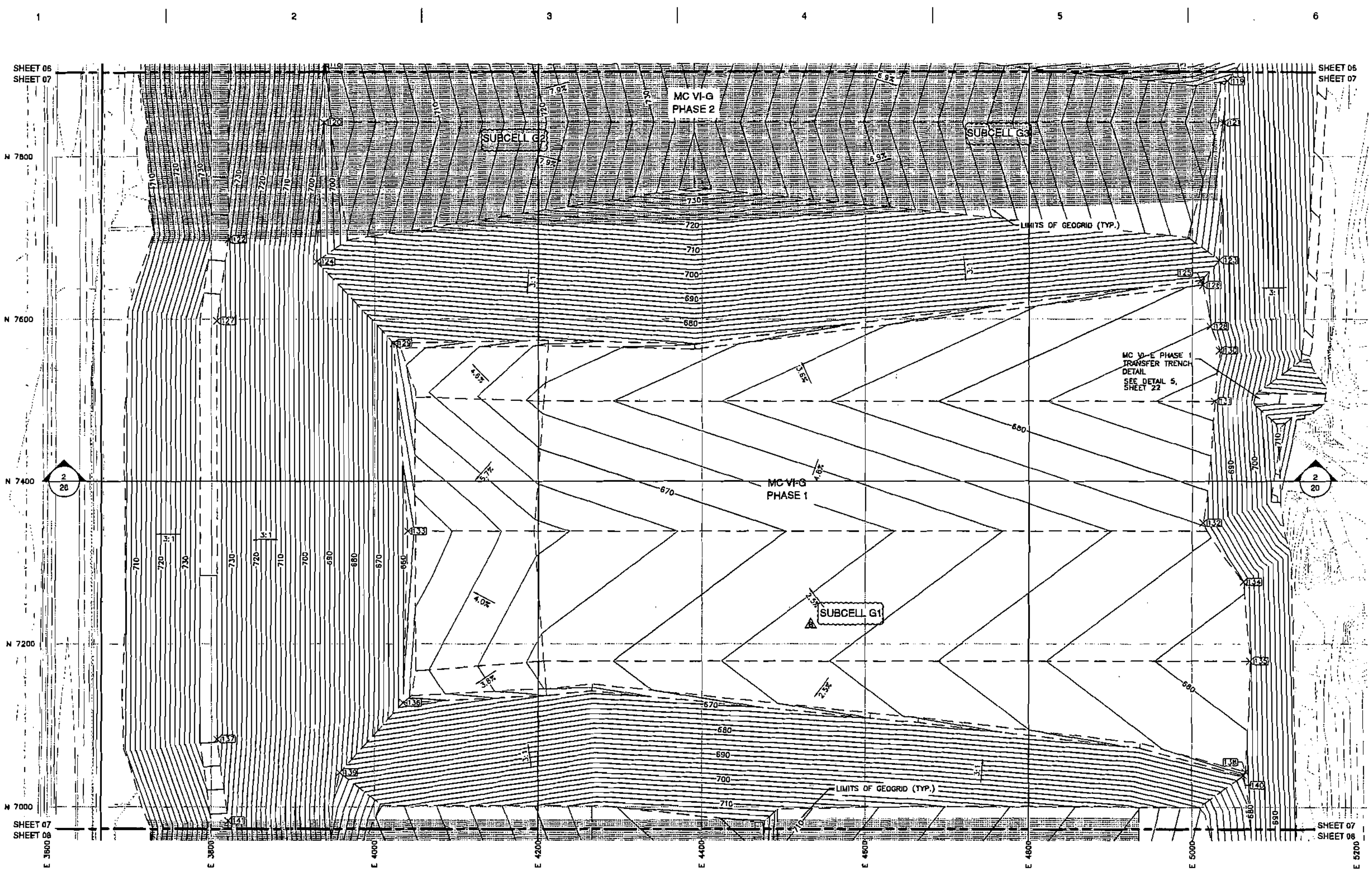
PROJECT NAME:
MASTER CELL VI F&G

PROJECT LOCATION:
WAYNE DISPOSAL, INC.
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO.: 13-080921-03	CAD FILE NAME: TOP OF SUBGRADE GRADING PLAN (1 OF 3)
DESIGNED BY: JHL	INCEP DATE: 11/12/08
DRAWN BY: DRL	DRAWING SCALE: AS SHOWN
CHECKED BY: JSS	SUBMITTED DATE: 9/23/11

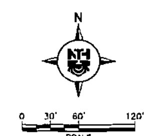
SHEET TITLE:
TOP OF SUBGRADE GRADING PLAN (1 OF 3)

SHEET REFERENCE NUMBER:
06



SUBGRADE PERIMETER DIKE COORDINATES			
Point No.	Northing	Easting	Elevation (ft)
122	7697.89	3821.03	730.74
123	7672.54	5032.68	686.26
124	7570.81	3928.84	694.50
125	7647.66	5010.45	678.68
126	7641.99	5012.71	680.19
127	7597.89	3806.80	735.60
128	7591.06	5021.51	682.01
129	7570.41	4023.20	663.24
130	7561.87	5032.75	683.13
131	7498.71	5027.05	685.09
132	7349.00	5012.85	678.14

SUBGRADE PERIMETER DIKE COORDINATES			
Point No.	Northing	Easting	Elevation (ft)
133	7338.74	4040.41	658.10
134	7276.06	5062.38	679.69
135	7179.18	5070.45	681.75
136	7127.70	4034.87	660.23
137	7083.24	3807.01	736.24
138	7043.49	5084.48	678.89
139	7042.16	3957.20	684.60
140	7039.03	5062.00	677.47
141	6983.25	3821.03	729.35
142	6687.01	3937.42	598.98
143	6636.63	3931.13	702.62



LEGEND

- EXISTING CONTOUR (2 FT INTERVAL)
- PROPERTY BOUNDARY
- PROPOSED GRADE BREAK
- 710 — PROPOSED TOP OF SUBGRADE CONTOUR (2 FT INTERVAL)
- AREA TO BE COVERED BY GEOGRID
- 100 — PROPOSED DIKE COORDINATE POINT NO.
- 3:1 — PROPOSED SLOPE

NOTE:

THE BASE MAP WAS CREATED USING AN AERIAL SURVEY TAKEN IN 2001 BY AIR-LAND SURVEY AND PROVIDED BY WDI, A SURVEY BY MCLLC IN OCTOBER 2007, AND A GROUND SURVEY BY WDI IN OCTOBER 2008.

NTH Consultants, Ltd.

Infrastructure Engineering and Environmental Services

Northville, MI	248.553.6300
Detroit, MI	313.237.3900
Lansing, MI	517.484.6900
Grand Rapids, MI	616.957.3690
Exton, PA	610.524.2300
Lehigh Valley, PA	484.893.1440
Cleveland, OH	216.334.4040
Indianapolis, IN	317.735.7849

REVISIONS

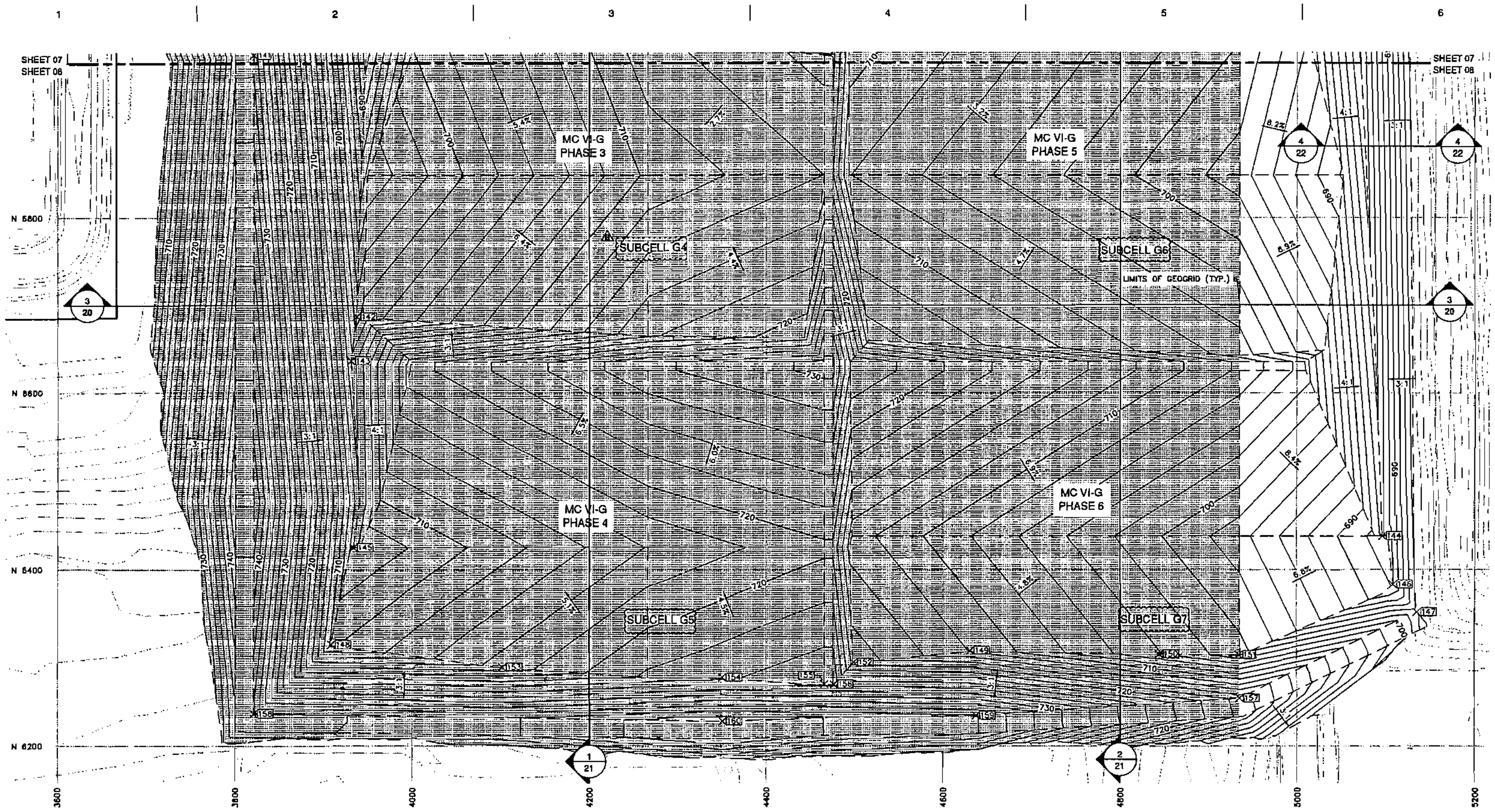
PROJECT NAME:
MASTER CELL VI F&G

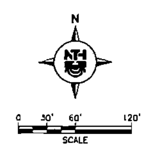
PROJECT LOCATION:
WAYNE DISPOSAL, INC.
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO. 13-060621-03	CAD FILE NAME: TOP OF SUBGRADE GRADING PLAN 2 OF 3
DESIGNED BY: ORL	INCEP DATE: 11/12/08
DRAWN BY: ORL	DRAWING SCALE: AS SHOWN
CHECKED BY: RBM	SUBMITTED DATE: 9/23/11

SHEET TITLE:
TOP OF SUBGRADE GRADING PLAN (2 OF 3)

SHEET REFERENCE NUMBER:
07





SUBGRADE PERIMETER DIKE COORDINATES			
Point No.	Northing	Easting	Elevation (ft)
144	6437.61	5096.19	685.31
145	6425.37	3933.71	704.74
146	6383.17	5108.23	687.81
147	6352.10	5135.27	696.41
148	6316.02	3908.50	709.72
149	6308.86	4630.41	711.90
150	6304.89	4844.00	704.12
151	6304.21	4934.01	700.81
152	6295.30	4498.77	717.18
153	6290.14	4101.64	716.79
154	6278.55	4350.36	723.66

SUBGRADE PERIMETER DIKE COORDINATES			
Point No.	Northing	Easting	Elevation (ft)
155	6270.50	4465.41	725.70
156	6270.26	4476.27	725.42
157	6254.80	4935.00	717.24
158	6237.41	3821.03	738.23
159	6235.06	4636.89	736.17
160	6228.94	4350.65	739.90

LEGEND

- EXISTING CONTOUR (2 FT INTERVAL)
- PROPERTY BOUNDARY
- PROPOSED GRADE BREAK
- 710 — PROPOSED TOP OF SUBGRADE CONTOUR (2 FT INTERVAL)
- AREA TO BE COVERED BY GEOGRID
- 100 — PROPOSED DIKE COORDINATE POINT NO.
- 3:1 — PROPOSED SLOPE

NOTES:

1. THE BASE MAP WAS CREATED USING AN AERIAL SURVEY TAKEN IN 2001 BY AIR-LAND SURVEY AND PROVIDED BY WDI, A SURVEY BY MCLLC IN OCTOBER 2007, AND A GROUND SURVEY BY WDI IN OCTOBER 2008.
2. A MINIMUM OF 5 YEARS PRIOR TO CONSTRUCTING MC VI-G PHASES 3 TO 6, WDI SHALL INVESTIGATE THE DIKE LOCATIONS AND NEED FOR DEWATERING FOR THE EXISTING MC I TO CONFIRM THE ASSUMPTIONS USED IN THE DESIGN. WDI SHALL INFORM THE MDEQ OF THE RESULTS OF THIS INVESTIGATION AND REVISE THE DESIGN, IF NECESSARY. THE REVISED DESIGN SHALL BE APPROVED BY THE MDEQ PRIOR TO CONSTRUCTION OF MC VI-G PHASES 3 TO 6.

NTH Consultants, Ltd.
Infrastructure Engineering and Environmental Services

Northville, MI	248.553.6300
Detroit, MI	313.237.3900
Lansing, MI	517.484.6900
Grand Rapids, MI	616.957.3690
Exton, PA	610.524.2300
Lehigh Valley, PA	484.893.1440
Cleveland, OH	216.334.4040
Indianapolis, IN	317.735.7549

REVISIONS

REV	DESCRIPTION	DATE	BY
A	[illegible]	[illegible]	DRL
B	[illegible]	[illegible]	DRL

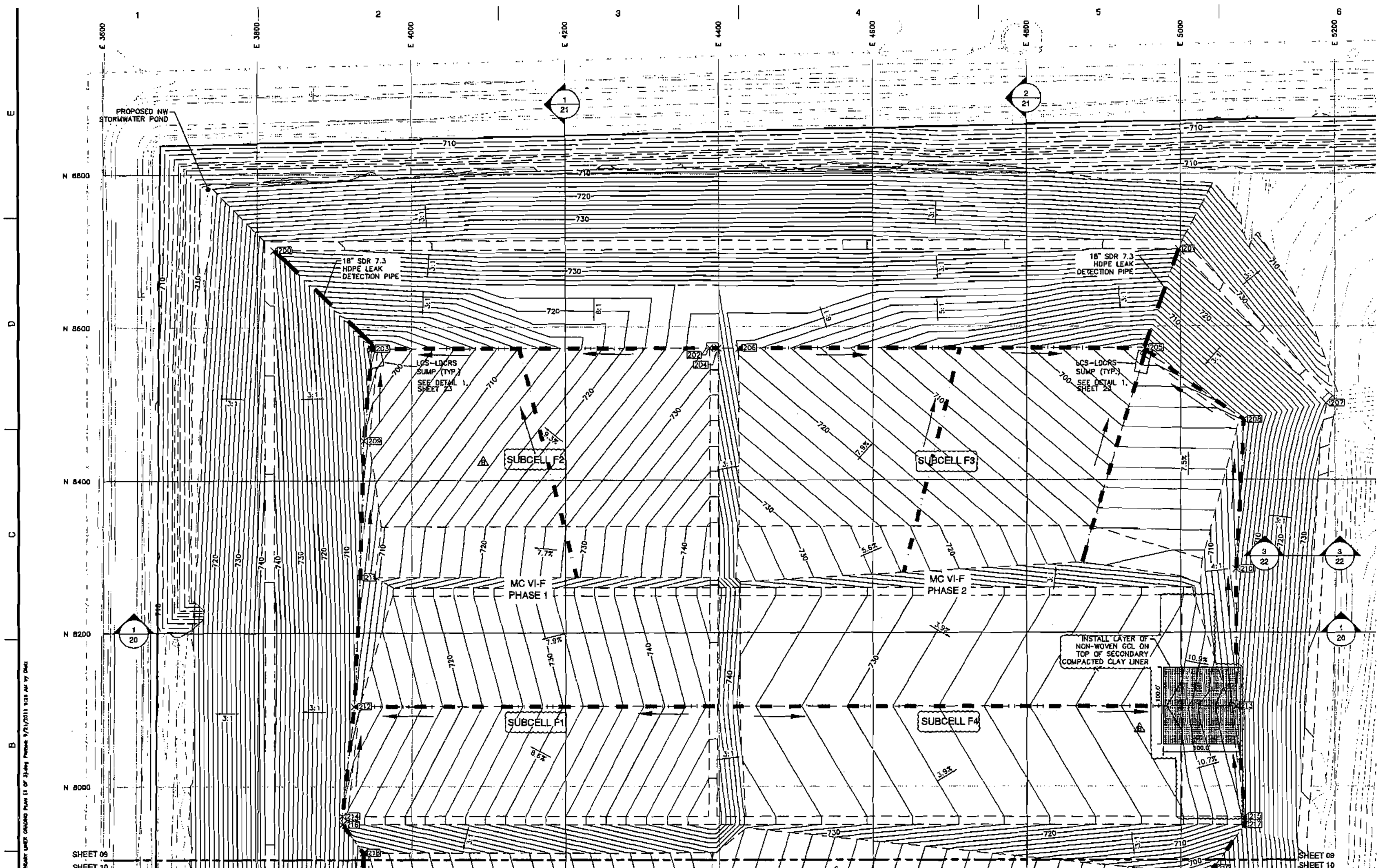
PROJECT NAME
MASTER CELL VI F&G

PROJECT LOCATION:
WAYNE DISPOSAL, INC.
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO. 13-060921-03	CAD FILE NAME: [illegible]
DESIGNED BY: JHL	INCEP DATE: 11/12/08
DRAWN BY: DRL	DRAWING SCALE: AS SHOWN
CHECKED BY: ISS	SUBMITTED DATE: 9/23/11

SHEET TITLE:
TOP OF SUBGRADE GRADING PLAN (3 OF 3)

SHEET REFERENCE NUMBER:
08



SECONDARY PERIMETER DIKE COORDINATES			
Point No.	Northing	Easting	Elevation (ft)
200	8700.81	3821.52	734.39
201	8700.81	4997.38	734.01
202	8572.25	4388.15	728.36
203	8572.25	3948.23	694.77
204	8572.25	4398.83	728.36
205	8572.25	4954.23	692.38
208	8572.25	4425.54	719.46
207	8500.61	5188.97	728.83
208	8478.75	5082.08	697.60
209	8451.96	3937.88	700.62
210	8282.62	5071.86	702.00

SECONDARY PERIMETER DIKE COORDINATES			
Point No.	Northing	Easting	Elevation (ft)
211	8272.87	3933.11	704.72
212	8104.36	3925.07	708.09
213	8104.36	5072.15	706.55
214	7961.11	3909.91	712.66
215	7960.76	5083.12	709.56
216	7950.56	3909.80	712.66
217	7950.24	5083.12	709.56
218	7913.41	3836.99	703.47
219	7892.49	5042.06	694.60
220	7842.73	3938.32	701.04
221	7842.73	5037.95	692.79

N

0 30' 60' 120'
SCALE

LEGEND

- EXISTING CONTOUR (2 FT INTERVAL)
- PROPERTY BOUNDARY
- PROPOSED GRADE BREAK
- 825 — PROPOSED TOP OF SECONDARY CONTOUR (2 FT INTERVAL)
- 710 — PROPOSED NW STORMWATER POND CONTOUR (2 FT INTERVAL)
- 200 — PROPOSED DIKE COORDINATE POINT NO.
- 3:1 — PROPOSED SLOPE
- PROPOSED 2 EXTRA LAYERS OF GEONET, 7.5' WIDE BENEATH GEOCOMPOSITE WITH FLOW DIRECTION
- PROPOSED SOLID LEAK DETECTION RISER PIPE
- PROPOSED SECONDARY COLLECTION SUMP

NOTE:

THE BASE MAP WAS CREATED USING AN AERIAL SURVEY TAKEN IN 2001 BY AIR-LAND SURVEY AND PROVIDED BY WDI, A SURVEY BY MCLLC IN OCTOBER 2007, AND A GROUND SURVEY BY WDI IN OCTOBER 2008.

NTH Consultants, Ltd.
Infrastructure Engineering and Environmental Services

Northville, MI	248.553.6300
Detroit, MI	313.237.3900
Lansing, MI	517.484.6900
Grand Rapids, MI	616.957.3880
Exton, PA	610.524.2300
Lehigh Valley, PA	484.893.1440
Cleveland, OH	216.334.4040
Indianapolis, IN	317.735.7849

REVISIONS			
REV	DESCRIPTION	DATE	BY
A	PHASING DESIGNATIONS	6/10/11	DRL
B	PER MDEQ COMMENTS	9/23/11	DRL

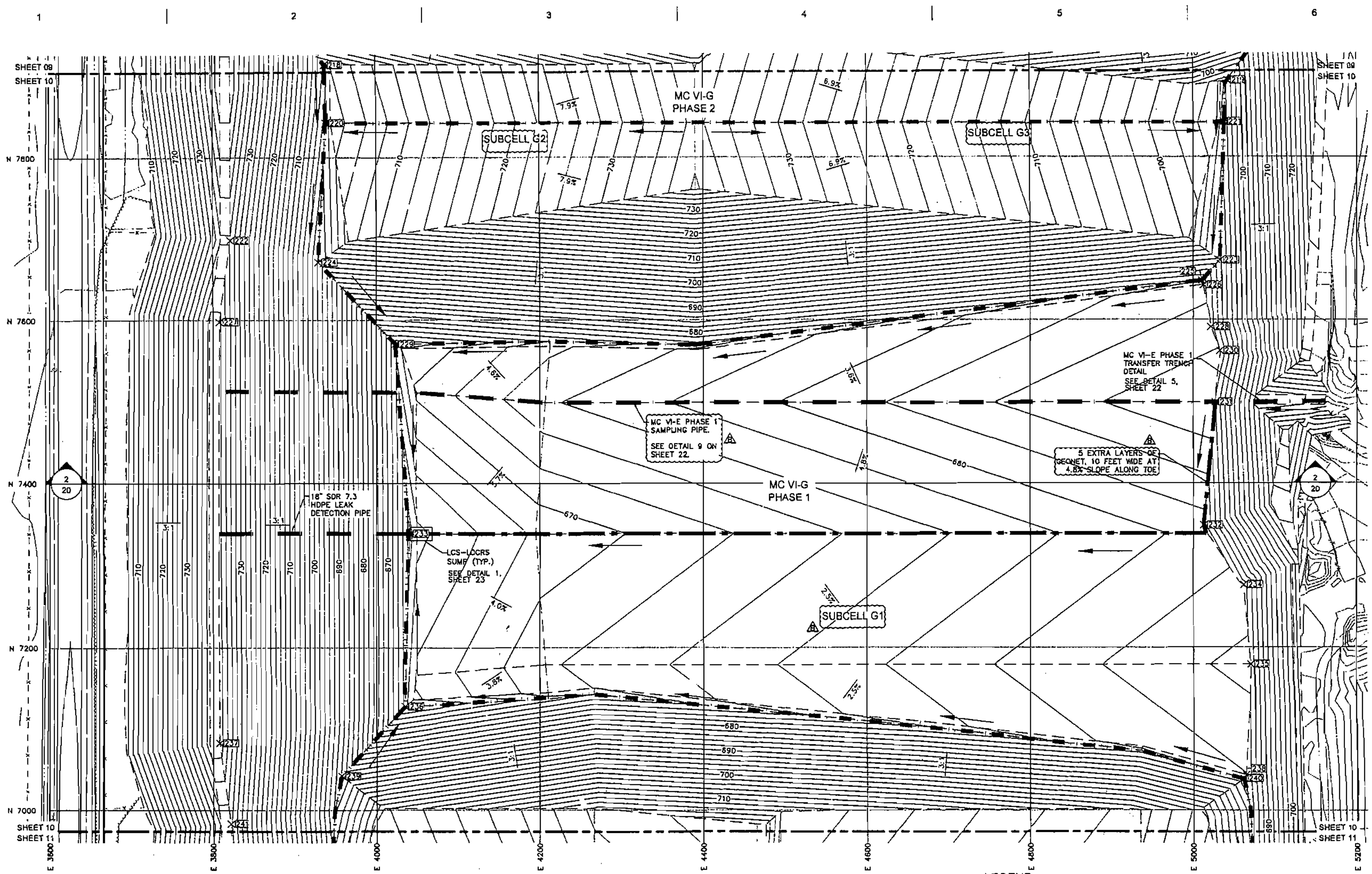
PROJECT NAME:
MASTER CELL VI F&G

PROJECT LOCATION:
WAYNE DISPOSAL, INC.
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO.: 13-080921-03	CAD FILE NAME: TOP OF SECONDARY LINER GRADING PLAN (1 OF 3)
DESIGNED BY: JHL	INCEP DATE: 11/12/08
DRAWN BY: DRL	DRAWING SCALE: AS SHOWN
CHECKED BY: ISS	SUBMITTED DATE: 9/23/11

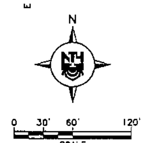
SHEET TITLE:
TOP OF SECONDARY LINER GRADING PLAN (1 OF 3)

SHEET REFERENCE NUMBER:
09



SECONDARY PERIMETER DIKE COORDINATES			
Point No	Northing	Easting	Elevation (ft)
222	7697.85	3821.52	733.74
223	7672.42	5032.72	689.36
224	7670.76	3929.03	697.85
225	7647.54	5010.47	681.80
226	7641.99	5012.71	683.24
227	7597.65	3807.29	738.60
226	7591.06	5021.51	685.01
229	7570.29	4023.33	686.36
230	7561.67	5032.75	686.20
231	7498.71	5027.05	688.09
232	7349.00	5012.85	691.14

SECONDARY PERIMETER DIKE COORDINATES			
Point No.	Northing	Easting	Elevation (ft)
233	7338.74	4040.54	681.22
234	7275.80	5061.92	682.69
235	7179.18	5070.45	684.75
236	7127.83	4034.99	663.35
237	7083.28	3807.50	739.24
238	7043.49	5064.48	681.99
239	7042.34	3957.36	687.71
240	7039.01	5061.89	680.59
241	6983.28	3821.52	732.35
242	6687.00	3937.54	702.10
243	6636.63	3931.26	705.74



LEGEND

- EXISTING CONTOUR (2 FT INTERVAL)
- PROPERTY BOUNDARY
- PROPOSED GRADE BREAK
- 710 — PROPOSED TOP OF SECONDARY CONTOUR (2 FT INTERVAL)
- 200 — PROPOSED DIKE COORDINATE POINT NO.
- 3:1 — PROPOSED SLOPE
- PROPOSED 2 EXTRA LAYERS OF GEONET, 7.5' WIDE BENEATH GEOCOMPOSITE WITH FLOW DIRECTION
- PROPOSED 5 EXTRA LAYERS OF GEONET, 11.5' WIDE, BENEATH GEOCOMPOSITE WITH FLOW DIRECTION
- PROPOSED LEAK DETECTION RISER/ SECONDARY SAMPLING PIPE
- PROPOSED SECONDARY COLLECTION SUMP

NOTE:

THE BASE MAP WAS CREATED USING AN AERIAL SURVEY TAKEN IN 2001 BY AIR-LAND SURVEY AND PROVIDED BY WDI, A SURVEY BY MCLLC IN OCTOBER 2007, AND A GROUND SURVEY BY WDI IN OCTOBER 2008.

NTH Consultants, L

Infrastructure Engineering a
Environmental Services

Northville, MI 248.553
Detroit, MI 313.237
Lansing, MI 517.484
Grand Rapids, MI 616.957
Exton, PA 610.524
Lehigh Valley, PA 484.893
Cleveland, OH 216.334
Indianapolis, IN 317.735

REVISIONS

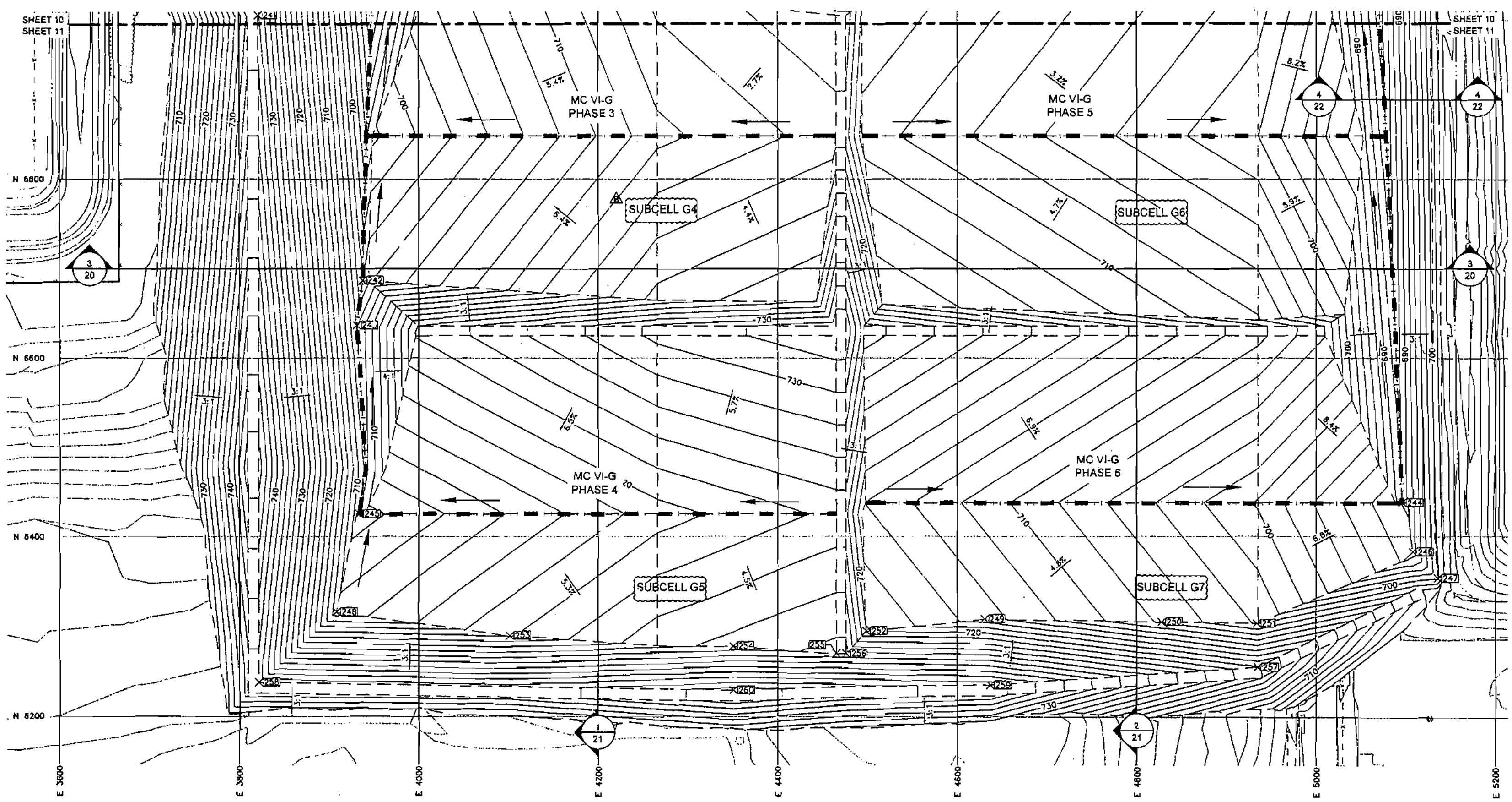
PROJECT NAME:
MASTER CELL VI F&G

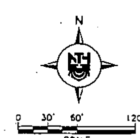
PROJECT LOCATION:
WAYNE DISPOSAL, INC
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO: 13-060821-03	CAD FILE NAM
DESIGNED BY: JHL	INCEP DATE 11/12/08
DRAWN BY: DRL	DRAWING SCA AS SHOW
CHECKED BY: ISS	SUBMITTED D 9/23/11

SHEET TITLE:
TOP OF SECONDARY LINER GRADING PLAN OF 3)

SHEET REFERENCE NUMBER:
10





SECONDARY PERIMETER DIKE COORDINATES			
Point No.	Northing	Easting	Elevation (ft)
244	6437.59	5096.06	688.43
245	6425.35	3933.63	707.86
246	6383.34	5107.71	690.84
247	6353.82	5135.70	699.60
248	6316.02	3908.50	712.72
249	6308.86	4630.41	714.90
250	6305.63	4827.81	707.70
251	6304.21	4934.01	703.81
252	6295.30	4498.77	720.18
253	6290.14	4101.64	719.79
254	6278.55	4350.36	726.66

SECONDARY PERIMETER DIKE COORDINATES			
Point No.	Northing	Easting	Elevation (ft)
255	6270.50	4465.41	728.70
256	6270.2^	4476.27	728.59
257	6255.28	4934.88	720.24
258	6237.90	3821.52	739.23
259	6235.55	4636.87	739.17
260	6229.43	4350.65	742.90

LEGEND

Symbol	Description
710	EXISTING CONTOUR (2 FT INTERVAL)
	PROPERTY BOUNDARY
	PROPOSED GRADE BREAK
710	PROPOSED TOP OF SECONDARY CONTOUR (2 FT INTERVAL)
200	PROPOSED DIKE COORDINATE POINT NO.
3:1	PROPOSED SLOPE
	PROPOSED 2 EXTRA LAYERS OF GEONET, 7.5' WIDE BENEATH GEOCOMPOSITE WITH FLOW DIRECTION

NOTES:

1. THE BASE MAP WAS CREATED USING AN AERIAL SURVEY TAKEN IN 2001 BY AIR-LAND SURVEY AND PROVIDED BY WDI, A SURVEY BY MCLLC IN OCTOBER 2007, AND A GROUND SURVEY BY WDI IN OCTOBER 2008.
2. A MINIMUM OF 5 YEARS PRIOR TO CONSTRUCTING MC VI-G PHASES 3 TO 6, WDI SHALL INVESTIGATE THE DIKE LOCATIONS AND NEED FOR DEWATERING FOR THE EXISTING MC I TO CONFIRM THE ASSUMPTIONS USED IN THE DESIGN. WDI SHALL INFORM THE MDEQ OF THE RESULTS OF THIS INVESTIGATION AND REVISE THE DESIGN, IF NECESSARY. THE REVISED DESIGN SHALL BE APPROVED BY THE MDEQ PRIOR TO CONSTRUCTION OF MC VI-G PHASES 3 TO 6.

NTH Consultants, L
Infrastructure Engineering a
Environmental Services

Northville, MI 248.553.
Detroit, MI 313.237.
Lansing, MI 517.484
Grand Rapids, MI 616.957.
Exton, PA 610.524
Lehigh Valley, PA 484.893
Cleveland, OH 216.334
Indianapolis, IN 317.735

REVISIONS

REV	DESCRIPTION	DATE
A		
B		

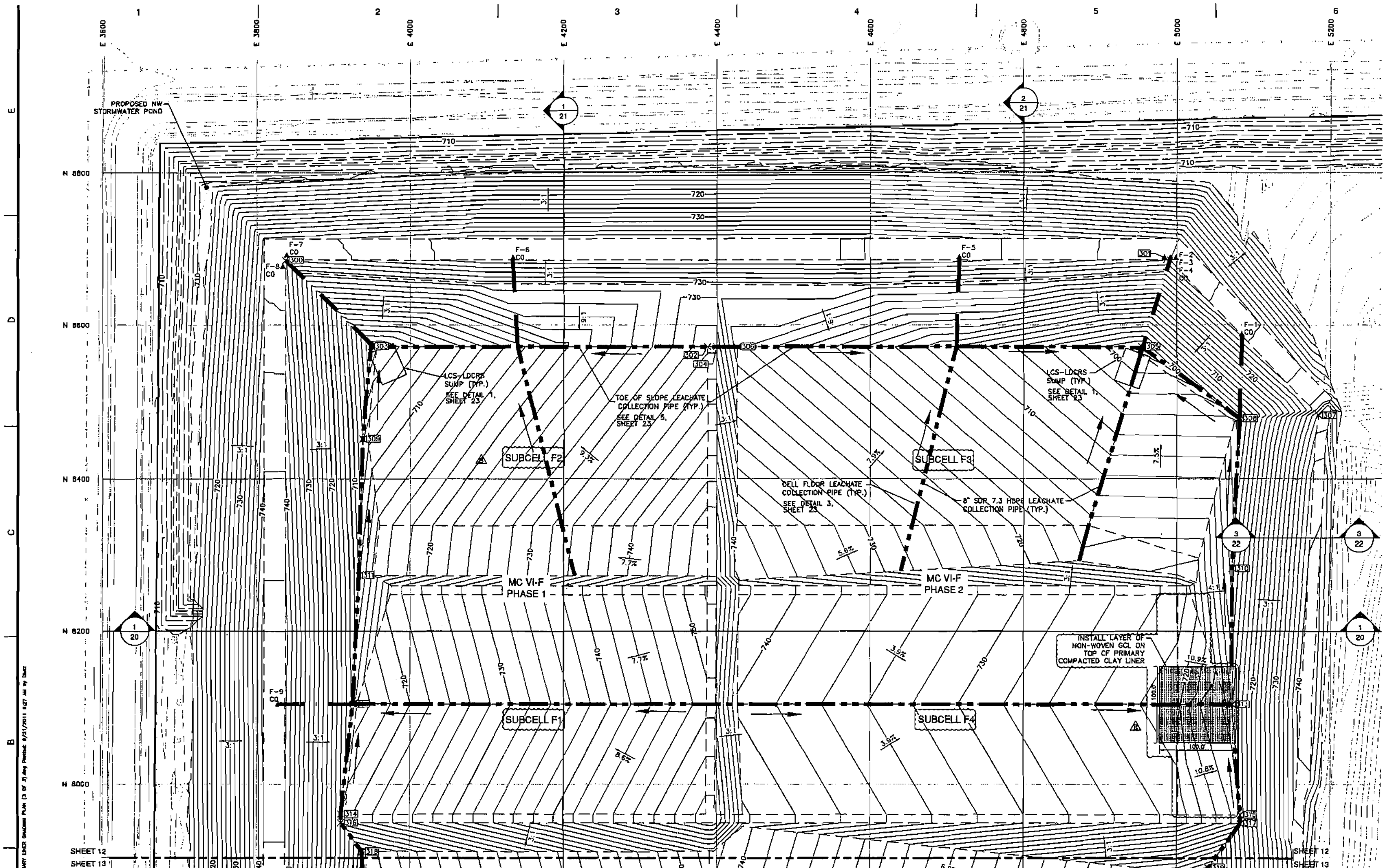
PROJECT NAME:
MASTER CELL VI F&G

PROJECT LOCATION:
WAYNE DISPOSAL, INC
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO.: 13-060921-03	CAD FILE NAME
DESIGNED BY: JHL	INCEP DATE 11/12/08
DRAWN BY: DRL	DRAWING SCALE AS SHOWN
CHECKED BY: ISS	SUBMITTED DATE 9/23/11

SHEET TITLE:
TOP OF SECONDARY LINER GRADING PLAN OF 3)

SHEET REFERENCE NUMBER:
11



PRIMARY PERIMETER DIKE COORDINATES			
Point No.	Northing	Easting	Elevation (ft)
300	8685.01	3837.32	734.39
301	8685.01	4990.85	734.01
302	8571.54	4388.00	733.49
303	8571.54	3948.60	699.97
304	8571.54	4399.64	733.49
305	8571.54	4954.14	697.53
306	8571.54	4426.45	724.56
307	8482.21	5185.03	734.79
308	8478.59	5081.75	702.80
309	8451.95	3938.08	705.82
310	8282.69	5071.67	707.20

PRIMARY PERIMETER DIKE COORDINATES			
Point No.	Northing	Easting	Elevation (ft)
311	8273.20	3933.29	709.92
312	8104.36	3925.25	713.29
313	8104.36	5071.95	711.75
314	7961.21	3910.06	717.86
315	7960.81	5082.91	714.76
316	7949.77	3909.93	717.86
317	7949.43	5082.91	714.76
318	7912.56	3937.63	708.50
319	7891.54	5041.36	699.63
320	7842.73	3938.51	706.24
321	7842.73	5037.74	697.99

LEGEND

- EXISTING CONTOUR (2 FT INTERVAL)
- PROPERTY BOUNDARY
- PROPOSED GRADE BREAK
- 710 — PROPOSED TOP OF PRIMARY CONTOUR (2 FT INTERVAL)
- 710 — PROPOSED NW STORMWATER POND CONTOUR (2 FT INTERVAL)
- 300 — PROPOSED DIKE COORDINATE POINT NO.
- 3:1 — PROPOSED SLOPE
- PROPOSED LEACHATE COLLECTION PIPE AND FLOW DIRECTION
- F-1 CO — PROPOSED LEACHATE CLEANOUT PIPE
- PROPOSED PRIMARY COLLECTION SUMP

0 30' 60' 120'
SCALE

NOTE:

THE BASE MAP WAS CREATED USING AN AERIAL SURVEY TAKEN IN 2001 BY AIR-LAND SURVEY AND PROVIDED BY WDI, A SURVEY BY MCLLC IN OCTOBER 2007, AND A GROUND SURVEY BY WDI IN OCTOBER 2008.

NTH Consultants, Ltd.
Infrastructure Engineering and Environmental Services

Northville, MI	248.553.6300
Detroit, MI	313.237.3900
Lansing, MI	517.484.8900
Grand Rapids, MI	616.957.3690
Exton, PA	610.524.2300
Lehigh Valley, PA	484.893.1440
Cleveland, OH	216.334.4040
Indianapolis, IN	317.735.7649

REVISIONS

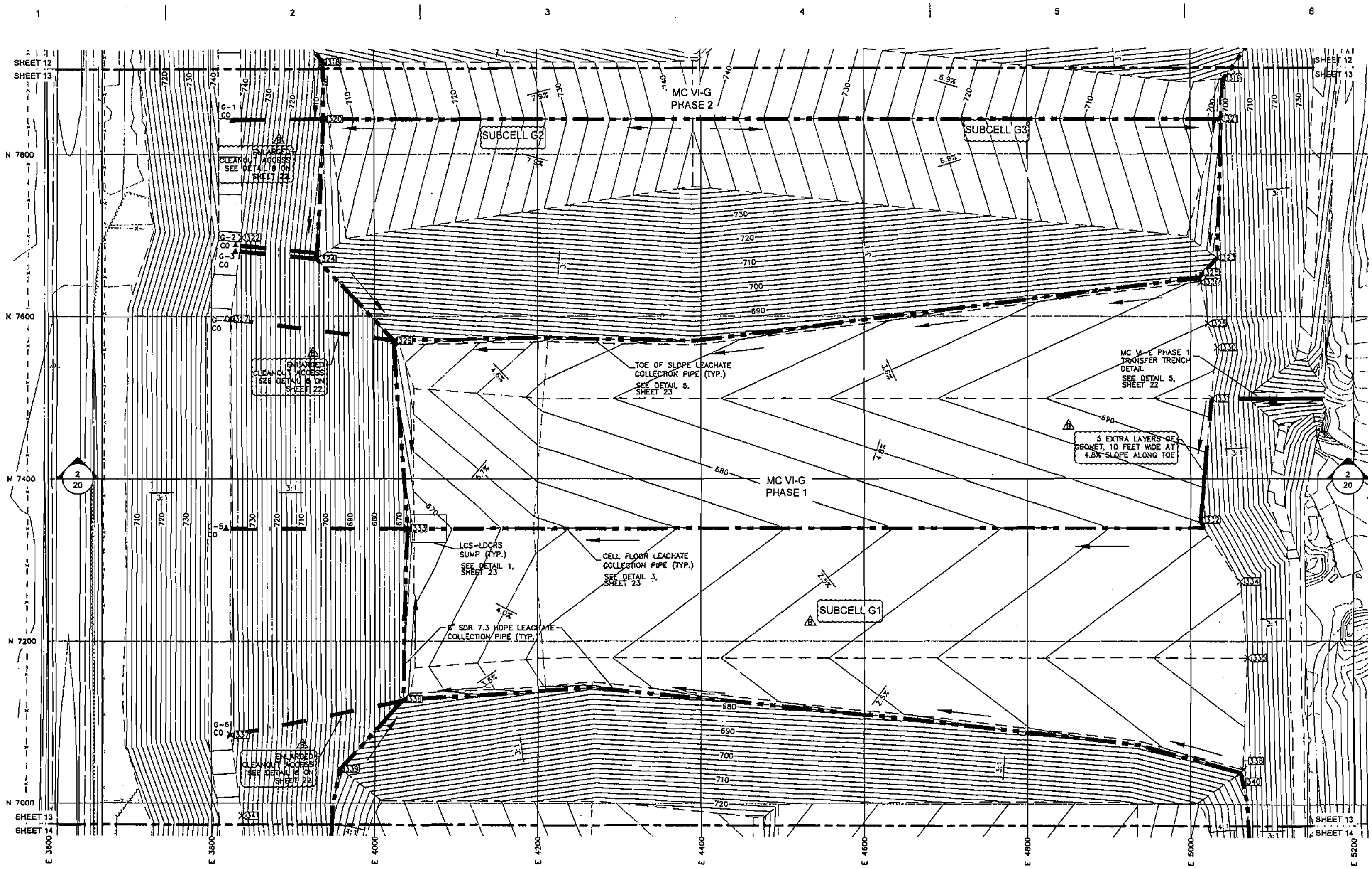
PROJECT NAME:
MASTER CELL VI F&G

PROJECT LOCATION:
WAYNE DISPOSAL, INC.
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO.: 13-080921-03	CAD FILE NAME: TOP OF PRIMARY LINER GRADING PLAN (1 OF 3)
DESIGNED BY: JHL	INCEP DATE: 11/12/08
DRAWN BY: DRL	DRAWING SCALE: AS SHOWN
CHECKED BY: JSS	SUBMITTED DATE: 9/23/11

SHEET TITLE:
TOP OF PRIMARY LINER GRADING PLAN (1 OF 3)

SHEET REFERENCE NUMBER:
12



PRIMARY PERIMETER DIKE COORDINATES			
Point No.	Northing	Easting	Elevation (ft)
322	7696.73	3837.32	733.74
323	7672.20	5032.54	694.58
324	7670.57	3929.29	702.88
325	7647.35	5010.49	687.00
326	7641.99	5012.71	688.30
327	7596.74	3823.09	738.60
328	7591.06	5021.51	690.24
329	7570.10	4023.55	671.56
330	7561.67	5032.75	691.59
331	7498.71	5027.05	693.52
332	7349.00	5012.65	686.42

PRIMARY PERIMETER DIKE COORDINATES			
Point No.	Northing	Easting	Elevation (ft)
333	7338.74	4040.74	666.42
334	7273.49	5061.28	687.73
335	7179.18	5070.45	689.94
336	7128.04	4035.19	668.55
337	7084.38	3823.30	739.24
338	7043.49	5064.48	687.10
339	7042.63	3957.62	692.90
340	7038.96	5061.69	685.79
341	6984.38	3837.32	732.35
342	6886.99	3937.74	707.30
3'3	6836.62	3931.46	710.94

N

0 30' 60' 120'
SCALE

LEGEND

710	EXISTING CONTOUR (2 FT INTERVAL)
	PROPERTY BOUNDARY
	PROPOSED GRADE BREAK
710	PROPOSED TOP OF PRIMARY CONTOUR (2 FT INTERVAL)
300	PROPOSED DIKE COORDINATE POINT NO.
3:1	PROPOSED SLOPE
	PROPOSED 5 EXTRA LAYERS OF GEONET WITH TRANSMISSIVITY ≥ 1.3 X 10^{-3} M^2/S, 10' WIDE, BENEATH GEOCOMPOSITE WITH FLOW DIRECTION
	PROPOSED LEACHATE COLLECTION PIPE AND FLOW DIRECTION
G-1 CO	PROPOSED LEACHATE CLEANOUT PIPE
	PROPOSED PRIMARY COLLECTION SUMP

NOTE:

THE BASE MAP WAS CREATED USING AN AERIAL SURVEY TAKEN IN 2001 BY AIR-LAND SURVEY AND PROVIDED BY WDI, A SURVEY BY MCLLC IN OCTOBER 2007, AND A GROUND SURVEY BY WOI IN OCTOBER 2008.

NTH Consultants, L
Infrastructure Engineering an
Environmental Services

Northville, MI 248.553.
Detroit, MI 313.237.
Lansing, MI 517.484.
Grand Rapids, MI 616.957.
Exton, PA 610.524.
Lehigh Valley, PA 484.893.
Cleveland, OH 216.334.
Indianapolis, IN 317.735.

REVISIONS

REV	DESCRIPTION	DATE
A	[illegible]	[illegible]
B	[illegible]	[illegible]

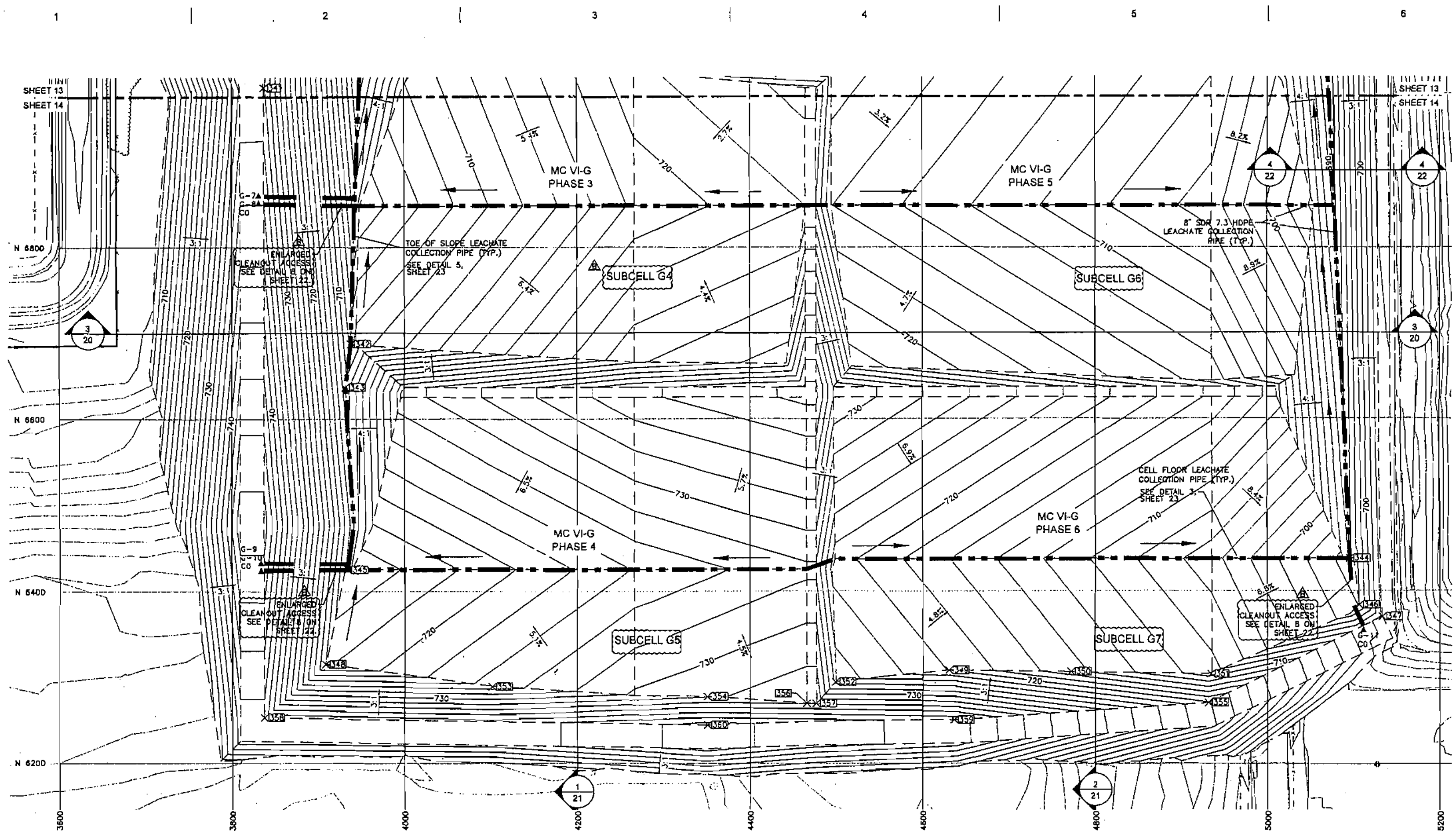
PROJECT NAME
MASTER CELL VI F&G

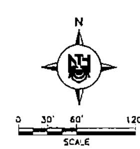
PROJECT LOCATION
WAYNE DISPOSAL, INC
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO.: 13-060921-03	CAD FILE NAME: TOP OF PRIMARY GRADING PLAN
DESIGNED BY: JHL	INCEP DATE: 11/12/08
DRAWN BY: DRL	DRAWING SCALE: AS SHOWN
CHECKED BY: ISS	SUBMITTED DATE: 9/23/11

SHEET TITLE:
TOP OF PRIMARY LINER GRADING PLAN (2 OF 3)

SHEET REFERENCE NUMBER:
13





LEGEND

710 (dotted line)	EXISTING CONTOUR (2 FT INTERVAL)
(solid line)	PROPERTY BOUNDARY
(dashed line)	PROPOSED GRADE BREAK
710 (double line)	PROPOSED TOP OF PRIMARY PRIMARY CONTOUR (2 FT INTERVAL)
300	PROPOSEO OIKE COOROINATE POINT NO.
3:1	PROPOSED SLOPE
(heavy dashed line with arrow)	PROPOSED LEACHATE COLLECTION PIPE AND FLOW DIRECTION
G-8 CO	PROPOSED LEACHATE CLEANOUT PIPE

PRIMARY PERIMETER DIKE COORDINATES

Point No.	Northing	Easting	Elevation (ft)
344	6437.60	5095.87	693.63
345	6425.32	3934.02	713.06
346	6383.71	5106.68	695.89
347	6370.28	5133.49	704.60
348	6316.02	3908.50	717.88
349	6308.86	4630.41	720.03
350	6307.07	4772.00	714.72
351	6304.21	4934.01	709.18
352	6295.30	4498.77	725.35
353	6290.14	4101.66	724.99
354	6278.55	4350.36	731.79

PRIMARY PERIMETER DIKE COORDINATES

Point No	Northing	Easting	Elevation (ft)
355	6270.86	4931.07	720.24
356	6270.50	4465.41	733.79
357	6270.26	4476.27	733.80
358	6253.54	3837.32	739.23
359	6251.34	4636.24	739.17
360	6245.23	4350.52	742.90

NOTES:

1. THE BASE MAP WAS CREATED USING AN AERIAL SURVEY TAKEN IN 2001 BY AIR-LANO SURVEY ANO PROVIDED BY WDI, A SURVEY BY MCLLC IN OCTOBER 2007, AND A GROUND SURVEY BY WOI IN OCTOBER 2008.
2. A MINIMUM OF 5 YEARS PRIOR TO CONSTRUCTING MC VI-G PHASES 3 TO 6, WOI SHALL INVESTIGATE THE OIKE LOCATIONS ANO NEED FOR DEWATERING FOR THE EXISTING MC I TO CONFIRM THE ASSUMPTIONS USED IN THE DESIGN. WDI SHALL INFORM THE MDEQ OF THE RESULTS OF THIS INVESTIGATION AND REVISE THE DESIGN, IF NECESSARY. THE REVISED DESIGN SHALL BE APPROVED BY THE MDEQ PRIOR TO CONSTRUCTION OF MC VI-G PHASES 3 TO 6.

NTH Consultants, Lt

Infrastructure Engineering an
Environmental Services

Northville, MI	248.553.6
Detroit, MI	313.237.3
Lansing, MI	517.484.6
Grand Rapids, MI	616.857.3
Exton, PA	610.524.2
Lehigh Valley, PA	484.893.1
Cleveland, OH	216.334.4
Indianapolis, IN	317.735.7

REVISIONS

REV	DESCRIPTION	DATE
A	PHASING DESIGNATIONS	[illegible]
B	PER MDEQ COMMENTS	[illegible]

PROJECT NAME
MASTER CELL VI F&G

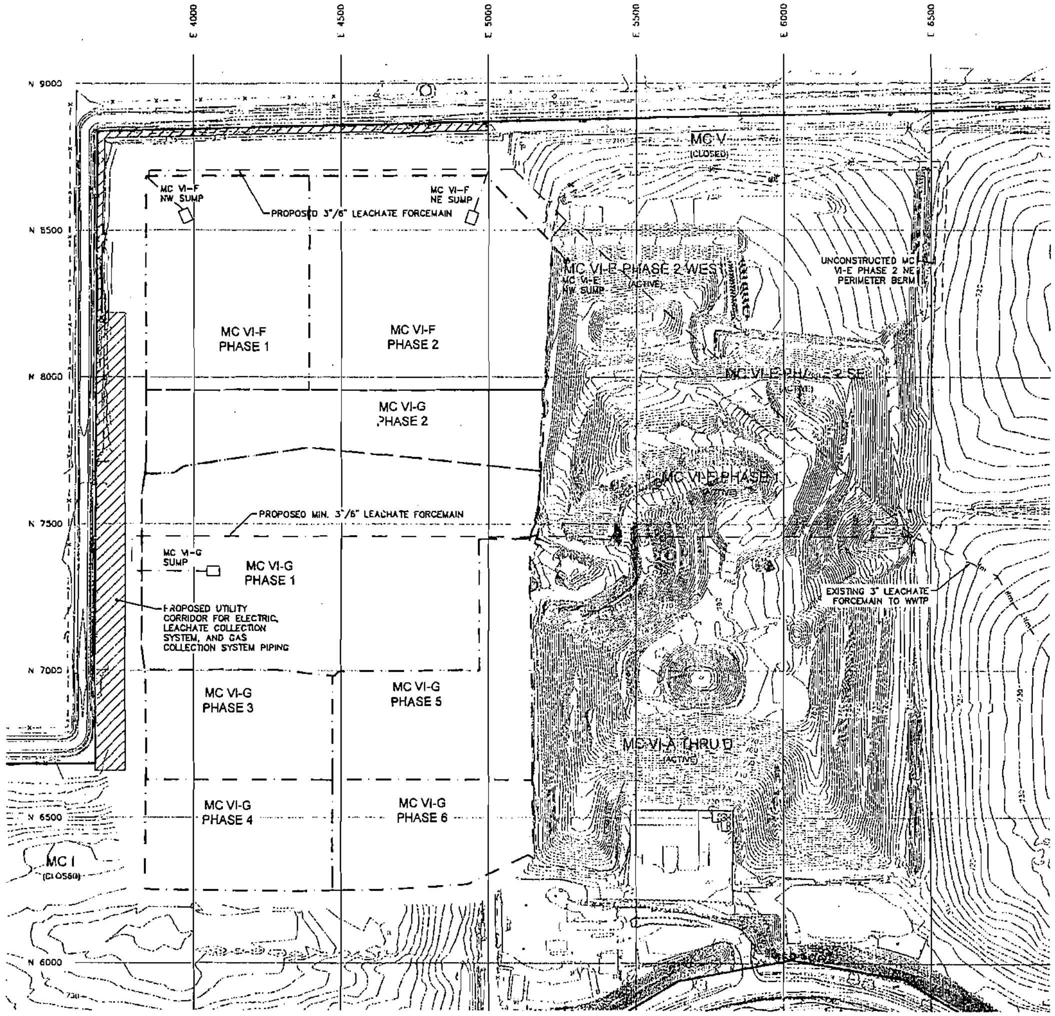
PROJECT LOCATION
WAYNE DISPOSAL, INC
SITE NO. 2
BELLEVILLE, MICHIGAN

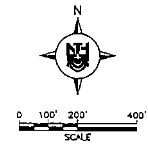
NTH PROJECT NO: 13-060921-03	CAD FILE NAME: TOP OF PRIMARY GRADING PLAN
DESIGNED BY: JHL	INCEP DATE: 11/12/08
DRAWN BY: DRL	DRAWING SCALE: AS SHOWN
CHECKED BY: ISS	SUBMITTED DATE: 9/23/11

SHEET TITLE:
TOP OF PRIMARY LINE
GRADING PLAN (3 OF 3

SHEET REFERENCE NUMBER:
14

1	2	3	4	5	6





LEGEND

710	EXISTING CONTOUR (2 FT INTERVAL)
	EXISTING 3" LEACHATE FORCEMAIN
	PROPERTY BOUNDARY
	PROPOSED PHASE BOUNDARY
	PROPOSED 3"/6" DUAL CONTAINED LEACHATE FORCEMAIN
	PROPOSED UTILITY CORRIDOR

NOTE:

1. THE BASE MAP WAS CREATED USING AN AERIAL SURVEY TAKEN IN 2001 BY AIR-LAND SURVEY AND PROVIDED BY WDI, A SURVEY BY MCLLC IN OCTOBER 2007, AND A GROUND SURVEY BY WDI IN OCTOBER 2008.

NTH Consultants, L
Infrastructure Engineering ar
Environmental Services

Northville, MI 248.553
Detroit, MI 313.237.
Lansing, MI 517.484.
Grand Rapids, MI 616.957.
Exton, PA 610.524.
Lehigh Valley, PA 484.893.
Cleveland, OH 216.334.
Indianapolis, IN 317.735.

REVISIONS

REV	DESCRIPTION	DATE
A	[illegible]	[illegible]

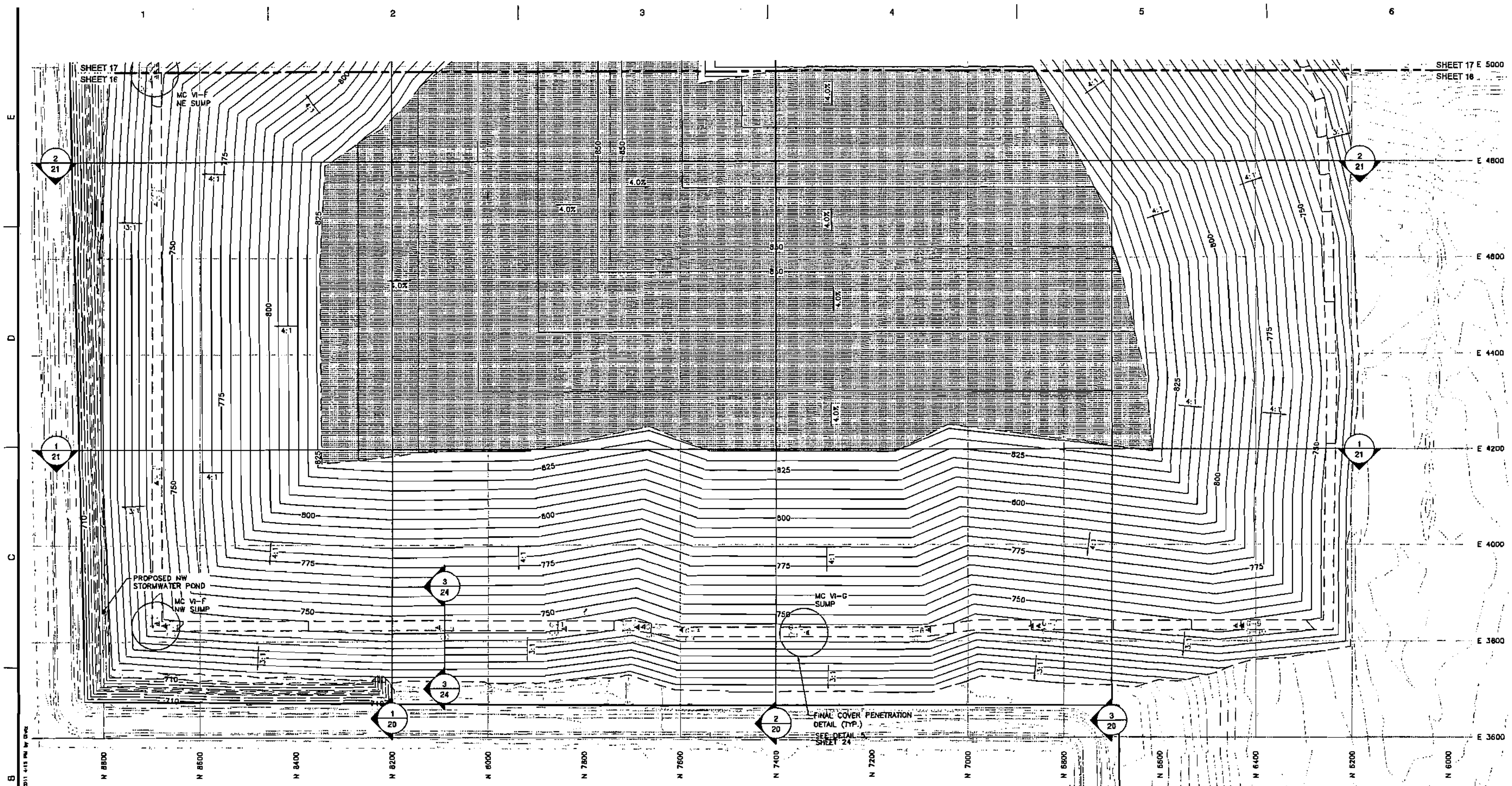
PROJECT NAME
MASTER CELL VI F&G

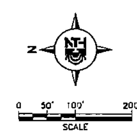
PROJECT LOCATION
WAYNE DISPOSAL, INC
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO.: 13-060921-03	CAD FILE NAME: [illegible]
DESIGNED BY: GRL	INCEP DATE: 11/12/08
DRAWN BY: GRL	DRAWING SCALE: AS SHOWN
CHECKED BY: RBM	SUBMITTED DATE: 2/28/11

SHEET TITLE:
LEACHATE MANAGEMENT PLAN

SHEET REFERENCE NUMBER:
15





LEGEND

	EXISTING CONTOUR (2 FT INTERVAL)
	PROPERTY BOUNDARY
	PROPOSED GRADE BREAK
825	PROPOSED TOP OF FINAL COVER CONTOUR (5 FT INTERVAL)
710	PROPOSED NW STORMWATER POND CONTOUR (2 FT INTERVAL)
3:1	PROPOSED SLOPE
	PROPOSED PASSIVE GAS VENT/TRENCH
	PROPOSED LEACHATE COLLECTION SYSTEM CLEANOUTS
	PROPOSED SUMP LOCATION AND COVER PENETRATION
	PROPOSED GEOCOMPOSITE WITH TRANSMISSIVITY > 5.0 X10^{-4} M^2/S (REMAINING COVER GEOCOMPOSITE TRANSMISSIVITY ≥ 7.0 X 10^{-6} M^2/S)

NOTES:

1. THE BASE MAP WAS CREATED USING AN AERIAL SURVEY TAKEN IN 2001 BY AIR-LAND SURVEY AND PROVIDED BY WDI, A SURVEY BY MCLLC IN OCTOBER 2007, AND A GROUND SURVEY BY WDI IN OCTOBER 2008.
2. INSTALL GAS MANAGEMENT SYSTEM IN ACCORDANCE WITH THE APPROVED CLOSURE PLAN.

NTH Consultants, Ltd.

Infrastructure Engineering and Environmental Services

Northville, MI	248.553.6300
Detroit, MI	313.237.3900
Lansing, MI	517.484.6900
Grand Rapids, MI	616.957.3680
Exton, PA	610.524.2300
Lehigh Valley, PA	484.893.1440
Cleveland, OH	216.334.4040
Indianapolis, IN	317.735.7649

REVISIONS

REV	DESCRIPTION	DATE	BY

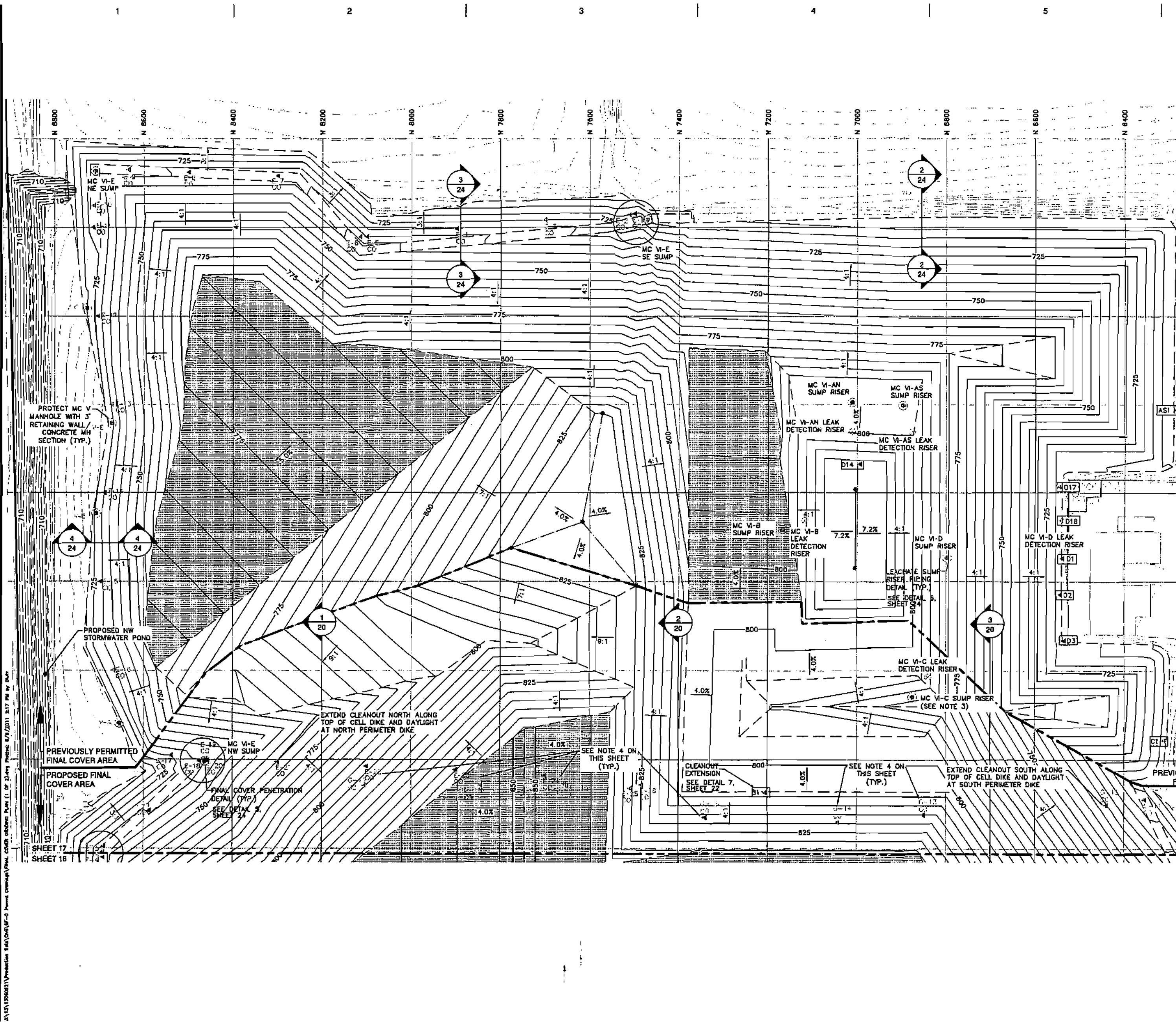
PROJECT NAME:
MASTER CELL VI F&G

PROJECT LOCATION:
WAYNE DISPOSAL, INC.
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO.: 13-080921-03	CAD FILE NAME: FINAL COVER GRADING PLAN (1 OF 2)
DESIGNED BY: DRL	INCEP DATE: 11/12/08
DRAWN BY: DRL	DRAWING SCALE: AS SHOWN
CHECKED BY: RBM	SUBMITTED DATE: 2/28/11

SHEET TITLE:
FINAL COVER GRADING PLAN (1 OF 2)

SHEET REFERENCE NUMBER:
16



0 50' 100' 200'
SCALE

LEGEND

	EXISTING CONTOUR (2 FT INTERVAL)
	PROPERTY BOUNDARY
	EXISTING/PREVIOUSLY PERMITTED LEACHATE SUMP AND COVER PENETRATION
E-1 CO	EXISTING/PREVIOUSLY PERMITTED LEACHATE COLLECTION SYSTEM CLEANOUTS
	EXISTING LEAK DETECTION, COLLECTION, AND REMOVAL SYSTEM RISERS
	EXISTING APPROXIMATE LOCATION OF COVER DRAIN OUTLETS
	PREVIOUSLY PERMITTED PASSIVE GAS VENT
	PROPOSED GRADE BREAK
825	PROPOSED TOP OF FINAL COVER CONTOUR (5 FT INTERVAL)
710	PROPOSED NW STORMWATER POND CONTOUR (2 FT INTERVAL)
3:1	PROPOSED SLOPE
	PROPOSED PASSIVE GAS VENT/TRENCH
	PROPOSED LEACHATE COLLECTION SYSTEM CLEANOUTS
	PROPOSED SUMP LOCATION AND COVER PENETRATION
	PROPOSED GEOCOMPOSITE WITH TRANSMISSIVITY $\geq 5.0 \times 10^{-4}$ M²/S (REMAINING COVER GEOCOMPOSITE TRANSMISSIVITY $\geq 7.0 \times 10^{-5}$ M²/S)

NOTES:

1. THE BASE MAP WAS CREATED USING AN AERIAL SURVEY TAKEN IN 2001 BY AIR-LAND SURVEY, AND PROVIDED BY WDI, A SURVEY BY MCLLC IN OCTOBER 2007 AND A GROUND SURVEY BY WDI IN OCTOBER 2008.
2. CLEANOUTS IN MC VI-AN, AS, B, C, AND D ARE TO BE ABANDONED, EXCEPT B1, C1, D1 THROUGH D3, D14, D17, D18 AND AS1.
3. BEFORE PLACING WASTE AROUND MC VI-C SUMP RISER, A MONITORING PROGRAM SHOULD BE IMPLEMENTED TO MONITOR ITS FUNCTIONALITY. (A)
4. PRIOR TO PLACING WASTE AROUND CLEANOUTS E-22 THROUGH E-26 AND CLEANOUTS G-13 THROUGH G-19, THE CLEANOUTS SHOULD BE EVALUATED TO DETERMINE IF THE LEACHATE COLLECTION LINE CAN BE CLEANED BY A SINGLE ACCESS POINT. IF NOT, THE CLEANOUT SHOULD TO BE EXTENDED IN ACCORDANCE WITH DETAIL 7 ON SHEET 22 OR ALONG INTERIOR DIKE TO PERIMETER DIKE.
5. INSTALL GAS MANAGEMENT SYSTEM IN ACCORDANCE WITH THE APPROVED CLOSURE PLAN.

NTH Consultants, Ltd.
Infrastructure Engineering and Environmental Services

Northville, MI	248.553.6300
Detroit, MI	313.237.3900
Lansing, MI	517.484.6900
Grand Rapids, MI	616.957.3690
Exton, PA	610.524.2300
Lehigh Valley, PA	484.893.1440
Cleveland, OH	216.334.4040
Indianapolis, IN	317.735.7649

REVISIONS

REV	DESCRIPTION	DATE	BY
A	PHASING DESIGNATIONS	8/18/11	DRL

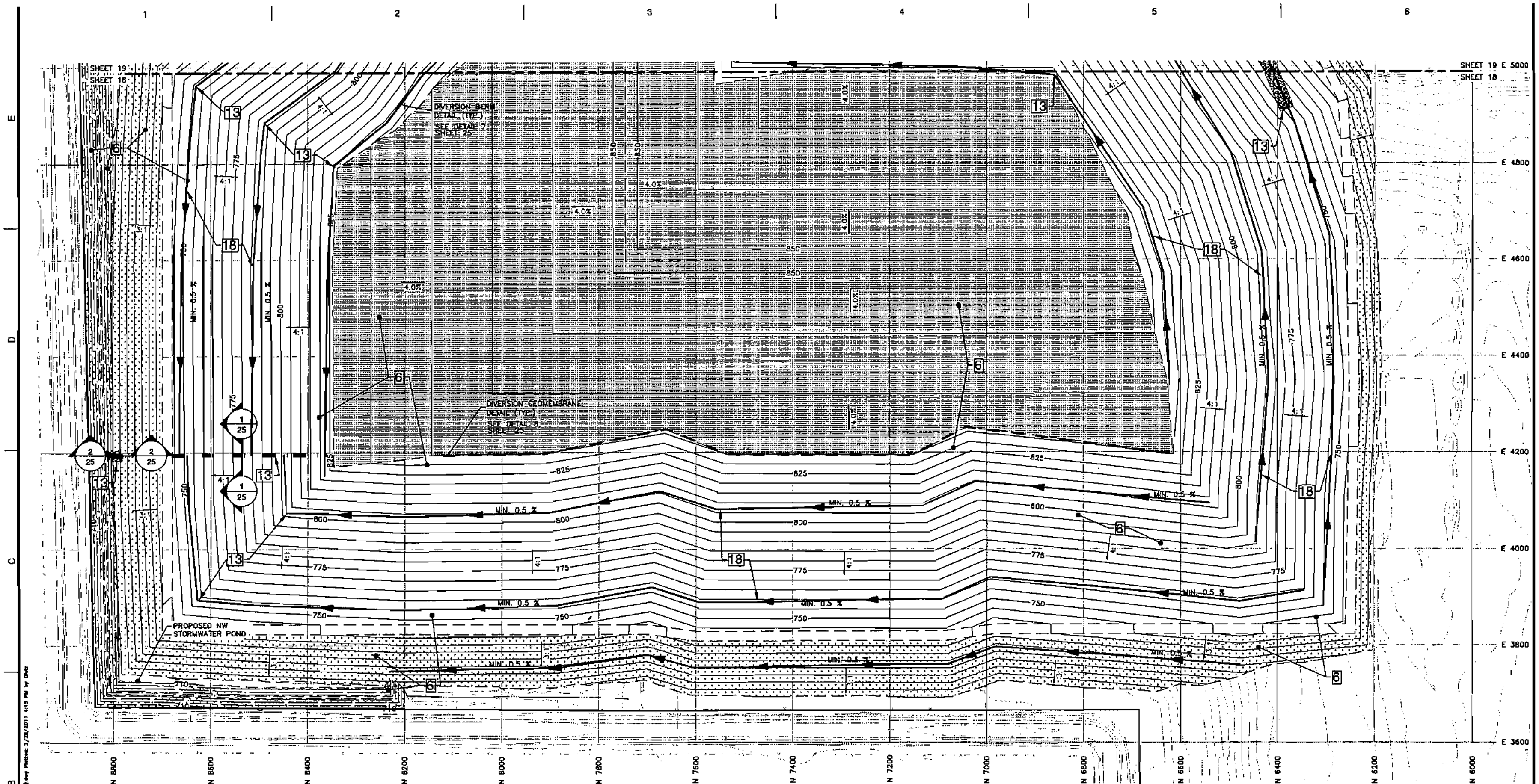
PROJECT NAME
MASTER CELL VI F&G

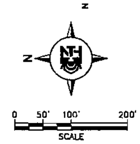
PROJECT LOCATION
WAYNE DISPOSAL, INC.
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO.: 13-080821-03	CAD FILE NAME: FINAL COVER GRADING PLAN (1 OF 2)
DESIGNED BY: DRL	INCEP DATE: 11/12/08
DRAWN BY: DRL	DRAWING SCALE: AS SHOWN
CHECKED BY: RBM	SUBMITTED DATE 2/28/11

SHEET TITLE:
FINAL COVER GRADING PLAN (2 OF 2)

SHEET REFERENCE NUMBER:
17





LEGEND

	EXISTING CONTOUR (2 FT INTERVAL)
	PROPERTY BOUNDARY
	PROPOSED GRADE BREAK
825	PROPOSED TOP OF FINAL COVER CONTOUR (5 FT INTERVAL)
710	PROPOSED NW STORMWATER POND CONTOUR (2 FT INTERVAL)
3:1	PROPOSED SLOPE
	PROPOSED DIVERSION GEOMEMBRANE
	PROPOSED DIVERSION BERM
	PROPOSED DOWNSLOPE SPILLWAY
	PROPOSED OUTLET SWALE
	PROPOSED RIP-RAP
	PROPOSED PERMANENT SEEDING-AT TIME OF DIKE CONSTRUCTION
	PROPOSED GEOCOMPOSITE WITH TRANSMISSIVITY $\geq 5.0 \times 10^{-4}$ M^2/S (REMAINING COVER GEOCOMPOSITE TRANSMISSIVITY $\geq 7.0 \times 10^{-5}$ M^2/S)

SOIL EROSION AND SEDIMENTATION CONTROL LEGEND

6	SEEDING WITH MULCH AND/OR MATTING
13	RIPRAP, RUBBLE, CABIONS
18	DIVERSION BERM

NOTES:

1. THE BASE MAP WAS CREATED USING AN AERIAL SURVEY TAKEN IN 2001 BY AIR-LAND SURVEY AND PROVIDED BY WDI, A SURVEY BY MCLLC IN OCTOBER 2007, AND A GROUND SURVEY BY WDI IN OCTOBER 2008.
2. SILT FENCE PLACED AT TIME OF CONSTRUCTION AND MAINTAINED UNTIL VEGETATION ON OUTSIDE SLOPE OF DIKE IS ESTABLISHED. SEE STORM WATER MANAGEMENT SYSTEM DETAILS SHEET FOR DETAIL.

NTH Consultants, Ltd.
Infrastructure Engineering and Environmental Services

Northville, MI	248.553.6300
Detroit, MI	313.237.3900
Lansing, MI	517.484.6900
Grand Rapids, MI	616.957.3690
Exton, PA	610.524.2300
Lehigh Valley, PA	484.893.1440
Cleveland, OH	216.331.4040
Indianapolis, IN	317.735.7649

REVISIONS

REV	DESCRIPTION	DATE	BY

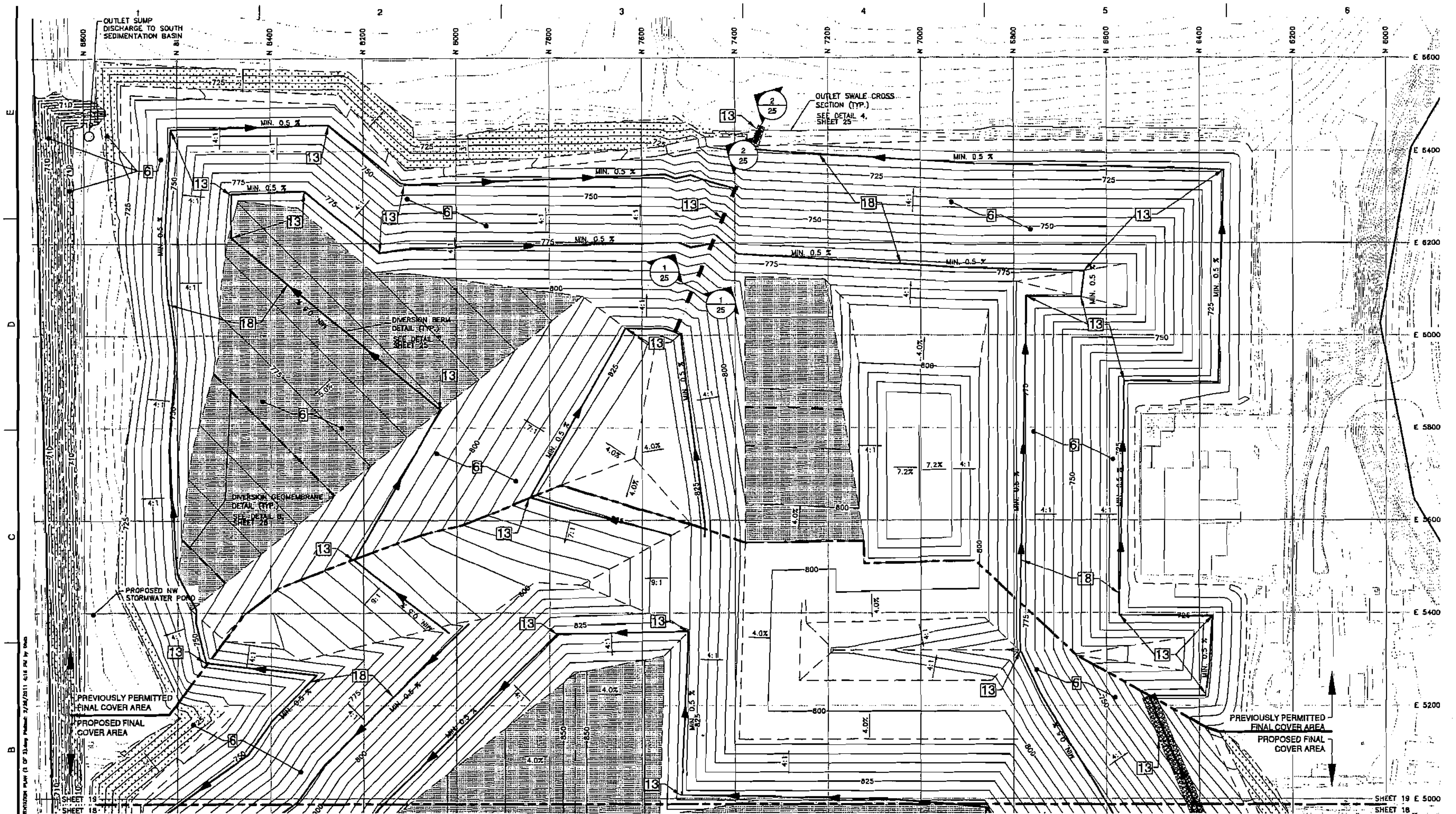
PROJECT NAME
MASTER CELL VI F&G

PROJECT LOCATION
WAYNE DISPOSAL, INC.
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO.: 13-080821-03	CAD FILE NAME: [illegible]
DESIGNED BY: DRL	INCEP DATE: 11/12/08
DRAWN BY: DRL	DRAWING SCALE: AS SHOWN
CHECKED BY: RBM	SUBMITTED DATE: 2/26/11

SHEET TITLE:
STORMWATER MANAGEMENT AND SEDIMENTATION PLAN (1 OF 2)

SHEET REFERENCE NUMBER:
18



0 50' 100' 200'
SCALE

LEGEND

- EXISTING CONTOUR (2 FT INTERVAL)
- PROPERTY BOUNDARY
- PROPOSED GRADE BREAK
- 825 — PROPOSED TOP OF FINAL COVER CONTOUR (5 FT INTERVAL)
- 710 — PROPOSED NORTH POND CONTOUR (2 FT INTERVAL)
- 3:1 — PROPOSED SLOPE
- PROPOSED DIVERSION GEOMEMBRANE
- PROPOSED DIVERSION BERM
- PROPOSED DOWNSLOPE SPILLWAY
- PROPOSED OUTLET SWALE
- PROPOSED RIP-RAP
- PROPOSED PERMANENT SEEDING-AT TIME OF DIKE CONSTRUCTION
- PROPOSED GEOCOMPOSITE WITH TRANSMISSIVITY $\geq 5.0 \times 10^{-4}$ M^2/S (REMAINING COVER GEOCOMPOSITE TRANSMISSIVITY $\geq 7.0 \times 10^{-5}$ M^2/S)

SOIL EROSION AND SEDIMENTATION CONTROL LEGEND

- 6 — SEEDING WITH MULCH AND/OR MATTING
- 13 — RIPRAP, RUBBLE, GABIONS
- 18 — DIVERSION BERM

NOTES:

1. THE BASE MAP WAS CREATED USING AN AERIAL SURVEY TAKEN IN 2001 BY AIR-LAND SURVEY AND PROVIDED BY WDI, A SURVEY BY MCLLC IN OCTOBER 2007, AND A GROUND SURVEY BY WDI IN OCTOBER 2008.
2. SILT FENCE PLACED AT TIME OF CONSTRUCTION AND MAINTAINED UNTIL VEGETATION ON OUTSIDE SLOPE OF DIKE IS ESTABLISHED. SEE STORM WATER MANAGEMENT SYSTEM DETAILS SHEET FOR DETAIL.

NTH Consultants, Ltd.
Infrastructure Engineering and Environmental Services

Northville, MI	248.553.6300
Detroit, MI	313.237.3900
Lansing, MI	517.484.6900
Grand Rapids, MI	616.957.3690
Exton, PA	610.524.2300
Lehigh Valley, PA	484.893.1440
Cleveland, OH	216.334.4040
Indianapolis, IN	317.735.7649

REVISIONS

REV	DESCRIPTION	DATE	BY

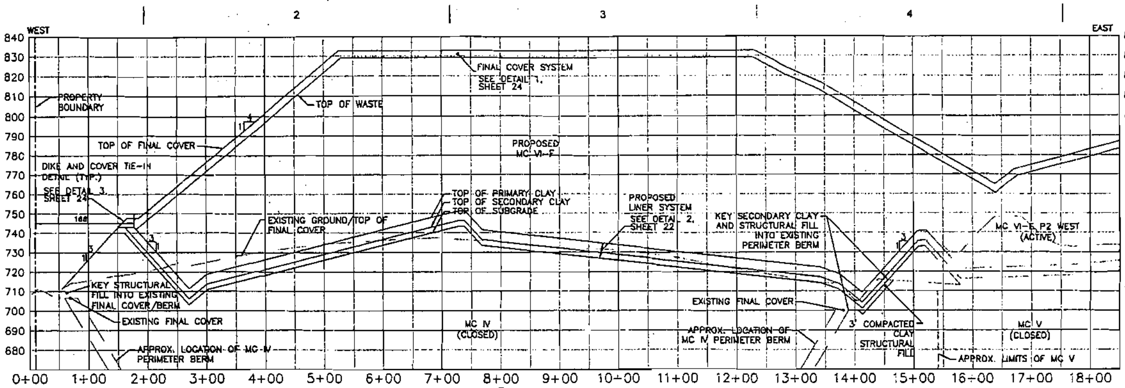
PROJECT NAME:
MASTER CELL VI F&G

PROJECT LOCATION:
WAYNE DISPOSAL, INC.
SITE NO. 2
BELLEVILLE, MICHIGAN

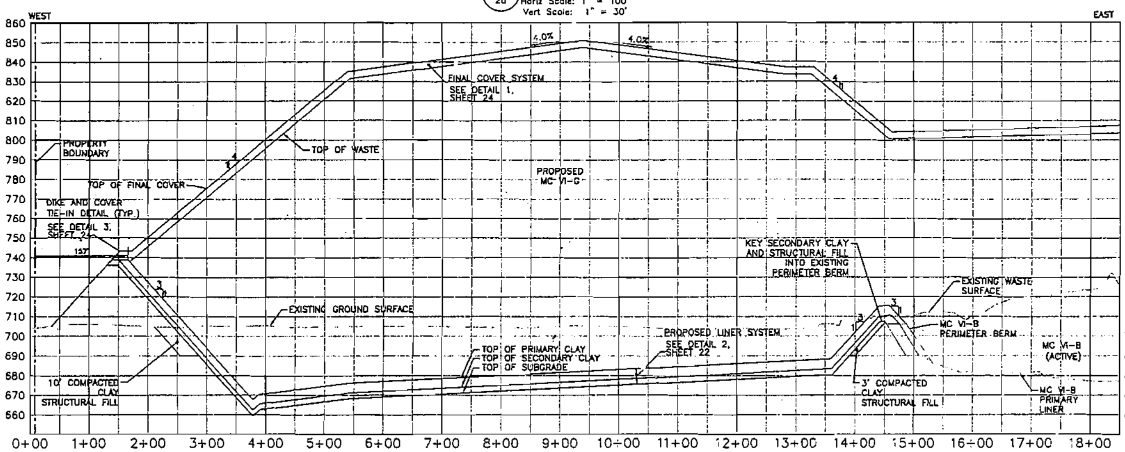
NTH PROJECT NO.: 13-060921-03	CAD FILE NAME: STORMWATER MANAGEMENT & SEDIMENTATION PLAN (2 OF 2)
DESIGNED BY: DRL	INCEP DATE: 11/12/08
DRAWN BY: DRL	DRAWING SCALE: AS SHOWN
CHECKED BY: RGM	SUBMITTED DATE: 2/28/11

SHEET TITLE:
STORMWATER MANAGEMENT AND SEDIMENTATION PLAN (2 OF 2)

SHEET REFERENCE NUMBER:
19



N 8200 PROFILE (1/20)
Horiz Scale: 1" = 100'
Vert Scale: 1" = 30'



N 7400 PROFILE (2/20)
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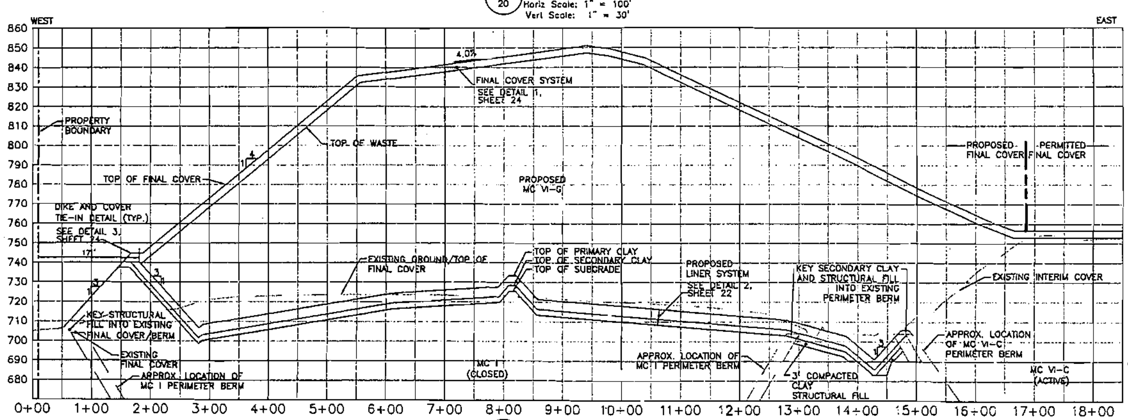
Vert Scale: 1" = 30'



N 6700 PROFILE (3/20)
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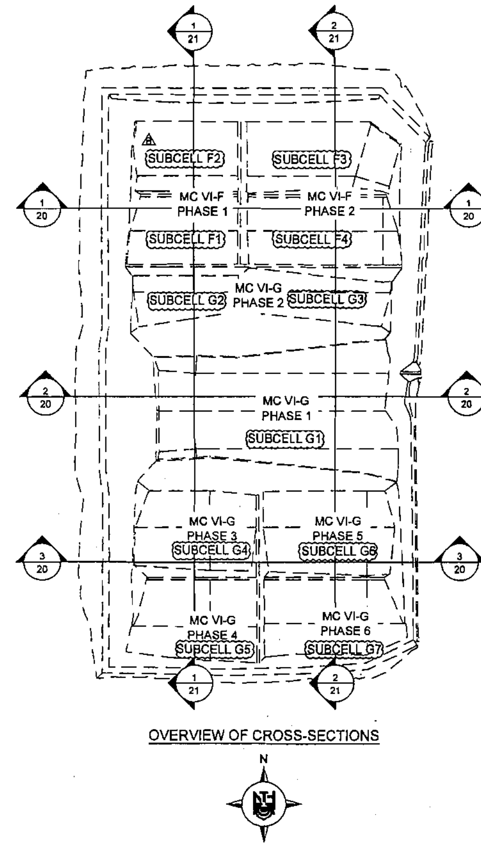

OVERVIEW OF CROSS-SECTIONS

NOTE:

PRIOR TO CELL CONSTRUCTION, DIG TEST PITS TO VERIFY MC I AND IV DIKE ALIGNMENTS.

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Infrastructure Engineering a
Environmental Services

Northville, MI 248.553
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Lansing, MI 517.484
Grand Rapids, MI 616.957
Exton, PA 610.524
Lehigh Valley, PA 484.893
Cleveland, OH 216.334
Indianapolis, IN 317.733

REVISIONS

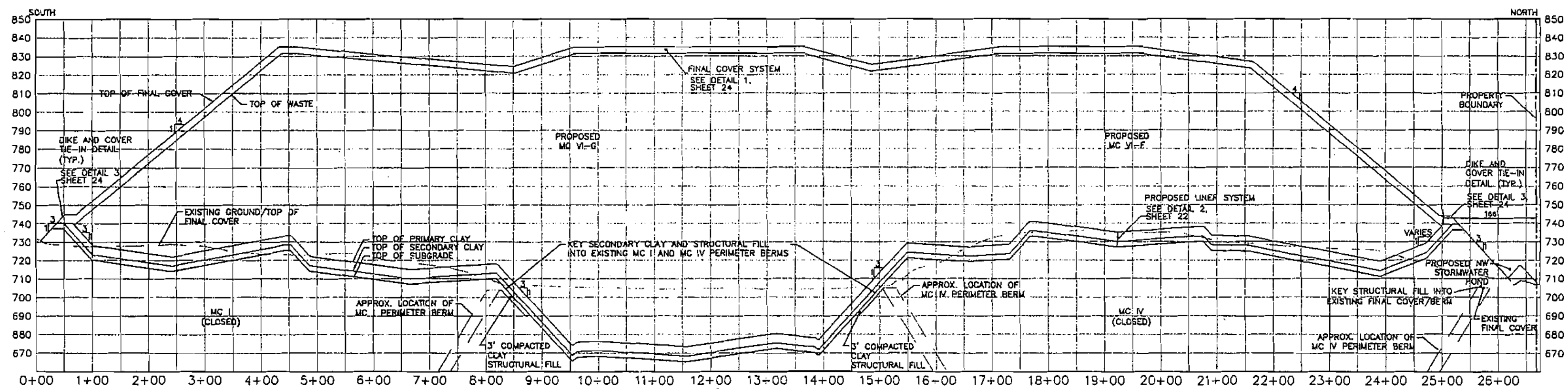
PROJECT NAME: MASTER CELL VI F&G

PROJECT LOCATION: WAYNE DISPOSAL, INC SITE NO. 2 BELLEVILLE, MICHIGAN

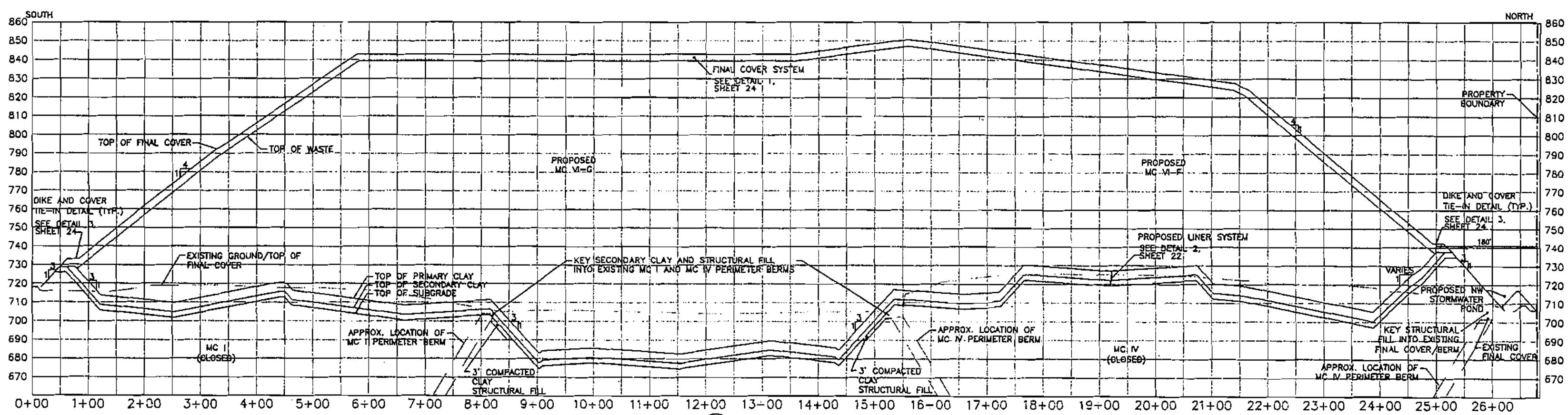
NTH PROJECT NO: 13-060921-03	CAD FILE NAME: CROSS SEC (1 OF 2)
DESIGNED BY: JHL	INCEP DATE: 11/12/08
DRAWN BY: ORL	DRAWING SC: AS SHOW
CHECKED BY: ISS	SUBMITTED D: 8/23/11

SHEET TITLE: CROSS SECTIONS (1 (

SHEET REFERENCE NUMBER: 20



1/21 E 4200 PROFILE
Horiz Scale: 1" = 100'
Vert Scale: 1" = 30'



2/21 E 4800 PROFILE
Horiz Scale: 1" = 100'
Vert Scale: 1" = 30'

NOTE:
PRIOR TO CELL CONSTRUCTION, DIG TEST PITS TO VERIFY MC I AND IV DIKE ALIGNMENTS.

NTH Consultants, L
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Environmental Services

Northville, MI	248.553.(
Detroit, MI	313.237.:
Lansing, MI	517.484.(
Grand Rapids, MI	616.967.:
Exton, PA	610.624.:
Lehigh Valley, PA	484.693.'
Cleveland, OH	216.334.(
Indianapolis, IN	317.735.:

REVISIONS

REV	DESCRIPTION	DATE

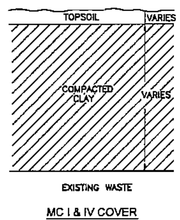
PROJECT NAME:
MASTER CELL VI F&G

PROJECT LOCATION:
WAYNE DISPOSAL, INC
SITE NO. 2
BELLEVILLE, MICHIGAN

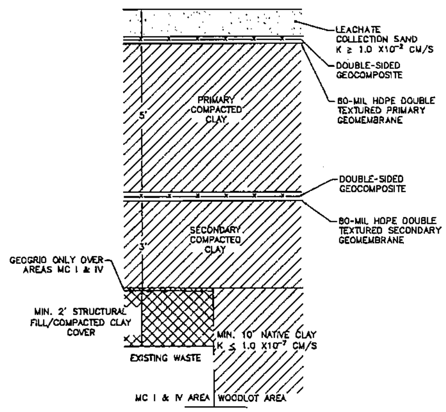
NTH PROJECT NO.: 13-060921-03	CAD FILE NAME: CROSS SECT (2 OF 3)
DESIGNED BY: DRL	INCEP DATE: 11/12/08
DRAWN BY: DRL	DRAWING SCALE: AS SHOWN
CHECKED BY: RBM	SUBMITTED ON: 2/28/11

SHEET TITLE:
CROSS SECTIONS (2 O

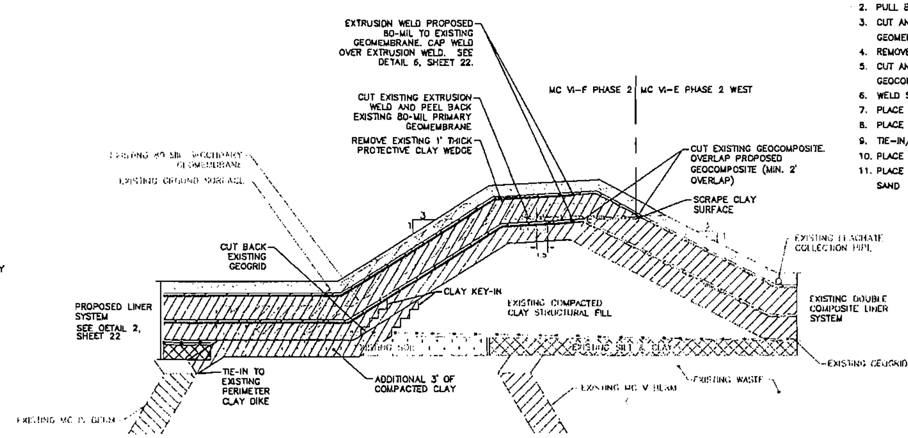
SHEET REFERENCE NUMBER:
21



1 EXISTING COVER DETAIL
22 NOT TO SCALE



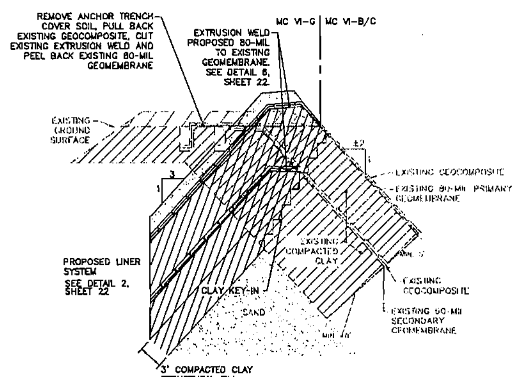
2 PROPOSED LINER SYSTEM
22 NOT TO SCALE



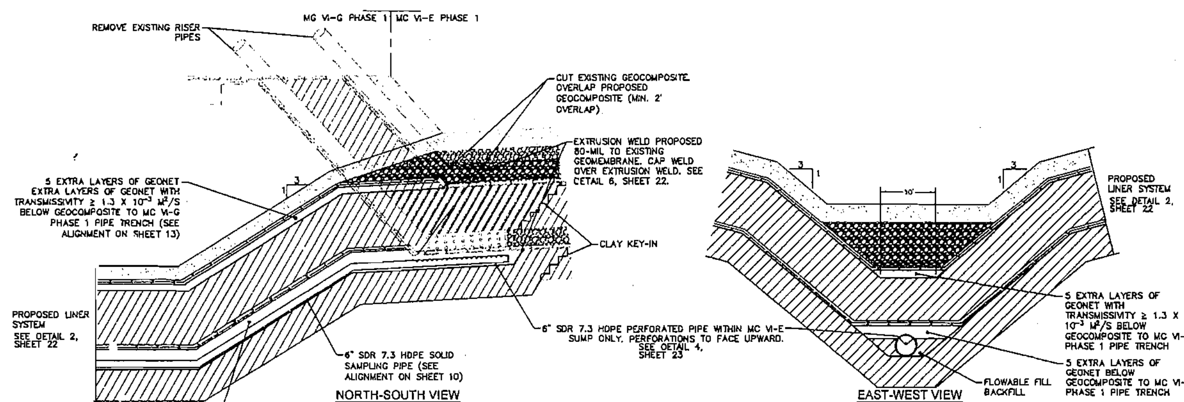
3 MC VI-F PHASE 2 & MC VI-E PHASE 2 WEST TIE-IN DETAIL
22 NOT TO SCALE

SEQUENCE OF CONSTRUCTION

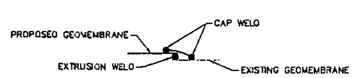
1. REMOVE CLAY WEDGE
2. PULL BACK PRIMARY GEOCOMPOSITE
3. CUT AND PULL BACK PRIMARY GEOMEMBRANE
4. REMOVE OUTSIDE CLAY DIKE
5. CUT AND PULL BACK SECONDARY GEOCOMPOSITE
6. WELD SECONDARY GEOMEMBRANE
7. PLACE SECONDARY GEOCOMPOSITE
8. PLACE PRIMARY CLAY
9. TIE-IN/WELD PRIMARY GEOMEMBRANE
10. PLACE PRIMARY GEOCOMPOSITE
11. PLACE 1 FOOT OF LEACHATE COLLECTION SAND



4 MC VI-G AND MC VI-B OR C TIE-IN DETAIL
22 NOT TO SCALE

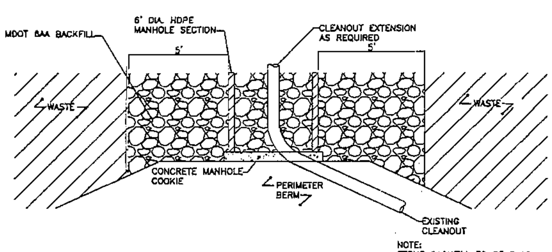


5 MC VI-E PHASE 1 TRANSFER TRENCH DETAIL
22 NOT TO SCALE



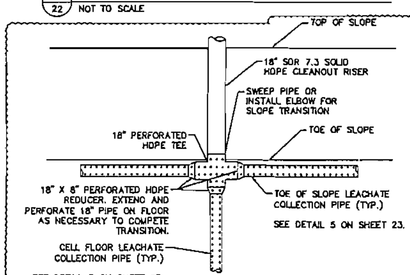
NOTE: DETAIL APPLIES AT LOCATIONS WHERE PROPOSED GEOMEMBRANE TIES INTO EXISTING GEOMEMBRANE

6 GEOMEMBRANE WELDING DETAIL
22 NOT TO SCALE

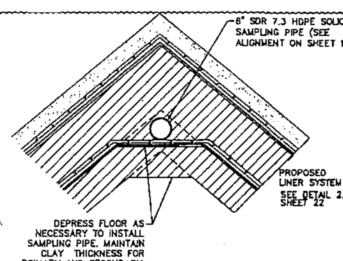


NOTE:
STONE BACKFILL TO BE PLACED AT SAME HEIGHT ON INTERIOR AND EXTERIOR OF MANHOLE.

7 CLEANOUT EXTENSION
22 NOT TO SCALE



8 ENLARGED CLEANOUT ACCESS
22 NOT TO SCALE



9 MC VI-E PHASE 1 SAMPLING PIPE
22 NOT TO SCALE

NTH Consultants, L
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Northville, MI	248.553
Detroit, MI	313.237
Lansing, MI	517.484
Grand Rapids, MI	616.957
Exton, PA	610.524
Lehigh Valley, PA	484.893
Cleveland, OH	216.334
Indianapolis, IN	317.735

REVISIONS

REV	DESCRIPTION	DAT
A	PHASING DESIGNATIONS	5/16/
B	PER MDEQ COMMENTS	6/23/

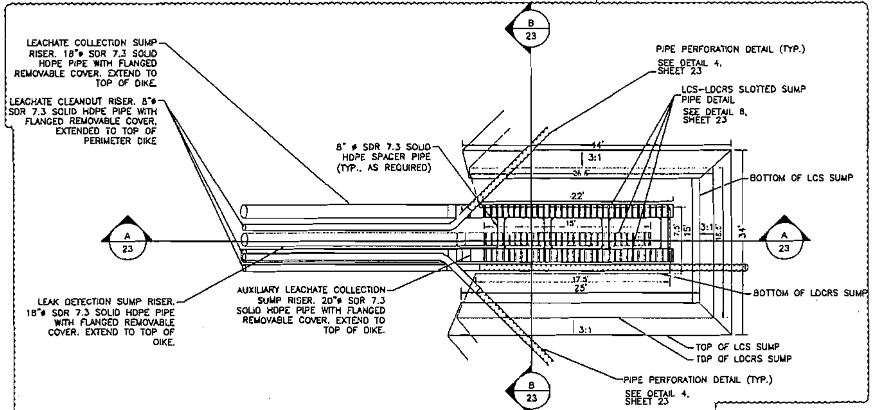
PROJECT NAME:
MASTER CELL VI F&G

PROJECT LOCATION
WAYNE DISPOSAL, INC
SITE NO. 2
BELLEVILLE, MICHIGA

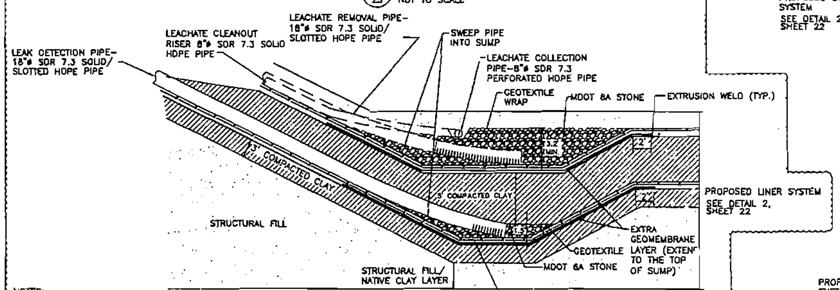
NTH PROJECT NO.: 13-060921-03	CAD FILE NA
DESIGNED BY: JHL	INCEP DATE: 11/12/08
DRAWN BY: DRL	DRAWING SC AS SHOW
CHECKED BY: ISS	SUBMITTED 6/23/11

SHEET TITLE:
LINER SYSTEM DETAI

SHEET REFERENCE NUMBER:
22

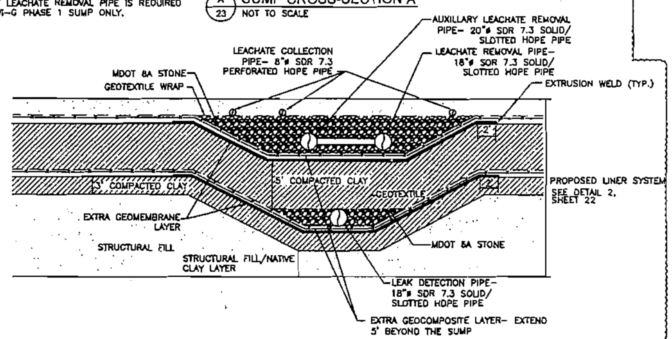


1/23 LCS-LDCRS SUMP (TYP.)
NOT TO SCALE

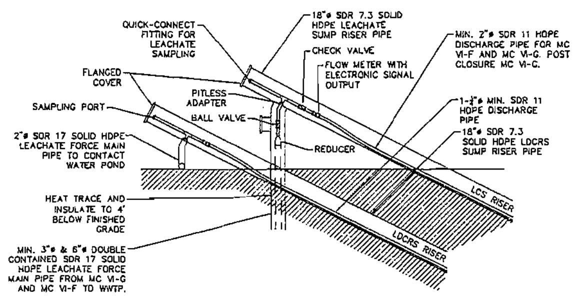


NOTES:
1. THE LCS AND LDCRS PUMP ELEVATIONS ARE:
   LDCRS "PUMP-ON" ELEV= TOP OF LDCRS SUMP
   LDCRS "PUMP-OFF" ELEV= 1 FOOT ABOVE LDCRS SUMP BOTTOM
   LCS "PUMP-ON" ELEV= AT LCS PIPE INVERT
   LCS "PUMP-OFF" ELEV= 1 FOOT ABOVE LCS SUMP BOTTOM
2. OTHER "PUMP-ON"/"PUMP-OFF" CONTROLS MAY BE USED PROVIDED LESS THAN 1 FOOT OF LEACHATE HEAD ON THE LINER IS MAINTAINED.
3. THE AUXILIARY LEACHATE REMOVAL PIPE IS REQUIRED FOR THE MC VI-G PHASE 1 SUMP ONLY.

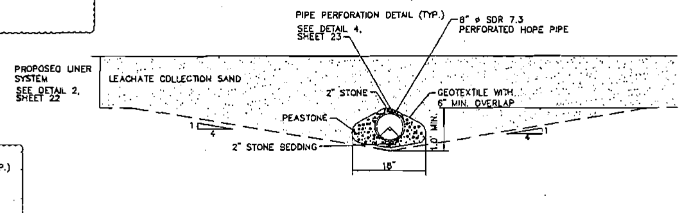
A/23 SUMP CROSS-SECTION A
NOT TO SCALE



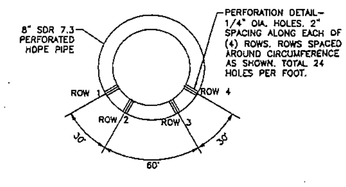
B/23 SUMP CROSS-SECTION B
NOT TO SCALE



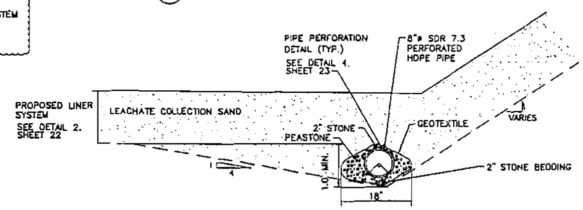
2/23 LCS AND LDCRS RISER DETAIL
NOT TO SCALE



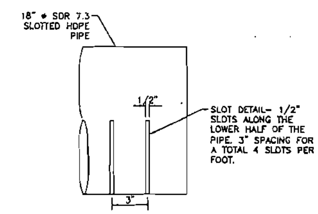
3/23 CELL FLOOR LEACHATE COLLECTION PIPE (TYP.)
NOT TO SCALE



4/23 PIPE PERFORATION DETAIL (TYP.)
NOT TO SCALE.



5/23 TOE OF SLOPE LEACHATE COLLECTION PIPE (TYP.)
NOT TO SCALE



6/23 LCS-LDCRS SLOTTED SUMP PIPE DETAIL
NOT TO SCALE

Geosynthetic Materials

Material	Location	Description	Product	Additional Requirements
80-mil Geomembrane	Primary and secondary liners	80-mil HDPE, textured both sides	GSE HD textured, or equivalent	Interface friction requirements in CQA Plan
40-mil Geomembrane	Final cover	40-mil HDPE, textured both sides	GSE HD textured, or equivalent	Interface friction requirements in CQA Plan
Geosynthetic Clay Liner	Final cover	Sodium bentonite encapsulated between two geotextiles that are needle punched or stitch bonded together	CETCO Bentomat ST, or equivalent	Internal shear strength requirements in CQA Plan
Geocomposite	LCS and LDCRS	200-mil HDPE, bonded top and bottom to geotextile meeting requirements below	GSE FABRINET, or equivalent	Transmissivity and interface friction requirements in CQA Plan
Cover Geocomposite	Final cover	200-mil HDPE, bonded top and bottom to geotextile meeting requirements below	GSE FABRINET, or equivalent	Transmissivity and interface friction requirements in CQA Plan
Geonet	LCS and LDCRS sumps, and LDCRS collectors	200-mil HDPE	GSE HYPERNET, or equivalent	Transmissivity requirements in CQA Plan
Geotextile	All geocomposites, gravel/geotextile envelopes for LCS, and final cover perimeter drain	Nominal 8 oz/yd2, needle-punched, nonwoven polypropylene	Amoco 4508, Synthetic Industries Geotex 801, or equivalent	AASHTO M288-98 requirements for Drainage Geotextile (Class 2)
Geogrid	Above Subgrade	Biaxial Polymeric Grid	Huesker Fortrac 80-80, or equivalent	None

LCS denotes leachate collection system
LDCRS denotes leak detection, collection, and removal system

NTH Consultants, Ltd.
Infrastructure Engineering and Environmental Services

Northville, MI	248.553.63
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Lansing, MI	517.484.69
Grand Rapids, MI	616.957.36
Exton, PA	610.524.23
Lehigh Valley, PA	484.893.14
Cleveland, OH	216.334.40
Indianapolis, IN	317.735.78

REVISIONS

REV	DESCRIPTION	DATE
1	PER MDEQ COMMENTS	8/23/11

PROJECT NAME
MASTER CELL VI F&G

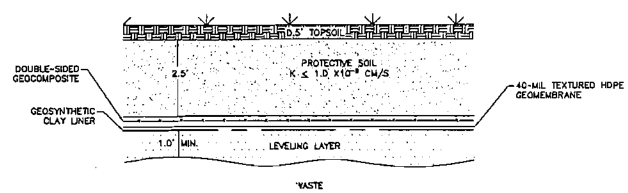
PROJECT LOCATION
WAYNE DISPOSAL, INC.
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO: 13-080921-03	CAD FILE NAME: LEACHATE COLLECTION SYSTEM DETAILS
DESIGNED BY: JHL	INCEP DATE: 11/12/08
DRAWN BY: ORL	DRAWING SCALE: AS SHOWN
CHECKED BY: ISS	SUBMITTED DATE: 8/23/11

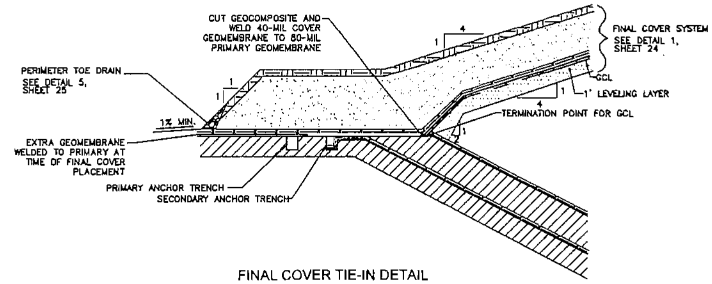
SHEET TITLE
LEACHATE COLLECTION SYSTEM DETAILS

SHEET REFERENCE NUMBER
23

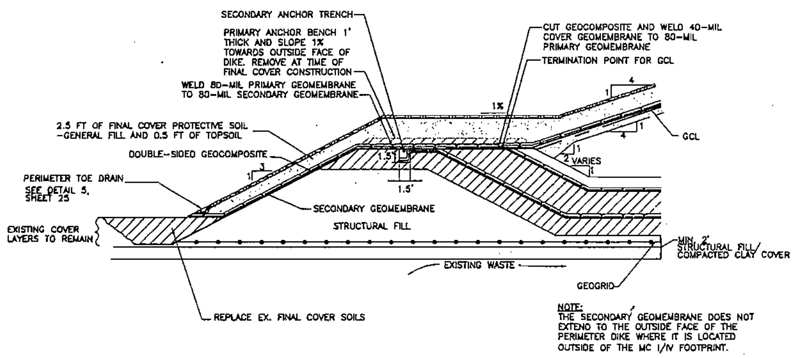
1 | 2 | 3 | 4 | 5 | 6



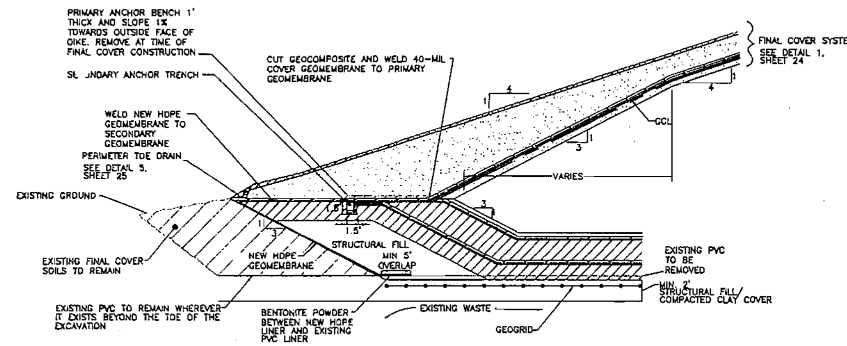
1/24 FINAL COVER SYSTEM
NOT TO SCALE



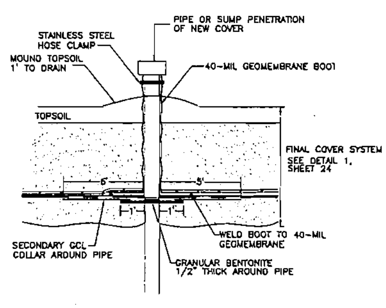
FINAL COVER TIE-IN DETAIL
2/24 MC VI-AN, AS, C & D
NOT TO SCALE



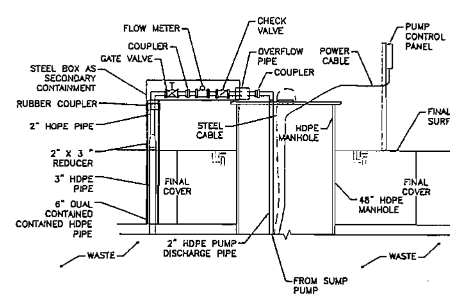
DIKE AND COVER TIE-IN DETAIL (TYP.)
3/24 MC VI-F, G & EAST SIDE OF VI-E
NOT TO SCALE



DIKE AND COVER TIE-IN DETAIL
4/24 NORTH SIDE OF MC VI-F
NOT TO SCALE



5/24 FINAL COVER PENETRATION DETAIL (TYP.)
NOT TO SCALE



LEACHATE SUMP RISER PIPING DETAIL
6/24 (VI-A, B, C, & D RISERS)
NOT TO SCALE

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Environmental Services

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Lansing, MI	517.484
Grand Rapids, MI	616.957
Exton, PA	610.524
Lehigh Valley, PA	484.893
Cleveland, OH	216.334
Indianapolis, IN	317.735

REVISIONS

REV	DESCRIPTION	DAT

PROJECT NAME
MASTER CELL VI F&G

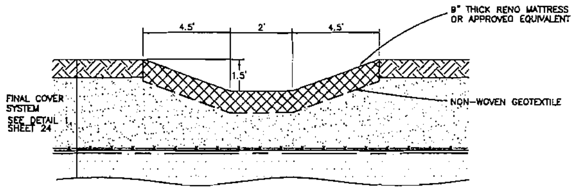
PROJECT LOCATION
WAYNE DISPOSAL, INC
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO.: 13-060921-03	CAD FILE NAM: FINAL COVER
DESIGNED BY: DRL	INCEP DATE: 11/12/08
DRAWN BY: DRL	DRAWING SC: AS SHOW
CHECKED BY: RBM	SUBMITTED D: 2/28/11

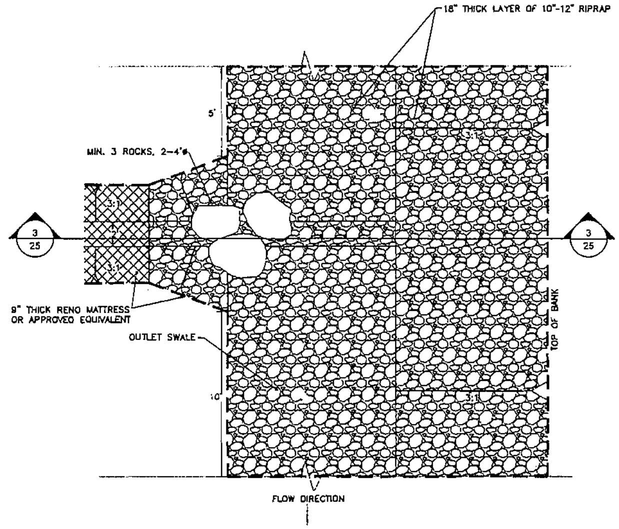
SHEET TITLE:
FINAL COVER DETAILS

SHEET REFERENCE NUMBER:
24

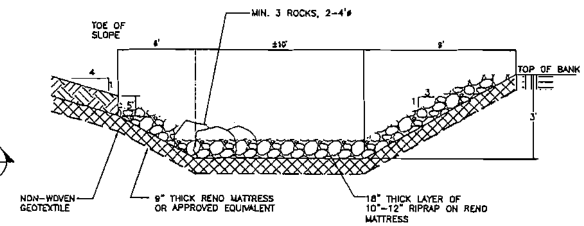
1	2	3	4	5	6



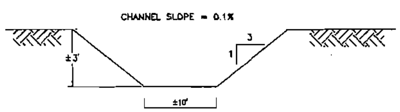
(1/25) SPILLWAY CROSS-SECTION
NOT TO SCALE



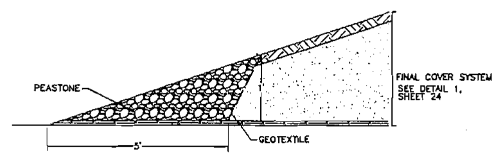
(2/25) TOE OF SPILLWAY DOWNSLOPE CHANNEL
NOT TO SCALE



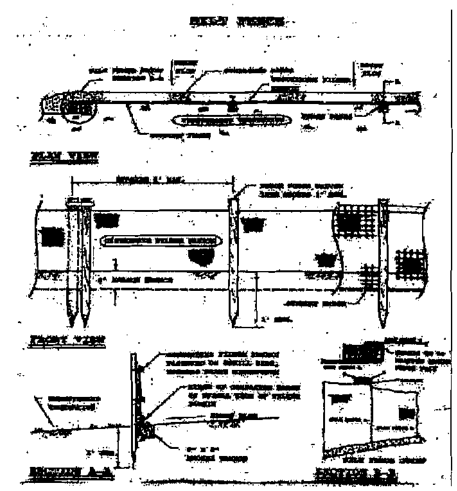
(3/25) TOE OF SPILLWAY PROFILE
NOT TO SCALE



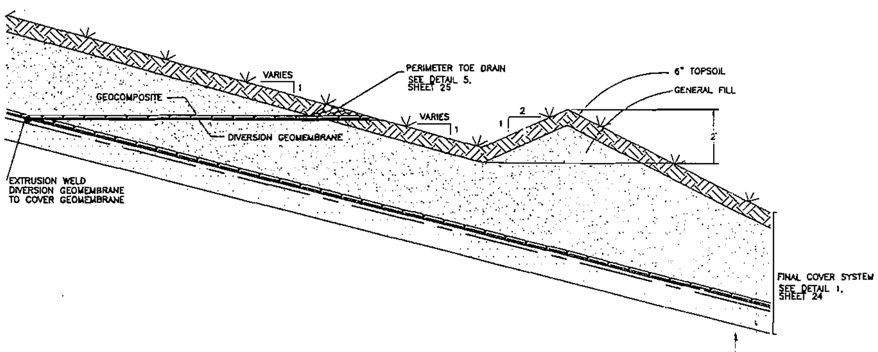
(4/25) OUTLET SWALE CROSS SECTION (TYP.)
NOT TO SCALE



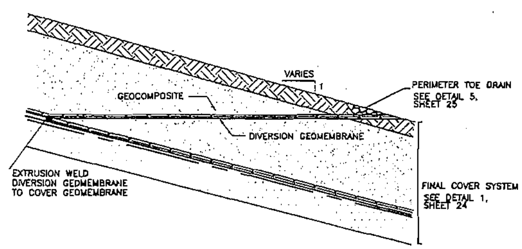
(5/25) PERIMETER TOE DRAIN
NOT TO SCALE



(6/25) SILT FENCE DETAIL (TYP.)
NOT TO SCALE



(7/25) DIVERSION BERM DETAIL (TYP.)
NOT TO SCALE



(8/25) DIVERSION GEOMEMBRANE DETAIL (TYP.)
NOT TO SCALE

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Northville, MI	248.553.
Detroit, MI	313.237.
Lansing, MI	517.484.
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Exton, PA	610.524.
Lehigh Valley, PA	484.893.
Cleveland, OH	216.334.
Indianapolis, IN	317.735.

REVISIONS

REV	DESCRIPTION	DATE

PROJECT NAME
MASTER CELL VI F&G

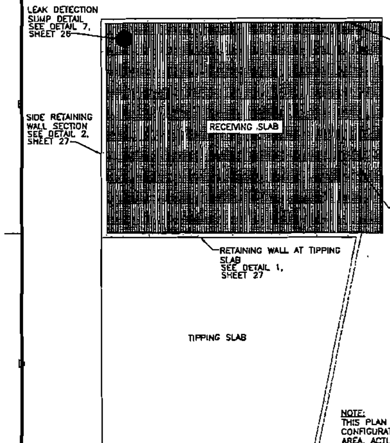
PROJECT LOCATION
WAYNE DISPOSAL, INC
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO: 13-060921-03	CAD FILE NAME
DESIGNED BY: DRL	INCEP DATE: 11/12/08
DRAWN BY: DRL	DRAWING SCALE: AS SHOWN
CHECKED BY: RBM	SUBMITTED DATE: 2/28/11

SHEET TITLE:
STORM WATER MANAGEMENT SYSTEM DETAILS

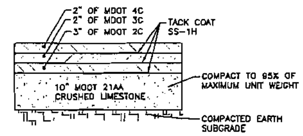
SHEET REFERENCE NUMBER:
25

1	2	3	4	5	6

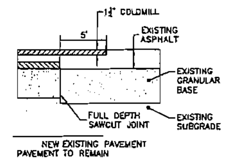


NOTE:
THIS PLAN VIEW REPRESENTS A GENERAL CONFIGURATION FOR THE TRANSFER BOX AREA. ACTUAL LAYOUT, DIMENSIONS, AND FEATURES WILL BE DETERMINED AT TIME OF TRANSFER BOX LOCACTION/RELOCATION.

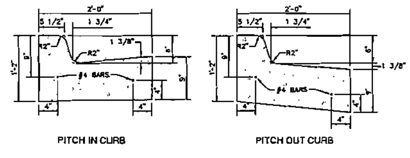
1 / 26 TRANSFER BOX PLAN VIEW
NOT TO SCALE



2 / 26 TYPICAL PAVEMENT DETAIL
NOT TO SCALE

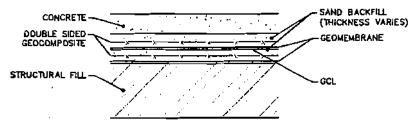


3 / 26 BUTT JOINT
NOT TO SCALE

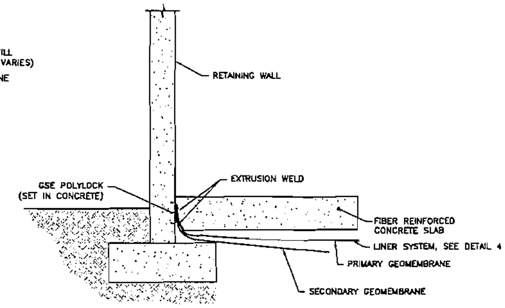


NOTE:
BASE AND SUBBASE AGGREGATES TO EXTEND MINIMUM 1'-0" BEHIND BACK OF CURB.

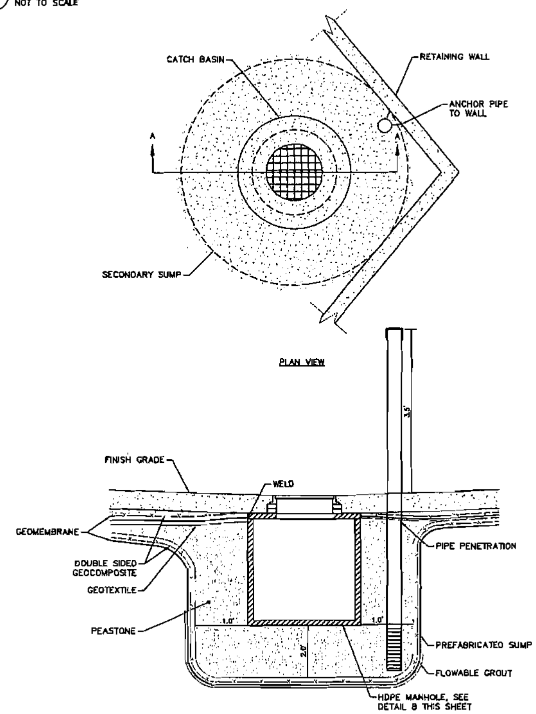
4 / 26 F4 CURB DETAIL
NOT TO SCALE



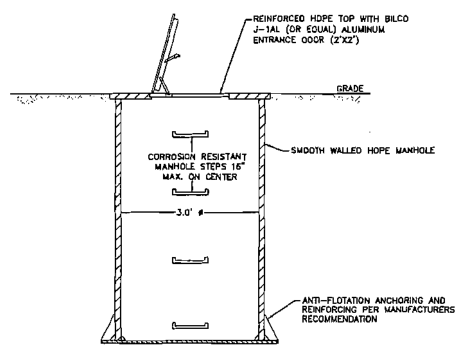
5 / 26 LINER SYSTEM
NOT TO SCALE



6 / 26 POLYLOCK ANCHOR
NOT TO SCALE



7 / 26 LEAK DETECTION SUMP DETAIL
NOT TO SCALE



8 / 26 HDPE CATCH BASIN
NOT TO SCALE

NTH Consultants, Ltd.
Infrastructure Engineering and Environmental Services

Northville, MI	248.553.6300
Detroit, MI	313.237.3900
Lansing, MI	517.484.6900
Grand Rapids, MI	616.957.3690
Exton, PA	610.524.2300
Lehigh Valley, PA	484.893.1440
Cleveland, OH	216.334.4040
Indianapolis, IN	317.735.7649

REVISIONS

REV	DESCRIPTION	DATE	BY

PROJECT NAME
MASTER CELL VI F&G

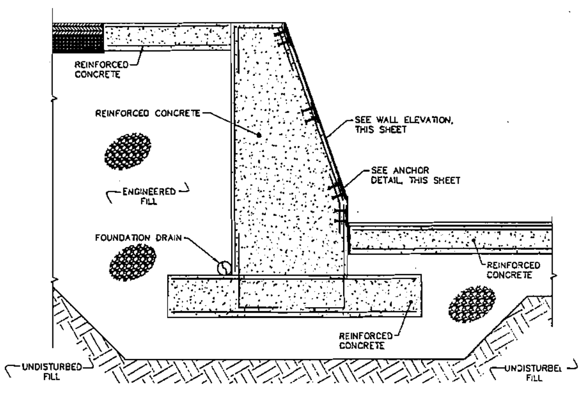
PROJECT LOCATION
WAYNE DISPOSAL, INC.
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO: 13-080921-03	CAD FILE NAME: TRANSFER BOX DETAILS
DESIGNED BY: KRO	MDEP DATE: 11/12/08
DRAWN BY: KRO	DRAWING SCALE: NONE
CHECKED BY: RBM	SUBMITTED DATE: 2/28/11

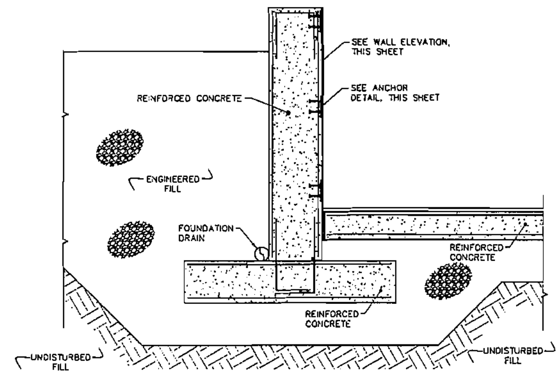
SHEET TITLE:
TRANSFER BOX DETAILS (1 OF 2)

SHEET REFERENCE NUMBER:
26

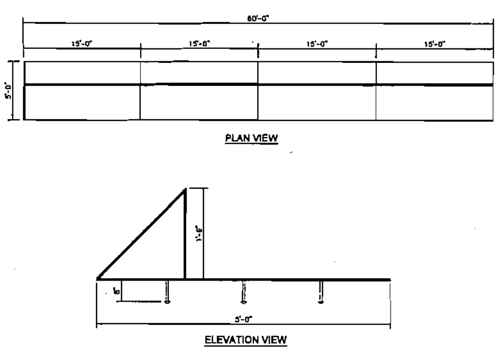
1 2 3 4 5 6



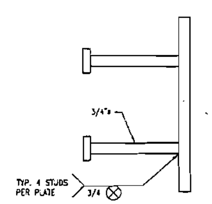
1/27 RETAINING WALL AT TIPPING SLAB
NOT TO SCALE



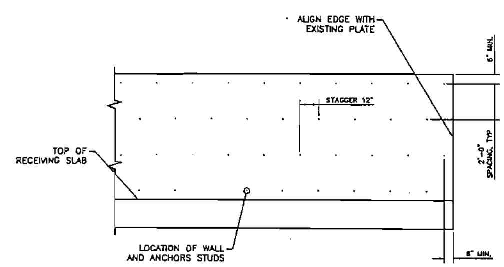
2/27 SIDE RETAINING WALL SECTION
NOT TO SCALE



3/27 TRUCK STOP SECTION
NOT TO SCALE



4/27 ANCHOR DETAIL
NOT TO SCALE



5/27 WALL ELEVATION
NOT TO SCALE

NTH Consultants, L
Infrastructure Engineering & Environmental Services

Northville, MI	248.553
Detroit, MI	313.237
Lansing, MI	517.484
Grand Rapids, MI	616.957
Exton, PA	610.524
Lehigh Valley, PA	484.893
Cleveland, OH	216.334
Indianapolis, IN	317.735

REVISIONS

REV	DESCRIPTION	DAT

PROJECT NAME
MASTER CELL VI F&G

PROJECT LOCATION
WAYNE DISPOSAL, INC
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO.: 13-060921-03	CAD FILE NA: TRANSFER BO
DESIGNED BY: KRO	INCEP DATE: 11/12/08
DRAWN BY: KRO	DRAWING SC: NONE
CHECKED BY: RBM	SUBMITTED: 2/28/11

SHEET TITLE:
TRANSFER BOX DETA
(2 OF 2)

SHEET REFERENCE NUMBER:
27

ZONING DISTRICTS

AG	AGRICULTURAL AND ESTATES
R-1B	SINGLE FAMILY RESIDENTIAL
RM	MULTIPLE FAMILY RESIDENTIAL
C-1	GENERAL BUSINESS
M-2	GENERAL INDUSTRIAL
AP	AIRPORT
M1	LIGHT INDUSTRIAL

LEGEND

— 838 —	EXIST. CONTOUR
———	℄ OF DITCH OR EDGE OF WATER
— — — —	EXIST. ZONING BOUNDARY

SCALE: 1" = 200'

0 200 400 600

NOTES

1. TOPOGRAPHIC INFORMATION OUTSIDE OF PROPERTY WAS OBTAINED FROM WAYNE COUNTY GIS.
2. 100 YEAR FLOOD PLAIN IS UNMAPPED, COMMUNITY ID: 260546, VAN BUREN TOWNSHIP.
3. ZONING BOUNDARIES ARE DERIVED FROM VAN BUREN CHARTER: ZONING MAP, 1/24/2007. IN MANY CASES COINCIDE WITH PROPERTY BOUNDARY AND ARE DIFFICULT TO SEE ON DRAWING.

MIDWESTERN CONSULTING

Civil, Environmental and Transportation Engineers, Planners, Surveyors, Landscape Architects
3815 Plaza Drive, Ann Arbor, Michigan 48108
Phone: 734.995.0200
Fax 734.995.0599

CLIENT
ENVIRONMENTAL QUALITY COMPANY
36255 MICHIGAN AVENUE
WAYNE, MI 48184

WAYNE DISPOSAL, INC.

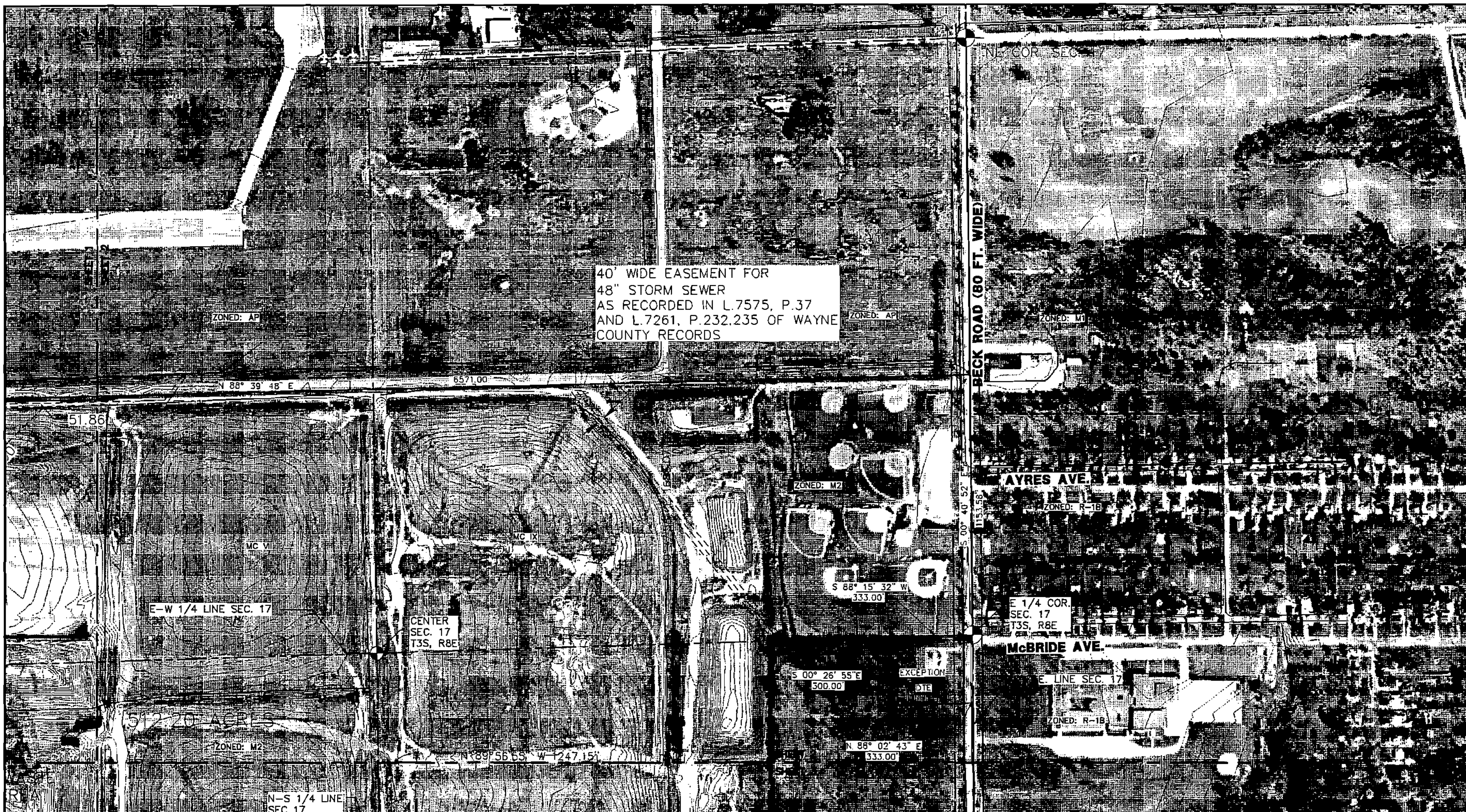
SITE NO. 2
MASTER CELL VI - F & G
AREA PLAN

1

DATE: 8/13/09
SHEET 1 OF 4
CADD:
CHK:
PM:
TECH: M.V.V.
SURVEY: 07174ev01

JOB No. 07174
REVISIONS: REV. DATE

NTH SHEET 28 OF 31



ZONING DISTRICTS

AG	AGRICULTURAL AND ESTATES
R-1B	SINGLE FAMILY REDIDENTIAL
RM	MULTIPLE FAMILY RESIDENTIAL
C-1	GENERAL BUSINESS
M-2	GENERAL INDUSTRIAL
AP	AIRPORT
M1	LIGHT INDUSTRIAL

LEGEND

---838---	EXIST. CONTOUR
———	℄ OF DITCH OR EDGE OF WATER
— — — —	EXIST. ZONING BOUNDARY

SCALE: 1" = 200'

0 200 400 600

NOTES

1. TOPOGRAPHIC INFORMATION OUTSIDE OF PROPERTY WAS OBTAINED FROM WAYNE COUNTY GIS.
2. 100 YEAR FLOOD PLAIN IS UNMAPPED, COMMUNITY ID: 260546, VAN BUREN TOWNSHIP.
3. ZONING BOUNDARIES ARE DERIVED FROM VAN BUREN CHARTER: ZONING MAP, 1/24/2007. IN MANY CASES CONCIDE WITH PROPERTY BOUNDARY AND ARE DIFFICULT TO SEE ON DRAWING.

JOB No. 07174

REVISIONS: REV. DATE

DATE: 8/13/08
SHEET 2 OF 4
CADD:
ENG:
PM:
TECH: M.V.V.
SURVEY: 07174m01

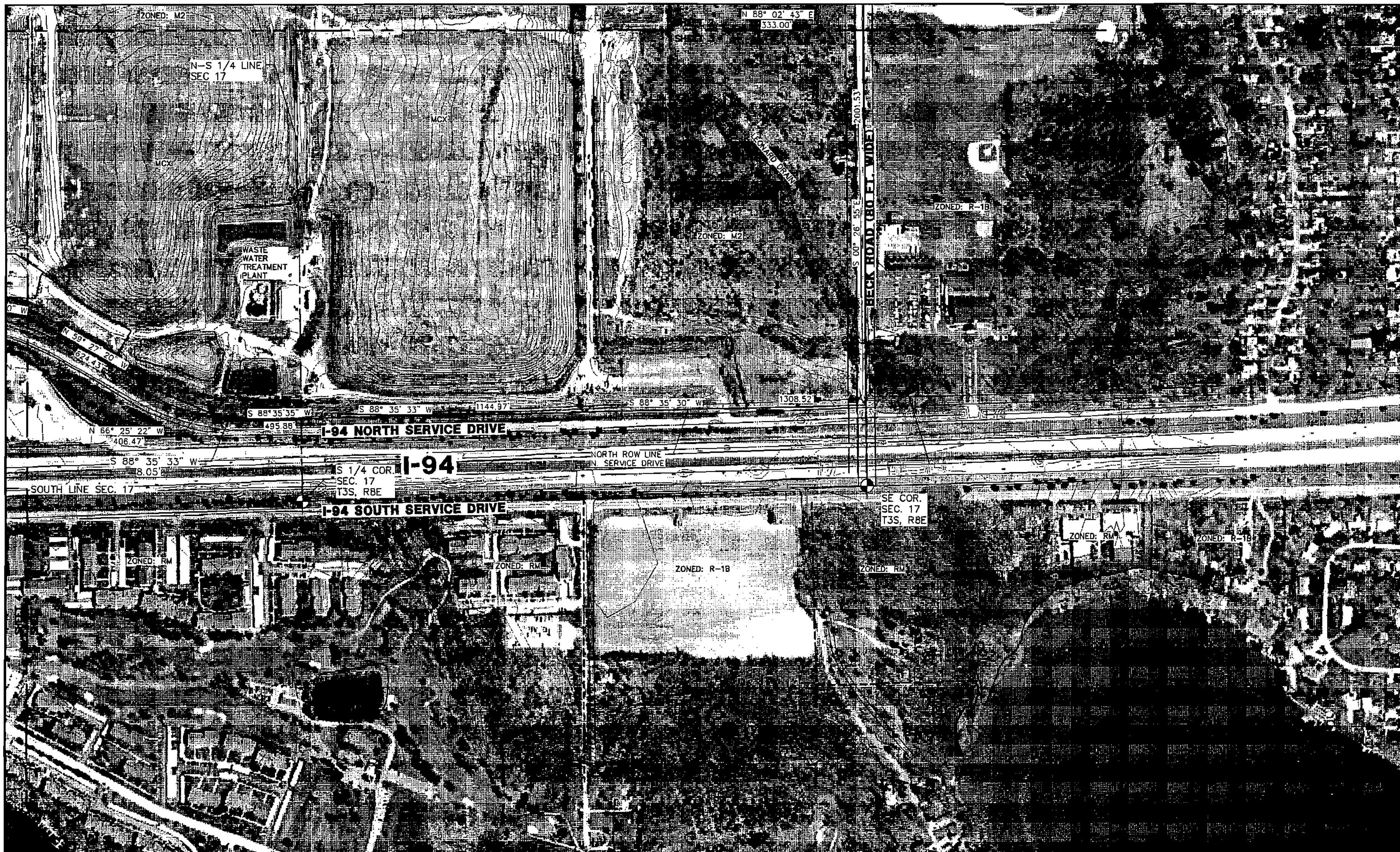
2

WAYNE DISPOSAL, INC.

SITE NO. 2
MASTER CELL VI – F & G
AREA PLAN

CLIENT
ENVIRONMENTAL QUALITY COMPANY
36255 MICHIGAN AVENUE
WAYNE, MI 48184

MIDWESTERN CONSULTING
Civil, Environmental and Transportation Engineers
Planners, Surveyors
Landscape Architects
3815 Plaza Drive
Ann Arbor, Michigan 48108
Phone: 734.995.0200
Fax 734.995.0599



ZONING DISTRICTS

AG	AGRICULTURAL AND ESTATES
R-1B	SINGLE FAMILY RESIDENTIAL
RM	MULTIPLE FAMILY RESIDENTIAL
C-1	GENERAL BUSINESS
M2	GENERAL INDUSTRIAL
AP	AIRPORT
M1	LIGHT INDUSTRIAL

LEGEND

- - 838 - -	EXIST. CONTOUR
————	℄ OF DITCH OR EDGE OF WATER
— — — — —	EXIST. ZONING BOUNDARY

SCALE: 1" = 200'

0 200 400 600

NOTES

1. TOPOGRAPHIC INFORMATION OUTSIDE OF PROPERTY WAS OBTAINED FROM WAYNE COUNTY GIS.
2. 100 YEAR FLOOD PLAIN IS UNMAPPED, COMMUNITY ID: 260546, VAN BUREN TOWNSHIP.
3. ZONING BOUNDARIES ARE DERIVED FROM VAN BUREN CHARTER: ZONING MAP, 1/24/2007. IN MANY CASES COINCIDE WITH PROPERTY BOUNDARY AND ARE DIFFICULT TO SEE ON DRAWING.

MIDWESTERN CONSULTING

Civil, Environmental and Transportation Engineers
Planners, Surveyors
Landscape Architects

3815 Plaza Drive
Ann Arbor, Michigan 48108
Phone: 734.995.0200
Fax: 734.995.0599

CLIENT
ENVIRONMENTAL QUALITY COMPANY
36255 MICHIGAN AVENUE
WAYNE, MI 48184

WAYNE DISPOSAL, INC.

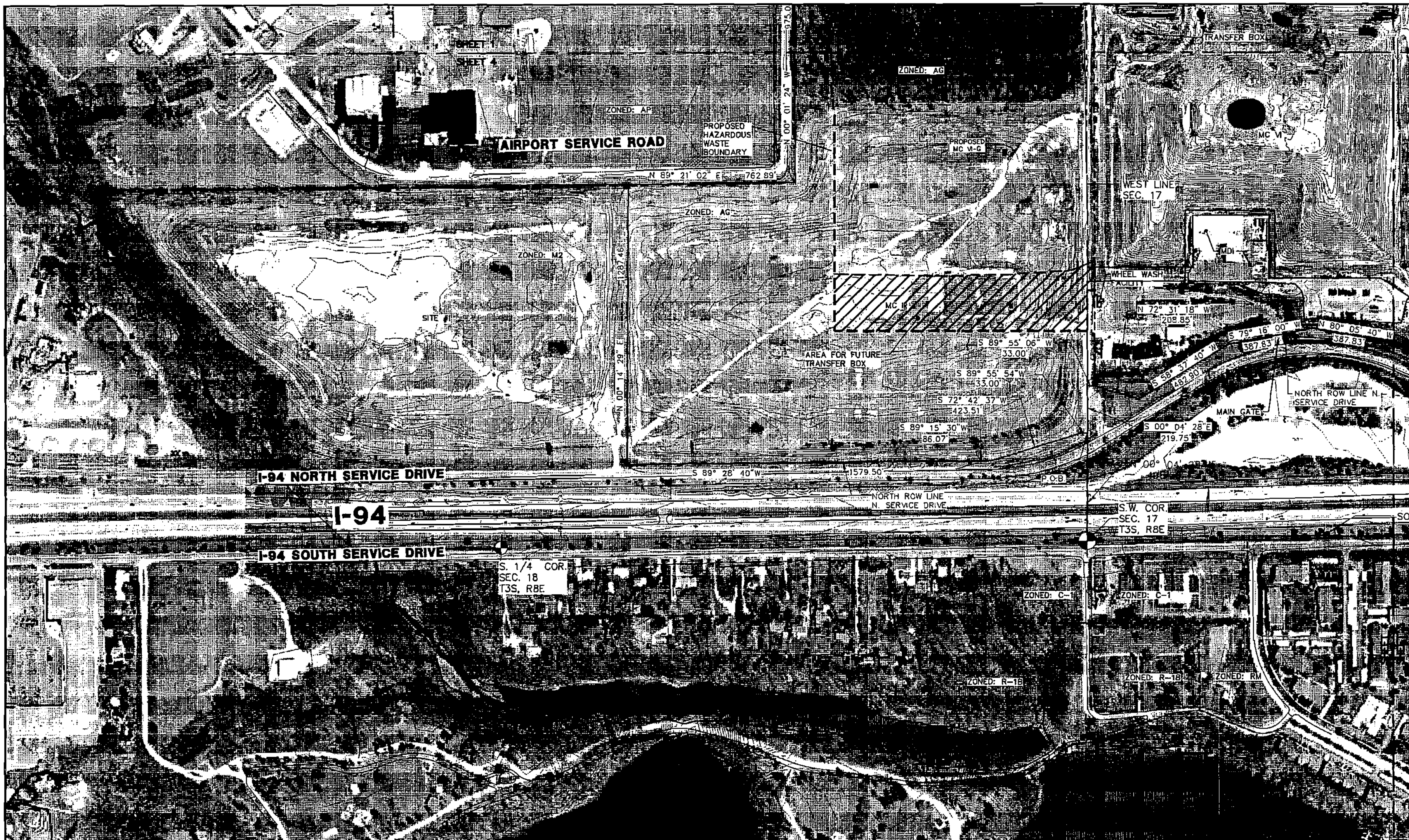
SITE NO. 2
MASTER CELL VI - F & G
AREA PLAN

3

DATE: 8/13/09
SHEET 3 OF 4
CADD:
ENG:
PM:
TECH: M.V.V.
SURVEY: 07174ev01

JOB No. 07174
REVISIONS:
REV. DATE

NTH SHEET 30 OF 31



ZONING DISTRICTS

AG	AGRICULTURAL AND ESTATES
R-1B	SINGLE FAMILY REDIDENTIAL
RM	MULTIPLE FAMILY RESIDENTIAL
C-1	GENERAL BUSINESS
M-2	GENERAL INDUSTRIAL
AP	AIRPORT
M1	LIGHT INDUSTRIAL

LEGEND

- 838 — EXIST. CONTOUR
- ℄ OF DITCH OR EDGE OF WATER
- EXIST. ZONING BOUNDART

SCALE: 1" = 200'

0 200 400 800

NOTES

1. TOPOGRAPHIC INFORMATION OUTSIDE OF PROPERTY WAS OBTAINED FROM WAYNE COUNTY GIS.
2. 100 YEAR FLOOD PLAIN IS UNMAPPED, COMMUNITY ID: 260546, VAN BUREN TOWNSHIP.
3. ZONING BOUNDARIES ARE DERIVED FROM VAN BUREN CHARTER: ZONING MAP, 1/24/2007. IN MANY CASES COINCIDE WITH PROPERTY BOUNDARY AND ARE DIFFICULT TO SEE ON DRAWING.

JOB No.	07174
REVISIONS:	REV. DATE
DATE:	8/13/09
SHEET	4 OF 4
CADD:	
ENG:	
PM:	
TECH:	M.V.V.
SURVEY\07174ev01	

4

WAYNE DISPOSAL, INC.

SITE NO. 2
MASTER CELL VI – F & G
AREA PLAN

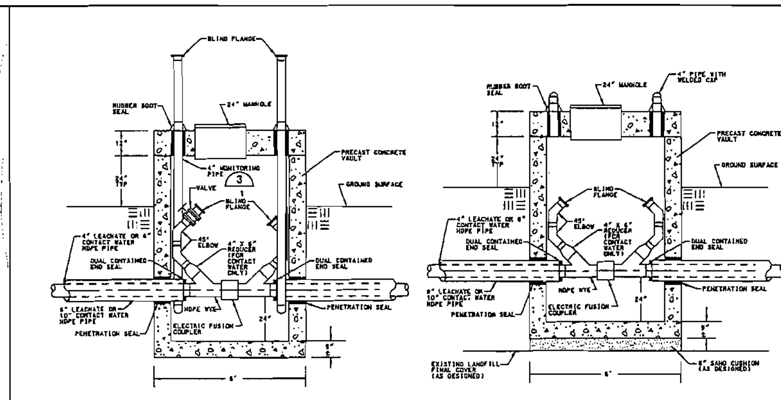
CLIENT
ENVIRONMENTAL QUALITY COMPANY
36255 MICHIGAN AVENUE
WAYNE, MI 48184

MIDWESTERN CONSULTING

Civil, Environmental and Transportation Engineers
Planners, Surveyors
Landscape Architects

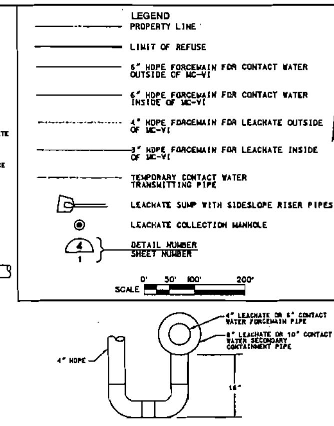
3815 Plaza Drive
Ann Arbor, Michigan 48108
Phone: 734.995.0200
Fax 734.995.0599

NTH SHEET 31 OF 31

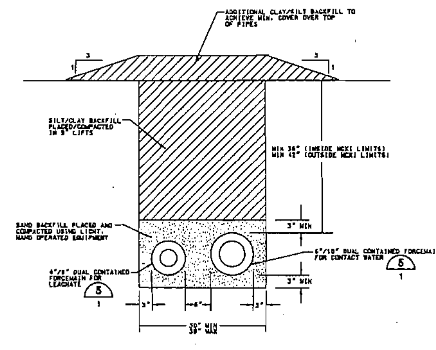


LEACHATE OR CONTACT WATER MONITOR AND SERVICE VAULT 1
NOT TO SCALE

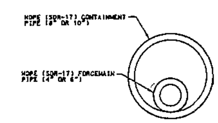
LEACHATE OR CONTACT WATER SERVICE VAULT 2
NOT TO SCALE



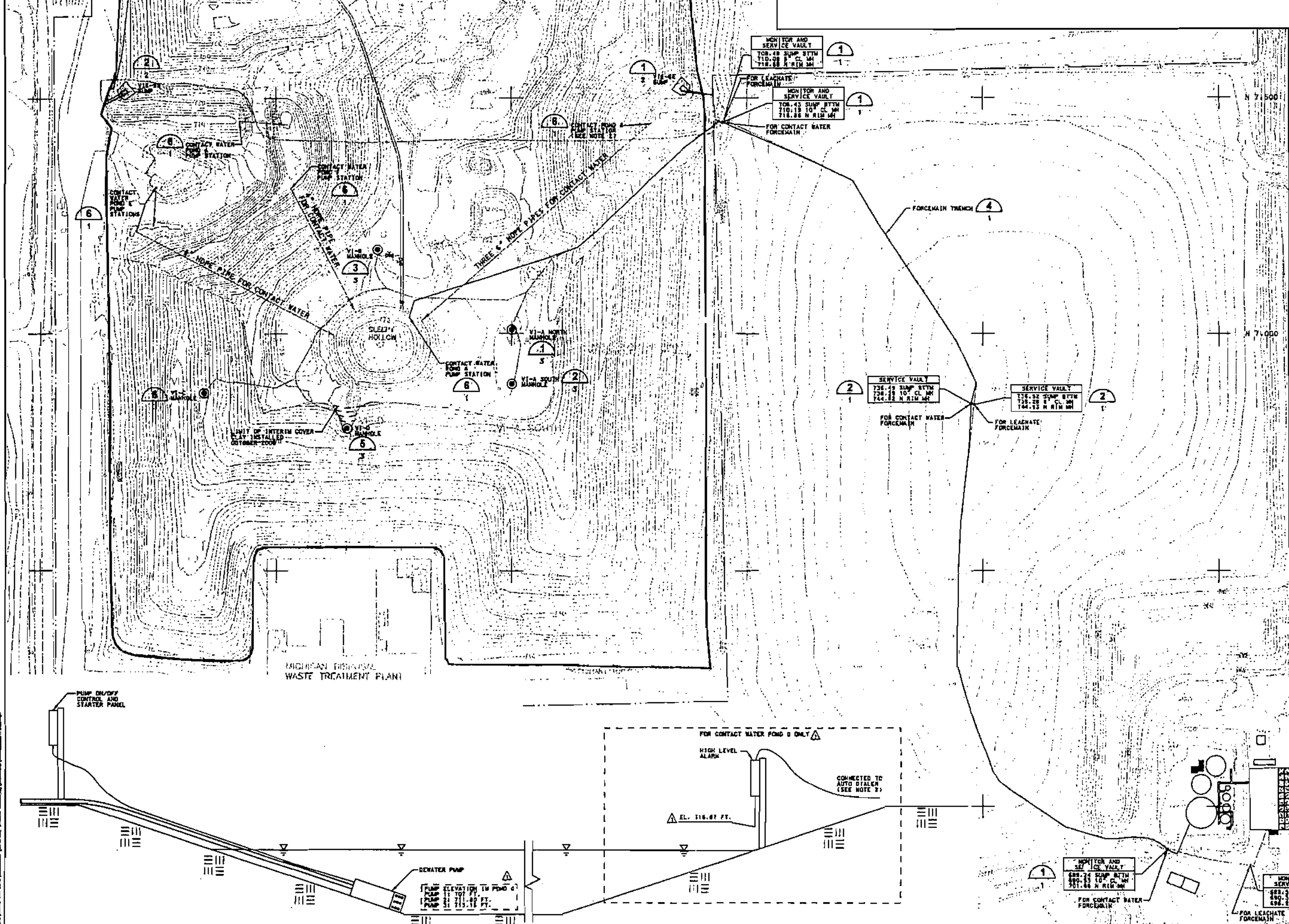
MONITOR RISER 3
NOT TO SCALE



TYPICAL FORCEMAIN TRENCHES OUTSIDE OF CELL MC-6 4
NOT TO SCALE



HDPE SECONDARY CONTAINMENT PIPE TYPICAL CROSS SECTION 5
NOT TO SCALE



TYPICAL PUMP STATION FOR CONTACT WATER POND (SEE NOTE 2) 6
NOT TO SCALE

NOTE:

1. TOPOGRAPHIC CONTOURS SHOWN WERE PROVIDED BY MIDWESTERN CONSULTANTS, INC; ANN ARBOR, MICHIGAN. DATE OF TOPO OUTSIDE LIMIT OF WASTE: SEPTEMBER 7, 2006 DATE OF TOPO INSIDE LIMIT OF WASTE: SEPTEMBER 4, 2008.
2. PUMPS IN CONTACT WATER POND G ARE CONTROLLED BY FLOATING SWITCH UNDER NORMAL OPERATION CONDITIONS. A HIGH LIQUID LEVEL SENSOR IS ALSO USED TO TRIGGER AN ALARM IF THE LIQUID LEVEL IS HIGHER THAN A PREDETERMINED LEVEL. AN AUTO DIALER WILL SEND THE ALARMING MESSAGE TO KEY PERSONNEL REMOTELY. IN ADDITION, THE ALARM WILL ALSO BE ACTIVATED IF THE POWER FOR THE PUMP IS INTERRUPTED. DURING THE WINTER OPERATION, THE PUMPS ARE CONTROLLED BY A PUMP PROTECTION CONTROLLER (COYOTE PUMP PROTECTORS OR EQUIVALENT). THE PUMP IS TURNED ON AT A PRESET INTERVAL AND WILL BE TURNED OFF WHEN IT IS RUNNING DRY.
3. THE MINIMUM REQUIRED PUMPING RATE (Q) DURING A 100-YEAR 24-HOUR STORM (4.36 INCHES) FOR CONTACT WATER PONDS ARE CALCULATED USING THE EQUATIONS LISTED IN THE FOLLOWING TABLE (LAST UPDATE OCT. 24, 2008):

POND NAME	WATERSHED AREA (SQ FT)	POND CAPACITY (GALLON)	RUNOFF OF 100 YR STORM (GALLON)	REQUIRED PUMPING RATE (GALLON PER MINUTE)
A	50,905	380,118	244,338	-
B	77,905	4,609,027	1,610,542*	-
E	70,298	234,820	215,511	-
F	261,165	743,228	708,777	-
G	514,700	287,000	1,388,817	1,544
H	475,450	6,020,200	1,282,148	-

* CALCULATED USING THE COMBINED WATERSHEDS FOR PONDS B AND Q

POND C IS REMOVED DUE TO THE INSTALLATION OF INTERMEDIATE COVER.
POND D IS REMOVED DUE TO THE WASTE REGRADING.

IF RUNOFF VOLUME > POND CAPACITY

$$Q = \frac{\text{RUNOFF VOLUME - POND CAPACITY}}{12 \text{ hrs} \times 60 \text{ minutes}}$$

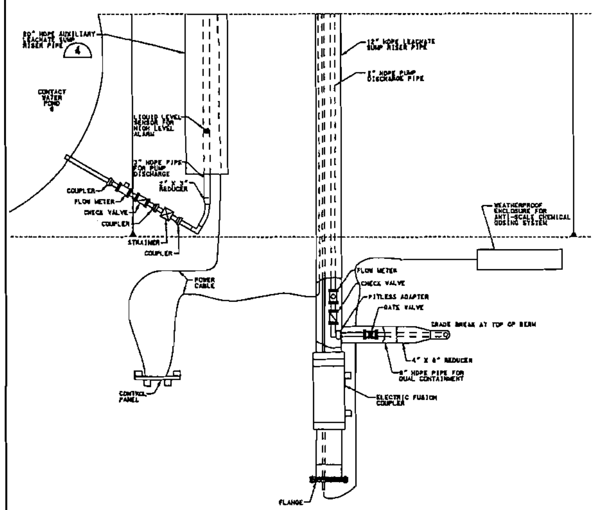
IF RUNOFF VOLUME ≤ POND CAPACITY

$$Q = 0$$

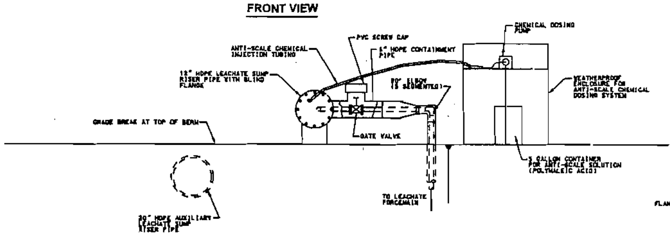
WAYNE DISPOSAL SITE NO. 2
WAYNE, MICHIGAN
LEACHATE SYSTEM AS-BUILTS

PROJECT NUMBER 8804203
SCALE AS SHOWN
DRAWING NO 1

PLAN VIEW



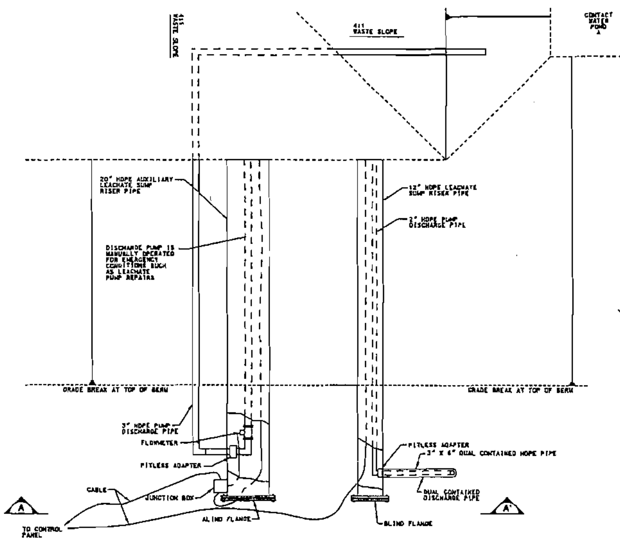
FRONT VIEW



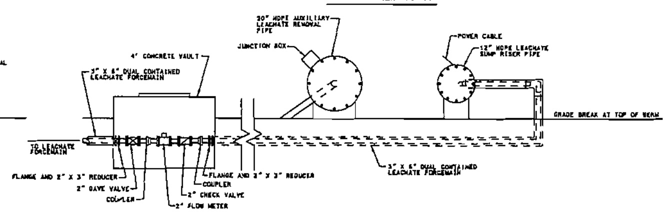
VIE-SE LEACHATE SUMP RISER PIPE 1

NOT TO SCALE

PLAN VIEW



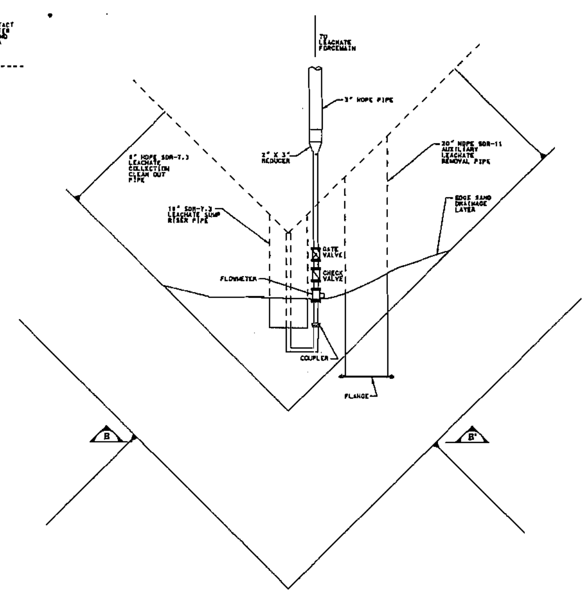
FRONT VIEW A - A'



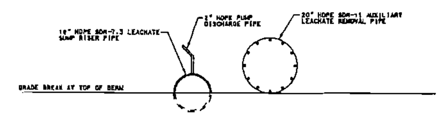
VIE-SW LEACHATE SUMP RISER PIPE' 2

NOT TO SCALE

PLAN VIEW

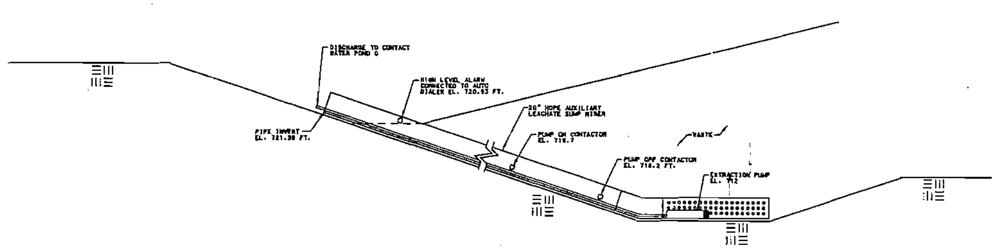


FRONT VIEW B - B'



VIE-NW LEACHATE SUMP RISER PIPE 3

NOT TO SCALE



VIE-SE AUXILIARY LEACHATE SUMP RISER 4

NOT TO SCALE

CTI and Associates, Inc.

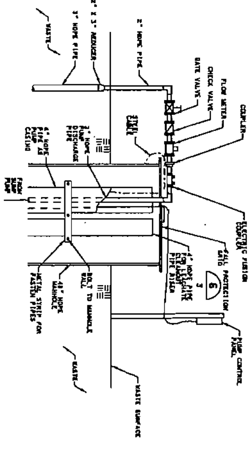
WAYNE DISPOSAL SITE NO. 2
WAYNE, MICHIGAN
LEACHATE SYSTEM AS-BUILTS

PROJECT NUMBER 880420

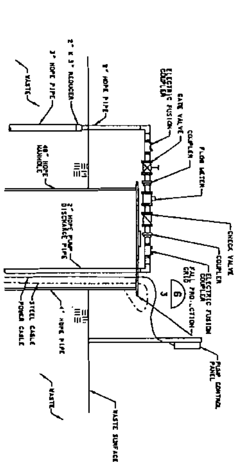
SCALE AS SHOWN

DRAWING NO

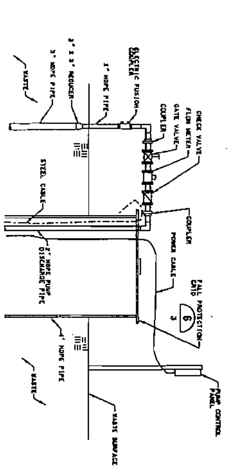
2



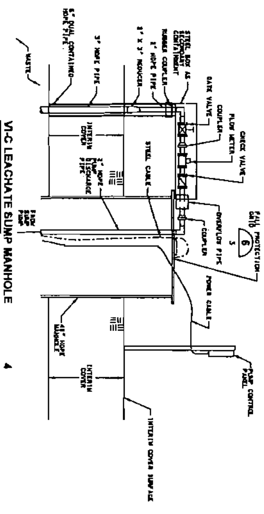
VI-A NORTH LEACHATE SUMP MANHOLE 1
NOT TO SCALE
NOTE: THIS MANHOLE IS LOCATED WITHIN ACTIVE AREA.



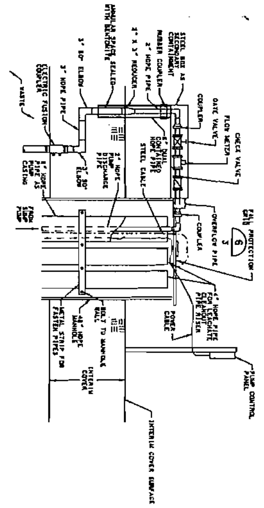
VI-A SOUTH LEACHATE SUMP MANHOLE 2
NOT TO SCALE
NOTE: THIS MANHOLE IS LOCATED WITHIN ACTIVE AREA.



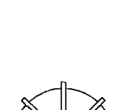
VI-B LEACHATE SUMP MANHOLE 3
NOT TO SCALE
NOTE: THIS MANHOLE IS LOCATED WITHIN ACTIVE AREA.



VI-C LEACHATE SUMP MANHOLE 4
NOT TO SCALE
NOTE: THIS MANHOLE IS LOCATED OUTSIDE OF ACTIVE AREA.



VI-D LEACHATE SUMP MANHOLE 5
NOT TO SCALE
NOTE: THIS MANHOLE IS LOCATED OUTSIDE OF ACTIVE AREA.



FALL PROTECTION GRID 6
NOT TO SCALE

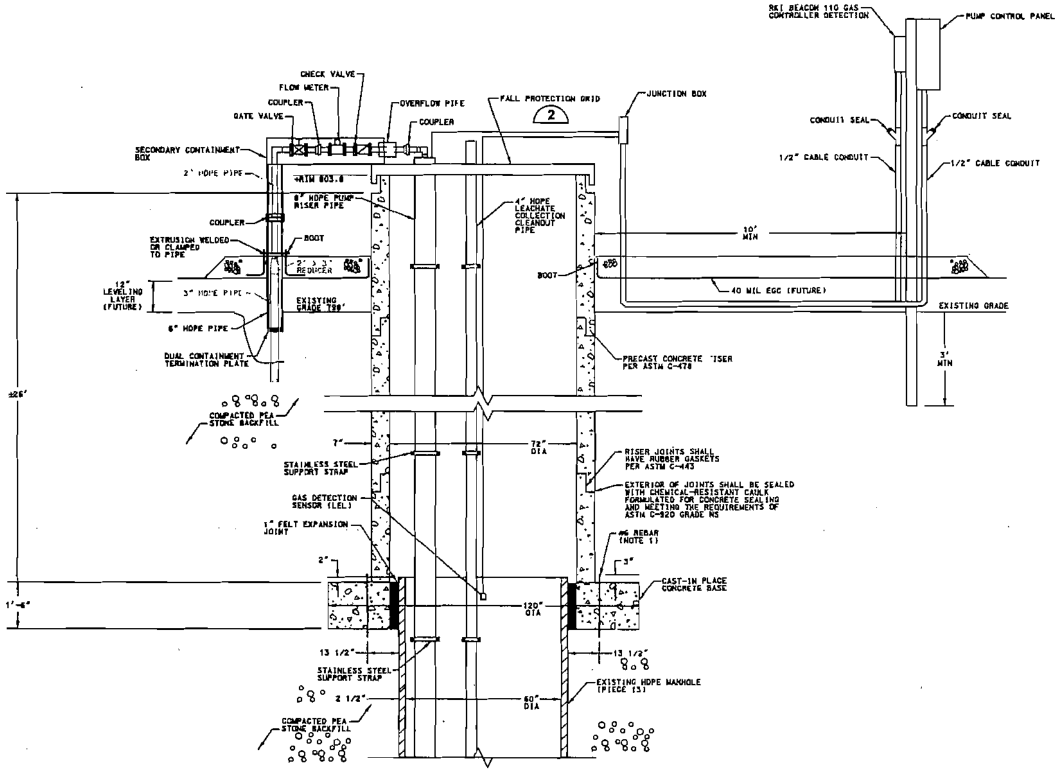
WAYNE DISPOSAL SITE NO. 2
WAYNE, MICHIGAN
LEACHATE SYSTEM AS-BUILTS

LEACHATE MANHOLE DETAILS

PROJECT NUMBER 08042039
SCALE AS SHOWN
DRAWING NO. 3

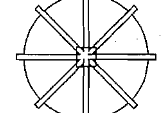
CTI and Associates, Inc.
12482 Emerson Drive
Brighton, Michigan 48116
248.486.5100 (fax)248.486.5050
www.cticompanies.com

DATE:	11/3/08
DESIGNED BY:	XZ
DRAWN BY:	BDA
CHECKED BY:	TYS
APPROVED BY:	TYS



OPEN MANHOLE OPTION 1

NOT TO SCALE



FALL PROTECTION GRID (TOP VIEW) 2

NOT TO SCALE

NOTE:

1. 24" LENGTH #6 REBAR EMBEDED IN CONCRETE BASE. 16 BARS TOTAL. EVENLY SPACED OUTSIDE OF CONCRETE MANHOLE SECTION TO PREVENT EXCESSIVE MOVEMENT OF THE SECTION DURING INSTALLATION.

DRAWING SIZE: 22"X34"

DATE:	1/11/2010
DESIGNED BY:	XZ
DRAWN BY:	BDA
CHECKED BY:	XZ
APPROVED BY:	

CTI and Associates, Inc.
12482 Emerson Drive
Brighton, Michigan 48116
248.486.5100 (fax)248.486.5050
www.cticompanies.com

WAYNE DISPOSAL SITE NO. 2
WAYNE, MICHIGAN

PROPOSED MC VI-A NORTH MANHOLE MODIFICATION

PROJECT NUMBER 98042039

SCALE NONE

DRAWING NO **1**

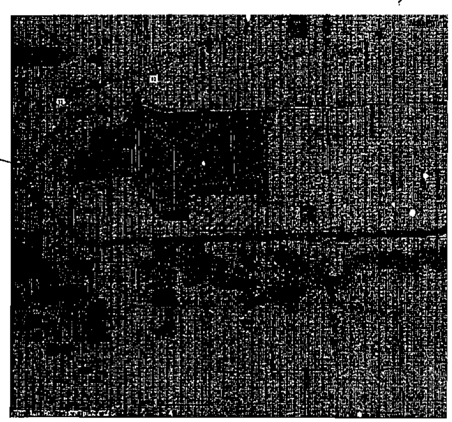
MASTER CELL VI-E DESIGN MODIFICATION PLANS
WAYNE DISPOSAL INC., SITE NO. 2
VAN BUREN TWP., WAYNE COUNTY, MICHIGAN

PREPARED FOR: WAYNE DISPOSAL, INC.
VAN BUREN TOWNSHIP, WAYNE COUNTY, MICHIGAN

PREPARED BY: NTH CONSULTANTS, LTD.
NORTHVILLE, MICHIGAN

DATE: MARCH 2008
REVISED DATE: SEPTEMBER 2011 (B)

SITE LOCATION



VICINITY SKETCH

N

INDEX

Revisions	No.	Sheet
A, B	1	TITLE/INDEX SHEET
	2	EXISTING TOPOGRAPHICAL MAP
A, B	3	SUBGRADE ELEVATION PLAN
A, B	4	TOP OF SECONDARY LINER ELEVATION PLAN
A, B	5	TOP OF PRIMARY LINER ELEVATION PLAN
A, B	6	ESTIMATED TOP OF PRIMARY LINER POST–SETTLEMENT ELEVATION PLAN
A, B	7	TOP OF FINAL COVER ELEVATION PLAN
A, B	8	STORMWATER MANAGEMENT AND SEDIMENT CONTROL PLAN
B	9	CROSS–SECTIONS
B	10	LINER SYSTEM DETAILS
A, B	11	LEACHATE COLLECTION SYSTEM DETAILS
A, B	12	FINAL COVER DETAILS
A	13	STORMWATER MANAGEMENT SYSTEM DETAILS
	14	MC V MISCELLANEOUS UTILITIES

NTH Consultants, L
Infrastructure Engineering a
Environmental Services

Northville, MI	248.553
Detroit, MI	313.237
Lansing, MI	517.484
Grand Rapids, MI	616.957
Exton, PA	610.524
Lehigh Valley, PA	484.893
Cleveland, OH	216.334
Indianapolis, IN	317.735

SUBMITTAL

REV	DESCRIPTION	DAT
A	PER MDEQ COMMENTS	[illegible]
B	[illegible]	[illegible]

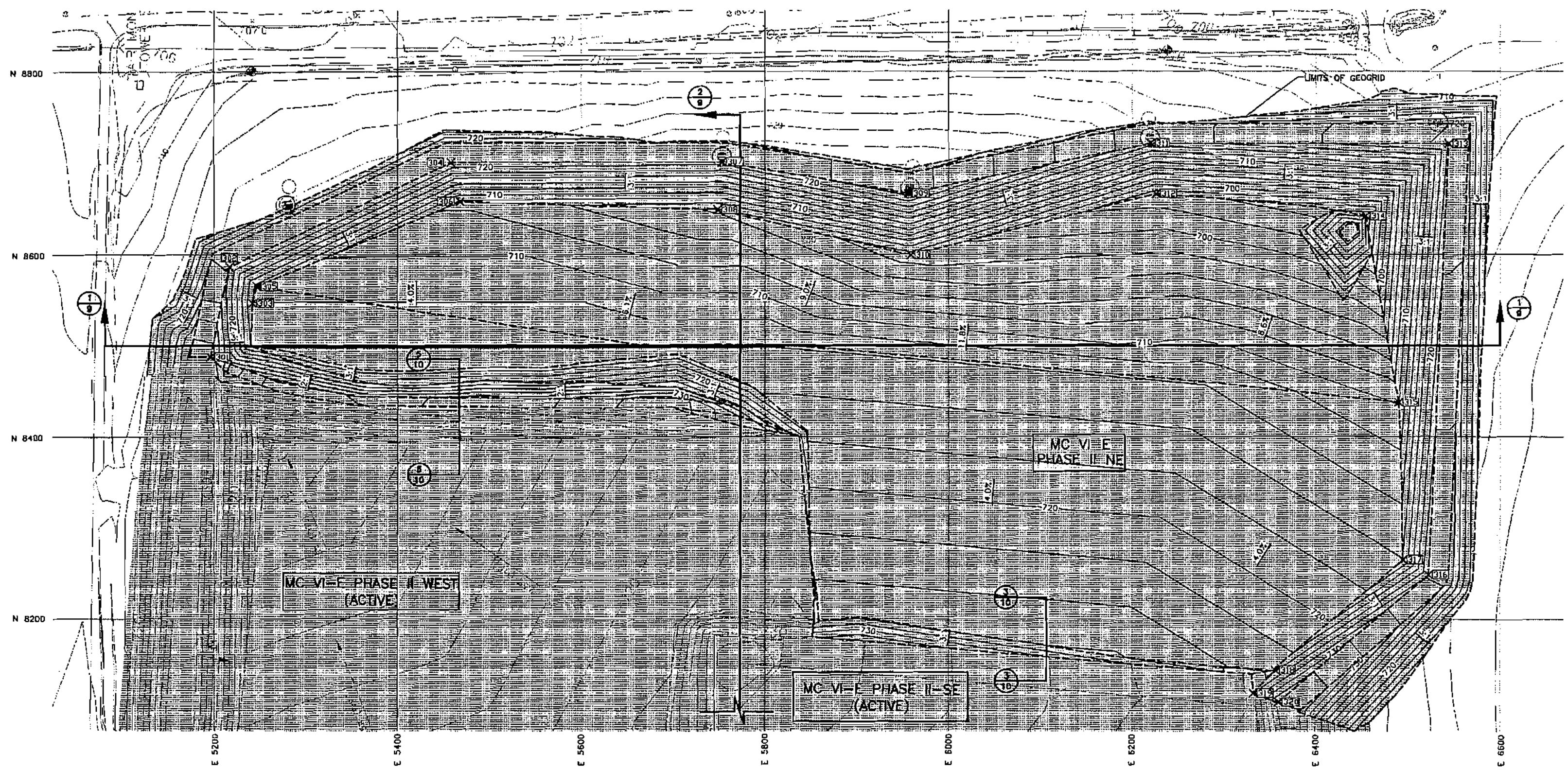
PROJECT NAME
MASTER CELL VI-E
DESIGN MODIFICATION

PROJECT LOCATION
WDI SITE NO. 2
VAN BUREN TWP., WA
COUNTY, MICHIGAN

NTH PROJECT NO.: 13-070804-05	CAD FILE NAM: SHEET 1
DESIGNED BY: JHL	INCEP DATE: 1/21/08
DRAWN BY: DRL	DRAWING SCA: NONE
CHECKED BY: ISS	SUBMITTED D: 9/28/2011

SHEET TITLE:
TITLE/INDEX

SHEET REFERENCE NUMBER:
1



PERIMETER DIKE COORDINATES			
POINT NO.	NORTHING	EASTING	ELEVATION
301	8487.63	5196.20	729.39
302	8586.60	5215.82	721.83
303	8546.89	5241.79	712.03
304	8700.42	5458.24	721.83
305	8565.19	5246.41	711.17
306	8657.89	5468.01	707.62
307	8700.42	5753.31	720.83
308	8649.05	5748.66	703.72
309	8666.63	5956.08	722.83
310	8599.09	5958.86	700.91
311	8720.70	6220.18	714.83
312	8666.18	6226.32	696.76
313	8720.70	6543.93	720.33
314	8641.95	6454.04	692.55
315	8437.99	6489.67	709.84
316	8248.43	6522.64	725.87
317	8264.74	6494.41	716.05
318	8144.33	6356.08	723.55
319	8119.26	6332.19	725.78
320	8109.46	6359.61	734.04

B A B

LEGEND:

- 730 — PROPOSED TOP OF DIKE/SUBGRADE CONTOURS (B)
- 730 — EXISTING CONTOUR
- — — PROPOSED GRADE BREAK
- 301 — PROPOSED DIKE COORDINATE POINT NUMBER ID
- AREA TO BE COVERED BY GEOGRID (B)
- ±5% — FLOOR SLOPE
- EXISTING LEACHATE SUMP
- EXISTING LEACHATE SUMP VALVE PIT

N

0 30' 60' 120'
SCALE

NTH Consultants, Ltd.
Infrastructure Engineering and Environmental Services

Northville, MI	248.553.6300
Detroit, MI	313.237.3900
Lansing, MI	517.484.6900
Grand Rapids, MI	616.957.3600
Exton, PA	610.524.2300
Lehigh Valley, PA	484.893.1440
Cleveland, OH	216.334.4040
Indianapolis, IN	317.735.7649

SUBMITTAL

REV	DESCRIPTION	DATE	BY
A	PER MDEQ COMMENTS	[illegible]	JHL
B	MODIFY FLOOR/TIE IN	[illegible]	DRL

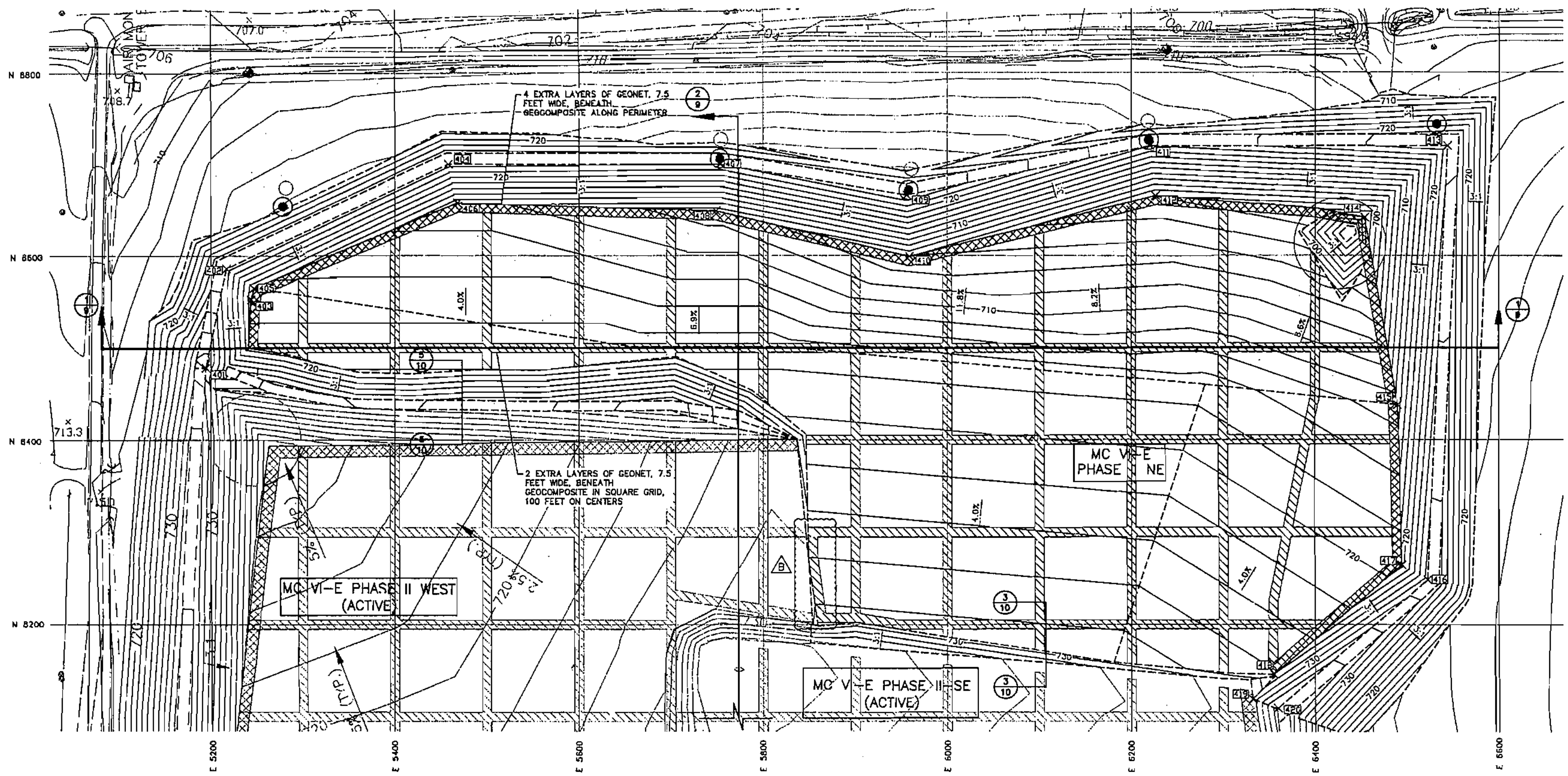
PROJECT NAME
MASTER CELL VI-E DESIGN MODIFICATION

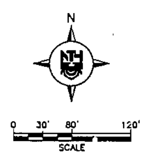
PROJECT LOCATION
WDI SITE NO. 2
VAN BUREN TWP., WAYNE COUNTY, MICHIGAN

NTH PROJECT NO.: 13-070804-05	CAD FILE NAME: SHEET 3
DESIGNED BY: JHL	INCEP DATE: 1/21/08
DRAWN BY: DRL	DRAWING SCALE: AS SHOWN
CHECKED BY: ISS	SUBMITTED DATE: 8/26/2011

SHEET TITLE:
SUBGRADE ELEVATION PLAN

SHEET REFERENCE NUMBER:
3





LEGEND:

Symbol	Description
730	PROPOSED TOP OF DIKE/ SECONDARY CLAY LINER CONTOURS (B)
730	EXISTING CONTOUR
— — —	PROPOSED GRADE BREAK
401	PROPOSED SECONDARY CLAY LINER POINT NUMBER ID
	PROPOSED 2 EXTRA LAYERS OF GEONET, 7.5' WIDE, BENEATH GEOCOMPOSITE IN SQUARE GRID
	EXISTING 2 EXTRA LAYERS OF GEONET, 7.5' WIDE, BENEATH GEOCOMPOSITE IN SQUARE GRID
	PROPOSED 4 EXTRA LAYERS OF GEONET, 7.5' WIDE BENEATH GEOCOMPOSITE ALONG PERIMETER
	EXISTING 4 EXTRA LAYERS OF GEONET, 7.5' WIDE BENEATH GEOCOMPOSITE ALONG PERIMETER
	PROPOSED SECONDARY COLLECTION SUMP LOCATION
	EXISTING SECONDARY COLLECTION SUMP LOCATION
±8%	FLOOR SLOPE
	EXISTING LEACHATE SUMP
	EXISTING LEACHATE SUMP VALVE PIT

SECONDARY CLAY LINER COORDINATES

POINT NO.	NORTHING	EASTING	ELEVATION
401	8478.50	5194.37	732.04
402	8586.60	5216.82	725.00
403	8552.78	5243.18	714.96
404	8700.42	5458.24	725.00
405	8565.19	5246.41	714.34
406	8657.89	5468.01	710.79
407	8700.42	5753.31	724.00
408	8649.05	5748.66	706.89
409	8666.63	5956.08	726.00
410	8599.09	5958.86	704.08
411	8720.70	6220.18	718.00
412	8666.18	6226.32	699.93
413	8720.70	6543.93	723.50
414	8641.95	6454.04	695.72
415	8437.99	6489.67	713.01
416	8248.43	6522.64	729.04
417	8264.74	6494.41	719.22
418	8146.04	6355.15	726.18
419	8119.26	6332.19	728.95
420	8109.46	6359.61	737.21

(B) (A)(B)

NTH Consultants,
Infrastructure Engineering
Environmental Services

Northville, MI	248.55
Detroit, MI	313.23
Lansing, MI	517.48
Grand Rapids, MI	616.85
Exton, PA	610.52
Lehigh Valley, PA	484.89
Cleveland, OH	216.33
Indianapolis, IN	317.73

SUBMITTAL

REV	DESCRIPTION	DAT
A	PER MDEQ COMMENTS	[illegible]
B	MODIFY FLOOR/TIE IN	[illegible]

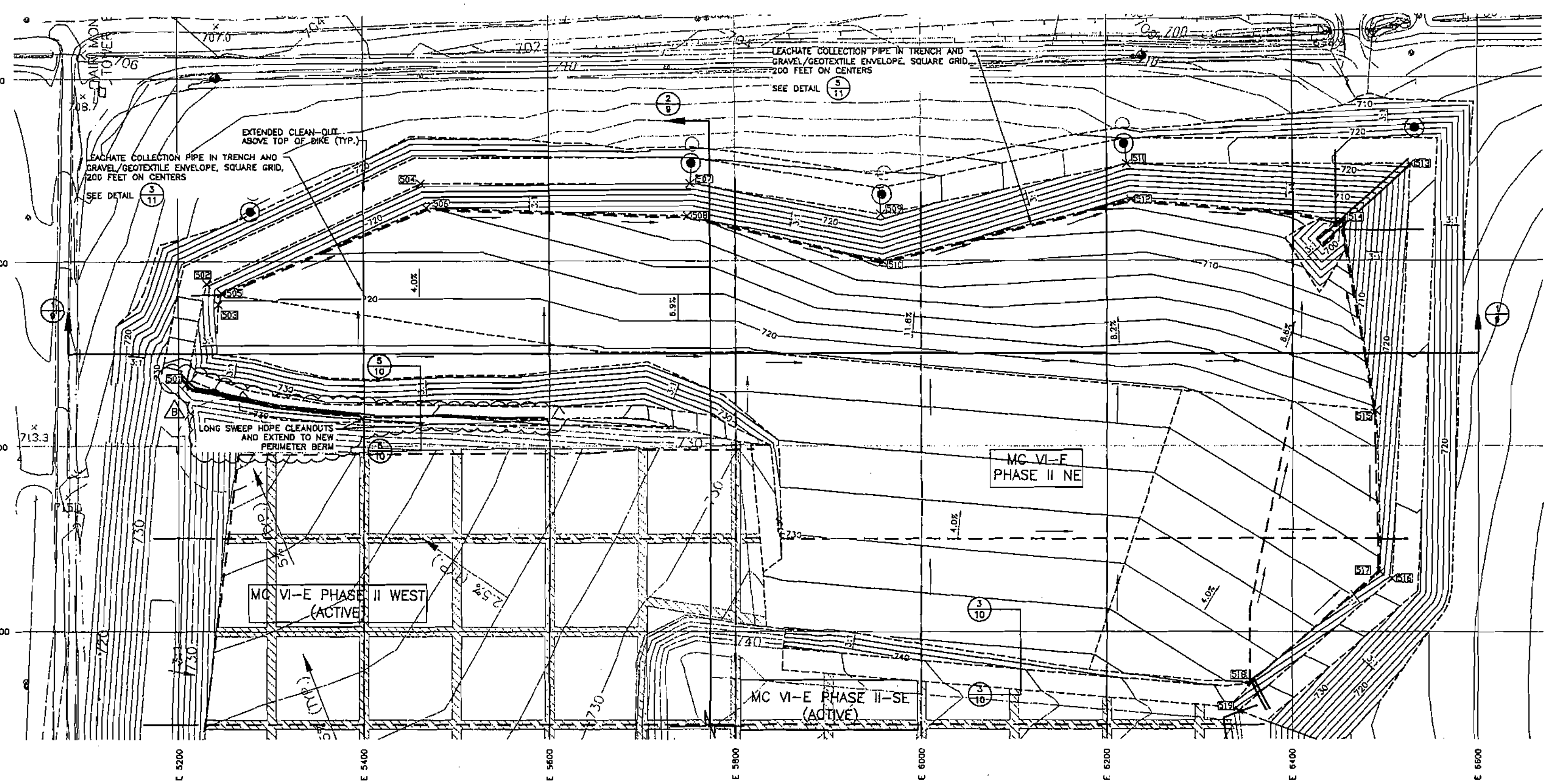
PROJECT NAME
MASTER CELL VI-E
DESIGN MODIFICATION

PROJECT LOCATION
WDI SITE NO. 2
VAN BUREN TWP., WA
COUNTY, MICHIGAN

NTH PROJECT NO.: 13-070804-05	CAD FILE NAM: SHEET 4
DESIGNED BY: JHL	INCEP DATE: 1/21/08
DRAWN BY: DRL	DRAWING SCA: AS SHOW
CHECKED BY: ISB	SUBMITTED D: 9/26/2011

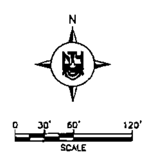
SHEET TITLE:
TOP OF SECONDARY
LINER ELEVATION PLA

SHEET REFERENCE NUMBER:
4



LEGEND:

- —730— PROPOSED TOP OF DIKE/ PRIMARY CLAY LINER CONTOURS (B)
- —730— EXISTING CONTOUR
- — — — PROPOSED GRADE BREAK
- 520 PROPOSED PRIMARY CLAY LINER POINT NUMBER ID
- PROPOSED LEACHATE COLLECTION SUMP LOCATION SEE DETAIL 1/11
- EXISTING LEACHATE COLLECTION SUMP LOCATION
- PROPOSED LEACHATE COLLECTION PIPE AND FLOW DIRECTION
- EXISTING LEACHATE COLLECTION PIPE AND FLOW DIRECTION
- EXISTING 2 EXTRA LAYERS OF GEONET, 7.5' WIDE, BENEATH GEOCOMPOSITE IN SQUARE GRID 100 FEET ON CENTERS
- ±8% FLOOR SLOPE
- EXISTING LEACHATE SUMP
- EXISTING LEACHATE SUMP VALVE PIT
- EXISTING CLEANOUT
- PROPOSED CLEANOUT



PRIMARY CLAY LINER COORDINATES

POINT NO.	NORTHING	EASTING	ELEVATION
501	8466.47	5208.11	732.36
502	8575.56	5230.55	725.00
503	8552.98	5243.24	720.23
504	8684.58	5461.79	725.00
505	8565.19	5246.41	719.62
506	8657.89	5468.01	716.07
507	8684.58	5752.00	724.00
508	8649.05	5748.66	712.17
509	8650.52	5956.38	726.00
510	8599.09	5958.86	709.36
511	8704.86	6221.78	718.00
512	8666.18	6226.32	705.21
513	8704.86	6527.36	723.50
514	8641.95	6454.04	701.00
515	8437.99	6489.67	718.29
516	8257.01	6507.34	729.00
517	8264.46	6494.44	724.51
518	8146.02	6355.69	731.45
519	8115.19	6342.71	737.66

(B) (A)(B)

NTH Consultants, L
Infrastructure Engineering an
Environmental Services

Northville, MI 248.553.
Detroit, MI 313.237.
Lansing, MI 517.484.
Grand Rapids, MI 616.987.
Exton, PA 610.524.
Lehigh Valley, PA 484.893.
Cleveland, OH 216.334.
Indianapolis, IN 317.735.

SUBMITTAL

REV	DESCRIPTION	DATE
A	PER MDEQ COMMENTS	[illegible]
B	MODIFY FLOORUTE IN	[illegible]

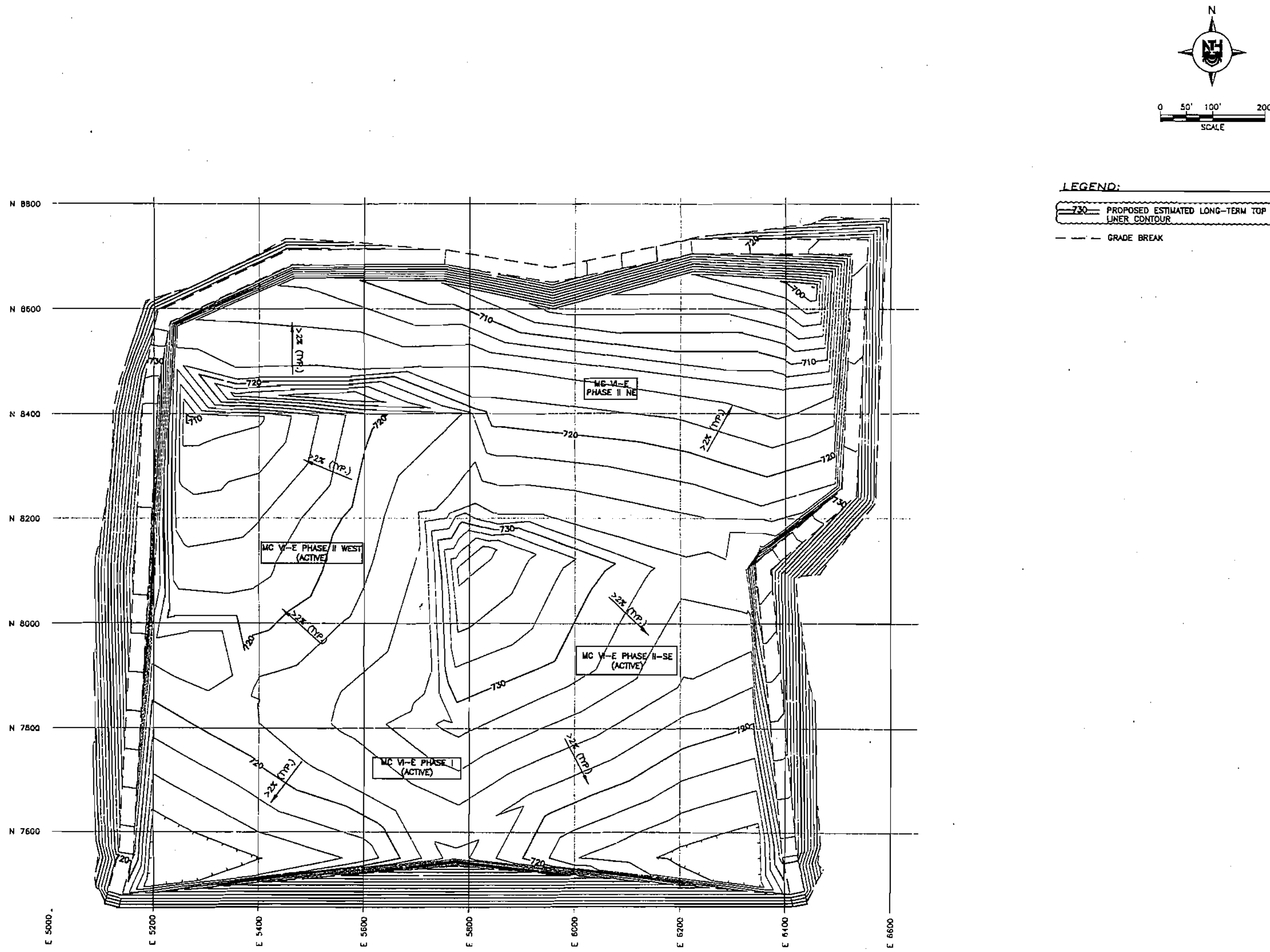
PROJECT NAME:
MASTER CELL VI-E
DESIGN MODIFICATION

PROJECT LOCATION
WDI SITE NO. 2
VAN BUREN TWP., WAY
COUNTY, MICHIGAN

NTH PROJECT NO.: 13-070804-05	CAD FILE NAME: SHEET 5
DESIGNED BY: JHL	INCEP DATE: 1/21/08
DRAWN BY: ORL	DRAWING SCAL AS SHOWN
CHECKED BY: ISS	SUBMITTED DA 9/28/2011

SHEET TITLE:
TOP OF PRIMARY LINE
ELEVATION PLAN

SHEET REFERENCE NUMBER:
5



LEGEND:

730 — PROPOSED ESTIMATED LONG-TERM TOP OF PRIMARY LINER CONTOUR

— — — GRADE BREAK

NTH Consultants, Lt

Infrastructure Engineering and Environmental Services

Northville, MI	248.553.6
Detroit, MI	313.237.3
Lansing, MI	517.484.8
Grand Rapids, MI	616.857.3
Exton, PA	610.524.2
Lehigh Valley, PA	484.893.1
Cleveland, OH	216.334.4
Indianapolis, IN	317.735.7

SUBMITTAL

REV	DESCRIPTION	DATE
A	[illegible]	[illegible]
B	[illegible]	[illegible]

PROJECT NAME

MASTER CELL VI-E DESIGN MODIFICATION

PROJECT LOCATION

WDI SITE NO. 2
VAN BUREN TWP., WAYN
COUNTY, MICHIGAN

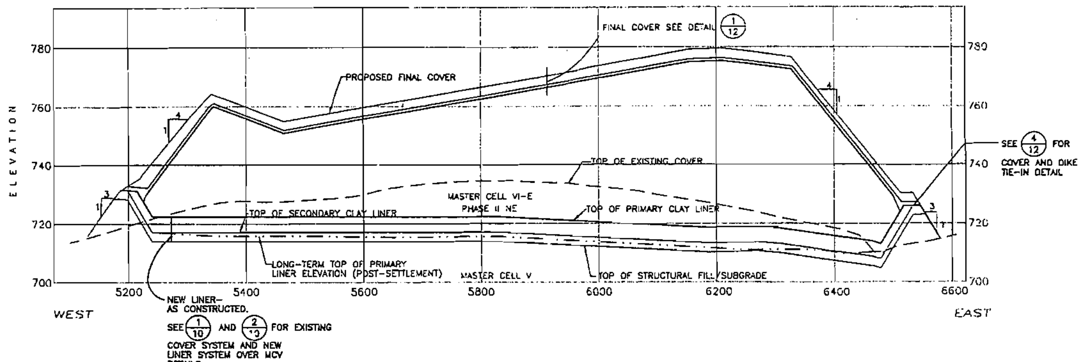
NTH PROJECT NO.: 13-070604-05	CAD FILE NAME: SHEET 6
DESIGNED BY: JHL	INCEP DATE: 1/21/08
DRAWN BY: DRL	DRAWING SCALE: AS SHOWN
CHECKED BY: ISS	SUBMITTED DATE: 9/28/2011

SHEET TITLE:

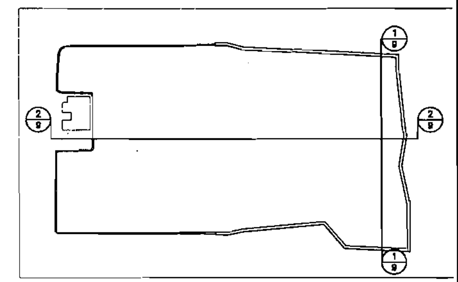
ESTIMATED TOP OF PRIMARY LINER POST-SETTLEMENT ELEVATION PLAN

SHEET REFERENCE NUMBER:

6



1/9 EAST–WEST CROSS SECTION

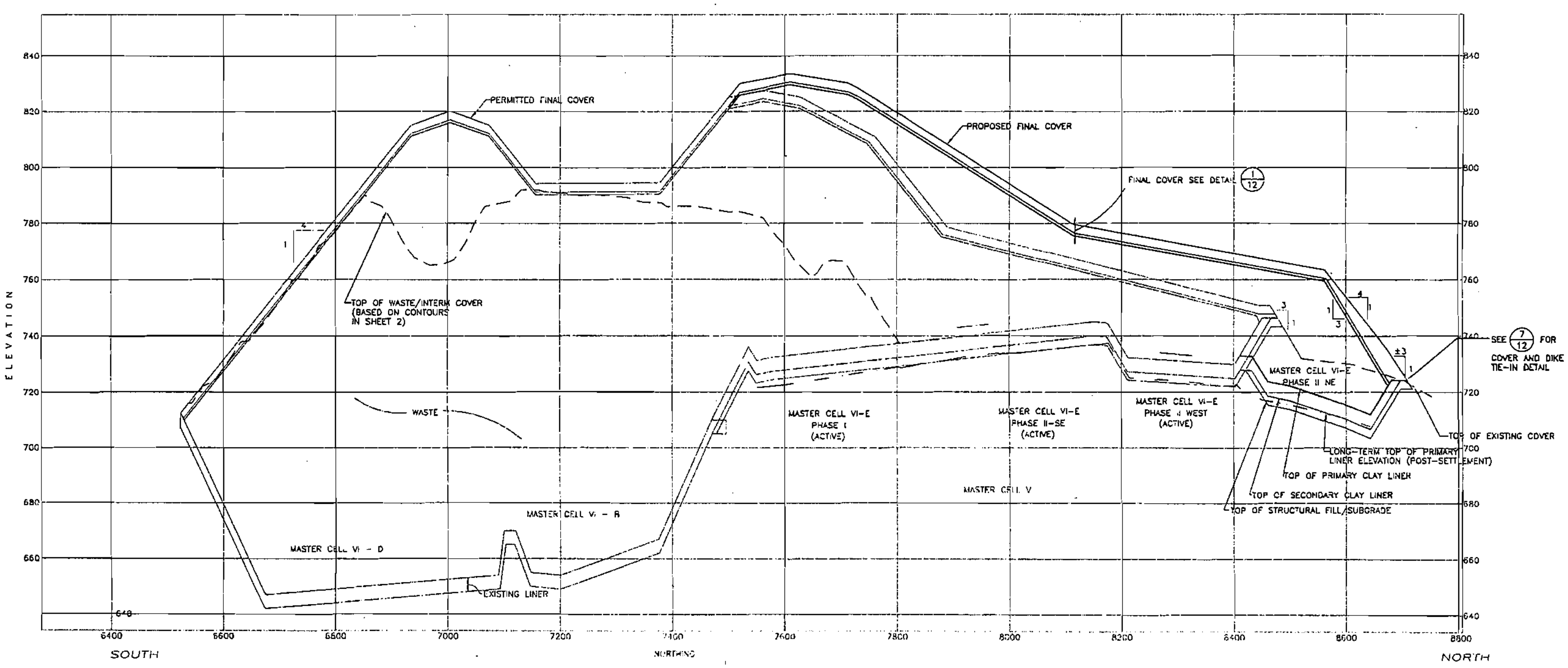


CROSS SECTION PLAN VIEW

N

LEGEND:

- PROPOSED COVER
- PROPOSED TOP OF PRIMARY LINER
- PROPOSED TOP OF SECONDARY/ STRUCTURAL FILL
- ESTIMATED LONG TERM TOP OF PRIMARY LINER (POST-SETTLEMENT)
- TOP OF EXISTING COVER/ WASTE GRADE



2/9 NORTH–SOUTH CROSS SECTION

VERTICAL SCALE 20' 0 20'

HORIZONTAL SCALE 100' 0 100'

NTH Consultants, Lt

Infrastructure Engineering and Environmental Services

Northville, MI	248.553.6
Detroit, MI	313.237.3
Lansing, MI	517.484.6
Grand Rapids, MI	616.957.3
Exton, PA	610.524.2
Lehigh Valley, PA	484.893.1
Cleveland, OH	216.334.4
Indianapolis, IN	317.735.7

SUBMITTAL

REV	DESCRIPTION	DATE
[illegible]	[illegible]	[illegible]

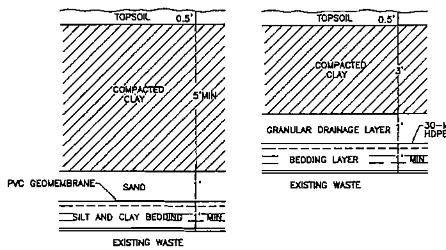
PROJECT NAME:
MASTER CELL VI-E DESIGN MODIFICATION

PROJECT LOCATION:
WDI SITE NO. 2
VAN BUREN TWP., WAY
COUNTY, MICHIGAN

NTH PROJECT NO: 13-070804-05	CAD FILE NAME: SHEET 9
DESIGNED BY: JHL	INCEP DATE: 1/21/08
DRAWN BY: DRL	DRAWING SCAL: AS SHOWN
CHECKED BY: ISS	SUBMITTED ON: 5/26/2011

SHEET TITLE:
CROSS-SECTIONS

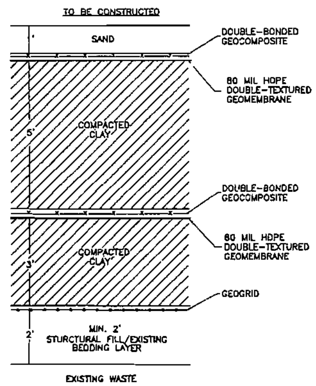
SHEET REFERENCE NUMBER:
9



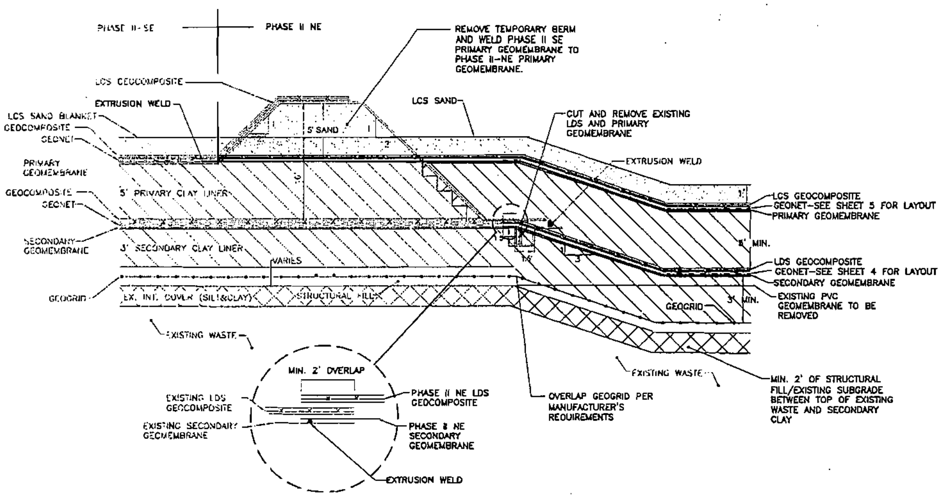
MC V COVER

MC VII COVER

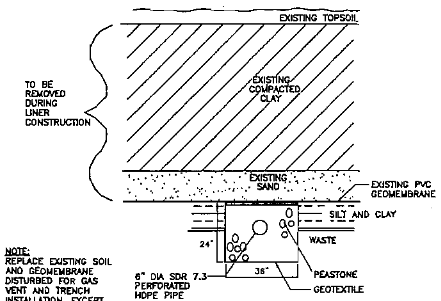
(1/10) EXISTING COVER DETAILS
NOT TO SCALE



(2/10) LINER SYSTEM OVER MC V
NOT TO SCALE

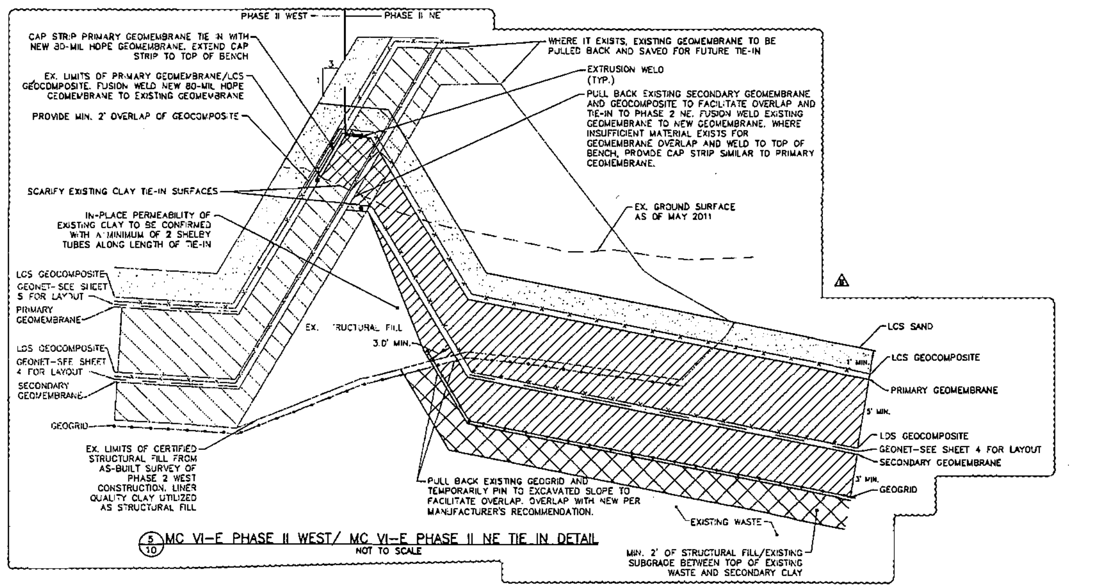


(3/10) MC VI-E PHASE II SE/ MC VI-E PHASE II NE TIE IN DETAIL
NOT TO SCALE



NOTE:
REPLACE EXISTING SOIL AND GEOMEMBRANE DISTURBED FOR GAS VENT AND TRENCH INSTALLATION, EXCEPT WHERE NEW LINER SYSTEM REPLACES THE FINAL COVER.

(4/10) MC-V GAS VENT TRENCH
NOT TO SCALE



(5/10) MC VI-E PHASE II WEST/ MC VI-E PHASE II NE TIE IN DETAIL
NOT TO SCALE

NTH Consultants, L
Infrastructure Engineering a
Environmental Services

Northville, MI	248.553
Detroit, MI	313.237
Lansing, MI	517.484
Grand Rapids, MI	616.957
Exton, PA	610.524
Lehigh Valley, PA	484.893
Cleveland, OH	216.334
Indianapolis, IN	317.735

SUBMITTAL

REV	DESCRIPTION	DATE
3	MODIFY FLOOR/TIE IN	

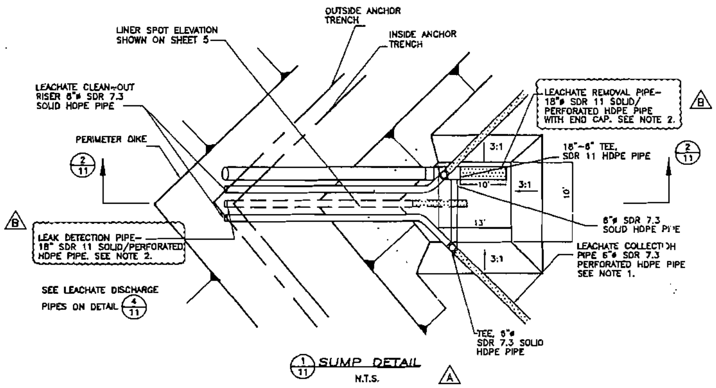
PROJECT NAME
MASTER CELL VI-E
DESIGN MODIFICATION

PROJECT LOCATION
WDI SITE NO. 2
VAN BUREN TWP., WAY
COUNTY, MICHIGAN

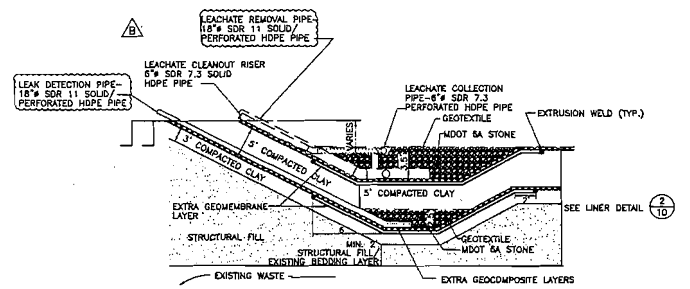
NTH PROJECT NO: 13-070804-05	CAD FILE NAME: SHEET 10
DESIGNED BY: JHL	SCOP DATE: 1/21/08
DRAWN BY: ORL	DRAWING SCALE: AS SHOWN
CHECKED BY: ISS	SUBMITTED ON: 9/26/2011

SHEET TITLE:
LINER SYSTEM DETAIL

SHEET REFERENCE NUMBER:
10

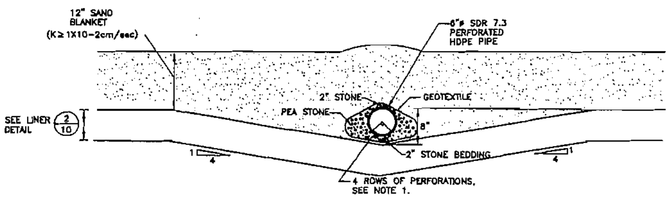


1/11 SUMP DETAIL
N.T.S.

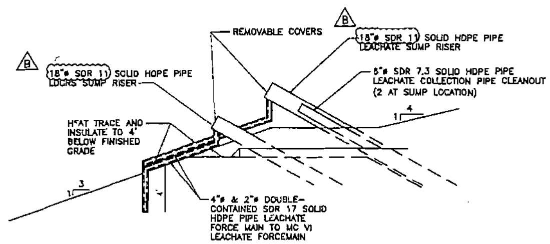


NOTE:
THE LCS AND LDS PUMP ELEVATIONS ARE:
1. LDS "PUMP-ON" ELEV= TOP OF LDS SUMP
2. LDS "PUMP-OFF" ELEV= 1 FOOT ABOVE LDS SUMP BOTTOM
3. LCS "PUMP-ON" ELEV= 0.67' BELOW TOP OF LCS SUMP
4. LCS "PUMP-OFF ELEV= 1 FOOT ABOVE LCS SUMP BOTTOM

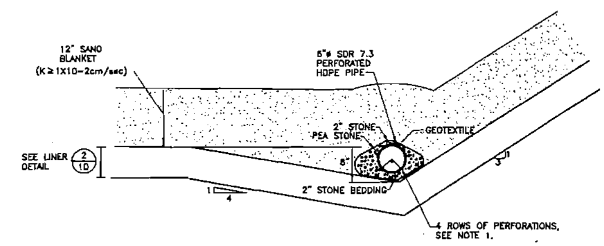
2/11 SUMP CROSS SECTION
N.T.S.



3/11 CELL FLOOR LEACHATE COLLECTION PIPE (TYP.)
N.T.S.



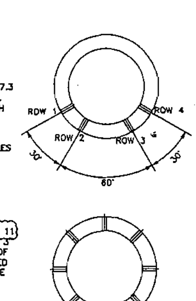
4/11 LCS AND LDCRS RISER DISCHARGE AFTER CLOSURE
N.T.S.



5/11 TOE OF SLOPE LEACHATE COLLECTION PIPE (TYP.)
N.T.S.

NOTES:
1. PIPE IS HDPE, 6" SDR 7.3 WITH 1/4" DIA. HOLES, 2" SPACING ALONG EACH OF (4) ROWS. ROWS SPACED AROUND CIRCUMFERENCE AS SHOWN. TOTAL 24 HOLES PER FOOT.

2. PIPE IS 18" HDPE SDR 11 WITH 3/8" DIA. HOLES. 3" SPACING ALONG EACH OF (8) ROWS. ROWS SPACED AROUND CIRCUMFERENCE AS SHOWN. TOTAL 32 HOLES PER FOOT.



Geosynthetic Materials

Material	Location	Description	Product	Additional Requirements
60-mil Geomembrane	Primary and secondary liners	60-mil HDPE, textured both sides	GSE HD textured, or equivalent	Interface friction requirements in CQA Plan
40-mil Geomembrane	Final cover	40-mil HDPE, textured both sides	GSE HD textured, or equivalent	Interface friction requirements in CQA Plan
Geosynthetic Clay Liner	Final cover	Sodium bentonite encapsulated between two geotextiles that are needle punched or stitch bonded together	CETCO Bentomat ST, or equivalent	Internal shear strength requirements in CQA Plan
Geocomposite	LCS and LDCRS	200-mil HDPE, bonded top and bottom to geotextile meeting requirements below	GSE FABRINET, or equivalent	Transmissivity and interface friction requirements in CQA Plan
Cover Geocomposite	Final cover	200-mil HDPE, bonded top and bottom to geotextile meeting requirements below	GSE FABRINET, or equivalent	Transmissivity and interface friction requirements in CQA Plan
Geonet	LCS and LDCRS sumps, LCS and LDCRS collectors	200-mil HDPE	GSE HYPERNET, or equivalent	Transmissivity requirements in CQA Plan
Geotextile	All geocomposites, gravel/geotextile envelopes for LCS, and final cover perimeter drain	Nominal 8 oz/yd2, needle-punched, nonwoven polypropylene	Amoco 4508, Synthetic Industries Geotex 801, or equivalent	AASHTO M288-96 requirements for Drainage Geotextile (Class 2)
Geogrid	Above Subgrade	Biaxial Polymeric Grid	Huesker Fortrac 60-80, or equivalent	None

LCS denotes leachate collection system
LDCRS denotes leak detection, collection, and removal system

NTH Consultants, Lt
Infrastructure Engineering an
Environmental Services

Northville, MI	248.553.6
Detroit, MI	313.237.3
Lansing, MI	517.484.6
Grand Rapids, MI	616.957.3
Exton, PA	610.524.2
Lehigh Valley, PA	484.693.1
Cleveland, OH	216.334.4
Indianapolis, IN	317.735.7

SUBMITTAL

REV	DESCRIPTION	DATE
A	PER MDEQ COMMENTS	[illegible]
B	MODIFY FLOOR/TIE IN	[illegible]

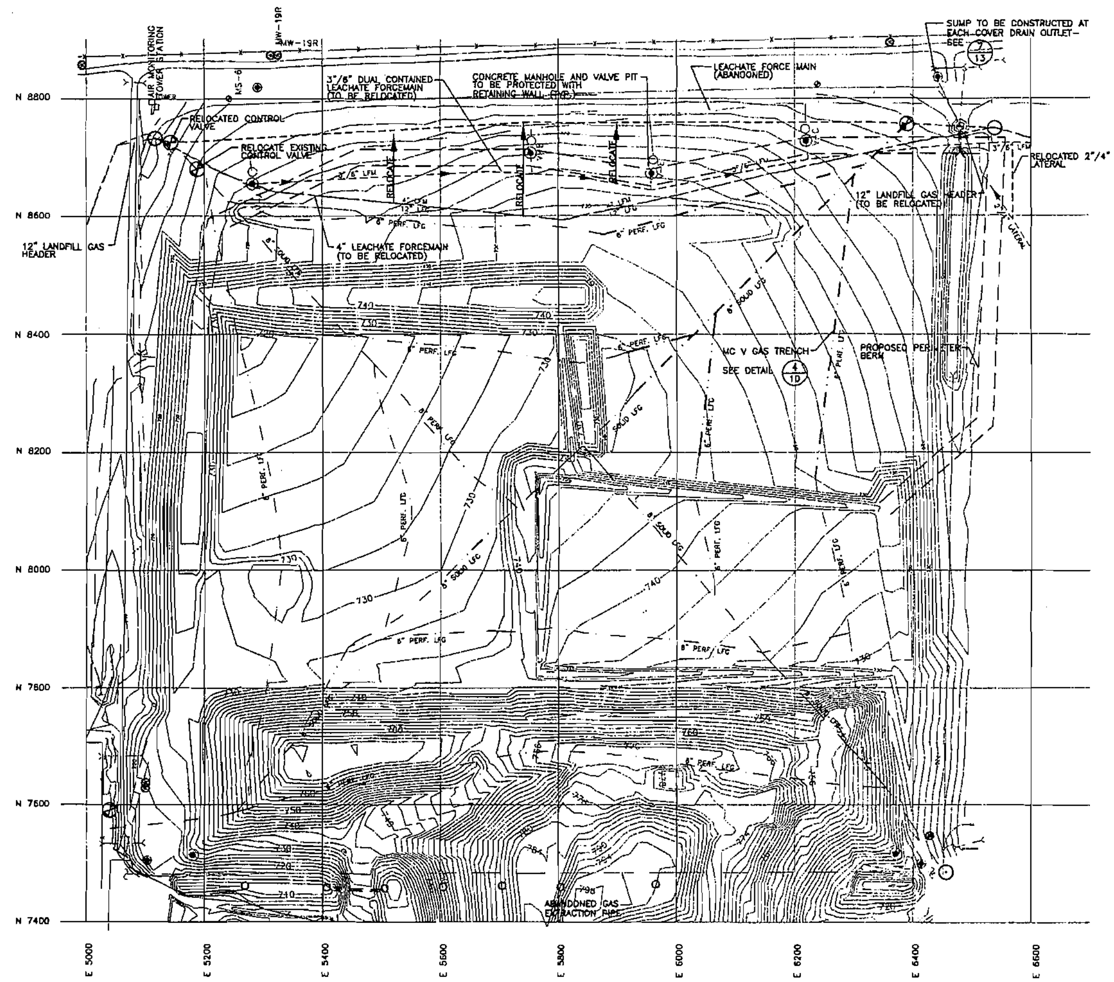
PROJECT NAME
MASTER CELL VI-E DESIGN MODIFICATION

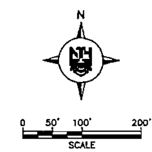
PROJECT LOCATION
WDI SITE NO. 2
VAN BUREN TWP., WAY
COUNTY, MICHIGAN

NTH PROJECT NO.: 13-070804-05	CAD FILE NAME: SHEET 11
DESIGNED BY: JHL	INCEP DATE: 1/21/08
DRAWN BY: DRL	DRAWING SCAL: AS SHOW
CHECKED BY: ISS	SUBMITTED DA: 9/26/2011

SHEET TITLE:
LEACHATE COLLECTIO SYSTEM DETAILS

SHEET REFERENCE NUMBER:
11





LEGEND:

- AS-BUILT LANDFILL GAS COLLECTION PIPE (6" PERF. LFG)
- PROPOSED LANDFILL GAS COLLECTION PIPE (6" PERF. LFG)
- PROPOSED TOP OF PERIMETER BERM
- LANDFILL GAS HEADER PIPE
- LEACHATE FORCEMAIN (4" LFM)
- RELOCATED UTILITY ALIGNMENT
- CONTROL VALVE
- CONDENSATE TRAP
- EXISTING LEACHATE SUMP
- EXISTING LEACHATE SUMP VALVE PIT
- EXISTING LYSIMETER
- EXISTING GROUNDWATER MONITORING WELL
- EXISTING CLEAN OUT
- APPROXIMATE LOCATION OF EXISTING COVER DRAIN OUTLETS
- EXISTING LEACHATE FORCEMAIN (ABANDONED)

NOTES:

1. TOPOGRAPHIC INFORMATION TAKEN FROM MAY 1998 AERIAL SURVEY BY AIR-LAND SURVEY, SURVEYS BY WDI IN JANUARY 2006, JANUARY 2007, NOVEMBER 2007, AND SURVEY FROM MCI LLC. IN OCTOBER 2007. CONTOUR INTERVAL= 2 FEET
2. UTILITY INFORMATION BASED ON SITE UTILITY PLAN PROVIDED BY MC LLC.

NTH Consultants, L
Infrastructure Engineering a
Environmental Services

Northville, MI	248.553.
Detroit, MI	313.237.
Lansing, MI	517.484.
Grand Rapids, MI	616.957.
Exton, PA	610.524.
Lehigh Valley, PA	484.893.
Cleveland, OH	216.334.
Indianapolis, IN	317.735.

SUBMITTAL

REV	DESCRIPTION	DATE
A	PERMCEO COMMENTS	[illegible]

PROJECT NAME

MASTER CELL VI-E
DESIGN MODIFICATION

PROJECT LOCATION

WDI SITE NO. 2
VAN BUREN TWP., WA
COUNTY, MICHGAN

NTH PROJECT NO.: 13-070804-05	CAD FILE NAME: SHEET 14
DESIGNED BY: JHL	INCEP DATE: 1/21/08
DRAWN BY: DRL	DRAWING SCALE: AS SHOWN
CHECKED BY: ISS	SUBMITTED DATE: 9/28/2011

SHEET TITLE:

MC V MISCELLANEOUS
UTILITIES

SHEET REFERENCE NUMBER:

14

WAYNE DISPOSAL, INC. SITE NO. 2
TRANSFER BOX RELOCATION

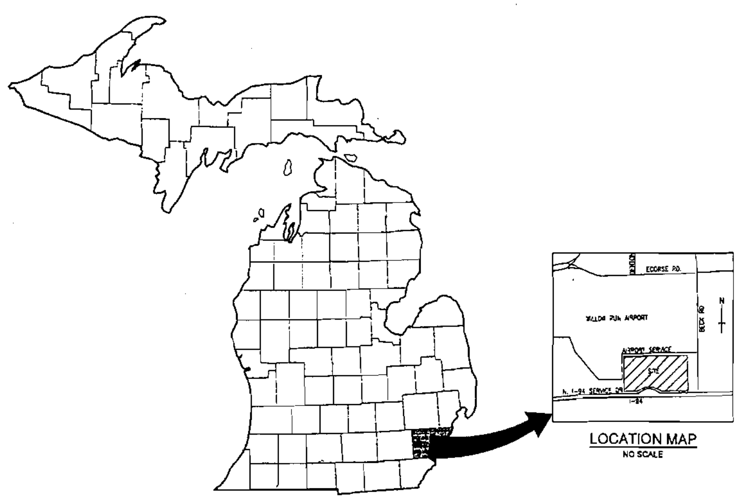
VAN BUREN TOWNSHIP, WAYNE COUNTY, MICHIGAN

NTH PROJECT NO. 13-060921-09

SEPTEMBER 2009

OWNER:
Wayne Disposal, Inc.
49350 N. I-94 Service Drive
Belleville, Michigan 48111

ENGINEER:
NTH Consultants, LTD.
41780 Six Mile Road
Northville, Michigan 48168



MICHIGAN
APPROX. SCALE: 1"=50 MILES

LOCATION MAP
NO SCALE

SHEET INDEX

NTH Consultants, L
Infrastructure Engineering ar
Environmental Services

Northville, MI	248.553.
Detroit, MI	313.237.
Lansing, MI	517.484.
Grand Rapids, MI	616.957.
Exton, PA	610.524.
Lehigh Valley, PA	484.693.
Cleveland, OH	216.334.
Indianapolis, IN	317.735.

SUBMITTAL

REV	DESCRIPTION	DATE

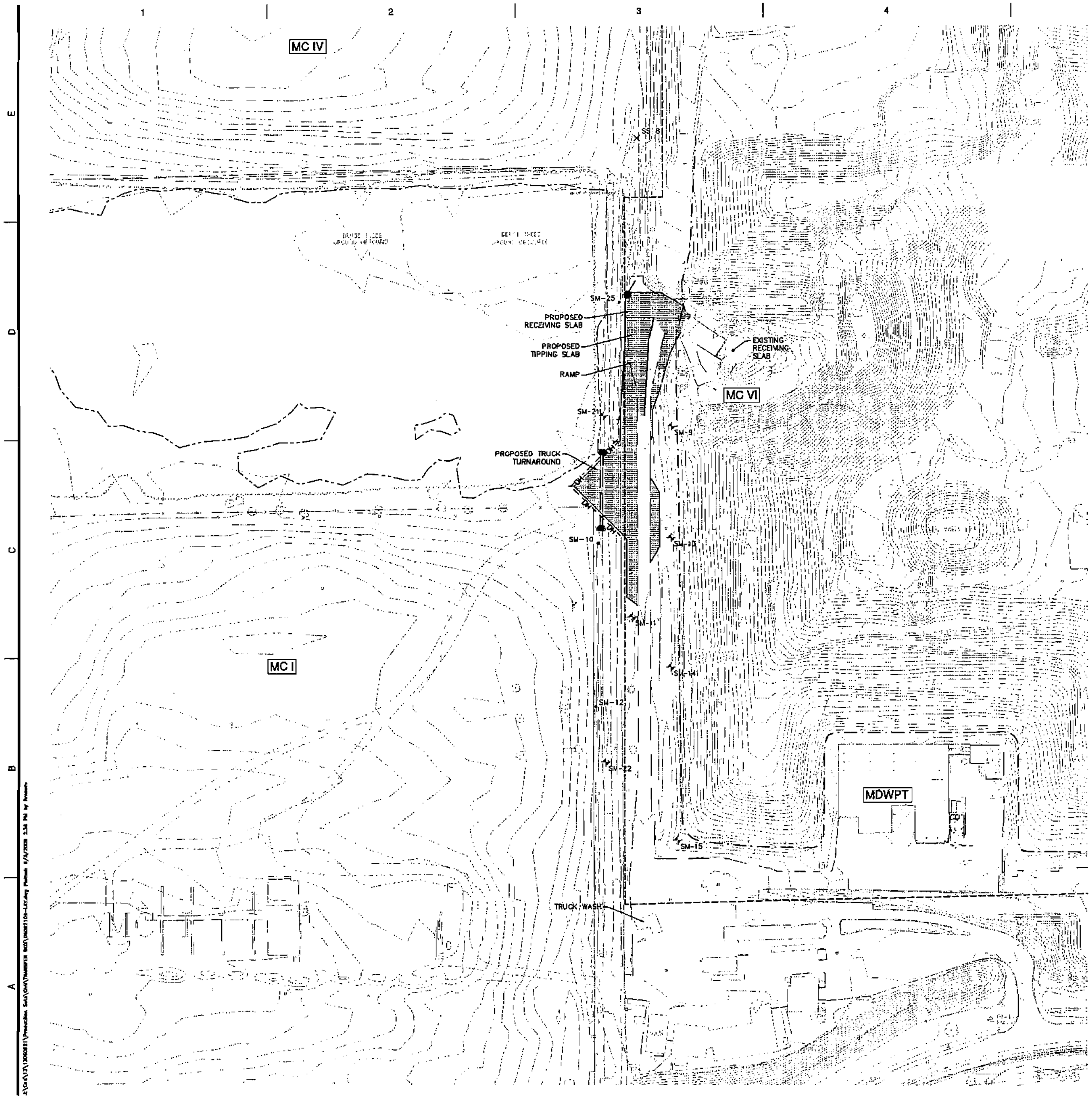
PROJECT NAME:
TRANSFER BOX RELOCATION

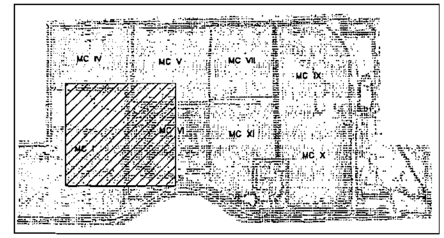
PROJECT LOCATION:
WAYNE DISPOSAL, INC
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO.: 13-060921-09	CAD FILE NAM 06092109-
DESIGNED BY: KRO	INCEP DATE 12/11/08
DRAWN BY: KRO	DRAWING SCA NONE
CHECKED BY: RBM	SUBMITTED D 8/4/09

SHEET TITLE:
TITLE SHEET

SHEET REFERENCE NUMBER:
C-100





LOCATION MAP

N

0 50' 100' 200'
SCALE

LEGEND:

- LIGHT
- UTILITY POLE
- SIGN
- EXISTING CONTOUR (2 FT INTERVAL)
- FENCE
- EDGE OF ROAD
- HAZARDOUS WASTE BOUNDARY
- INSIDE TOP OF DIKE/ LIMITS OF LINER
- STORM SEWER
- CULVERT
- WETLAND BOUNDARY
- PROPOSED RETAINING WALL
- PROPOSED STORM SEWER
- PROPOSED END SECTION/RIP RAP
- PROPOSED MANHOLE
- PROPOSED PAVEMENT
- SM-9 SOIL SAMPLING LOCATION
- SM-10 SEDIMENT SAMPLING LOCATION
- SS 8 SURFACE WATER SAMPLING LOCATION

NTH Consultants, Ltd.

Infrastructure Engineering and Environmental Services

Northville, MI	248.553.6300
Detroit, MI	313.237.3900
Lansing, MI	517.484.6900
Grand Rapids, MI	616.957.3690
Exton, PA	610.524.2300
Lehigh Valley, PA	484.893.1440
Cleveland, OH	216.334.4040
Indianapolis, IN	317.735.7649

SUBMITTAL

REV	DESCRIPTION	DATE	BY

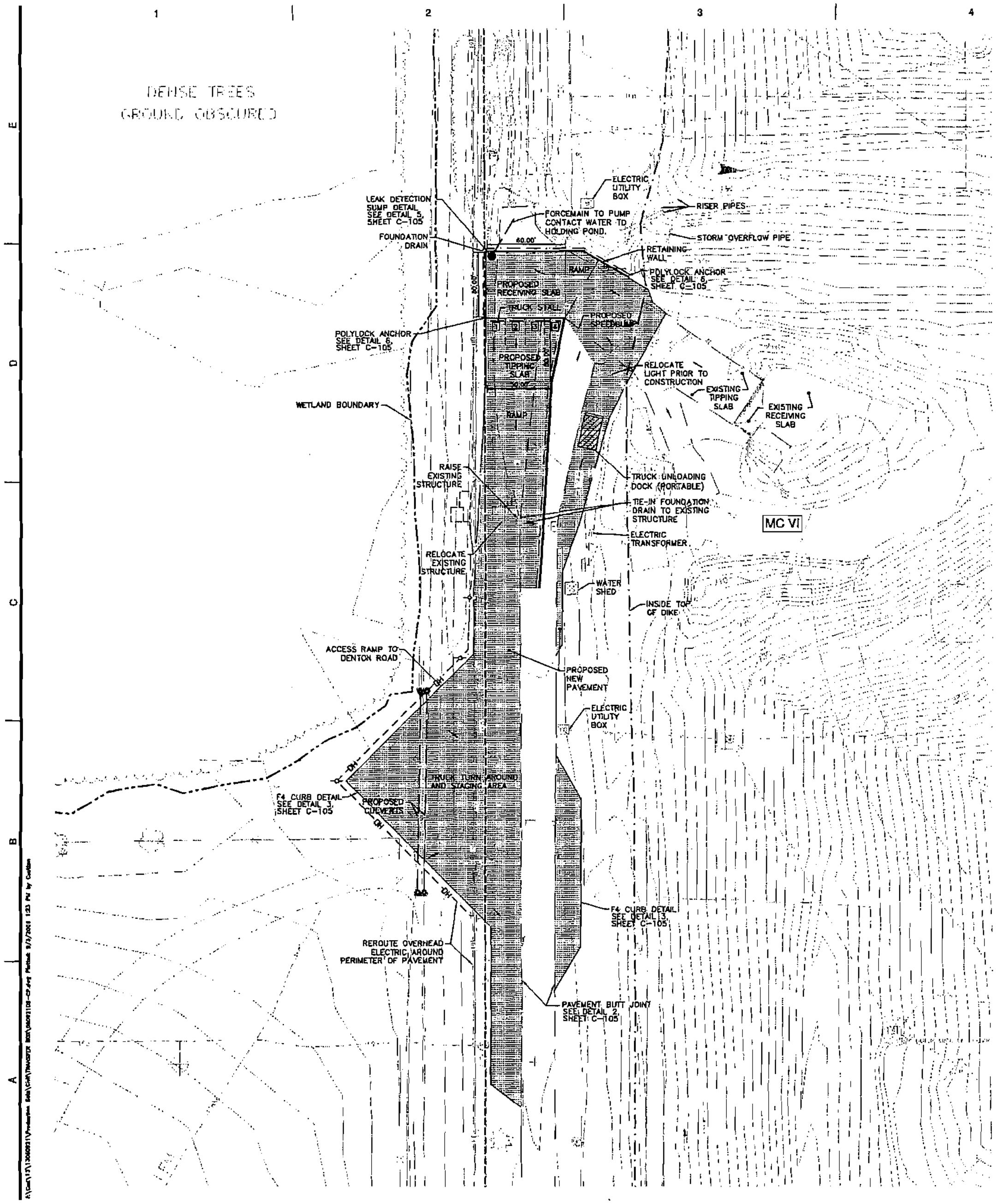
PROJECT NAME:
TRANSFER BOX RELOCATION

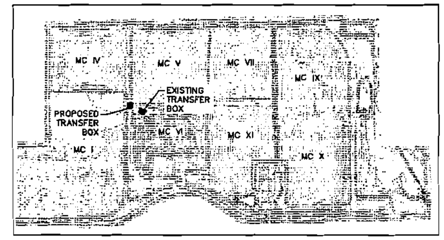
PROJECT LOCATION:
WAYNE DISPOSAL, INC.
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO.: 13-080921-09	CAD FILE NAME: 08092109-LAY
DESIGNED BY: NAME	INCEP DATE: 12/11/08
DRAWN BY: NAME	DRAWING SCALE: AS SHOWN
CHECKED BY: NAME	SUBMITTED DATE: 6/4/09

SHEET TITLE:
GENERAL LAYOUT PLAN

SHEET REFERENCE NUMBER:
C-101





LOCATION MAP

N

0 20' 40' 80'
SCALE

LEGEND:

- LIGHT
- UTILITY POLE
- SIGN
- EXISTING CONTOUR (2 FT INTERVAL)
- FENCE
- EDGE OF ROAD
- HAZARDOUS WASTE BOUNDARY
- INSIDE TOP OF DIKE/ LIMITS OF LINER
- OVERHEAD ELECTRIC
- LEACHATE LINE
- GAS HEADER
- UNDERGROUND ELECTRIC
- SURFACE ELECTRIC
- STORM SEWER
- CULVERT
- WETLAND BOUNDARY
- PROPOSED RETAINING WALL
- PROPOSED GRADE BREAKLINE
- PROPOSED CONTACT WATER FORCEMAIN
- PROPOSED SLOPE DIRECTION
- PROPOSED END SECTION/RIP RAP
- PROPOSED MANHOLE
- PROPOSED PAVEMENT
- PROPOSED FOUNDATION DRAIN

NTH Consultants, Ltd.
Infrastructure Engineering and Environmental Services

Northville, MI	248.553.6300
Detroit, MI	313.237.3900
Lansing, MI	517.484.6900
Grand Rapids, MI	616.957.3650
Exton, PA	610.524.2300
Lehigh Valley, PA	484.893.1440
Cleveland, OH	216.334.4040
Indianapolis, IN	317.735.7849

SUBMITTAL

REV	DESCRIPTION	DATE	BY

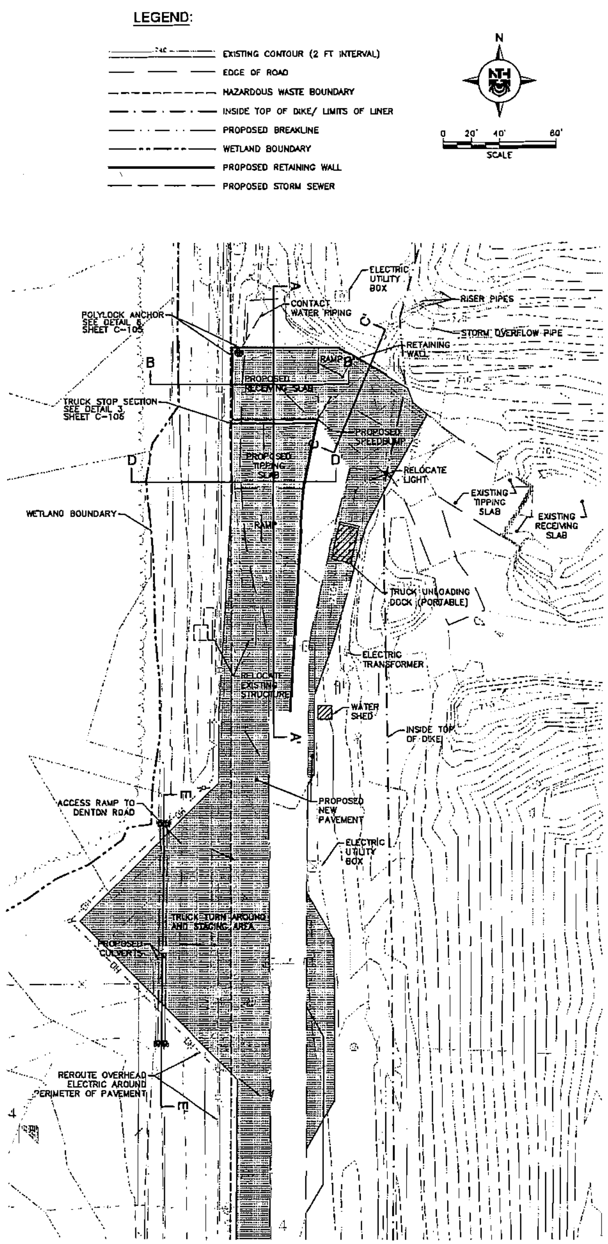
PROJECT NAME
TRANSFER BOX RELOCATION

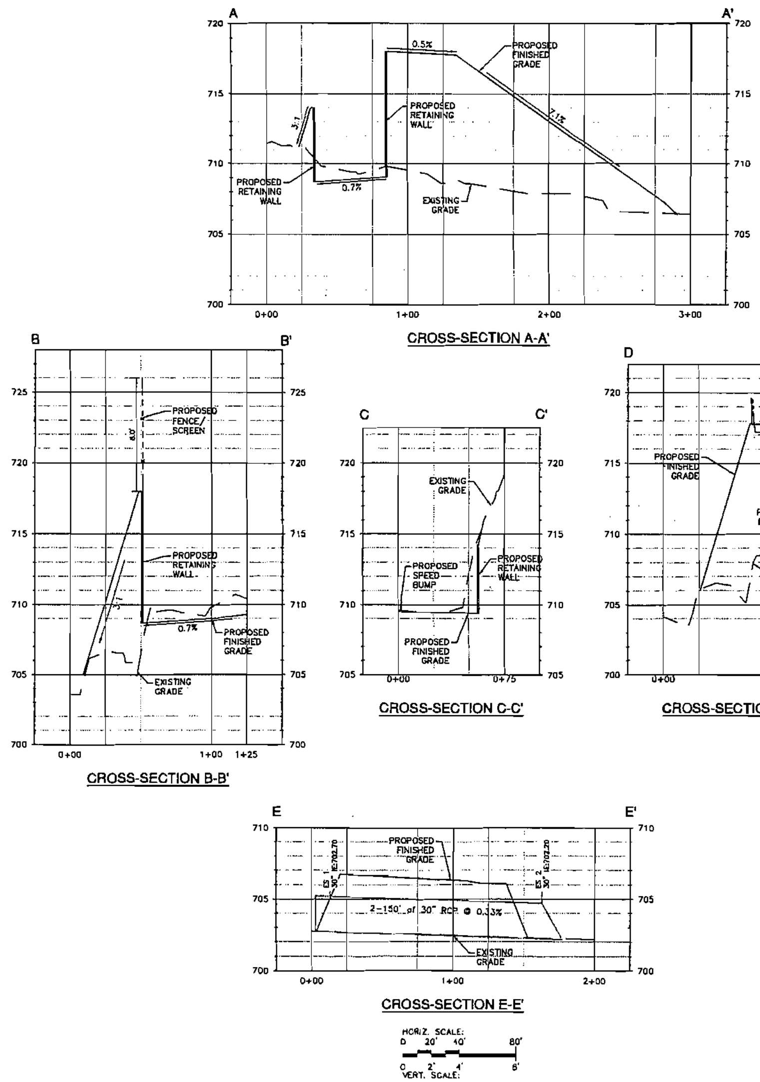
PROJECT LOCATION
WAYNE DISPOSAL, INC.
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO. 13-080921-08	CAD FILE NAME: 08092108-CP
DESIGNED BY: KRD	INCEP DATE: 12/11/08
DRAWN BY: KRD	DRAWING SCALE: AS SHOWN
CHECKED BY: RBM	SUBMITTED DATE: 9/4/09

SHEET TITLE:
CONCEPTUAL PLAN

SHEET REFERENCE NUMBER:
C-102





NTH Consultants, Ltd.

Infrastructure Engineering and Environmental Services

Northville, MI	248.553.6300
Detroit, MI	313.237.3900
Lansing, MI	517.484.6900
Grand Rapids, MI	616.957.3690
Exton, PA	610.524.2300
Lehigh Valley, PA	484.893.1440
Cleveland, OH	216.334.4040
Indianapolis, IN	317.735.7649

SUBMITTAL

REV	DESCRIPTION	DATE	BY

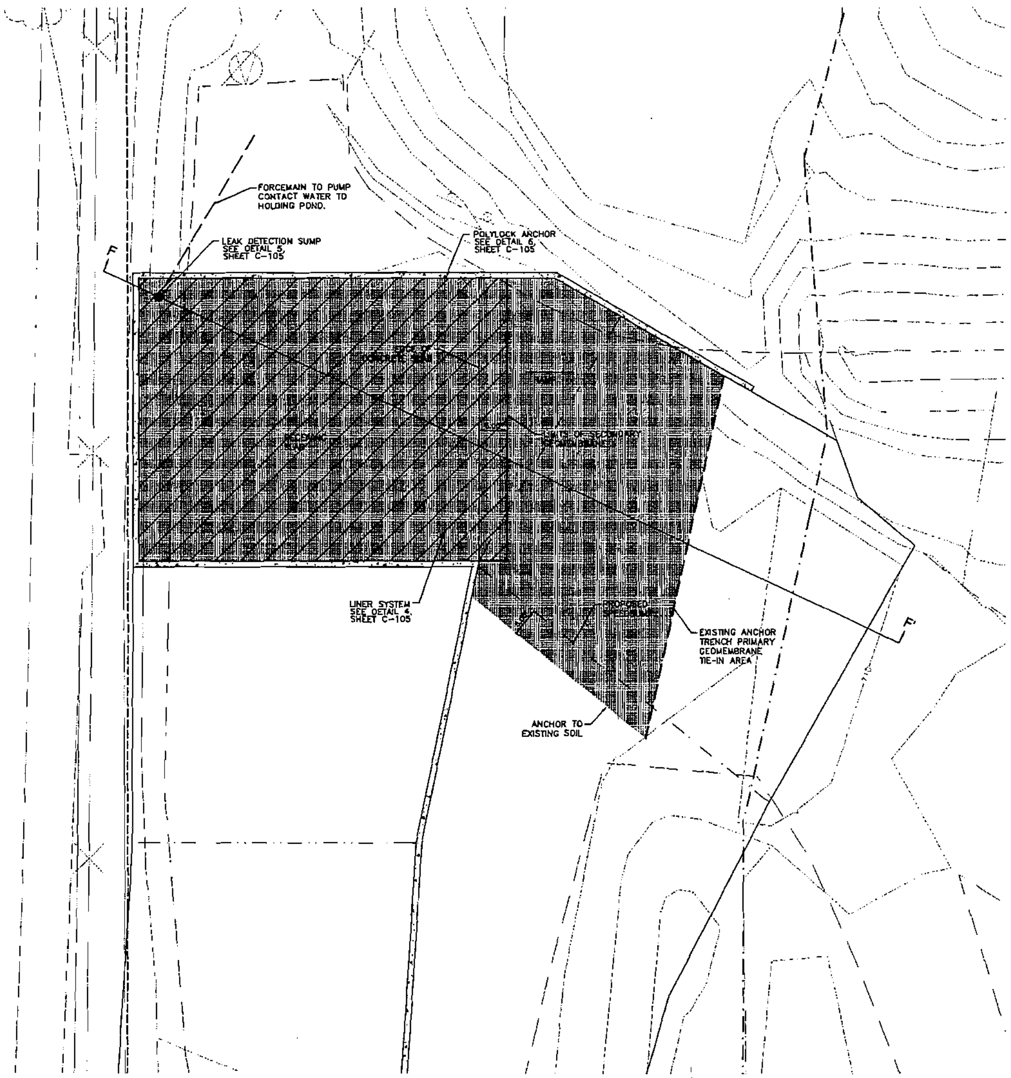
PROJECT NAME:
TRANSFER BOX RELOCATION

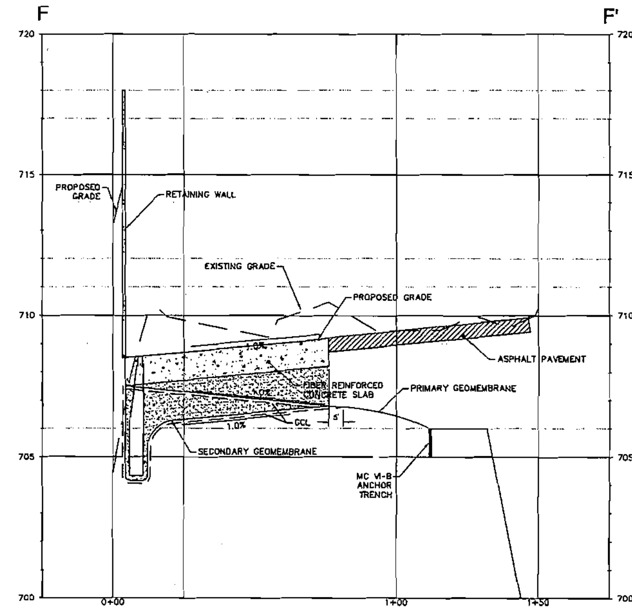
PROJECT LOCATION:
WAYNE DISPOSAL, INC.
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO.: 13-080821-09	CAD FILE NAME: 08082109-PR
DESIGNED BY: KRO	INCEP DATE: 12/11/08
DRAWN BY: KRO	DRAWING SCALE:
CHECKED BY: RBM	SUBMITTED DATE 8/4/09

SHEET TITLE:
CROSS-SECTIONS

SHEET REFERENCE NUMBER:
C-103

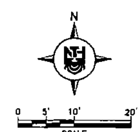




CROSS-SECTION F-F'

HORIZ. SCALE: 0 10' 20' 40'

0 1' 2' 4' VERT. SCALE



LEGEND:

- EXISTING CONTOUR (2 FT INTERVAL)
- FENCE
- EDGE OF ROAD
- HAZARDOUS WASTE BOUNDARY
- INSIDE TOP OF DIKE/ LIMITS OF LINER
- PROPOSED RETAINING WALL
- PROPOSED GRADE BREAKLINE
- PROPOSED CONTACT WATER FORCEMAIN
- PROPOSED MANHOLE
- PROPOSED PRIMARY GEOMEMBRANE
- PROPOSED SECONDARY GEOMEMBRANE

NTH Consultants, Ltd.

Infrastructure Engineering and Environmental Services

Northville, MI	248.553.6300
Detroit, MI	313.237.3900
Lansing, MI	517.484.6900
Grand Rapids, MI	616.957.3690
Exton, PA	610.524.2300
Lehigh Valley, PA	484.893.1440
Cleveland, OH	216.334.4040
Indianapolis, IN	317.735.7849

SUBMITTAL

REV	DESCRIPTION	DATE	BY

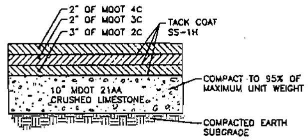
PROJECT NAME: TRANSFER BOX RELOCATION

PROJECT LOCATION: WAYNE DISPOSAL, INC. SITE NO. 2 BELLEVILLE, MICHIGAN

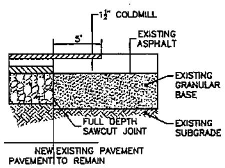
NTH PROJECT NO.: 13-080921-08	CAD FILE NAME: 08092109-LS
DESIGNED BY: KRO	INCEP DATE: 12/11/08
DRAWN BY: KRO	DRAWING SCALE: AS SHOWN
CHECKED BY: RBM	SUBMITTED DATE: 6/4/09

SHEET TITLE: LINER SYSTEM

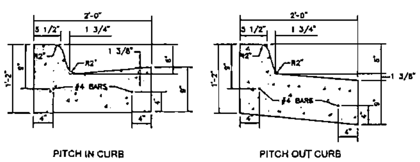
SHEET REFERENCE NUMBER: C-104



1 C-105 TYPICAL PAVEMENT DETAIL
NOT TO SCALE

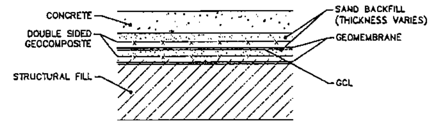


2 C-105 PAVEMENT BUTT JOINT
NOT TO SCALE

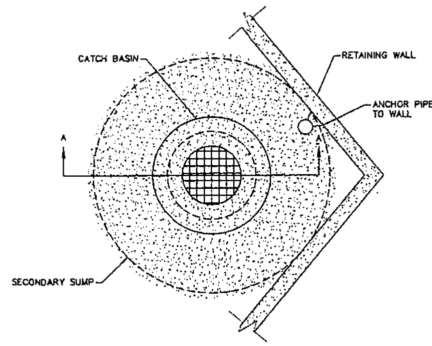


NOTE:
BASE AND SUBBASE AGGREGATES TO EXTEND MINIMUM 1'-0" BEHIND BACK OF CURB.

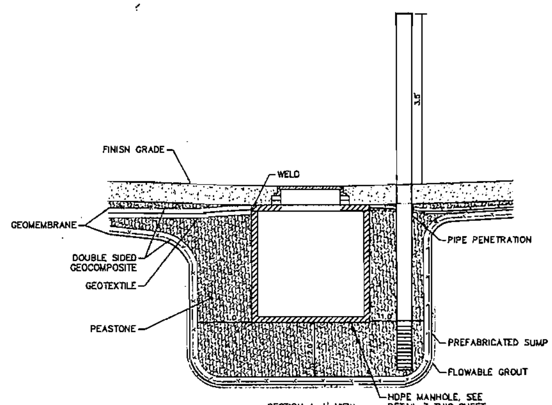
3 C-105 F4 CURB DETAIL
NOT TO SCALE



4 C-105 LINER SYSTEM
NOT TO SCALE

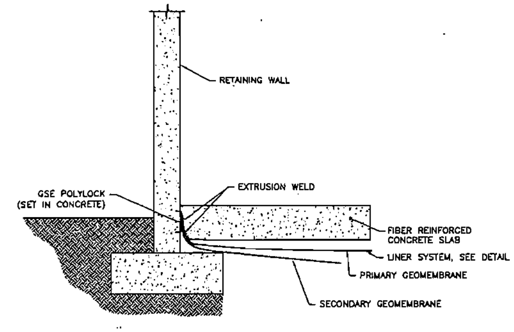


PLAN VIEW

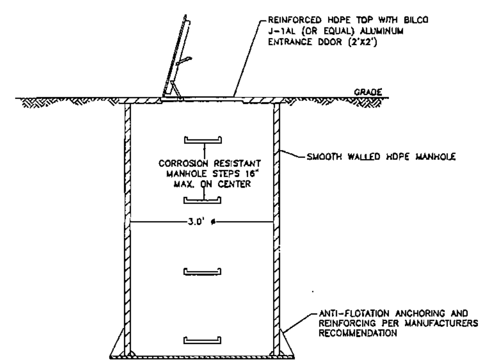


SECTION A-A' VIEW

5 C-105 LEAK DETECTION SUMP DETAIL
NOT TO SCALE



6 C-105 POLYLOCK ANCHOR
NOT TO SCALE



7 C-105 HDPE CATCH BASIN
NOT TO SCALE

NTH Consultants, L
Infrastructure Engineering and Environmental Services

Northville, MI
Detroit, MI
Lansing, MI
Grand Rapids, MI
Exton, PA
Lehigh Valley, PA
Cleveland, OH
Indianapolis, IN

REVISIONS

REV	DESCRIPTION	DATE

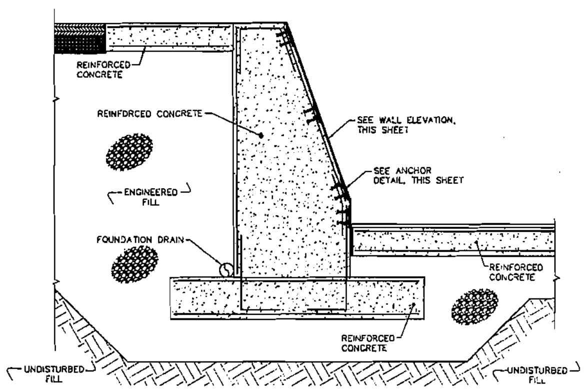
PROJECT NAME
TRANSFER BOX RELOCATION

PROJECT LOCATION
WAYNE DISPOSAL, INC.
SITE NO. 2
BELLEVILLE, MICHIGAN

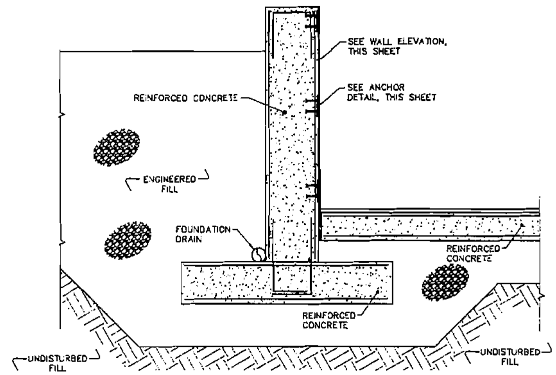
NTH PROJECT NO: 13-060921-08	CAD FILE NAME: 06092108-C
DESIGNED BY: KRO	INCEP DATE: 12/11/08
DRAWN BY: KRO	DRAWING SCALE: NONE
CHECKED BY: RBM	SUBMITTED DATE: 8/4/09

SHEET TITLE:
DETAILS

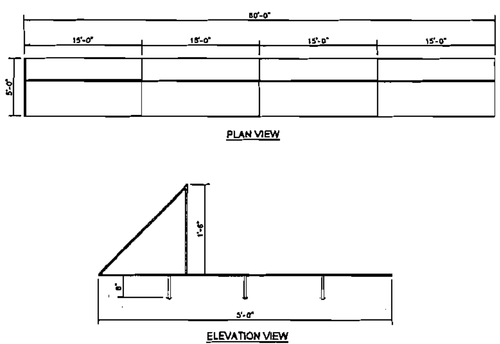
SHEET REFERENCE NUMBER:
C-105



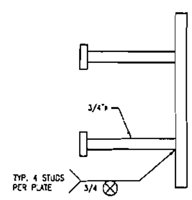
1 C-106 RETAINING WALL AT TIPPING SLAB
NOT TO SCALE



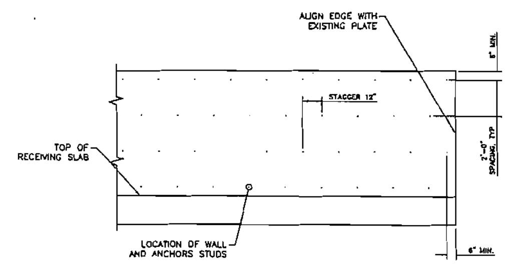
2 C-106 SIDE RETAINING WALL SECTION
NOT TO SCALE



3 C-106 TRUCK STOP SECTION
NOT TO SCALE



4 C-106 ANCHOR DETAIL
NOT TO SCALE



5 C-106 WALL ELEVATION
NOT TO SCALE

NTH Consultants, L
Infrastructure Engineering & Environmental Services

Northville, MI	248.553
Detroit, MI	313.237
Lansing, MI	517.484
Grand Rapids, MI	616.957
Exton, PA	610.524
Lehigh Valley, PA	484.893
Cleveland, OH	216.334
Indianapolis, IN	317.735

REVISIONS

REV	DESCRIPTION	DAT

PROJECT NAME
TRANSFER BOX RELOCATION

PROJECT LOCATION
WAYNE DISPOSAL, INC
SITE NO. 2
BELLEVILLE, MICHIGAN

NTH PROJECT NO.: 13-080821-09	CAD FILE NA: 08082109
DESIGNED BY: NAME	INCEP DATE: 12/11/08
DRAWN BY: NAME	DRAWING SC: NONE
CHECKED BY: NAME	SUBMITTED: 8/4/09

SHEET TITLE:
DETAILS

SHEET REFERENCE NUMBER:
C-106

Attachment 8

Acceptable Waste Types

DESCRIPTION OF HAZARDOUS WASTE TYPES

40 CFR 270.13

AND

NREPA 451, PART 111 R504(1)b

See MDEQ Application Form (EQP 5111) XIV "Description of Hazardous Waste Types".

Description of Hazardous Wastes
Wayne Disposal, Inc., Site # 2
MID 048 090 633

LINE NO.	A. EPA HAZARDOUS WASTECODE	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE	D1. PROCESS CODES			D2. PROCESS DESCRIPTION
1	D001[R]	200000	Y	D80			
2	D002	200000	Y	D80			
3	D003[R]	200000	Y	D80			
4	D004	200000	Y	D80			
5	D005	200000	Y	D80			
6	D006	200000	Y	D80			
7	D007	200000	Y	D80			
8	D008	200000	Y	D80			
9	D009	200000	Y	D80			
10	D010	200000	Y	D80			
11	D011	200000	Y	D80			
12	D012	200000	Y	D80			
13	D013	200000	Y	D80			
14	D014	200000	Y	D80			
15	D015	200000	Y	D80			
16	D016	200000	Y	D80			
17	D017	200000	Y	D80			
18	D018	200000	Y	D80			
19	D019	200000	Y	D80			
20	D020	200000	Y	D80			
21	D021	200000	Y	D80			
22	D022	200000	Y	D80			
23	D023	200000	Y	D80			
24	D024	200000	Y	D80			
25	D025	200000	Y	D80			
26	D026	200000	Y	D80			
27	D027	200000	Y	D80			
28	D028	200000	Y	D80			
29	D029	200000	Y	D80			
30	D030	200000	Y	D80			
31	D031	200000	Y	D80			
32	D032	200000	Y	D80			
33	D033	200000	Y	D80			
34	D034	200000	Y	D80			
35	D035	200000	Y	D80			
36	D036	200000	Y	D80			
37	D037	200000	Y	D80			
38	D038	200000	Y	D80			
39	D039	200000	Y	D80			
40	D040	200000	Y	D80			
41	D041	200000	Y	D80			
42	D042	200000	Y	D80			
43	D043	200000	Y	D80			
44	F001	200000	Y	D80			
45	F002	200000	Y	D80			
46	F003	200000	Y	D80			
47	F004	200000	Y	D80			

Description of Hazardous Wastes
Wayne Disposal, Inc., Site # 2
MID 048 090 633

LINE NO.	A. EPA HAZARDOUS WASTECODE	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE	D1. PROCESS CODES			D2. PROCESS DESCRIPTION
48	F005	200000	Y	D80			
49	F006	200000	Y	D80			
50	F007	200000	Y	D80			
51	F008	200000	Y	D80			
52	F009	200000	Y	D80			
53	F010	200000	Y	D80			
54	F011	200000	Y	D80			
55	F012	200000	Y	D80			
56	F019	200000	Y	D80			
57	F024	200000	Y	D80			
58	F025	200000	Y	D80			
59	F032	200000	Y	D80			
60	F034	200000	Y	D80			
61	F035	200000	Y	D80			
62	F037	200000	Y	D80			
63	F038	200000	Y	D80			
64	F039	200000	Y	D80			
65	K001	200000	Y	D80			
66	K002	200000	Y	D80			
67	K003	200000	Y	D80			
68	K004	200000	Y	D80			
69	K005	200000	Y	D80			
70	K006	200000	Y	D80			
71	K007	200000	Y	D80			
72	K008	200000	Y	D80			
73	K009	200000	Y	D80			
74	K010	200000	Y	D80			
75	K011	200000	Y	D80			
76	K013	200000	Y	D80			
77	K014	200000	Y	D80			
78	K015	200000	Y	D80			
79	K016	200000	Y	D80			
80	K017	200000	Y	D80			
81	K018	200000	Y	D80			
82	K019	200000	Y	D80			
83	K020	200000	Y	D80			
84	K021	200000	Y	D80			
85	K022	200000	Y	D80			
86	K023	200000	Y	D80			
87	K024	200000	Y	D80			
88	K025	200000	Y	D80			
89	K026	200000	Y	D80			
90	K027[R]	200000	Y	D80			
91	K028	200000	Y	D80			
92	K029	200000	Y	D80			
93	K030	200000	Y	D80			
94	K031	200000	Y	D80			
95	K032	200000	Y	D80			

LINE NO.	A. EPA HAZARDOUS WASTECODE	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE	D1. PROCESS CODES			D2. PROCESS DESCRIPTION
96	K033	200000	Y	D80			
97	K034	200000	Y	D80			
98	K035	200000	Y	D80			
99	K036	200000	Y	D80			
100	K037	200000	Y	D80			
101	K038	200000	Y	D80			
102	K039	200000	Y	D80			
103	K040	200000	Y	D80			
104	K041	200000	Y	D80			
105	K042	200000	Y	D80			
106	K043	200000	Y	D80			
107	K044[R]	200000	Y	D80			
108	K045[R]	200000	Y	D80			
109	K046	200000	Y	D80			
110	K047[R]	200000	Y	D80			
111	K048	200000	Y	D80			
112	K049	200000	Y	D80			
113	K050	200000	Y	D80			
114	K051	200000	Y	D80			
115	K052	200000	Y	D80			
116	K060	200000	Y	D80			
117	K061	200000	Y	D80			
118	K062	200000	Y	D80			
119	K069	200000	Y	D80			
120	K071	200000	Y	D80			
121	K073	200000	Y	D80			
122	K083	200000	Y	D80			
123	K084	200000	Y	D80			
124	K085	200000	Y	D80			
125	K086	200000	Y	D80			
126	K087	200000	Y	D80			
127	K088	200000	Y	D80			
128	K090	200000	Y	D80			
129	K091	200000	Y	D80			
130	K093	200000	Y	D80			
131	K094	200000	Y	D80			
132	K095	200000	Y	D80			
133	K096	200000	Y	D80			
134	K097	200000	Y	D80			
135	K098	200000	Y	D80			
136	K100	200000	Y	D80			
137	K101	200000	Y	D80			
138	K102	200000	Y	D80			
139	K103	200000	Y	D80			
140	K104	200000	Y	D80			
141	K105	200000	Y	D80			
142	K106	200000	Y	D80			

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LINE NO.	A. EPA HAZARDOUS WASTECODE	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE	D1. PROCESS CODES			D2. PROCESS DESCRIPTION
143	K107	200000	Y	D80			
144	K108	200000	Y	D80			
145	K109	200000	Y	D80			
146	K110	200000	Y	D80			
147	K111	200000	Y	D80			
148	K112	200000	Y	D80			
149	K113	200000	Y	D80			
150	K114	200000	Y	D80			
151	K115	200000	Y	D80			
152	K116	200000	Y	D80			
153	K117	200000	Y	D80			
154	K118	200000	Y	D80			
155	K123	200000	Y	D80			
156	K124	200000	Y	D80			
157	K125	200000	Y	D80			
158	K126	200000	Y	D80			
159	K131	200000	Y	D80			
160	K132	200000	Y	D80			
161	K136	200000	Y	D80			
162	K141	200000	Y	D80			
163	K142	200000	Y	D80			
164	K143	200000	Y	D80			
165	K144	200000	Y	D80			
166	K145	200000	Y	D80			
167	K147	200000	Y	D80			
168	K148	200000	Y	D80			
169	K149	200000	Y	D80			
170	K150	200000	Y	D80			
171	K151	200000	Y	D80			
172	K156	200000	Y	D80			
173	K157	200000	Y	D80			
174	K158	200000	Y	D80			
175	K159	200000	Y	D80			
176	K161	200000	Y	D80			
177	K169	200000	Y	D80			
178	K170	200000	Y	D80			
179	K171	200000	Y	D80			
180	K172	200000	Y	D80			
181	K174	200000	Y	D80			
182	K175	200000	Y	D80			
183	K176	200000	Y	D80			
184	K177	200000	Y	D80			
185	K178	200000	Y	D80			
186	K181	200000	Y	D80			
187	P001	200000	Y	D80			
188	P002	200000	Y	D80			
189	P003	200000	Y	D80			
190	P004	200000	Y	D80			

LINE NO.	A. EPA HAZARDOUS WASTECODE	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE	D1. PROCESS CODES			D2. PROCESS DESCRIPTION
191	P005	200000	Y	D80			
192	P006	200000	Y	D80			
193	P007	200000	Y	D80			
194	P008	200000	Y	D80			
195	P009	200000	Y	D80			
196	P010	200000	Y	D80			
197	P011	200000	Y	D80			
198	P012	200000	Y	D80			
199	P013	200000	Y	D80			
200	P014	200000	Y	D80			
201	P015	200000	Y	D80			
202	P016	200000	Y	D80			
203	P017	200000	Y	D80			
204	P018	200000	Y	D80			
205	P020	200000	Y	D80			
206	P021	200000	Y	D80			
207	P022	200000	Y	D80			
208	P023	200000	Y	D80			
209	P024	200000	Y	D80			
210	P026	200000	Y	D80			
211	P027	200000	Y	D80			
212	P028	200000	Y	D80			
213	P029	200000	Y	D80			
214	P030	200000	Y	D80			
215	P031	200000	Y	D80			
216	P033	200000	Y	D80			
217	P034	200000	Y	D80			
218	P036	200000	Y	D80			
219	P037	200000	Y	D80			
220	P038	200000	Y	D80			
221	P039	200000	Y	D80			
222	P040	200000	Y	D80			
223	P041	200000	Y	D80			
224	P042	200000	Y	D80			
225	P043	200000	Y	D80			
226	P044	200000	Y	D80			
227	P045	200000	Y	D80			
228	P046	200000	Y	D80			
229	P047	200000	Y	D80			
230	P048	200000	Y	D80			
231	P049	200000	Y	D80			
232	P050	200000	Y	D80			
233	P051	200000	Y	D80			
234	P054	200000	Y	D80			
235	P056	200000	Y	D80			
236	P057	200000	Y	D80			
237	P058	200000	Y	D80			
238	P059	200000	Y	D80			

LINE NO.	A. EPA HAZARDOUS WASTECODE	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE	D1. PROCESS CODES			D2. PROCESS DESCRIPTION
239	P060	200000	Y	D80			
240	P062	200000	Y	D80			
241	P063	200000	Y	D80			
242	P064	200000	Y	D80			
243	P065	200000	Y	D80			
244	P066	200000	Y	D80			
245	P067	200000	Y	D80			
246	P068	200000	Y	D80			
247	P069	200000	Y	D80			
248	P070	200000	Y	D80			
249	P071	200000	Y	D80			
250	P072	200000	Y	D80			
251	P073	200000	Y	D80			
252	P074	200000	Y	D80			
253	P075	200000	Y	D80			
254	P076	200000	Y	D80			
255	P077	200000	Y	D80			
256	P078	200000	Y	D80			
257	P081	200000	Y	D80			
258	P082	200000	Y	D80			
259	P084	200000	Y	D80			
260	P085	200000	Y	D80			
261	P087	200000	Y	D80			
262	P088	200000	Y	D80			
263	P089	200000	Y	D80			
264	P092	200000	Y	D80			
265	P093	200000	Y	D80			
266	P094	200000	Y	D80			
267	P095	200000	Y	D80			
268	P096	200000	Y	D80			
269	P097	200000	Y	D80			
270	P098	200000	Y	D80			
271	P099	200000	Y	D80			
272	P101	200000	Y	D80			
273	P102	200000	Y	D80			
274	P103	200000	Y	D80			
275	P104	200000	Y	D80			
276	P105	200000	Y	D80			
277	P106	200000	Y	D80			
278	P108	200000	Y	D80			
279	P109	200000	Y	D80			
280	P110	200000	Y	D80			
281	P111	200000	Y	D80			
282	P112	200000	Y	D80			
283	P113	200000	Y	D80			
284	P114	200000	Y	D80			
285	P115	200000	Y	D80			
286	P116	200000	Y	D80			

LINE NO.	A. EPA HAZARDOUS WASTECODE	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE	D1. PROCESS CODES			D2. PROCESS DESCRIPTION
287	P118	200000	Y	D80			
288	P119	200000	Y	D80			
289	P120	200000	Y	D80			
290	P121	200000	Y	D80			
291	P122	200000	Y	D80			
292	P123	200000	Y	D80			
293	P127	200000	Y	D80			
294	P128	200000	Y	D80			
295	P185	200000	Y	D80			
296	P188	200000	Y	D80			
297	P189	200000	Y	D80			
298	P190	200000	Y	D80			
299	P191	200000	Y	D80			
300	P192	200000	Y	D80			
301	P194	200000	Y	D80			
302	P196	200000	Y	D80			
303	P197	200000	Y	D80			
304	P198	200000	Y	D80			
305	P199	200000	Y	D80			
306	P201	200000	Y	D80			
307	P202	200000	Y	D80			
308	P203	200000	Y	D80			
309	P204	200000	Y	D80			
310	P205	200000	Y	D80			
311	U001	200000	Y	D80			
312	U002	200000	Y	D80			
313	U003	200000	Y	D80			
314	U004	200000	Y	D80			
315	U005	200000	Y	D80			
316	U006	200000	Y	D80			
317	U007	200000	Y	D80			
318	U008	200000	Y	D80			
319	U009	200000	Y	D80			
320	U010	200000	Y	D80			
321	U011	200000	Y	D80			
322	U012	200000	Y	D80			
323	U014	200000	Y	D80			
324	U015	200000	Y	D80			
325	U016	200000	Y	D80			
326	U017	200000	Y	D80			
327	U018	200000	Y	D80			
328	U019	200000	Y	D80			
329	U020	200000	Y	D80			
330	U021	200000	Y	D80			
331	U022	200000	Y	D80			
332	U023	200000	Y	D80			
333	U024	200000	Y	D80			
334	U025	200000	Y	D80			

LINE NO.	A. EPA HAZARDOUS WASTECODE	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE	D1. PROCESS CODES			D2. PROCESS DESCRIPTION
335	U026	200000	Y	D80			
336	U027	200000	Y	D80			
337	U028	200000	Y	D80			
338	U029	200000	Y	D80			
339	U030	200000	Y	D80			
340	U031	200000	Y	D80			
341	U032	200000	Y	D80			
342	U033	200000	Y	D80			
343	U034	200000	Y	D80			
344	U035	200000	Y	D80			
345	U036	200000	Y	D80			
346	U037	200000	Y	D80			
347	U038	200000	Y	D80			
348	U039	200000	Y	D80			
349	U041	200000	Y	D80			
350	U042	200000	Y	D80			
351	U043	200000	Y	D80			
352	U044	200000	Y	D80			
353	U045	200000	Y	D80			
354	U046	200000	Y	D80			
355	U047	200000	Y	D80			
356	U048	200000	Y	D80			
357	U049	200000	Y	D80			
358	U050	200000	Y	D80			
359	U051	200000	Y	D80			
360	U052	200000	Y	D80			
361	U053	200000	Y	D80			
362	U055	200000	Y	D80			
363	U056	200000	Y	D80			
364	U057	200000	Y	D80			
365	U058	200000	Y	D80			
366	U059	200000	Y	D80			
367	U060	200000	Y	D80			
368	U061	200000	Y	D80			
369	U062	200000	Y	D80			
370	U063	200000	Y	D80			
371	U064	200000	Y	D80			
372	U066	200000	Y	D80			
373	U067	200000	Y	D80			
374	U068	200000	Y	D80			
375	U069	200000	Y	D80			
376	U070	200000	Y	D80			
377	U071	200000	Y	D80			
378	U072	200000	Y	D80			
379	U073	200000	Y	D80			
380	U074	200000	Y	D80			
381	U075	200000	Y	D80			
382	U076	200000	Y	D80			

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LINE NO.	A. EPA HAZARDOUS WASTECODE	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE	D1. PROCESS CODES			D2. PROCESS DESCRIPTION
383	U077	200000	Y	D80			
384	U078	200000	Y	D80			
385	U079	200000	Y	D80			
386	U080	200000	Y	D80			
387	U081	200000	Y	D80			
388	U082	200000	Y	D80			
389	U083	200000	Y	D80			
390	U084	200000	Y	D80			
391	U085	200000	Y	D80			
392	U086	200000	Y	D80			
393	U087	200000	Y	D80			
394	U088	200000	Y	D80			
395	U089	200000	Y	D80			
396	U090	200000	Y	D80			
397	U091	200000	Y	D80			
398	U092	200000	Y	D80			
399	U093	200000	Y	D80			
400	U094	200000	Y	D80			
401	U095	200000	Y	D80			
402	U096	200000	Y	D80			
403	U097	200000	Y	D80			
404	U098	200000	Y	D80			
405	U099	200000	Y	D80			
406	U101	200000	Y	D80			
407	U102	200000	Y	D80			
408	U103	200000	Y	D80			
409	U105	200000	Y	D80			
410	U106	200000	Y	D80			
411	U107	200000	Y	D80			
412	U108	200000	Y	D80			
413	U109	200000	Y	D80			
414	U110	200000	Y	D80			
415	U111	200000	Y	D80			
416	U112	200000	Y	D80			
417	U113	200000	Y	D80			
418	U114	200000	Y	D80			
419	U115	200000	Y	D80			
420	U116	200000	Y	D80			
421	U117	200000	Y	D80			
422	U118	200000	Y	D80			
423	U119	200000	Y	D80			
424	U120	200000	Y	D80			
425	U121	200000	Y	D80			
426	U122	200000	Y	D80			
427	U123	200000	Y	D80			
428	U124	200000	Y	D80			
429	U125	200000	Y	D80			
430	U126	200000	Y	D80			

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LINE NO.	A. EPA HAZARDOUS WASTECODE	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE	D1. PROCESS CODES			D2. PROCESS DESCRIPTION
431	U127	200000	Y	D80			
432	U128	200000	Y	D80			
433	U129	200000	Y	D80			
434	U130	200000	Y	D80			
435	U131	200000	Y	D80			
436	U132	200000	Y	D80			
437	U133	200000	Y	D80			
438	U134	200000	Y	D80			
439	U135	200000	Y	D80			
440	U136	200000	Y	D80			
441	U137	200000	Y	D80			
442	U138	200000	Y	D80			
443	U140	200000	Y	D80			
444	U141	200000	Y	D80			
445	U142	200000	Y	D80			
446	U143	200000	Y	D80			
447	U144	200000	Y	D80			
448	U145	200000	Y	D80			
449	U146	200000	Y	D80			
450	U147	200000	Y	D80			
451	U148	200000	Y	D80			
452	U149	200000	Y	D80			
453	U150	200000	Y	D80			
454	U151	200000	Y	D80			
455	U152	200000	Y	D80			
456	U153	200000	Y	D80			
457	U154	200000	Y	D80			
458	U155	200000	Y	D80			
459	U156	200000	Y	D80			
460	U157	200000	Y	D80			
461	U158	200000	Y	D80			
462	U159	200000	Y	D80			
463	U160	200000	Y	D80			
464	U161	200000	Y	D80			
465	U162	200000	Y	D80			
466	U163	200000	Y	D80			
467	U164	200000	Y	D80			
468	U165	200000	Y	D80			
469	U166	200000	Y	D80			
470	U167	200000	Y	D80			
471	U168	200000	Y	D80			
472	U169	200000	Y	D80			
473	U170	200000	Y	D80			
474	U171	200000	Y	D80			
475	U172	200000	Y	D80			
476	U173	200000	Y	D80			
477	U174	200000	Y	D80			
478	U176	200000	Y	D80			

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LINE NO.	A. EPA HAZARDOUS WASTECODE	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE	D1. PROCESS CODES			D2. PROCESS DESCRIPTION
479	U177	200000	Y	D80			
480	U178	200000	Y	D80			
481	U179	200000	Y	D80			
482	U180	200000	Y	D80			
483	U181	200000	Y	D80			
484	U182	200000	Y	D80			
485	U183	200000	Y	D80			
486	U184	200000	Y	D80			
487	U185	200000	Y	D80			
488	U186	200000	Y	D80			
489	U187	200000	Y	D80			
490	U188	200000	Y	D80			
491	U189	200000	Y	D80			
492	U190	200000	Y	D80			
493	U191	200000	Y	D80			
494	U192	200000	Y	D80			
495	U193	200000	Y	D80			
496	U194	200000	Y	D80			
497	U196	200000	Y	D80			
498	U197	200000	Y	D80			
499	U200	200000	Y	D80			
500	U201	200000	Y	D80			
501	U202	200000	Y	D80			
502	U203	200000	Y	D80			
503	U204	200000	Y	D80			
504	U205	200000	Y	D80			
505	U206	200000	Y	D80			
506	U207	200000	Y	D80			
507	U208	200000	Y	D80			
508	U209	200000	Y	D80			
509	U210	200000	Y	D80			
510	U211	200000	Y	D80			
511	U213	200000	Y	D80			
512	U214	200000	Y	D80			
513	U215	200000	Y	D80			
514	U216	200000	Y	D80			
515	U217	200000	Y	D80			
516	U218	200000	Y	D80			
517	U219	200000	Y	D80			
518	U220	200000	Y	D80			
519	U221	200000	Y	D80			
520	U222	200000	Y	D80			
521	U223	200000	Y	D80			
522	U225	200000	Y	D80			
523	U226	200000	Y	D80			
524	U227	200000	Y	D80			
525	U228	200000	Y	D80			
526	U234	200000	Y	D80			

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LINE NO.	A. EPA HAZARDOUS WASTECODE	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE	D1. PROCESS CODES			D2. PROCESS DESCRIPTION
527	U235	200000	Y	D80			
528	U236	200000	Y	D80			
529	U237	200000	Y	D80			
530	U238	200000	Y	D80			
531	U239	200000	Y	D80			
532	U240	200000	Y	D80			
533	U243	200000	Y	D80			
534	U244	200000	Y	D80			
535	U246	200000	Y	D80			
536	U247	200000	Y	D80			
537	U248	200000	Y	D80			
538	U249	200000	Y	D80			
539	U271	200000	Y	D80			
540	U278	200000	Y	D80			
541	U279	200000	Y	D80			
542	U280	200000	Y	D80			
543	U328	200000	Y	D80			
544	U353	200000	Y	D80			
545	U359	200000	Y	D80			
546	U364	200000	Y	D80			
547	U367	200000	Y	D80			
548	U372	200000	Y	D80			
549	U373	200000	Y	D80			
550	U387	200000	Y	D80			
551	U389	200000	Y	D80			
552	U394	200000	Y	D80			
553	U395	200000	Y	D80			
554	U404	200000	Y	D80			
555	U409	200000	Y	D80			
556	U410	200000	Y	D80			
557	U411	200000	Y	D80			
558	001S	200000	Y	D80			
559	002S	200000	Y	D81			
560	003S	200000	Y	D82			
561	004S	200000	Y	D83			
562	005S	200000	Y	D84			
563	006S	200000	Y	D85			
564	007S	200000	Y	D86			
565	001K	200000	Y	D80			
566	002K	200000	Y	D80			
567	001U	200000	Y	D80			
568	002U	200000	Y	D80			
569	003U	200000	Y	D80			
570	004U	200000	Y	D80			
571	005U	200000	Y	D80			
572	006U	200000	Y	D80			
573	007U	200000	Y	D80			
574	008U	200000	Y	D80			

LINE NO.	A. EPA HAZARDOUS WASTECODE	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE	D1. PROCESS CODES			D2. PROCESS DESCRIPTION
575	009U	200000	Y	D80			
576	011U	200000	Y	D80			
577	012U	200000	Y	D80			
578	013U	200000	Y	D80			
579	014U	200000	Y	D80			
580	015U	200000	Y	D80			
581	016U	200000	Y	D80			
582	017U	200000	Y	D80			
583	020U	200000	Y	D80			
584	021U	200000	Y	D80			
585	022U	200000	Y	D80			
586	023U	200000	Y	D80			
587	024U	200000	Y	D80			
588	025U	200000	Y	D80			
589	027U	200000	Y	D80			
590	028U	200000	Y	D80			
591	029U	200000	Y	D80			
592	030U	200000	Y	D80			
593	031U	200000	Y	D80			
594	032U	200000	Y	D80			
595	033U	200000	Y	D80			
596	034U	200000	Y	D80			
597	036U	200000	Y	D80			
598	037U	200000	Y	D80			
599	038U	200000	Y	D80			
600	040U	200000	Y	D80			
601	041U	200000	Y	D80			
602	042U	200000	Y	D80			
603	043U	200000	Y	D80			
604	044U	200000	Y	D80			
605	046U	200000	Y	D80			
606	047U	200000	Y	D80			
607	048U	200000	Y	D80			
608	049U	200000	Y	D80			
609	050U	200000	Y	D80			
610	051U	200000	Y	D80			
611	052U	200000	Y	D80			
612	054U	200000	Y	D80			
613	055U	200000	Y	D80			
614	056U	200000	Y	D80			
615	057U	200000	Y	D80			
616	058U	200000	Y	D80			
617	059U	200000	Y	D80			
618	061U	200000	Y	D80			
619	063U	200000	Y	D80			
620	064U	200000	Y	D80			
621	065U	200000	Y	D80			
622	068U	200000	Y	D80			

Description of Hazardous Wastes
Wayne Disposal, Inc., Site # 2
MID 048 090 633

LINE NO.	A. EPA HAZARDOUS WASTECODE	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE	D1. PROCESS CODES			D2. PROCESS DESCRIPTION
623	070U	200000	Y	D80			
624	071U	200000	Y	D80			
625	072U	200000	Y	D80			
626	073U	200000	Y	D80			
627	074U	200000	Y	D80			
628	075U	200000	Y	D80			
629	076U	200000	Y	D80			
630	077U	200000	Y	D80			
631	078U	200000	Y	D80			
632	079U	200000	Y	D80			
633	080U	200000	Y	D80			
634	082U	200000	Y	D80			
635	083U	200000	Y	D80			
636	086U	200000	Y	D80			
637	088U	200000	Y	D80			
638	089U	200000	Y	D80			
639	090U	200000	Y	D80			
640	092U	200000	Y	D80			
641	093U	200000	Y	D80			
642	094U	200000	Y	D80			
643	095U	200000	Y	D80			
644	096U	200000	Y	D80			
645	097U	200000	Y	D80			
646	098U	200000	Y	D80			
647	099U	200000	Y	D80			
648	100U	200000	Y	D80			
649	101U	200000	Y	D80			
650	102U	200000	Y	D80			
651	103U	200000	Y	D80			
652	104U	200000	Y	D80			
653	106U	200000	Y	D80			
654	108U	200000	Y	D80			
655	110U	200000	Y	D80			
656	111U	200000	Y	D80			
657	112U	200000	Y	D80			
658	113U	200000	Y	D80			
659	114U	200000	Y	D80			
660	115U	200000	Y	D80			
661	116U	200000	Y	D80			
662	117U	200000	Y	D80			
663	118U	200000	Y	D80			
664	119U	200000	Y	D80			
665	120U	200000	Y	D80			
666	121U	200000	Y	D80			
667	122U	200000	Y	D80			
668	124U	200000	Y	D80			
669	127U	200000	Y	D80			
670	128U	200000	Y	D80			

LINE NO.	A. EPA HAZARDOUS WASTECODE	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE	D1. PROCESS CODES			D2. PROCESS DESCRIPTION
671	129U	200000	Y	D80			
672	131U	200000	Y	D80			
673	132U	200000	Y	D80			
674	134U	200000	Y	D80			
675	135U	200000	Y	D80			
676	136U	200000	Y	D80			
677	137U	200000	Y	D80			
678	138U	200000	Y	D80			
679	139U	200000	Y	D80			
680	140U	200000	Y	D80			
681	141U	200000	Y	D80			
682	142U	200000	Y	D80			
683	143U	200000	Y	D80			
684	144U	200000	Y	D80			
685	146U	200000	Y	D80			
686	147U	200000	Y	D80			
687	148U	200000	Y	D80			
688	150U	200000	Y	D80			
689	151U	200000	Y	D80			
690	152U	200000	Y	D80			
691	153U	200000	Y	D80			
692	154U	200000	Y	D80			
693	155U	200000	Y	D80			
694	157U	200000	Y	D80			
695	158U	200000	Y	D80			
696	159U	200000	Y	D80			
697	160U	200000	Y	D80			
698	161U	200000	Y	D80			
699	162U	200000	Y	D80			
700	163U	200000	Y	D80			
701	164U	200000	Y	D80			
702	165U	200000	Y	D80			
703	166U	200000	Y	D80			
704	167U	200000	Y	D80			
705	168U	200000	Y	D80			
706	169U	200000	Y	D80			
707	170U	200000	Y	D80			
708	171U	200000	Y	D80			
709	172U	200000	Y	D80			
710	173U	200000	Y	D80			
711	174U	200000	Y	D80			
712	175U	200000	Y	D80			
713	PCBs	200000	Y	D80			
714	CAMU-eligible	200000	Y	D80			

Attachment 9

Groundwater Monitoring Program Sampling and Analysis Plan

Section 27

Groundwater Sampling and Analysis Plan
Wayne Disposal Inc.

MID 048 090 633

I. INTRODUCTION

40 CFR, Part 264.97 requires the owner or operator of a hazardous waste facility to develop and follow a consistent program of groundwater sampling and analysis procedures. The program must include procedures and techniques for:

1) sample collection;
2) sample preservation and shipment;
3) analytical procedures; and
4) chain of custody control.

This document has been developed to direct the efforts of Wayne Disposal, Inc.'s (WDI) groundwater monitoring personnel and thereby meet the requirement of the rule referenced above.

II. GENERAL DESCRIPTION

The current groundwater monitoring system for WDI consists of 22 wells, numbered 18, 19R, 20 through 22, 23AR, 24, 25, 26A, 27A, 28 through 30, 31AR, 32, 34A, 35A, 36 through 39 AND 40R. Wells numbered 1A through 17, 26, 27, 31 and 41 through 47 also exist at the site but do not form a part of the groundwater monitoring sampling network for the hazardous waste management area of WDI. Wells OB-21, OB-23R, OB-24, OB 34R and OB-40R are also monitored under the Toxic Substances Control Act (TSCA) per conditions contained in 40CFR 761.75. Well locations are shown on Attachment A.

For Cell VI-F&G, a two-phase monitoring system will be implemented to supplement the current monitoring program. Construction of the MC VI-F&G area is expected to begin with the

Woodlot (MC VI-G Phase 1 and Phase 2) and then proceed into the northernmost cells (MC VI-F, Phase I and Phase 2). During this initial monitoring phase, a line of wells will be established south of the Woodlot (MC VI-G, Phase I and Phase 2, to monitor these cells. As shown on Attachment A, this initial set of wells has been designated as OB-48 through OB-52. -. Observation well W-1, which was installed as part of the hydrogeologic investigation, will be re-designated as OB-48. This initial set of wells will also include four new wells (OB-49, and OB-50 through OB-52). Three wells (OB-50, OB-51 and OB-52) will be installed to monitor the lower sand aquifer and one (OB-49) will be installed to monitor the bedrock. Note that existing wells OB-34A and OB-35A will also serve to monitor the MC VI-F area.

When the next phase of construction begins on the next cell further south (MC VI-G, Phase 3 through 6), the initial wells will be abandoned, and additional wells will be installed (or re-designated) at the downgradient (i.e., south) side of MC 1, which will be incorporated into the Part 111 groundwater monitoring program for MC VI-F&G. This second set of wells will include existing observation well W-10S (to be re-designated as OB-53), existing wells OB-6, OB-8, OB-12R, and OB-13 (to be re-designated as dual Part 111/115 monitoring wells), and four new monitoring wells (OB-54, OB-55, OB-58 and OB-59).

Proposed monitoring wells installed for the initial Phase I monitoring sequencing (OB-50, OB-51, and OB-52) are contingent upon identifying a suitable location along the MC 1 dike which does not go through the MC VI-G liner. Additionally, because the area in which these wells can be installed will be in the way during construction, installation will be completed following construction of the south slope of MC VI-G Phase I.

With the exception of wells OB-50, OB-51 and OB-52, well installation for each of the phase will be completed at least one year prior to the placement of waste so that "background sample collection" can be implemented. For wells OB-50, OB-51, and OB-52, the background sample collection may be completed on an excellerated schedule due to the need to install these wells post construction.

Copies of the well logs for all of WDI's wells are included in Attachment B. As new wells are added or abandoned, Attachment A and Attachment B must updated and the updates submitted to the MDEQ.

III. LABORATORY

Analyses of samples from the wells are conducted by a contract laboratory, TriMatrix Laboratories, Inc. (TriMatrix) of Grand Rapids, MI. Analytical arrangements and sample bottle preparation can be ordered in advance by calling TriMatrix. Request all analyses when calling for bottles so the laboratory personnel can properly prepare the containers.
If WDI decides to contract analysis of groundwater samples to another laboratory, the change will be made only after at least two concurrent sampling/analysis events show adequate correlation of analysis results of the existing and proposed contract laboratories.

IV. REQUIRED DOCUMENTATION

Documentation required for this monitoring program include:
a) A field notebook must be utilized to record all pertinent field data and sampling information during every sampling event. This must include the name(s) of sampling personnel, sample date, sample time, sample location, depth to standing water in the well, calculations for determining the volume of water to be purged from the well prior to sampling, results of any field measurements on groundwater samples and observations of sample characteristics or the sampling environment. Any odors, colors, sheens or other unusual characteristics of the samples must be described in detail. Copies of these field data notes must be included in reports sent to MDEQ.

b) During each sampling event, a Monitoring Well Inspection/Damage Report must be filled out and sent to the QEHS Department. A copy of this form is included as Attachment C-2. This report must be filled out to note any conditions of the monitoring wells or surrounding area that needs maintenance or repairs.

c) An equipment inventory, repair and calibration log is maintained in the Engineering field office. This log is used to list the inventory (by serial number) of all sampling apparatus and field measurement devices. Any changes of equipment or repairs to equipment must be noted in this log, as well as daily instrument calibrations, etc.

d) Also required for the sampling process are standard chain of custody forms from TriMatrix. A sample copy of this record is included herein as Attachment C-1. This sheet must be filled out fully for each sample submitted for analysis as described in Section X.

V. STANDING WATER LEVEL MEASUREMENTS

The sampling schedule for the uppermost aquifer wells is generally arranged such that the wells are sampled the month immediately following that in which Wells 1A through 17 are sampled. To obtain the best picture of static water levels for the site, 1) the levels must be obtained for all wells listed on Attachment E before any water is removed for purging or sampling, and 2) the levels must be obtained for all wells in as short a time as possible on the same day, due to barometric pressure effects. This means that static water levels for the wells are generally determined at least 30 days in advance of their sampling. This is the only case where purging and sampling does not immediately follow the water level observations.

The depth to standing water within the well casing is measured from the top of casing (TOC). The top of the well casing is exposed by removing the white plastic Well Wizard™ well heads. <u>The surveyed point on the casing is always at the edge on the north side of the casing</u>. Additionally, there is a permanent mark on the north side of the casing which marks the edge from which water levels are to be taken. The TOC elevations shall be surveyed at least once every two years to verify accuracy. Removal of the well head is necessary for determination of the standing water level. The depth to water is measured using an electric water level indicator. Attachment D describes the operating procedures for the water level indicator, which is used for this purpose.

When using the water level indicator, make certain that the probe and submersed portion of the cable are cleaned with distilled water and a clean cloth, followed by a distilled water rinse. This prevents cross contamination between wells. Lower the probe into the casing slowly while watching for the light. Carefully determine the water level by raising and lowering the probe at the water surface, and monitoring the light and buzzer. Record the distance from the point on the cable at TOC to the nearest marking on the cable within the well casing. The markings on the cable are scaled in 0.01 foot intervals. Record the measurement to the nearest 0.01 foot. The depth to standing water is then the distance from the probe tip at the water level to the marking on the cable. Record this depth in the field notebook.

VI. WELL PURGING

Before purging a well, it is necessary to determine the quantity of water contained within the well casing. This is done by subtracting the depth to standing water from the depth to the well screen. The depth to standing water must be determined just prior to beginning sample collection. The depth to the well screen for each existing well is listed on Attachment E. The difference between screen depth and water level depth is the height of water standing within the well. Multiply this height of water by 0.17 gallons per foot (for 2 inch diameter well casing). Multiply that product by 3, the number of standing volumes to be purged, which is the minimum recommended by MDEQ. The resultant product is the total quantity to be purged from the well, in gallons. Once again,

Amt. purged (in gallons) = (Ht. of standing water) x 0.17 x 3

Record these calculations in the field notebook.

The depth to the well screen should be confirmed every four years by removing the dedicated pump assemblies and lowering the water level indicator probe to the very bottom of the well casing for a determination of the clear depth of the well (make sure that the indicator cable is cleaned between each well). In addition, well depths should be checked if a change in well yield or sample appearance (i.e. turbidity) is noted. It is very important to ensure that the pump and tubing are kept clean when removed from the well (i.e. do not place equipment on ground, rather, wrap in plastic sheeting).

Once three standing well volumes have been removed, measure and record the pH and specific conductance of the water coming from the well. Continue to record these values at a rate of once every 10 minutes. After three values of pH and specific conductance have been obtained in this manner, compare the highest and lowest values. If the difference between the highest and lowest pH value is 0.07 su or less, then the well is considered stabilized with respect to pH. If the difference between the highest and lowest specific conductance values is 18 μmhos/cm or less, then well stabilization with respect to this parameter is considered complete. If the difference between the highest and lowest values for either parameter exceeds this criteria, pump the well another 10 minutes and recheck both parameters. Perform the comparison again, using only the last three monitored values of pH and specific conductance. Once the criteria are satisfied for any three consecutive monitored values of both pH and specific conductance, then consider the well fully stabilized and proceed with sampling. Measure and record well water temperature at this time as well. Record in the field notebook all the data obtained to establish well stabilization. In the cases where an individual well cannot be purged to stabilization in a manner described above because the well becomes fully dewatered, then sample the well after completely dewatering (evacuating) the well four times. For each sampling event, the second, third and fourth well evacuations should be performed within three days of the previous well evacuation. Sampling should be accomplished as soon after the fourth well evacuation as possible, depending upon the rate at which the water level in the well recovers. Measure and record pH, specific conductance and temperature in the field at the time the sample is obtained from such a well. Fully record in the field notebook all instances of well evacuation.

At Site II, we employ the "Well Wizard"™ system of dedicated pumps. This means that each well has a submersible pump within it, generally located at the well screen. The control unit and cylinders of compressed nitrogen are the other components that complete this system. Because sampling immediately follows the purging step in nearly all cases, the sampling box is always included during well purging. The sample box is discussed in greater detail in the Sample Collection portion of this document.

Prior to a sampling round for the wells, replace the sampling box discharge tube. To set up the Well Wizard™ system for operation, connect the nitrogen cylinder hose to the supply port on the controller unit. Connect one end of the coiled tubing within the controller unit to the Drive Air Out port on the unit, and the other end to the smaller of the two ports on the well head assembly. Connect the water sample line from the larger of the two well head ports to the back of the sampling box. Make certain that the valve on the rear of the box directs flow out of the box and through the discharge tube, until well purging is completed.

To initiate purging, begin the flow of nitrogen from the cylinder. Measure the quantity of water purged from the well using the graduated 3 gallon bucket kept with this equipment. Note that all purged water should be discharged on the ground away from the well. Do not allow the purged water to re-enter the well or the well protective casing nor should you allow ponding of the water around the well. Further background on Well Wizard™ operation can be gained by referring to Attachment F. Report any problems with equipment function to the Regulatory Affairs Department.

VII. SAMPLE COLLECTION

Upon completion of the well purging step, or upon return to a well which has been evacuated four times for purging, you are ready to take samples. Make sure each sample bottle for a given monitoring well has a label (affixed by the analytical laboratory personnel) which contains our facility name, the monitoring well number, the date and the sampler's initials. If a preservative has been included by the laboratory, such a note should appear on the label.

In the past sampling programs, it has been shown that airborne artifacts from disposal operations and engine exhaust can affect the number of detected constituents and their concentrations within groundwater samples. For this reason, a controlled-atmosphere sampling box was constructed for use in the collection of groundwater samples. Nitrogen, under positive pressure, is used as the sampling atmosphere within the box, thereby minimizing the probability of impacts to sample quality by airborne artifacts. All groundwater samples taken from WDI wells using dedicated pumps shall be taken within the sampling box.

In preparation for sampling, connect the nitrogen cylinder to the sampling box and purge the box atmosphere with nitrogen for 20 to 30 minutes. Make certain that all sample bottles to be used at a given location are placed within the box prior to purging the box atmosphere. Remove the caps from the bottles during the purging process to expose the interior of the bottles to the nitrogen environment. A new laboratory grade tygon tube connecting the wellhead to the sampling box must be used for the collection of samples from each location. When all is ready, turn the valve on the rear of the sampling box, diverting the flow of water from the discharge tube to the sampling tube within the box.

Samples for volatile organic compounds will be filled first. No headspace is permitted in the small glass vials. This may require several attempts but it can and must be done. Make certain not to touch the inside of bottle necks or caps with your hands. Next, fill the bottles for total organic carbon, total phenolics, metals and then other miscellaneous parameters, in this order. Fill each sample bottle to the very top and allow minimal headspace (air bubbles when capped and tipped) and take care not to spill any of the preservatives. Record the number and type of samples taken and the time of sampling on the chain of custody record.

Trip blanks (VOC vials filled with laboratory "clean" water) shall accompany the sample containers every day that samples are collected. A trip blank is provided by the laboratory for each batch of sample bottles (usually one for each cooler). These remain unopened throughout the sampling day and are submitted with the sample bottles. A field blank shall also be collected at each well sampled. A field blank is an empty (except for preservative) VOC vial that is opened in the nitrogen sampling box and filled with laboratory provided "clean" water while that well is being sampled. The purpose is to replicate the sampling environment in all ways except for the source of water in the container. Both kinds of blanks should be preserved, handled and shipped exactly as the well samples are. All of the trip blanks and a minimum of one field blank for each ten samples will be analyzed on a random basis for the primary parameters. However, if a positive result for any primary parameter is noted in a given well, the matching field blanks will immediately be analyzed for the offending parameter(s). A complete replicate sample shall be obtained from one well, chosen randomly, during each sampling round and will be analyzed for the same parameters as the sample it replicates.

VIII. SAMPLE PRESERVATION AND SHIPMENT

Attachment G is a tabulation of sample preservation procedures for TriMatrix. The samples must be preserved in accordance with the procedures outlined in this attachment. For all samples the laboratory provides clean, pre-preserved bottles (where necessary). Samples to be analyzed for dissolved metals must be field filtered with a 0.45 µm in-line filter cartridge and preserved with a couple of drops of reagent grade HNO_3 to a pH of less than 2. If the samples cannot be field filtered for any reason they must be filtered and preserved immediately upon delivery to the laboratory.

When the sample collection step is completed, open the sampling box, transfer all sample bottles to a cooler and pack the cooler with ice. Make sure that after each well sampling is completed that the tubing for the sampling box, is replaced with new tubing and the chain of custody record is completed.

All collected samples and blanks must be stored in a secure location until delivery to the contract laboratory personnel. This means within site of sampling personnel or locked in a secure location. Chain of custody records must accompany the samples at all times. The handling of these forms is covered in the Chain of Custody Control portion of this document.

IX. ANALYTICAL PROCEDURES

The parameters to be tested for as part of the monitoring program for the uppermost aquifer wells are shown in Attachment H.

Specific analytical procedures and target detection limits, consistent with the current WHMD Operational Memo Gen-8, and used by TriMatrix for this monitoring program are tabulated in Attachment I. However, when changes to analytical methods or to the detection limits contained within MDEQ WHMD Operational Memo Gen-8 are published and made available, the contents of Attachment I must be updated accordingly. Further, this attachment should be reviewed periodically to determine if the laboratory has made changes that should be reflected in the attachment. QA/QC frequencies, and precision and accuracy calculations are included in Trimatrix's QA/QC manual. Changes made to detection limits, analytical methods or QA/QC in response to regulatory requirements can be utilized in this monitoring program without changing the plan, but must be included in updated sampling and analysis plans.

Field measurements of specific conductance, pH and temperature will be performed using the equipment and procedures described in Attachment J. The instruments must be calibrated prior to each day of use and the appropriate notation made in the Equipment Inventory, Repair and Calibration Log described in Section IV.

TriMatrix's Quality Assurance Manual is included as Attachment K. This manual describes the internal policies, guidelines and procedures of TriMatrix. This manual is not intended to describe the specific details of this particular monitoring program. Rather, we are to use this document as a guideline in evaluating TriMatrix's QA/QC and standard operating procedures to ensure that generally acceptable practices are employed.

X. CHAIN OF CUSTODY CONTROL

Chain of Custody refers to the record of individuals and external conditions of sample handling through the time of laboratory analysis. The chain of custody record included as Attachment C is the principal document of this record. These sheets must be fully filled in with sampling information as well as the persons involved and shipment conditions during transport to the analytical laboratory. These sheets must accompany the samples to the laboratory.

When the samples are surrendered at the laboratory, each chain of custody record must be signed by the person transporting the samples as well as a representative of the receiving laboratory. The lab will make a copy of each sheet for us and keep the originals. The copy must be maintained in the files. Upon completion of a full round of sampling, transmit depth to standing water information, field monitoring data and all chain of custody records to the EQ Quality Environmental Health & Safety (QEHS) Department.

XI. EQUIPMENT AND WELL MAINTENANCE

Equipment used for the collection and analysis of groundwater samples must be maintained in working order and replaced or repaired promptly when necessary. Electrodes for pH and specific conductance should be replaced annually, or sooner if they become difficult to calibrate or appear to malfunction. The dedicated Well Wizard™ pumps and associated equipment require no routine maintenance but should be promptly replaced or repaired in the event of a malfunction. Any pump removed from a well should be thoroughly cleaned before replacement. Tubing removed from the well should be packaged and stored to prevent contamination or replaced. As outlined in Section IV, records of instrument calibration and any equipment replacement or repair must be kept in the Equipment Log maintained at the Engineering field office.

The well casings, protective covers, and Well Wizard™ pump heads should be inspected for damage at the time of each well sampling. Any damage should be noted in the field notebook and a Monitoring Well Inspection/Damage Report must be filled out and sent to the Regulatory Affairs Department. A copy of this form is included as Attachment C-2. Also note any surface erosion, standing water at the well or evidence of a damaged grout seal around the well.

In the event any damage requiring well repair becomes necessary, a Damage Incident Report will be prepared by the QEHS Department. A copy of this report will be placed in the site Operating Log and the Groundwater Monitoring Operating Log. A proposed method of well repair will be prepared and submitted to the MDEQ for approval. Repair efforts will be undertaken after approval by the MDEQ is received. The MDEQ shall then be notified at least 24 hours prior to initiating the repair efforts. Following completion of the well repairs, as-built documentation of the repair efforts will be prepared. A copy of this will be placed in the site Operating Log and the Groundwater Monitoring Operating Log. A copy will also be sent to the MDEQ.

XII. Statistical Evaluation and Reporting Requirements

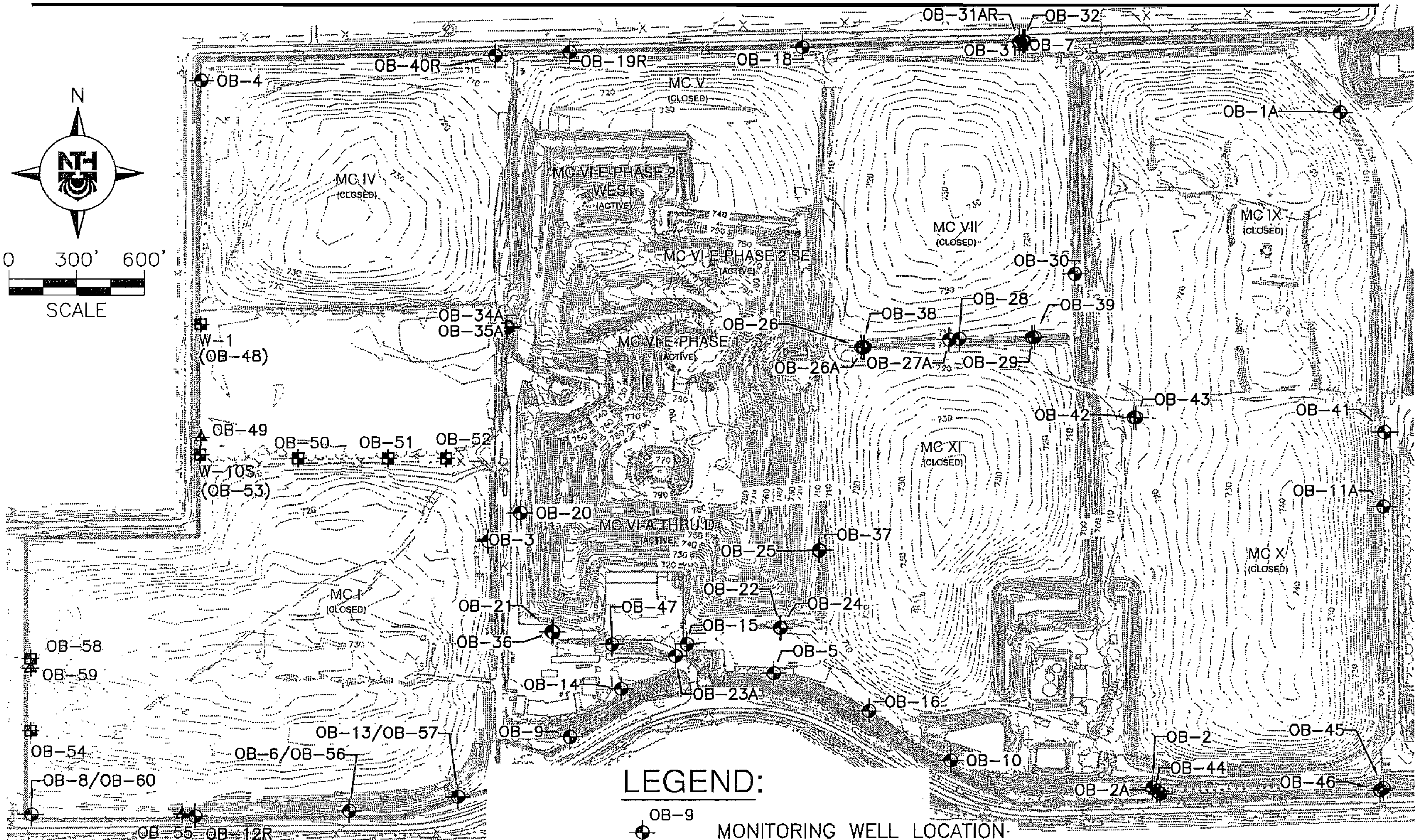
All ground water analyses for the uppermost aquifer wells must be analyzed for evidence of statistically significant increases in concentrations of all primary and secondary monitoring parameters as described in Attachment L

The analytical reports, the records of the field procedures and a report of the statistical analyses (narrative and tubular) must be submitted to the MDEQ within 60 days after each calendar quarter. This report will also include a summary of the review of QA/QC data, a narrative of the sampling event including dates and sampling personnel, and a description of any unusual events or conditions encountered. Copies of the analysis and report must be maintained in designated files at the administration office at the site. In addition, an annual report summarizing the results of groundwater monitoring results and which evaluates groundwater flow directions and rates for the uppermost aquifer must be submitted to MDEQ by March 1 of the following year.

Attachment A

Well Location Map

(Site II - WDI/MDWTP)



LEGEND:

- OB-9 — MONITORING WELL LOCATION
- OB-55 — PROPOSED MC VI F/G BEDROCK WELL LOCATIONS
- OB-54 — PROPOSED MC VI F/G SAND AQUIFER WELL LOCATIONS
- 710 — EXISTING TOPOGRAPHIC CONTOUR

NTH PROJECT No.: 13060921-06	DESIGNED BY: DLP	CHECKED BY: DLP	DRAWING SCALE: AS SHOWN	NTH Consultants, Ltd. Infrastructure Engineering and Environmental Services	WAYNE DISPOSAL, INC. SITE NO. 2	GROUNDWATER MONITORING WELL LOCATION MAP	ATTACHMENT: A
CAD FILE NAME: 060921-WLM	DRAWN BY: KRO	INCEPTION DATE: 11/16/09	PLOT DATE: 10/4/2011		VAN BUREN TWP., WAYNE COUNTY, MICHIGAN		

J:\62\62080376\Production Sets\Env\WLM\060921-WLM.dwg

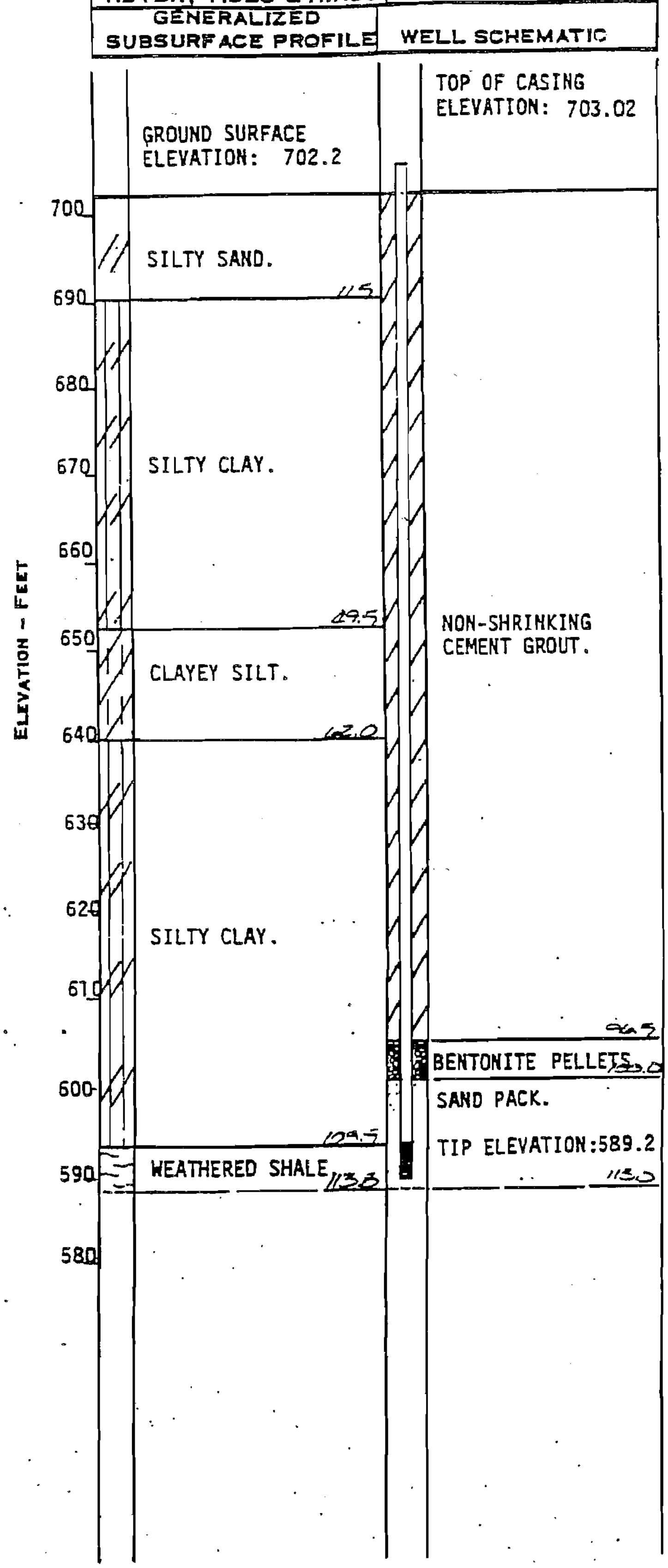
Attachment B

WDI Ground Water Monitoring Well Logs

(WDI)

LOG OF GROUNDWATER MONITORING WELL

CLASSIFICATIONS BY:
NEYER, TISEO & HINDO, LTD.



GROUNDWATER DATA

DATE	GROUND-WATER ELEV. (FEET)	COMMENTS
9-24-84	654.69	
10-22-84	653.22	

CASING – DIAMETER: 2.0"
– LENGTH: 108.0'
– MATERIAL: PVC

SCREEN – DIAMETER: 2.0"
– LENGTH: 5.0"
– MESH: .006" slot
– MATERIAL: PVC

WELL STARTED: 9-11-84
WELL COMPLETED: 9-11-84
INSPECTOR: J. Serwik
DRILLER: J. Blank
CONTRACTOR: American Drilling
EQUIPMENT: CME-75

NOTES:
1. For details of the subsurface strata see Log of Test Boring No. OB-18.
2. Top of casing elevations and ground surface elevations provided by Wayne Disposal, Inc.

NEYER, TISEO & HINDO, LTD.
CONSULTING ENGINEERS

GROUNDWATER MONITORING WELL No. OB-18

LANDFILL SITE NO. 2

NTH Consultants, Ltd.

MONITORING WELL NO. OB-19R

Project Name : WAYNE DISPOSAL LANDFILL - SITE NO. 2 — NTH Proj. No: 13-3051 01-

Project Location : VAN BUREN TWP., WAYNE COUNTY, MICHIGAN — Checked By : ACE

LOG OF MONITORING WELL

Generalized Subsurface Profile	Depth (ft)	Installation Schematic	Depth (ft)
GROUND SURFACE ELEVATION: 706.1		TOP OF WELL CASING ELEVATION: 709.12	
SILTY MEDIUM SAND	7.5	"PURE GOLD" GROUT	103.5
SILTY SAND	14.8	HYDRATED BENTONITE PELLETS	107.5
SILTY CLAY	62.0	SAND	121.0
SILTY CLAY	69.0	TIP ELEVATION: 585.6	
CLAYEY SILT	87.0		
SILTY CLAY	92.5		
SILT	97.0		
SANDY CLAY	101.0		
SILT	107.5		
BEDROCK: WEATHERED SHALE	121.0		
END OF BORING			

ELEV. (FT) scale: 705, 700, 695, 690, 685, 680, 675, 670, 665, 660, 655, 650, 645, 640, 635, 630, 625, 620, 615, 610, 605, 600, 595, 590, 585

GROUNDWATER DATA

Date	Ground-water Elev.(ft)	Comments
12/01/94	654.50	Before Development

NOTES:

[1] FOR DETAILS OF SUBSURFACE STRATA FROM 0-90', SEE LOG OF TEST BORING OB-19; FOR 90-121', SEE LOG OF TEST BORING OB-19R

[2] TOP OF CASING & GROUND SURFACE ELEVATIONS PROVIDED BY WAYNE DISPOSAL, INC

[3] WELL LOCATION: 8873.2 N, 5324.4 E

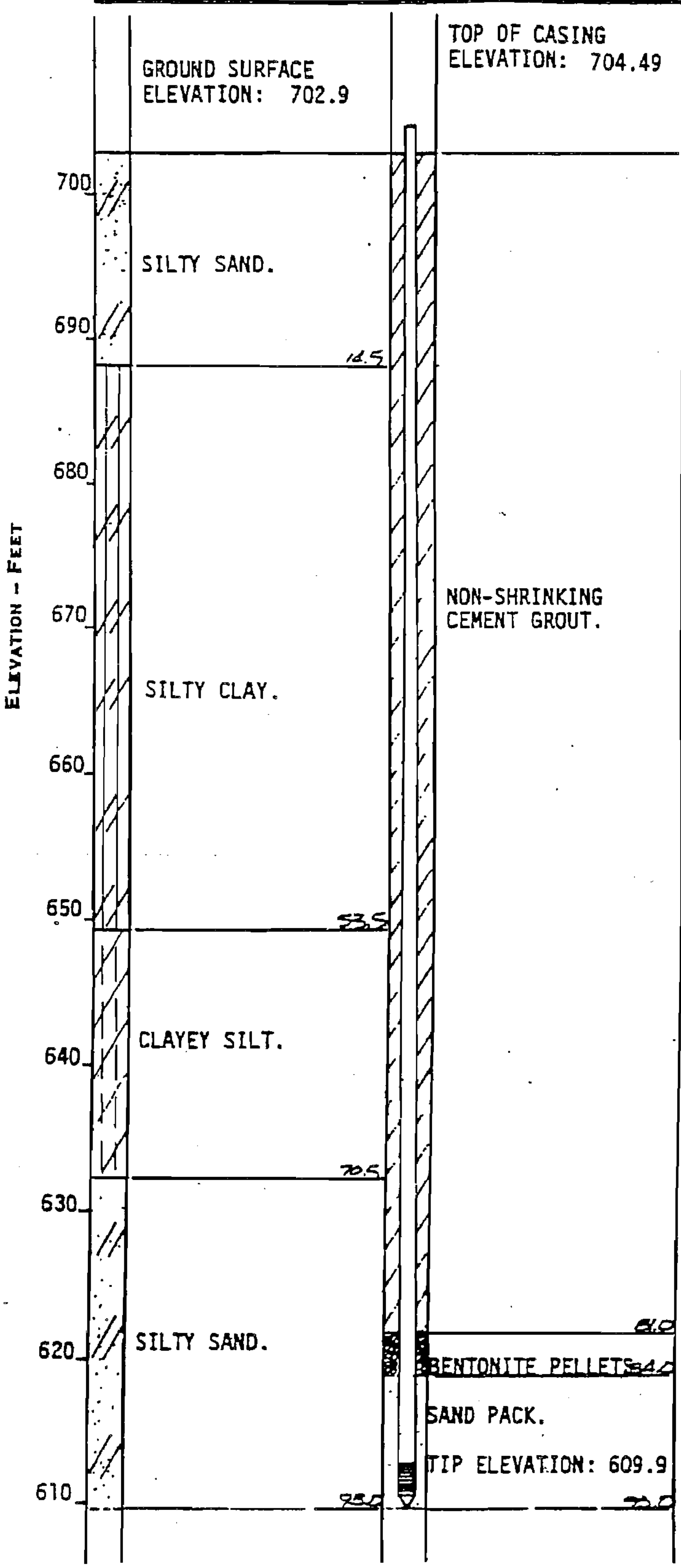
Started:	11/22/94	Casing Diameter:	2.0"
Completed:	11/22/94	Casing Length:	118.0'
Inspector:	R. LEE	Casing Type:	STAINLESS STEEL
Driller:	G. QUALLS	Screen Diameter:	2.0"
Contractor:	GEO-TEK, INC.	Screen Length:	5.0'
Equipment:	CME-850 ALL-TERRAIN DRILL RIG	Screen Mesh:	0.010"
Well Type:	MONITORING	Screen Type:	STAINLESS STEEL

Figure No. A-2

LOG OF GROUNDWATER MONITORING WELL

CLASSIFICATIONS BY:
NEYER, TISEO & HINDO, LTD.

GENERALIZED SUBSURFACE PROFILE	WELL SCHEMATIC



GROUNDWATER DATA

DATE	GROUND-WATER ELEV. (FEET)	COMMENTS
9-12-84	653.24	
9-24-84	653.13	

CASING - DIAMETER: 2.0"
- LENGTH: 90.0'
- MATERIAL: Galvanized

SCREEN - DIAMETER: 2.0"
- LENGTH: 3.0'
- MESH: .007" slot
- MATERIAL: Stainless Steel

WELL STARTED: 8-1-84
WELL COMPLETED: 8-2-84
INSPECTOR: J. Serwik
DRILLER: J. Blank
CONTRACTOR: American Drilling
EQUIPMENT: CME-75

NOTES:
1. For details of the subsurface stra
   see Log of Test Boring No. OB-20.
2. Top of casing elevations and groun
   surface elevations provided by Way
   Disposal, Inc.

NEYER, TISEO & HINDO, LTD.
CONSULTING ENGINEERS

GROUNDWATER MONITORING WELL No. OB-20

WAYNE DISPOSAL LANDFILL SITE NO. 2
VAN BUREN TOWNSHIP

LOG OF GROUNDWATER MONITORING WELL

CLASSIFICATIONS BY:
NEYER, TISEO & HINDO, LTD.

GENERALIZED SUBSURFACE PROFILE / WELL SCHEMATIC

GROUND SURFACE ELEVATION: 699.9

TOP OF CASING ELEVATION: 704.80

Elevation – Feet	Subsurface Profile	Depth
	SILTY SAND.	2.0
690	SILTY SAND.	12.0
680 / 670	SILTY CLAY.	37.0
660	SILTY CLAY.	45.5
650	SANDY SILT.	50.0
640 / 630	SILTY CLAY.	67.0
	CLAYEY SILT.	73.5
620	SANDY CLAY.	82.0
610	SILTY CLAY.	94.5
	SILTY SAND.	98.5
600	GRAVELLY SAND.	100

Well schematic:
- NON-SHRINKING CEMENT GROUT.
- 89.3
- BENTONITE PELLETS. 91.2
- SAND PACK.
- TIP ELEVATION: 600.9 100.0

GROUNDWATER DATA

DATE	GROUND-WATER ELEV. (FEET)	COMMENTS
9-12-84	652.64	
9-24-84	652.64	
10-22-84	652.44	

CASING – DIAMETER: 2.0"
– LENGTH: 94.0'
– MATERIAL: PVC

SCREEN – DIAMETER: 2.0"
– LENGTH: 5.0'
– MESH: .006" slot
– MATERIAL: PVC

WELL STARTED: 7-23-84
WELL COMPLETED: 7-24-84
INSPECTOR: J. Serwik
DRILLER: J. Blank
CONTRACTOR: American Drilling
EQUIPMENT: CME-75

NOTES:
1. For details of the subsurface strat see Log of Test Boring No. OB-21.
2. Top casing elevations and ground surface elevations provided by Wayn Disposal, Inc.

NEYER, TISEO & HINDO, LTD.
CONSULTING ENGINEERS

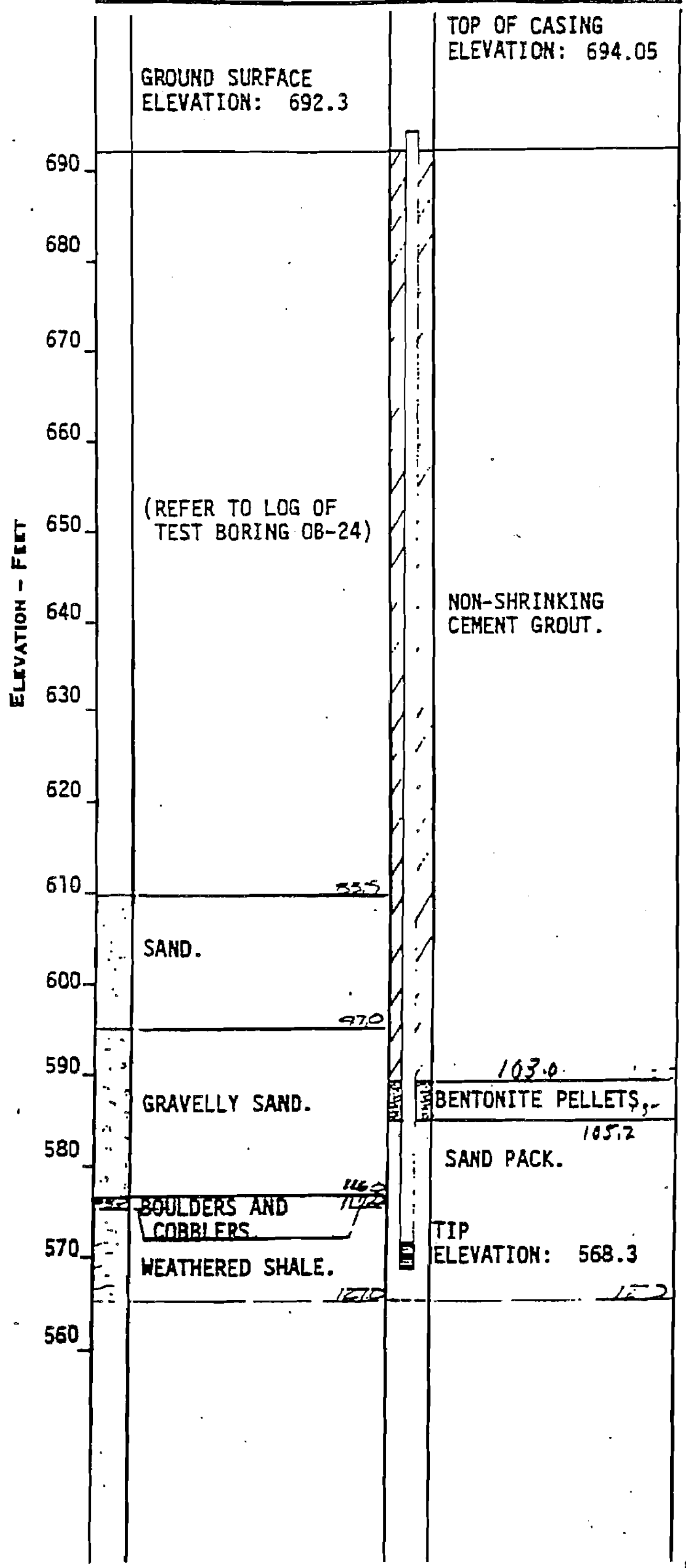
GROUNDWATER MONITORING WELL NO. OB-21

WAYNE DISPOSAL LANDFILL SITE NO. 2
VAN BUREN TOWNSHIP

LOG OF GROUNDWATER MONITORING WELL

CLASSIFICATIONS BY:
NEYER, TISEO & HINDO, LTD.

GENERALIZED SUBSURFACE PROFILE	WELL SCHEMATIC



GROUND WATER DATA

DATE	GROUND-WATER ELEV. (FEET)	COMMENTS
9-24-84	654.24	
10-22-84	653.32	

CASING
- DIAMETER: 2.0"
- LENGTH: 119.0
- MATERIAL: PVC

SCREEN
- DIAMETER: 2.0"
- LENGTH: 5.0'
- MESH: .006" slot
- MATERIAL: PVC

WELL STARTED: 9-14-84
WELL COMPLETED: 9-14-84
INSPECTOR: J. Serwik
DRILLER: J. Blank
CONTRACTOR: American
EQUIPMENT: CME-75

NOTES:
1. For details of the subsurface strat see Log of Test Boring No. OB-22.
2. Top of casing elevations and grounc surface elevations provided by Wayn Disposal, Inc.

NEYER, TISEO & HINDO, LTD.
CONSULTING ENGINEERS

GROUNDWATER MONITORING WELL NO. OB-22
WAYNE DISPOSAL LANDFILL SITE NO. 2
VAN BUREN TOWNSHIP

Project No:

Project: Well Re-Location

Client: Wayne Disposal, Inc.

Location: Site No. 2 Belleville, MI

Well ID: OB-23A

Enclosure:

Engineer: M. Takacs

SUBSURFACE PROFILE

Depth	Symbol	Description	Depth/Elev.	Well Construction	Remarks
0		Ground Surface	0		
0–12		**sand:** fine gray, silty with trace gravel and clay	700 / 12		
12–95		**Clay:** gray, silty with trace sand and gravel	688 / 95		Casing 2" Stainless Steel
95–125		**Sand:** gray, medium to coarse with trace gravel	605 / 125		Annular Space pH neutral grout Screen 5 foot 2" diameter Stainless Steel 7 Slot
125–130		**Shale:** gray, weathered	571		

Drilled By: American Drilling

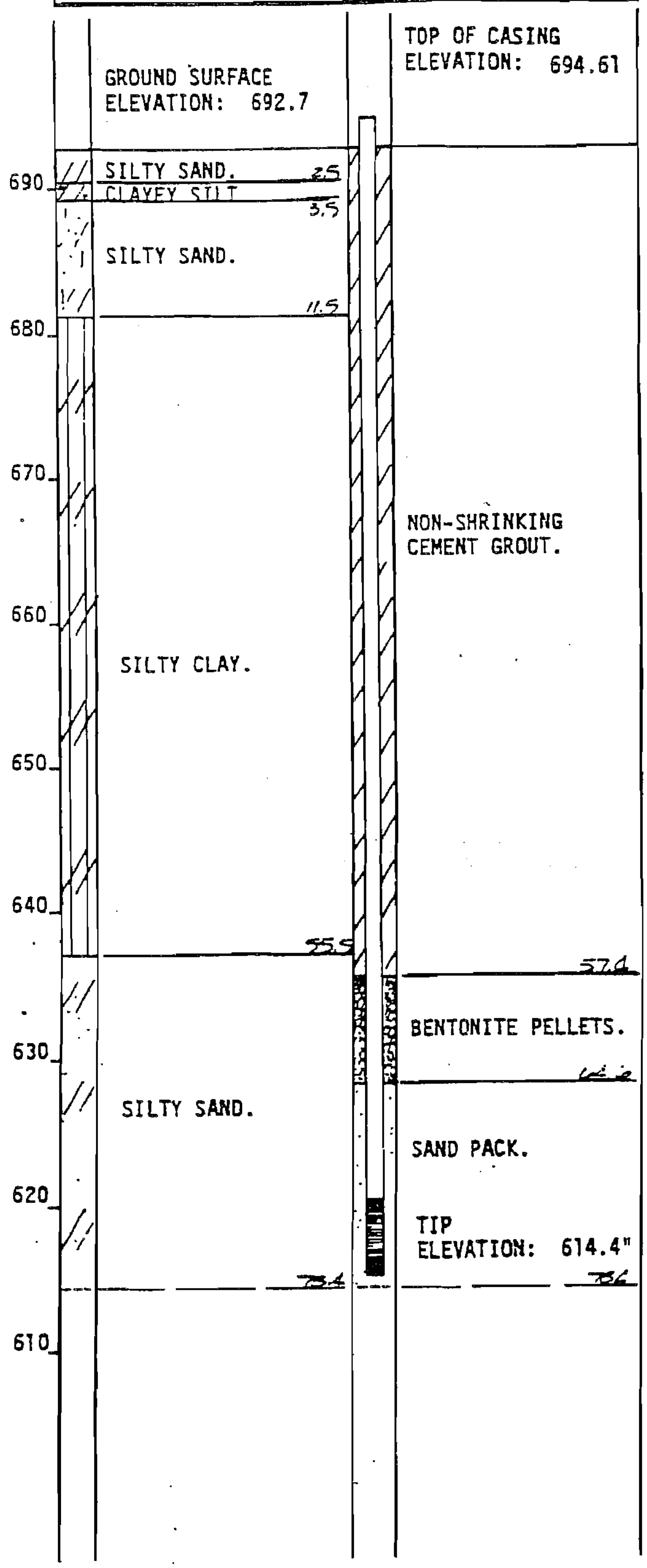
Drill Method: 6.25 inch HSA to EOB

Sheet: 1 of 1

LOG OF GROUNDWATER MONITORING WELL

CLASSIFICATIONS BY:
NEYER, TISEO & HINDO, LTD.

GENERALIZED SUBSURFACE PROFILE	WELL SCHEMATIC



GROUNDWATER DATA

DATE	GROUND-WATER ELEV. (FEET)	COMMENTS
9-12-84	653.62	
9-24-84	653.67	
10-22-84	653.30	

CASING - DIAMETER: 2.0"
- LENGTH: 73.3'
- MATERIAL: PVC

SCREEN - DIAMETER: 2.0"
- LENGTH: 5.0'
- MESH: .006" slot
- MATERIAL: PVC

WELL STARTED: 7-24-84
WELL COMPLETED: 7-24-84
INSPECTOR: J. Serwik
DRILLER: J. Blank
CONTRACTOR: American Drilling
EQUIPMENT: CME-75

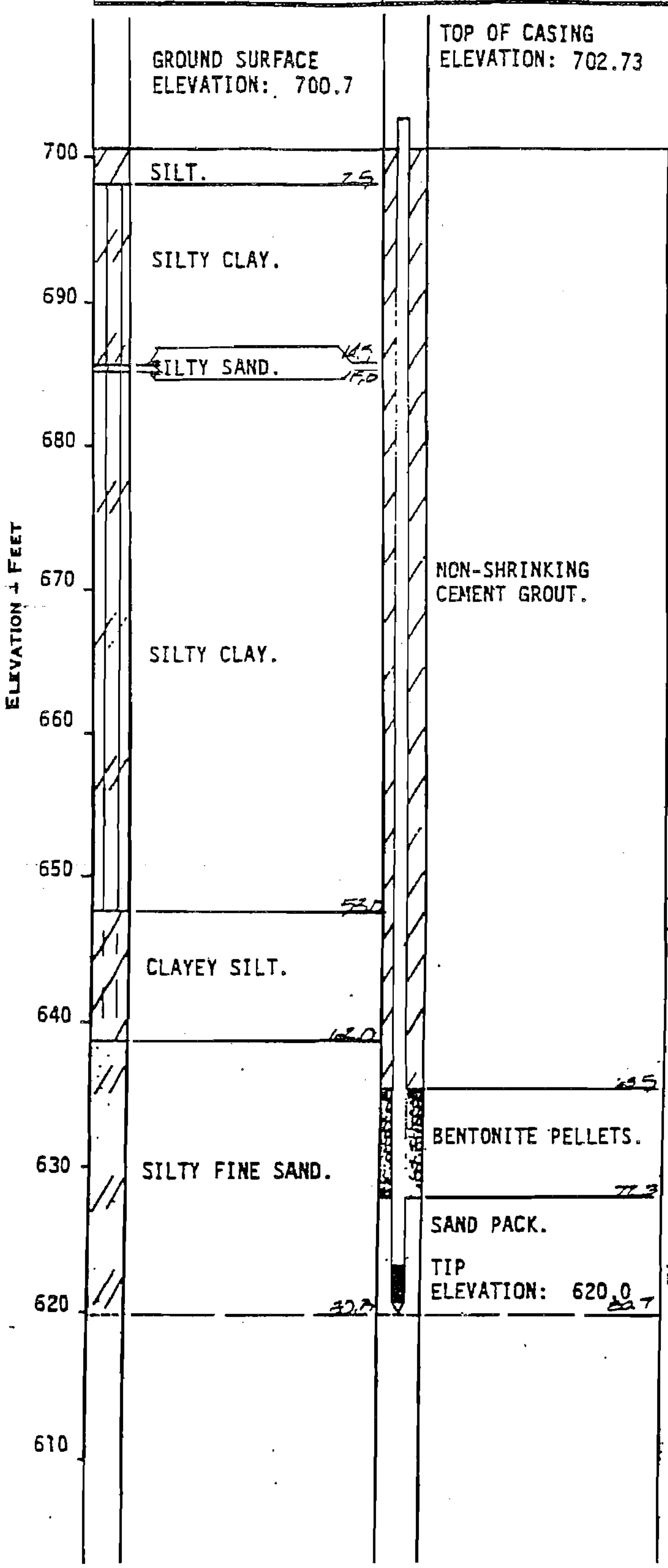
NOTES:
1. For details of the subsurface strat see Log of Test Boring No. OB-24.
2. Top of casing elevations and ground surface elevations provided by Wayn Disposal, Inc.

NEYER, TISEO & HINDO, LTD.
CONSULTING ENGINEERS

GROUNDWATER MONITORING WELL NO. OB-24

WAYNE DISPOSAL LANDFILL SITE NO. 2

LOG OF GROUNDWATER MONITORING WELL	
CLASSIFICATIONS BY: NEYER, TISEO & HINDO, LTD.	
GENERALIZED SUBSURFACE PROFILE	WELL SCHEMATIC



GROUNDWATER DATA

DATE	GROUND-WATER ELEV. (FEET)	COMMENTS
9-12-84	653.50	
9-24-84	653.86	
10-22-84	653.51	

CASING – DIAMETER: 2.0"
– LENGTH: 77.7
– MATERIAL: Galvanized

SCREEN – DIAMETER: 2.0"
– LENGTH: 3.0'
– MESH: .007" slot
– MATERIAL: Stainless Steel

WELL STARTED: 8-25-84
WELL COMPLETED: 8-25-84
INSPECTOR: J. Serwik
DRILLER: J. Blank
CONTRACTOR: American Drilling
EQUIPMENT: CME-75

NOTES:
1. For details of the subsurface strata see Log of Test Boring No. OB-25.
2. Top of casing elevations and ground surface elevations provided by Wayne Disposal, Inc.

NEYER, TISEO & HINDO, LTD.
CONSULTING ENGINEERS

GROUNDWATER MONITORING WELL No. OB-25

WAYNE DISPOSAL LANDFILL SITE NO. 2
VAN BUREN TOWNSHIP

NEYER, TISEO & HINDO, LTD.

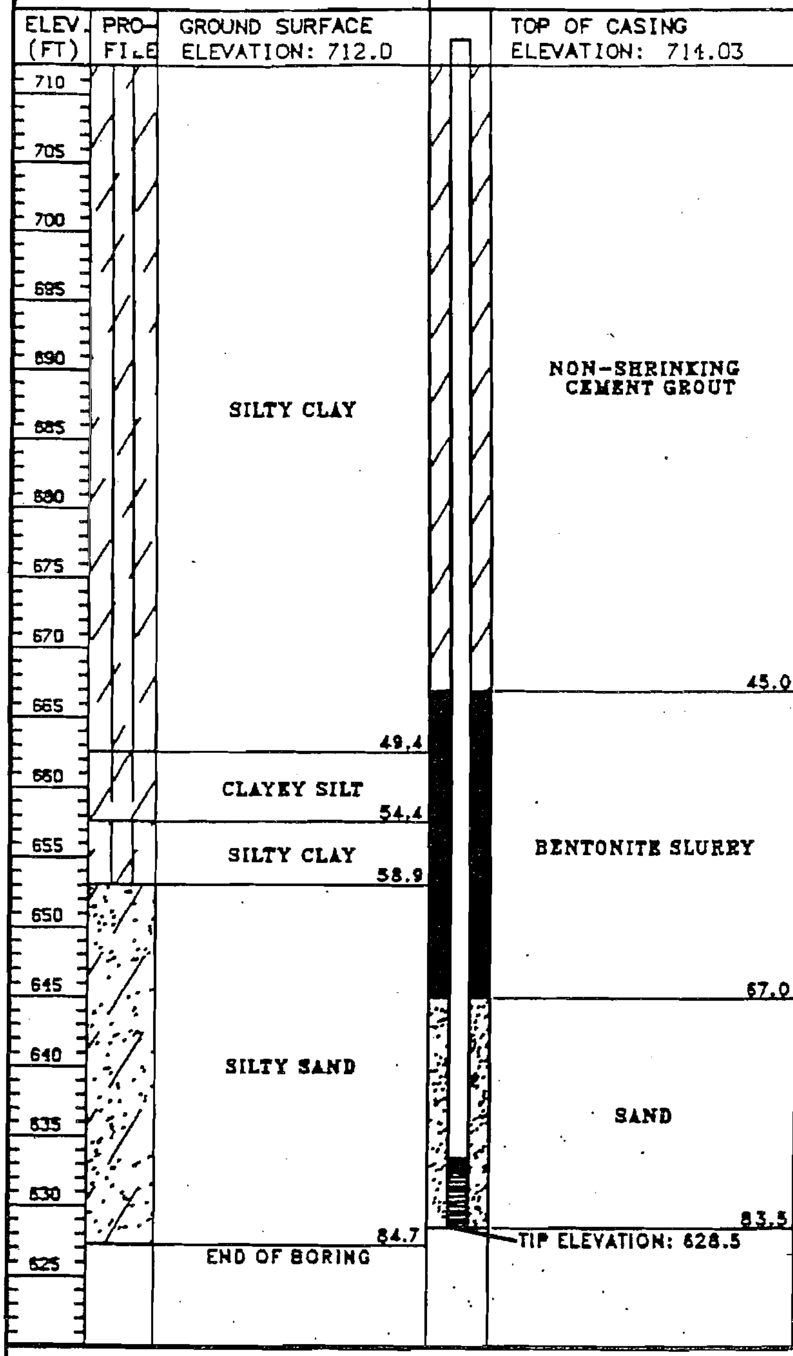
MONITOR WELL NO. OB-26A

Project Name: WAYNE DISPOSAL LANDFILL – SITE NO. 2
Project Location: VAN BUREN TWP., WAYNE COUNTY, MICHIGAN

NTH Pro. No. 94315 OW
Chk. By: RLB

LOG OF MONITOR INSTALLATION

Generalized Subsurface Profile | Schematic



GROUNDWATER DATA

Date	Ground-water Elev. (ft)	Comments
9/23/87	650.69	
9/24/87	650.62	
9/25/87	650.42	
9/28/87	650.58	

NOTES :

[1] FOR DETAILS OF SUBSURFACE STRATA, SEE LOG OF TEST BORING NO. OB-26
[2] TOP OF CASING AND GROUND SURFACE ELEVATIONS PROVIDED BY WAYNE DISPOSAL, INC.

Started:	9/18/87	Casing Diam.:	2"
Completed:	9/21/87	Casing Length:	80.5'
Inspector:	R. BURNS	Casing Type:	60.5' GALV. / 20' SS
Driller:	S REMPALSKI	Screen Diam.:	2"
Contractor:	MATECO DRILLING COMPANY	Screen Length:	5'
Equipment:	CME-550	Screen Mesh:	0.01"
Observation Type:	MONITORING WELL	Screen Type:	STAINLESS STEEL

Figure No. 9

NEYER, TISEO & HINDO, LTD.

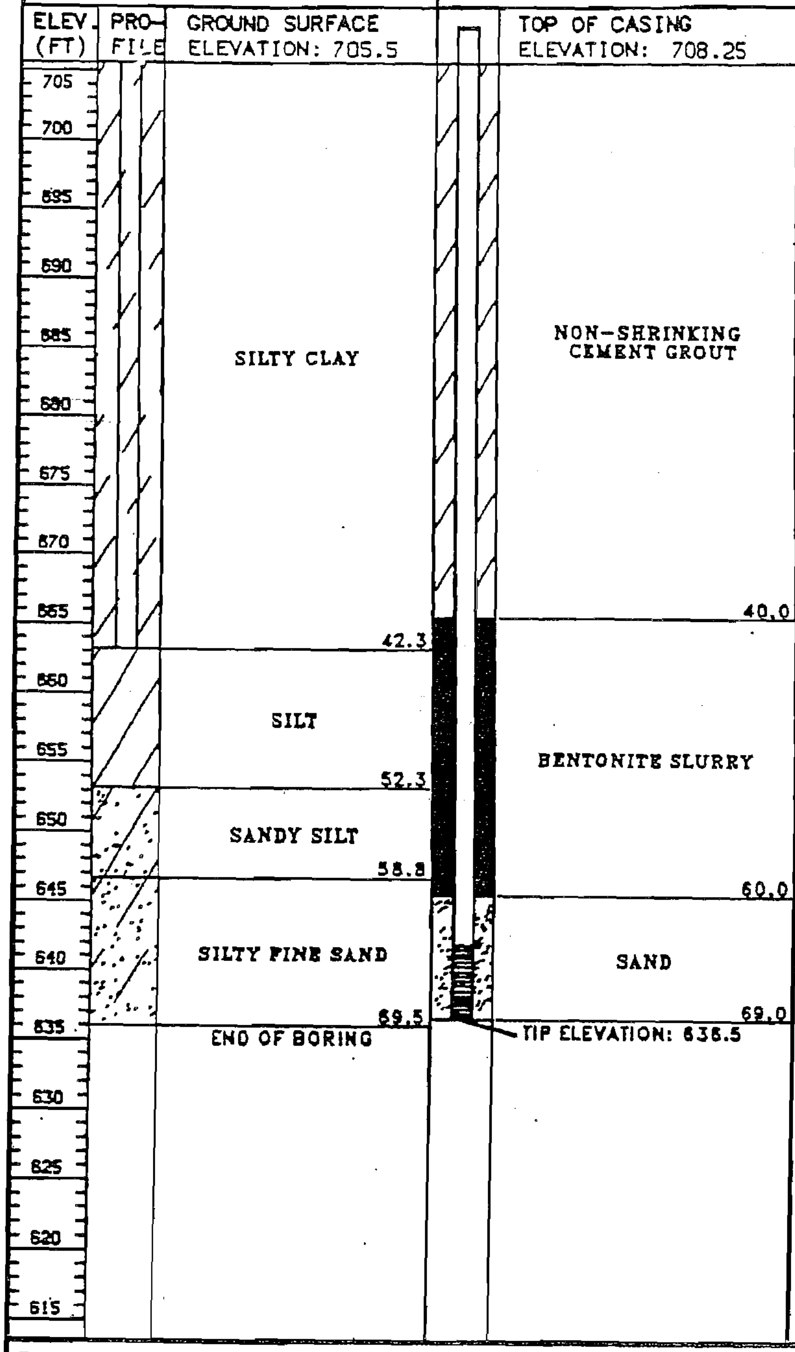
MONITOR WELL NO. OB-27A

Project Name: WAYNE DISPOSAL LANDFILL – SITE NO. 2 — **NTH Pro. No.** 94315 OW

Project Location: VAN BUREN TWP., WAYNE COUNTY, MICHIGAN — **Chk. By:** RLB

LOG OF MONITOR INSTALLATION

Generalized Subsurface Profile | Schematic



GROUNDWATER DATA

Date	Ground-water Elev. (ft)	Comments
10/7/87	658.75	
10/23/87	650.49	

NOTES :

[1] FOR DETAILS OF SUBSURFACE STRATA, SEE LOG OF TEST BORING NO. OB-27

[2] TOP OF CASING AND GROUND SURFACE ELEVATIONS PROVIDED BY WAYNE DISPOSAL, INC.

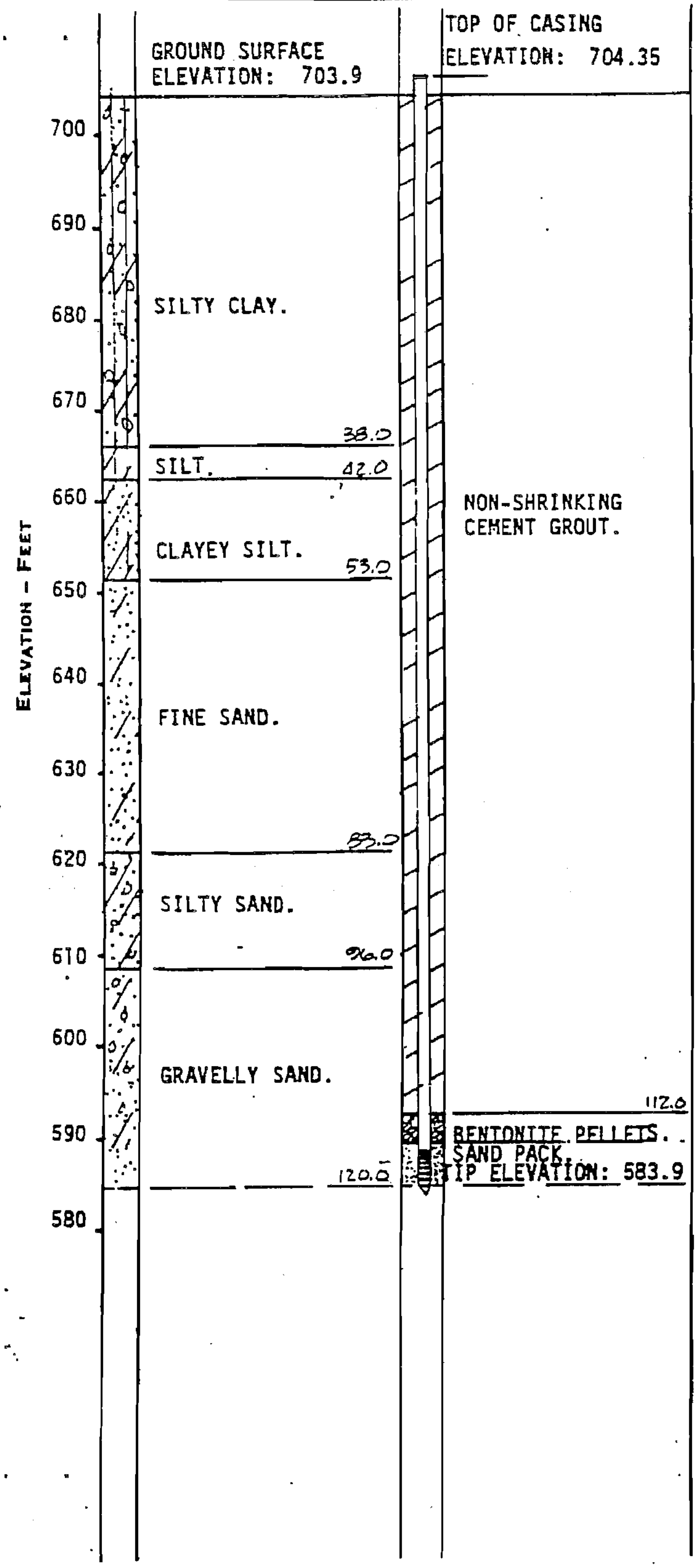
Started:	10/5/87	Casing Diam.:	2"
Completed:	10/5/87	Casing Length:	67'
Inspector:	R. BURNS	Casing Type:	47' GALV. / 20' SS
Driller:	S. REMPALSKI	Screen Diam.:	2"
Contractor:	MATECO DRILLING COMPANY	Screen Length:	5'
Equipment:	CME-550	Screen Mesh:	0.01"
Observation Type:	MONITORING WELL	Screen Type:	STAINLESS STEEL

Figure No. 10

LOG OF GROUNDWATER MONITORING WELL

CLASSIFICATIONS BY:
NEYER, TISEO & HINDO, LTD.

GENERALIZED SUBSURFACE PROFILE	WELL SCHEMATIC
GROUND SURFACE ELEVATION: 703.9	TOP OF CASING ELEVATION: 704.35



GROUNDWATER DATA

DATE	GROUND-WATER ELEV. (FEET)	COMMENTS
9-12-84	653.60	
9-24-84	653.69	
10-22-84	653.54	

CASING - DIAMETER: 2.0"
- LENGTH: 117.0
- MATERIAL: Galvanized

SCREEN - DIAMETER: 2.0"
- LENGTH: 3.0'
- MESH: .007" slot
- MATERIAL: Stainless Steel

WELL STARTED: 8-13-84
WELL COMPLETED: 8-14-84
INSPECTOR: J. Serwik
DRILLER: J. Blank
CONTRACTOR: American Drilling
EQUIPMENT: CME-75

NOTES:
1. For details of the subsurface stra
   see Log of Test Boring No. 28.
2. Top of casing elevations and grour
   surface elevations provided by Way
   Disposal, Inc.

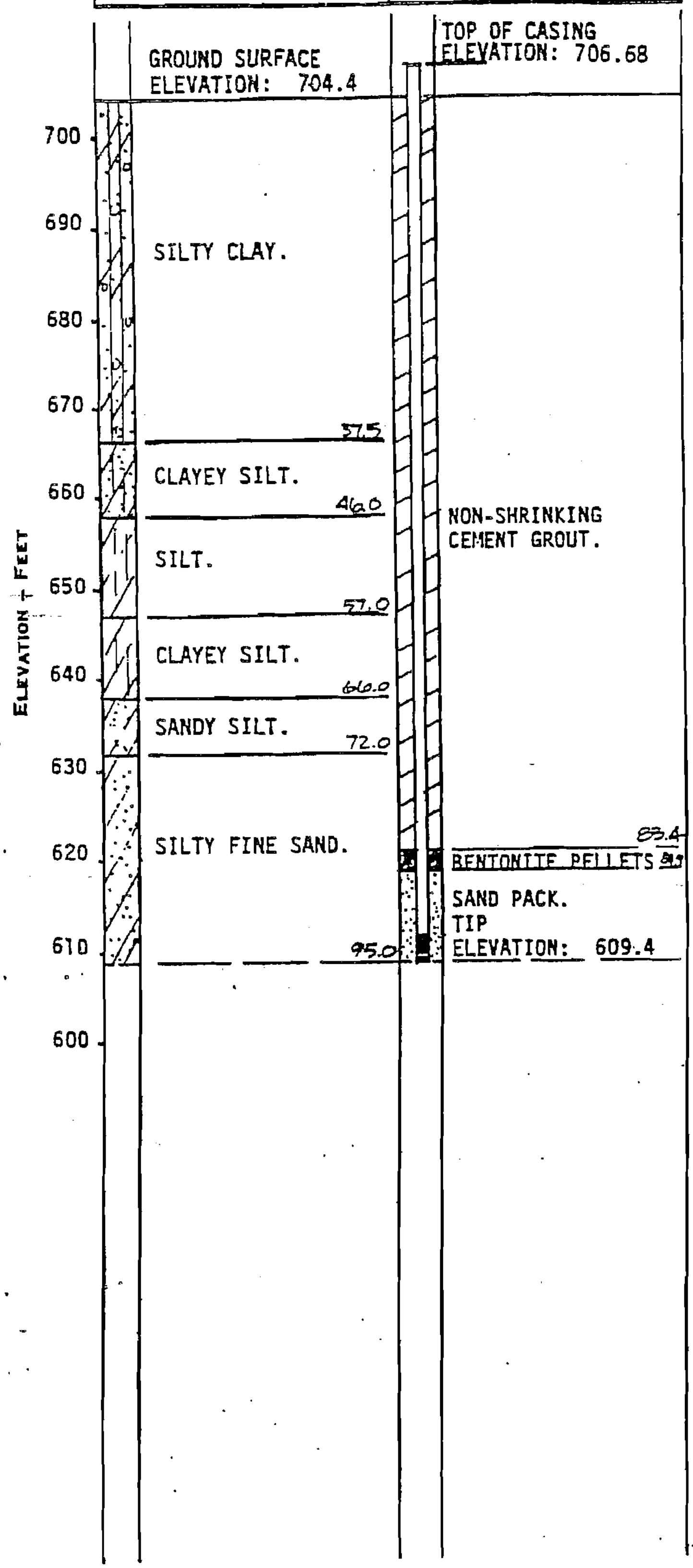
NEYER, TISEO & HINDO, LTD.
CONSULTING ENGINEERS

GROUNDWATER MONITORING WELL No. DB-28

WAYNE DISPOSAL LANDFILL SITE NO. 2
VAN BUREN TOWNSHIP
WAYNE COUNTY, MICHIGAN

LOG OF GROUNDWATER MONITORING WELL

CLASSIFICATIONS BY:
NEYER, TISEO & HINDO, LTD.



GROUNDWATER DATA

DATE	GROUND-WATER ELEV. (FEET)	COMMENTS
9-12-84	653.61	
9-24-84	653.63	
10-22-84	653.36	

CASING – DIAMETER: 2.0"
– LENGTH: 90.0'
– MATERIAL: PVC

SCREEN – DIAMETER: 2.0"
– LENGTH: 5.0'
– MESH: .006" slot
– MATERIAL: PVC

WELL STARTED: 7-30-84
WELL COMPLETED: 7-30-84
INSPECTOR: J. Serwik
DRILLER: J. Blank
CONTRACTOR: American Drilling
EQUIPMENT: CME-75

NOTES:
1. For details of the subsurface stra
see Log of Test Boring No. OB-29.
2. Top of casing elevations and grou
surface elevations provided by Wa
Disposal, Inc.

NEYER, TISEO & HINDO, LTD.
CONSULTING ENGINEERS

GROUNDWATER MONITORING WELL No. OB-29

WAYNE DISPOSAL LANDFILL SITE NO. 2
VAN BUREN TOWNSHIP
WAYNE COUNTY, MICHIGAN

LOG OF GROUNDWATER MONITORING WELL

CLASSIFICATIONS BY:
NEYER, TISEO & HINDO, LTD.

GENERALIZED SUBSURFACE PROFILE	WELL SCHEMATIC
GROUND SURFACE ELEVATION: 702.4	TOP OF CASING ELEVATION: 703.60
SILTY CLAY. (to 54.0)	NON-SHRINKING CEMENT GROUT. (to 83.3)
SILTY CLAY. (to 61.0)	
CLAYEY SILT. (to 68.0)	
SILTY CLAY. (to 71.0)	
SILT. (to 82.5)	
SANDY SILT. (to 88.5)	BENTONITE PELLETS. (to 88.7)
SILTY FINE SAND. (to 95.0)	SAND PACK. TIP ELEVATION: 607.4

ELEVATION – FEET: 700, 690, 680, 670, 660, 650, 640, 630, 620, 610, 600

GROUNDWATER DATA

DATE	GROUND-WATER ELEV. (FEET)	COMMENTS
9-12-84	653.61	
9-24-84	653.81	
10-22-84	653.38	

CASING – DIAMETER: 2.0"
– LENGTH: 92.0'
– MATERIAL: Galvanized

SCREEN – DIAMETER: 2.0"
– LENGTH: 3.0'
– MESH: .007" slot
– MATERIAL: Stainless Steel

WELL STARTED: 8-29-84
WELL COMPLETED: 8-29-84
INSPECTOR: J. Serwik
DRILLER: J. Blank
CONTRACTOR: American Drilling
EQUIPMENT: CME-75

NOTES:
1. For details of the subsurface stra see Log of Test Boring No. OB-30.
2. Top of casing elevations and grour surface elevations provided by Way Disposal, Inc.

NEYER, TISEO & HINDO, LTD.
CONSULTING ENGINEERS

GROUNDWATER MONITORING WELL NO. OB-30

WAYNE DISPOSAL LANDFILL SITE NO. 2
VAN BUREN TOWNSHIP
WAYNE COUNTY, MICHIGAN

DATE: 10-8-84

LOG OF GROUNDWATER MONITORING WELL

CLASSIFICATIONS BY:
NEYER, TISEO & HINDO, LTD.

GENERALIZED SUBSURFACE PROFILE	WELL SCHEMATIC
GROUND SURFACE ELEVATION: 697.7	TOP OF CASING ELEVATION: 699.27
SILTY SAND. (7.5)	NON-SHRINKING CEMENT GROUT. (53.5)
SILTY CLAY. (25.0)	BENTONITE PELLETS. (57.0)
CLAYEY SILT. (41.5)	SAND PACK.
SILTY CLAY. (53.0)	TIP ELEVATION: 627.7 (72.0)
CLAYEY SILT. (57.0)	
SILTY CLAY. (60.5)	
SILTY FINE SAND. (69.1)	
SANDY CLAY. (69.5)	

ELEVATION – FEET: 690, 680, 670, 660, 650, 640, 630, 620

GROUNDWATER DATA

DATE	GROUND-WATER ELEV. (FEET)	COMMENTS
9-24-84	655.60	
10-22-84	655.25	

CASING – DIAMETER: 2.0"
– LENGTH: 67.0'
– MATERIAL: Galvanized

SCREEN – DIAMETER: 2.0"
– LENGTH: 3.0'
– MESH: .007" slot
– MATERIAL: Stainless Steel

WELL STARTED: 9-18-84
WELL COMPLETED: 9-18-84
INSPECTOR: J. Serwik
DRILLER: J. Blank
CONTRACTOR: American Drilling
EQUIPMENT: CME-75

NOTES:
1. For details of the subsurface strat[a] see Log of Test Boring No. OB-31.
2. Top of casing elevations and ground surface elevations provided by Wayne Disposal, Inc.

NEYER, TISEO & HINDO, LTD.
CONSULTING ENGINEERS

GROUNDWATER MONITORING WELL No. OB-31

WAYNE DISPOSAL LANDFILL SITE NO. 2
VAN BUREN TOWNSHIP
WAYNE COUNTY, MICHIGAN

NTH Consultants, Ltd.

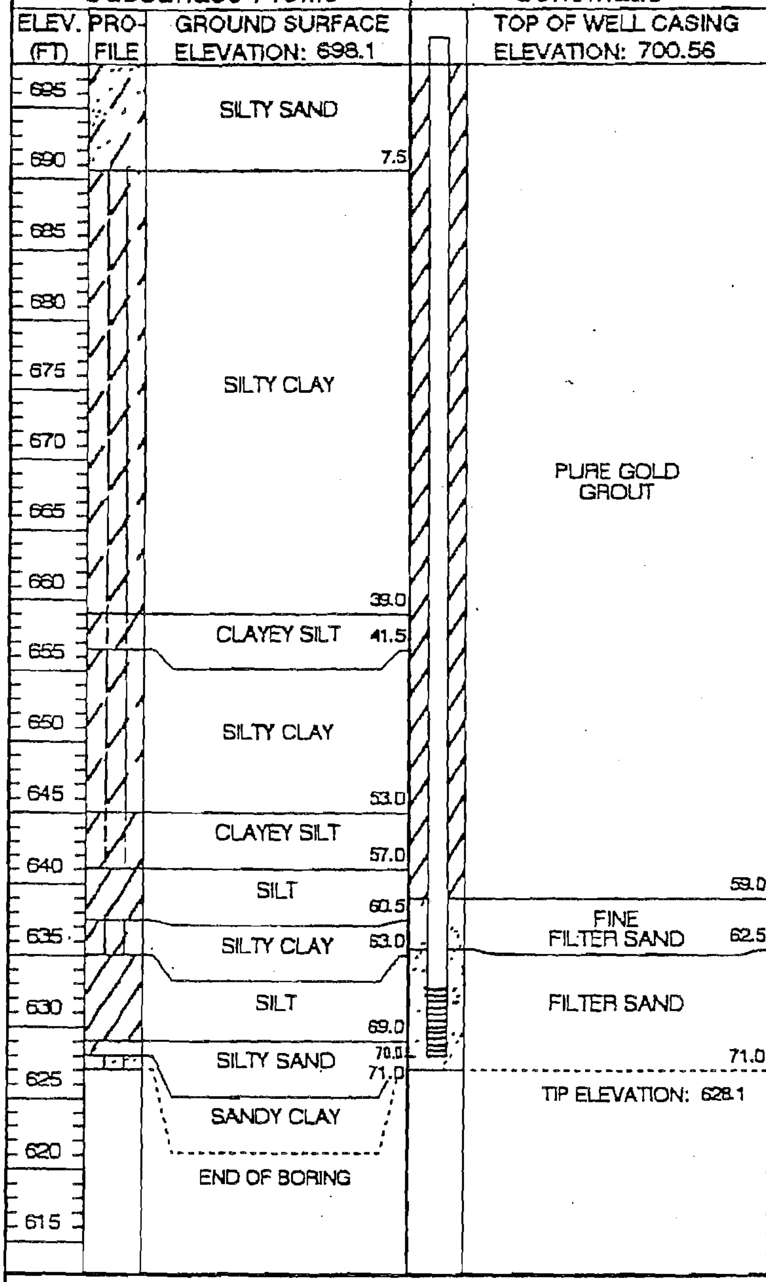
MONITORING WELL NO. OB-31AR

Project Name : WAYNE DISPOSAL, INC. - SITE NO. 2 — **NTH Proj. No:** 13-3051 00

Project Location : VAN BUREN TOWNSHIP, WAYNE COUNTY, MICHIGAN — **Checked By :** ACE

LOG OF MONITORING WELL

Generalized Subsurface Profile — Installation Schematic



GROUNDWATER DATA

Date	Ground-water Elev.(ft)	Comments
02/03/93	653.91	BEFORE DEVELOPMENT
02/09/93	656.36	BEFORE DEVELOPMENT
02/25/93	656.19	

NOTES :

[1] FOR DETAILS OF SUBSURFACE STRATA, SEE LOG OF TEST BORING NO. OB-31AR.
[2] TOP OF CASING & GROUND SURFACE ELEVATIONS PROVIDED BY WAYNE DISPOSAL, INC.
[3] WELL INSTALLED TO REPLACE MONITORING WELL NO. OB-31A.
[4] CENTRALIZERS WERE USED TO MAINTAIN THE VERTICALITY OF THE WELL ASSEMBLY IN THE BOREHOLE.

FIELD MEASUREMENTS DURING DRILLING:

pH: 8.53
SPEC. COND: 361 μmhos/cm

FIELD MEASUREMENTS AFTER DEVELOPMENT:

pH: 8.21
SPEC. COND: 309 μmhos/cm

Started: 02/02/93
Completed: 02/03/93
Inspector: C. ENDLER
Driller: G. QUALLS
Contractor: GEO-TEK, INC.
Equipment: CME-750 ALL-TERRAIN DRILLING RIG
Well Type: MONITORING

Casing Diameter: 2.0"
Casing Length: 67.5'
Casing Type: STAINLESS STEEL
Screen Diameter: 2.0"
Screen Length: 5.0'
Screen Mesh: 0.007"
Screen Type: STAINLESS STEEL

Figure No. A-4

NEYER, TISEO & HINDO, LTD.

MONITOR WELL NO. OB-32

Project Name: WAYNE DISPOSAL LANDFILL – SITE NO. 2 — NTH Pro. No. 94315 OW

Project Location: VAN BUREN TWP., WAYNE COUNTY, MICHIGAN — Chk. By: RLB

LOG OF MONITOR INSTALLATION

Generalized Subsurface Profiles — GROUND SURFACE ELEVATION: 697.8

Schematic — TOP OF CASING ELEVATION: 701.35

Stratum	Depth to bottom (ft)
SILTY SAND	7.5
SILTY CLAY	39.0
CLAYEY SILT	41.5
SILTY CLAY	53.0
CLAYEY SILT	57.0
SILTY CLAY	60.5
SILTY FINE SAND	69.1
SANDY CLAY	87.0
SILTY CLAY	113.0
WEATHERED CLAYEY SHALE	121.0
SHALE	133.0

END OF BORING

Schematic	Depth to bottom (ft)
NON-SHRINKING CEMENT GROUT	90.0
BENTONITE SLURRY	120.0
SAND	132.5

TIP ELEVATION: 565.3

Elevation scale (FT): 695, 690, 685, 680, 675, 670, 665, 660, 655, 650, 645, 640, 635, 630, 625, 620, 615, 610, 605, 600, 595, 590, 585, 580, 575, 570, 565

GROUNDWATER DATA

Date	Ground-water Elev.(ft)	Comments
7/23/87	655.70	
7/28/87	651.35	
7/29/87	651.25	
7/31/87	651.15	
8/18/87	651.00	
8/21/87	650.72	
8/25/87	650.77	
8/31/87	651.10	
9/4/87	650.78	

NOTES :

[1] FOR DETAILS OF SUBSURFACE STRATA, SEE LOG OF TEST BORING NO. OB-32.

[2] TOP OF CASING AND GROUND SURFACE ELEVATIONS PROVIDED BY WAYNE DISPOSAL, INC.

Started:	7/21/87	Casing Diam.:	2"
Completed:	7/21/87	Casing Length:	127'
Inspector:	R. BURNS / M. TAKACS	Casing Type:	107.5' GALV. / 20' SS
Driller:	S. REMPALSKI	Screen Diam.:	2"
Contractor:	MATECO DRILLING COMPANY	Screen Length:	5'
Equipment:	CME-550	Screen Mesh:	0.007"
Observation Type:	MONITORING WELL	Screen Type:	STAINLESS STEEL

Figure No. 12

MONITORING WELL NO: OB-34A

Project Name: *WAYNE DISPOSAL, INC.*

Project Location: *BELLEVILLE, MICHIGAN*

NTH CONSULTANTS, LTD.

NTH Proj. No: *13-020395-01*

Checked By: RBM

LOG OF MONITORING WELL

Generalized Subsurface Profile

GROUND SURFACE ELEVATION: 707.1

ELEV. (FT)	Description	Depth
		0.0
705	Fill: Silty Clay	3.0
690, 675, 660	Silty Clay	
645		61.0
630	Silt	80.0
	Sand	90.0
615	End of Boring	

Installation Schematic

TOP OF WELL CASING ELEVATION: 712.05

Description	Depth
	0.0
Non-Shrinking Cement Grout	78.0
Bentonite Slurry	81.0
Sand	90.0
Tip Elev: 617.8'	

GROUNDWATER DATA

DATE	ELEV. (ft.)	COMMENTS
06-24-03	n/a	due to use of drilling fluids

NOTES

[1] For details of subsurface strata, see Log of Test Boring OB-34A.

Started:	*06/23/03*
Completed:	*06/24/03*
Inspector:	*K. Warning*
Contractor:	*American Drilling & Testing Co.*
Driller:	*R. Rumptz / H. Pace*
Equipment:	*CME-750 & CME-550*
Well Type:	*Monitoring*

Casing Diameter:	*2.0 in*
Casing Length:	*89.25 ft*
Casing Type:	*Stainless Steel*
Screen Diameter:	*2.0 in*
Screen Length:	*5.0 ft*
Screen Mesh:	*0.007 in*
Screen Type:	*Stainless Steel*

FIGURE NO.

MONITORING WELL NO: OB-35A

NTH CONSULTANTS, LTD.

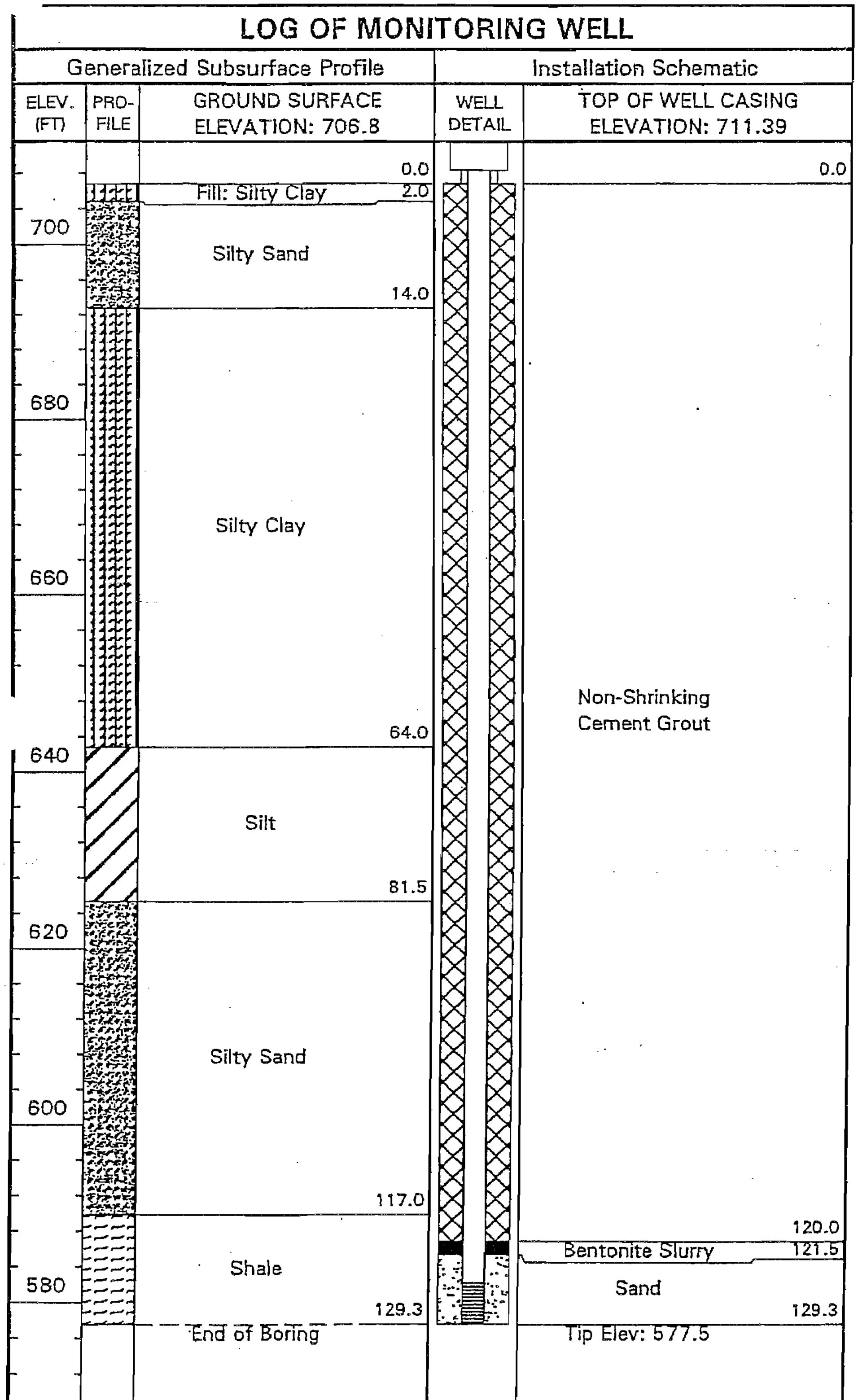
Project Name: *WAYNE DISPOSAL, INC.*

Project Location: *BELLEVILLE, MICHIGAN*

NTH Proj. No: *13-020395-01*

Checked By: RBM

LOG OF MONITORING WELL



GROUNDWATER DATA

DATE	ELEV. (ft.)	COMMENTS
06-24-03	n/a	due to use of drilling fluids

NOTES

[1] For details of subsurface strata, see Log of Test Boring OB-35A.

Started:	*06/19/03*
Completed:	*06/20/03*
Inspector:	*K. Warning*
Contractor:	*American Drilling & Testing Co.*
Driller:	*R. Rumptz / H. Pace*
Equipment:	*CME-750 & CME-550*
Well Type:	*Monitoring*

Casing Diameter:	*2.0 in*
Casing Length:	*128.89 ft*
Casing Type:	*Stainless Steel*
Screen Diameter:	*2.0 in*
Screen Length:	*5.0 ft*
Screen Mesh:	*0.007 in*
Screen Type:	*Stainless Steel*

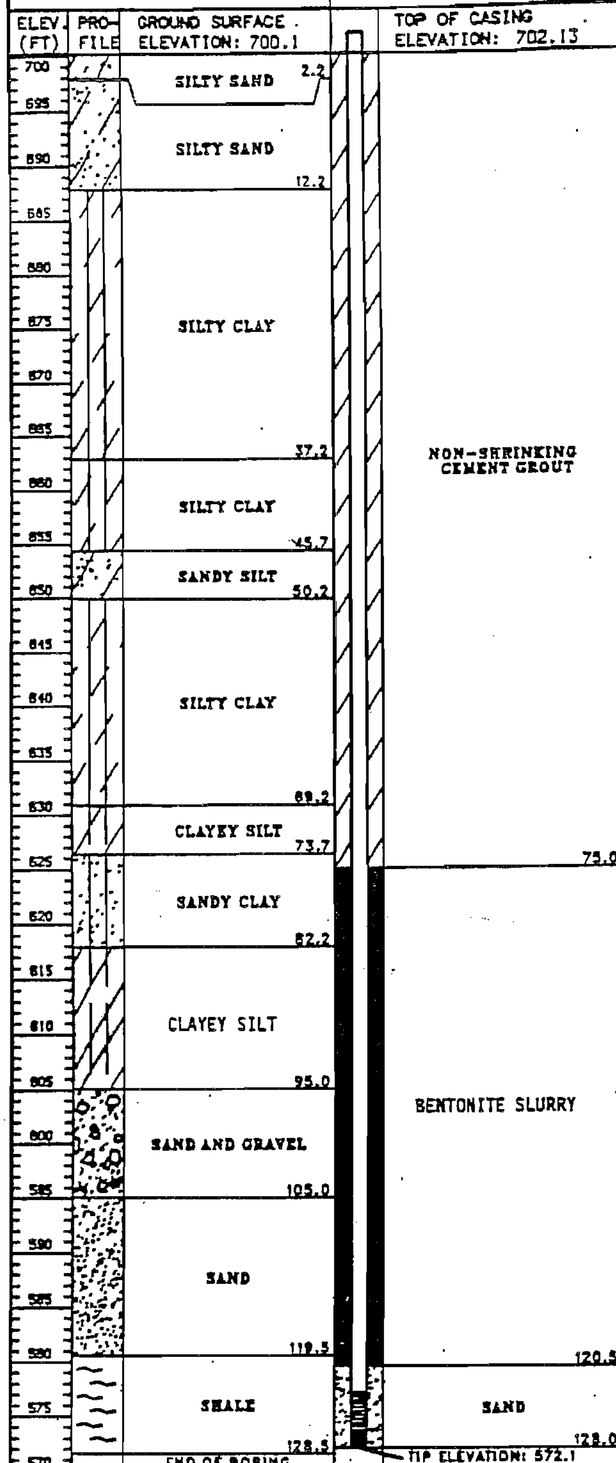
FIGURE NO.

NEYER, TISEO & HINDO, LTD.

MONITOR WELL NO. OB-36

Project Name: WAYNE DISPOSAL LANDFILL – SITE NO. 2 NTH Pro. No. 94315 OW
Project Location: VAN BUREN TWP., WAYNE COUNTY, MICHIGAN Chk. By: RLB

LOG OF MONITOR INSTALLATION



GROUNDWATER DATA

Date	Ground-water Elev.(ft)	Comments
10/22/87	649.70	

NOTES :

[1] FOR DETAILS OF SUBSURFACE STRATA, SEE LOG OF TEST BORING NO. OB-36

[2] TOP OF CASING AND GROUND SURFACE ELEVATIONS PROVIDED BY WAYNE DISPOSAL, INC.

Started:	10/1/87	Casing Diam.:	2"
Completed:	10/1/87	Casing Length:	125'
Inspector:	M. TAKACS / R. BURNS	Casing Type:	70' GAVL. / 55' SS
Driller:	S. REMPALSKI	Screen Diam.:	2"
Contractor:	MATECO DRILLING COMPANY	Screen Length:	5'
Equipment:	CME-550	Screen Mesh:	0.007"
Observation Type:	MONITORING WELL	Screen Type:	STAINLESS STEEL

Figure No. 15

NEYER, TISEO & HINDO, LTD.

MONITOR WELL NO. OB-37

Project Name: WAYNE DISPOSAL LANDFILL – SITE NO. 2 NTH Proj. No. 94315 OW

Project Location: VAN BUREN TWP., WAYNE COUNTY, MICHIGAN Chk. By: RLB

LOG OF MONITOR INSTALLATION

GROUND SURFACE ELEVATION: 701.7

TOP OF CASING ELEVATION: 705.53

Generalized Subsurface Profile

Depth (ft)	Stratum
0 – 3.5	SILT
3.5 – 15.5	SILTY CLAY
15.5 – 16.0	SILTY SAND
16.0 – 54.0	SILTY CLAY
54.0 – 63.0	CLAYEY SILT
63.0 – 91.0	SILTY FINE SAND
91.0 – 117.5	GRAVELLY SAND
117.5 – 121.0	SANDY GRAVEL
121.0 – 123.0	WEATHERED SHALE
123.0 – 130.0	SHALE
130.0	END OF BORING

Elevation scale (ft): 700, 695, 690, 685, 680, 675, 670, 665, 660, 655, 650, 645, 640, 635, 630, 625, 620, 615, 610, 605, 600, 595, 590, 585, 580, 575, 570

Schematic

Depth (ft)	Material
0 – 55.0	NON-SHRINKING CEMENT GROUT
55.0 – 122.0	BENTONITE SLURRY
122.0 – 128.0	SAND

TIP ELEVATION: 572.7

GROUNDWATER DATA

Date	Ground-water Elev. (ft)	Comments
7/25/87	663.21	
7/28/87	652.10	

NOTES :

[1] FOR DETAILS OF SUBSURFACE STRATA, SEE LOG OF TEST BORING NO. OB-37

[2] TOP OF CASING AND GROUND SURFACE ELEVATIONS PROVIDED BY WAYNE DISPOSAL, INC.

Started:	9/23/87
Completed:	9/24/87
Inspector:	R. BURNS
Driller:	S. REMPALSKI
Contractor:	MATECO DRILLING COMPANY
Equipment:	CME-550
Observation Type:	MONITORING WELL

Casing Diam.:	2"
Casing Length:	129.3'
Casing Type:	54.3' GALV. / 75' SS
Screen Diam.:	2"
Screen Length:	3.5'
Screen Mesh:	0.01"
Screen Type:	STAINLESS STEEL

Figure No. 16

NEYER, TISEO & HINDO, LTD.

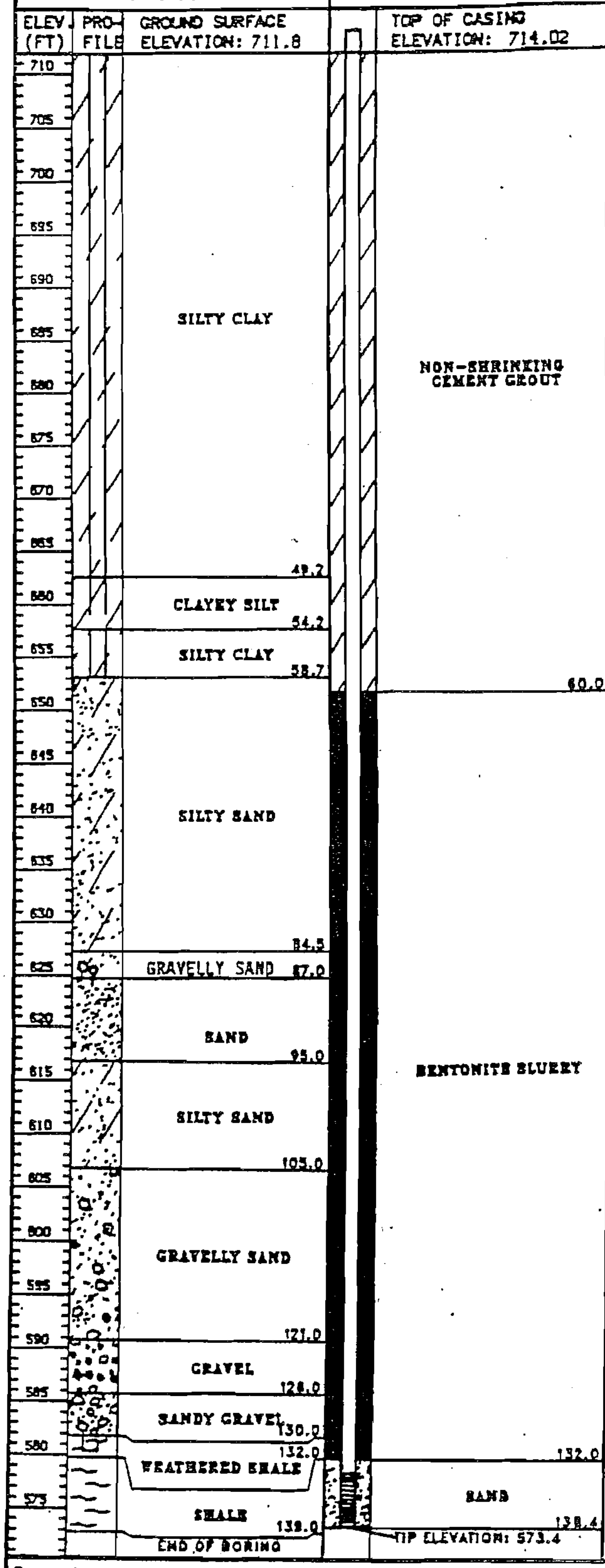
MONITOR WELL NO. OB-38

Project Name: WAYNE DISPOSAL LANDFILL - SITE NO. 2
Project Location: VAN BUREN TWP., WAYNE COUNTY, MICHIGAN

NTH Pro. No. 94315 OW
Chk. By: RLB

LOG OF MONITOR INSTALLATION

Generalized Subsurface Profile | Schematic



GROUNDWATER DATA

Date	Ground-water Elev. (ft)	Comments
9/18/87	653.12	
9/23/87	651.13	
9/24/87	651.02	
9/25/87	650.86	
9/28/87	650.70	

NOTES :

[1] FOR DETAILS OF SUBSURFACE STRATA, SEE LOG OF TEST BORING NO. OB-39
[2] TOP OF CASING AND GROUND SURFACE ELEVATIONS PROVIDED BY WAYNE DISPOSAL, INC.

Started:	9/9/87	Casing Diam.:	2"
Completed:	9/10/87	Casing Length:	137.1'
Inspector:	R. BURNS / M. TAKACS	Casing Type:	50.1' GALV. / 87' SS
Driller:	S. REMPALSKI	Screen Diam.:	2"
Contractor:	MATECO DRILLING COMPANY	Screen Length:	3.5'
Equipment:	CME-550	Screen Mesh:	0.01"
Observation Type:	MONITORING WELL	Screen Type:	STAINLESS STEEL

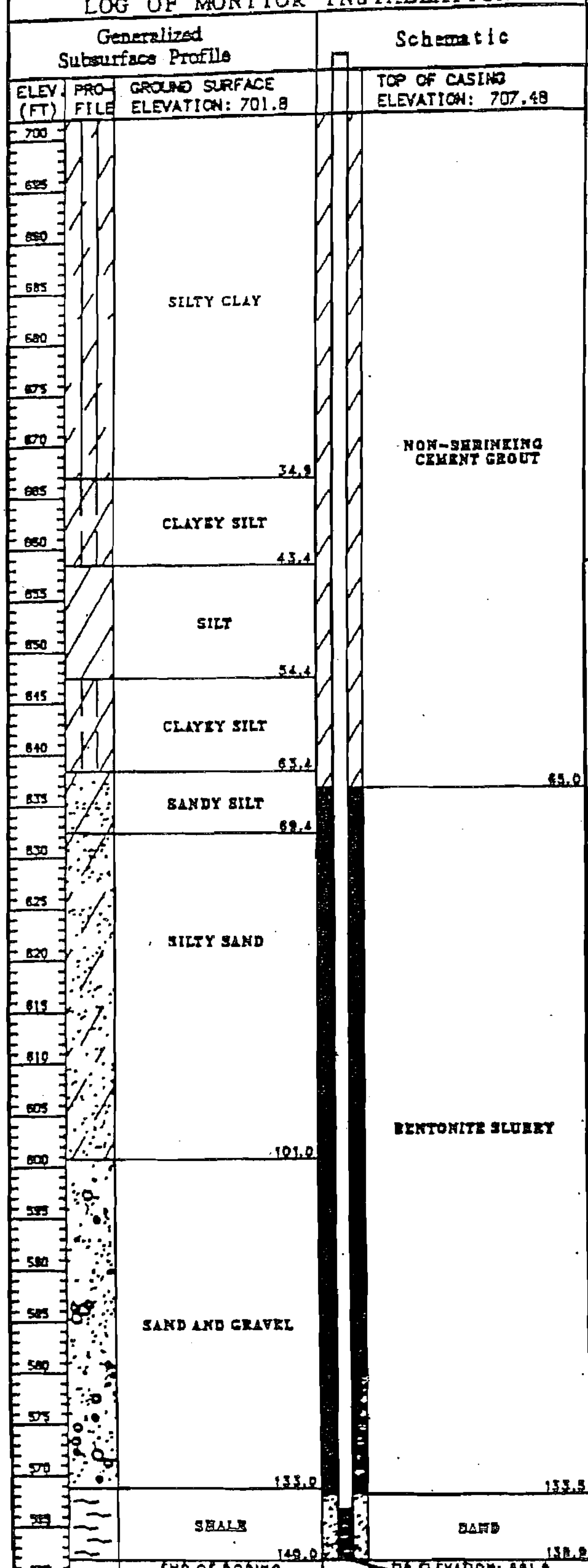
Figure No. 17

NEYER, TISEO & HINDO, LTD.

MONITOR WELL NO. OB-39

Project Name: WAYNE DISPOSAL LANDFILL – SITE NO. 2 — NTH Pro. No. 94315 OW
Project Location: VAN BUREN TWP., WAYNE COUNTY, MICHIGAN — Chk. By: RLB

LOG OF MONITOR INSTALLATION



GROUNDWATER DATA

Date	Ground-water Elev. (ft)	Comments
9/1/87	652.28	
9/4/87	651.50	
9/9/87	650.88	
9/22/87	650.50	

NOTES :

[1] FOR DETAILS OF SUBSURFACE STRATA, SEE LOG OF TEST BORING NO. OB-39

[2] TOP OF CASING AND GROUND SURFACE ELEVATIONS PROVIDED BY WAYNE DISPOSAL, INC.

Started:	8/31/87	Casing Diam.:	2"
Completed:	9/1/87	Casing Length:	140.4'
Inspector:	R. BURNS	Casing Type:	65.4' GALV. / 75' SS
Driller:	S. REMPALSKI	Screen Diam.:	2"
Contractor:	MATECO DRILLING COMPANY	Screen Length:	5'
Equipment:	CME-550	Screen Mesh:	0.007"
Observation Type:	MONITORING WELL	Screen Type:	STAINLESS STEEL

Figure No. 18

NTH Consultants, Ltd.

MONITORING WELL NO. OB-40R

Project Name : WAYNE DISPOSAL, INC. - SITE NO. 2 — **NTH Proj. No:** 13-3051 00

Project Location : VAN BUREN TOWNSHIP, WAYNE COUNTY, MICHIGAN — **Checked By :** ACE

LOG OF MONITORING WELL

Generalized Subsurface Profile			Installation Schematic
ELEV. (FT)	PRO-FILE	GROUND SURFACE ELEVATION: 706.2	TOP OF WELL CASING ELEVATION: 708.72
705 – 690		SILTY SAND (to 17.0)	PURE GOLD GROUT
685 – 625		SILTY CLAY	
		CONTINUED ON NEXT SHEET	CONTINUED ON NEXT SHEET

Elevation scale: 705, 700, 695, 690, 685, 680, 675, 670, 665, 660, 655, 650, 645, 640, 635, 630, 625

GROUNDWATER DATA

Date	Ground-water Elev. (ft)	Comments
02/01/93	659.72	BEFORE DEVELOPMENT
02/09/93	658.14	BEFORE DEVELOPMENT
02/25/93	656.69	

NOTES :

[1] FOR DETAILS OF SUBSURFACE STRATA, SEE LOG OF TEST BORING NO. OB-40R.

[2] TOP OF CASING & GROUND SURFACE ELEVATIONS PROVIDED BY WAYNE DISPOSAL, INC.

[3] WELL INSTALLED TO REPLACE MONITORING WELL NO. OB-40.

[4] CENTRALIZERS WERE USED TO MAINTAIN THE VERTICALITY OF THE WELL ASSEMBLY IN THE BOREHOLE.

FIELD MEASUREMENTS DURING DRILLING:

pH: 8.10
SPEC. COND: 310 μmhos/cm

FIELD MEASUREMENTS AFTER DEVELOPMENT:

pH: 8.03
SPEC. COND: 302 μmhos/cm

Started:	01/29/93	Casing Diameter:	2.0"
Completed:	02/01/93	Casing Length:	93.5'
Inspector:	C. ENDLER	Casing Type:	STAINLESS STEEL
Driller:	G. QUALLS	Screen Diameter:	2.0"
Contractor:	GEO-TEK, INC.	Screen Length:	5.0'
Equipment:	CME-750 ALL-TERRAIN DRILLING RIG	Screen Mesh:	0.007"
Well Type:	MONITORING	Screen Type:	STAINLESS STEEL

Figure No. A-6a

NTH Consultants, Ltd.

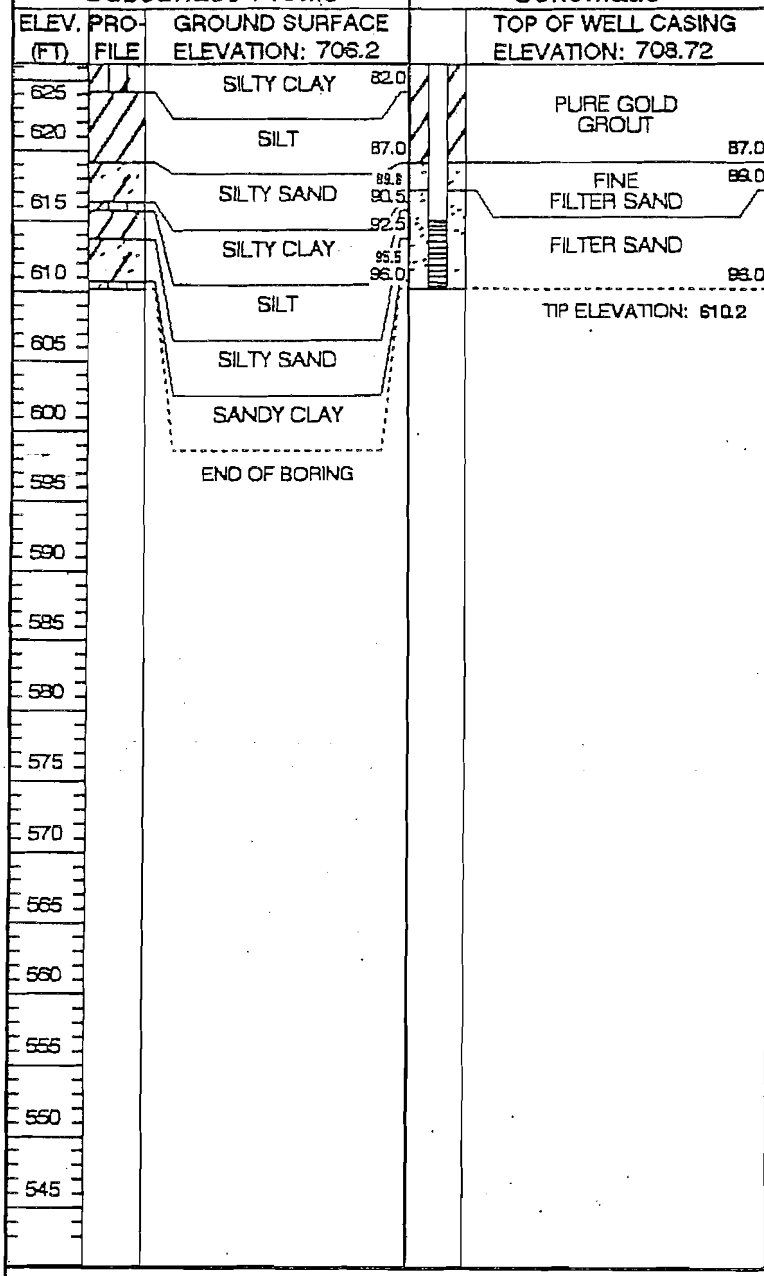
MONITORING WELL NO. OB-40R

Project Name : WAYNE DISPOSAL, INC. - SITE NO. 2 — NTH Proj. No: 13-3051 00

Project Location : VAN BUREN TOWNSHIP, WAYNE COUNTY, MICHIGAN — Checked By : ACE

LOG OF MONITORING WELL

Generalized Subsurface Profile | Installation Schematic



GROUNDWATER DATA

Date	Groundwater Elev. (ft)	Comments
02/01/93	659.72	BEFORE DEVELOPMENT
02/09/93	658.14	BEFORE DEVELOPMENT
02/25/93	656.69	

NOTES :

[1] FOR DETAILS OF SUBSURFACE STRATA, SEE LOG OF TEST BORING NO. OB-40R.

[2] TOP OF CASING & GROUND SURFACE ELEVATIONS PROVIDED BY WAYNE DISPOSAL, INC.

[3] WELL INSTALLED TO REPLACE MONITORING WELL NO. OB-40.

[4] CENTRALIZERS WERE USED TO MAINTAIN THE VERTICALITY OF THE WELL ASSEMBLY IN THE BOREHOLE.

FIELD MEASUREMENTS DURING DRILLING:

pH: 8.10
SPEC. COND: 310 μmhos/cm

FIELD MEASUREMENTS AFTER DEVELOPMENT:

pH: 8.03
SPEC. COND: 302 μmhos/cm

Started:	01/29/93	Casing Diameter:	2.0"
Completed:	02/01/93	Casing Length:	93.5'
Inspector:	C. ENDLER	Casing Type:	STAINLESS STEEL
Driller:	G. QUALLS	Screen Diameter:	2.0"
Contractor:	GEO-TEK, INC.	Screen Length:	5.0'
Equipment:	CME-750 ALL-TERRAIN DRILLING RIG	Screen Mesh:	0.007"
Well Type:	MONITORING	Screen Type:	STAINLESS STEEL

Figure No. A-6b

NTH Consultants, Ltd.

MONITORING WELL NO. OB-47

Project Name : MICHIGAN DISPOSAL, INCORPORATED — NTH Proj. No: 90323 OW

Project Location : VAN BUREN TWP, WAYNE COUNTY, MICHIGAN — Check By :

LOG OF MONITORING WELL

Generalized Subsurface Profile

GROUND SURFACE ELEVATION: 699.9

ELEV. (FT)	Stratum	Depth to bottom (ft)
695	FILL: SAND	4.2
690, 685	SAND	15.5
680, 675, 670, 665, 660	SILTY CLAY	40.5
655, 650, 645	SILTY CLAY	55.8
640, 635, 630, 625, 620	SILTY CLAY	78.8
	CLAYEY SILT	80.0

CONTINUED ON THE NEXT SHEET

Installation Schematic

TOP OF WELL CASING ELEVATION: 702.57

Material	Depth to bottom (ft)
CEMENT GROUT	73.0
BENTONITE SLURRY	80.0

CONTINUED ON THE NEXT SHEET

GROUNDWATER DATA

Date	Ground-water Elev. (ft)	Comments
07/12/90	652.96	
07/16/90	652.95	

NOTES :

[1] FOR DETAILS OF SUBSURFACE STRATIGRAPHY, SEE LOG OF TEST BORING OB-47.
[2] WELL DEVELOPED WITH COMPRESSED AIR ON 07/16/90.
[3] TOP OF CASING AND GROUND SURFACE ELEVATIONS DETERMINED BY WDI PERSONNEL.
[4] DEPTH TO FIRST COUPLING IS 0.3 FEET BELOW GROUND SURFACE; SECOND COUPLING IS 10.3 FEET BELOW GROUND SURFACE.

Started:	07/02/90	Casing Diameter:	2" I.D.
Completed:	07/12/90	Casing Length:	103 FT
Inspector:	G. CROCKFORD	Casing Type:	60' STAINLESS/43' GALVANIZED
Driller:	M. PUFFPAFF	Screen Diameter:	2"
Contractor:	ENVIRONMENTAL DRILLING & SERVICES, INC.	Screen Length:	5'
Equipment:	FAILING F-7	Screen Mesh:	.007
Well Type:	MONITORING WELL	Screen Type:	STAINLESS STEEL

Figure No. 2

NTH Consultants, Ltd.

MONITORING WELL NO. OB-47

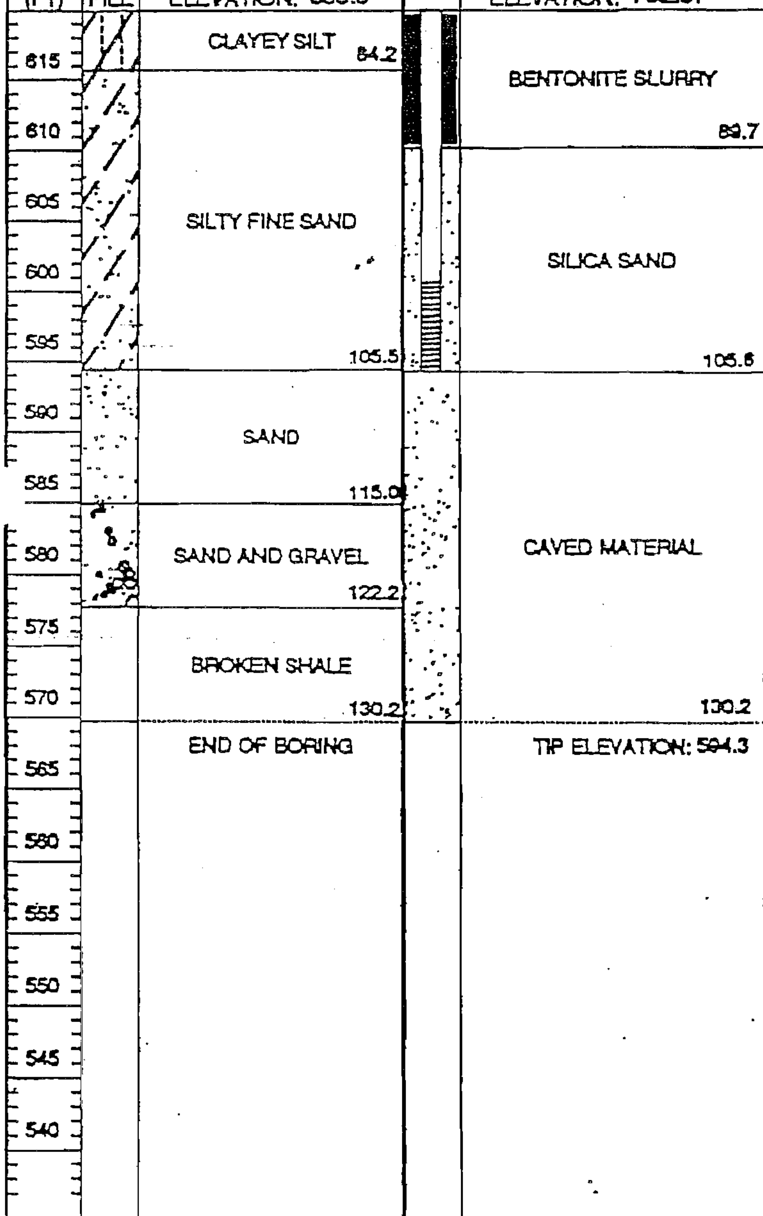
Project Name : MICHIGAN DISPOSAL, INCORPORATED — NTH Proj. No: 90323 OW

Project Location : VAN BUREN TWP, WAYNE COUNTY, MICHIGAN — Check By :

LOG OF MONITORING WELL

Generalized Subsurface Profile — Installation Schematic

ELEV. (FT) — PROFILE — GROUND SURFACE ELEVATION: 699.9 — TOP OF WELL CASING ELEVATION: 702.57



GROUNDWATER DATA

Date	Ground-water Elev.(ft)	Comments
07/12/90	652.96	
07/16/90	652.95	

NOTES :

[1] FOR DETAILS OF SUBSURFACE STRATIGRAPHY, SEE LOG OF TEST BORING OB-47.

[2] WELL DEVELOPED WITH COMPRESSED AIR ON 07/16/90.

[3] TOP OF CASING AND GROUND SURFACE ELEVATIONS DETERMINED BY WDI PERSONNEL.

[4] DEPTH TO FIRST COUPLING IS 0.3 FEET BELOW GROUND SURFACE; SECOND COUPLING IS 10.3 FEET BELOW GROUND SURFACE.

Started: 07/02/90
Completed: 07/12/90
Inspector: G. CROCKFORD
Driller: M. PUFFPAFF
Contractor: ENVIRONMENTAL DRILLING & SERVICES, INC.
Equipment: FAILING F-7
Well Type: MONITORING WELL

Casing Diameter: 2" I.D.
Casing Length: 103 FT
Casing Type: 60' STAINLESS/43' GALVANIZED
Screen Diameter: 2"
Screen Length: 5'
Screen Mesh: .007
Screen Type: STAINLESS STEEL

Figure No. 2

Attachment C

Chain of Custody & Monitoring Well Damage Report

TriMatrix Laboratories, Inc.

5560 Corporate Exchange Court SE Grand Rapids, MI 49512
Phone (616) 975-4500 Fax (616) 942-7463
www.trimatrixlabs.com

Chain of Custody Record

COC No. 115809

Page ____ of ____

For Lab Use Only

Cart
VOA Rack/Tray
Receipt Log No.
Project Chemist
Laboratory Project No.

Client Name	Project Name
Address	Client Project No. / P.O. No.
	Invoice To ☐ Client ☐ Other (comments)
Phone	Contact/Report To
Fax	

Analyses Requested

PRESERVATIVES
- A NONE pH~7
- B HNO_3 pH<2
- C H_2SO_4 pH<2
- D 1+1 HCl pH<2
- E NaOH pH>12
- F ZnAc/NaOH pH>9
- G MeOH
- H Other (note below)

Container Type (corresponds to Container Packing List)

Test Group	Matrix Code	Laboratory Sample Number		Sample ID	Cooler ID	Sample Date	Sample Time	COMP	GRAB	Matrix	Number of Containers Submitted										Total	Sample Comments
			1																			
			2																			
			3																			
			4																			
			5																			
			6																			
			7																			
			8																			
			9																			
			10																			

Sampled By (print)	How Shipped? Hand Carrier________	Comments	
Sampler's Signature	Tracking No.		
Company	1. Relinquished By Date Time	2. Relinquished By Date Time	3. Relinquished By Date Time
	1. Received By Date Time	2. Received By Date Time	3. Received For Lab By Date Time

MONITORING WELL INSPECTION/DAMAGE REPORT

DATE: ______________________________

NAME: ______________________________

SITE: ______________________________

*Place a check-mark for any of the items that are not acceptable and provide comments below.

WELL ID	LOCK	Annular Seal	Protective Casing	Markings	Dedicated Pump	Casing
OB-1A						
OB-2A						
OB-3						
OB-4						
OB-5						
OB-6						
OB-7						
OB-8						
OB-9						
OB-10						
OB-11A						
OB-12						
OB-13						
OB-14						
OB-15						
OB-16						
OB-17						
OB-18						
OB-19R						
OB-20						
OB-21						
OB-22						
OB-23A						
OB-24						
OB-25						
OB-26A						
OB-27A						
OB-28						
OB-29						
OB-30						
OB-31AR						
OB-32						
OB-34A						
OB-35A						
OB-36						
OB-37						
OB-38						
OB-39						

WELL ID	LOCK	Annular Seal	Protective Casing	Markings	Dedicated Pump	Casing
OB-40R						
OB-41						
OB-42						
OB-43						
OB-44						
OB-45						
OB-46						
OB-47						

DETAILS OF PROBLEM(S) ENCOUNTERED: ______________________________

____

____

____

____

____

____

ACTIONS REQUIRED TO REMEDY THE PROBLEM(S): ______________________________

____

____

____

____

____

SUBMIT THIS FORM IMMEDIATELY TO THE SITE MANAGER AND THE REGULATORY AFFAIRS MANAGER OR THEIR DESIGNEE

Attachment D

Operating Procedures for the Water Level Indicator

INSTRUCTION MANUAL

ET-89

ELECTRIC TAPE

Attachment D

KECK INSTRUMENTS, INC

KECK TAPE GUARD

The Keck "Tape Guard" was developed to protect instrumentation, tapes and sample tubing from the wearing edges of well casing. Made of smooth flexible polystyrene, the "Tape Guard" easily adapts to any 2" or 4" well.

Instructions

Simply compress the "Tape Guard" and insert into the opening of any 2" to 4" well pipe. Allo instrumentation, tubing or tape to ride on th smooth surface of the "Tape Guard" to pre wear.

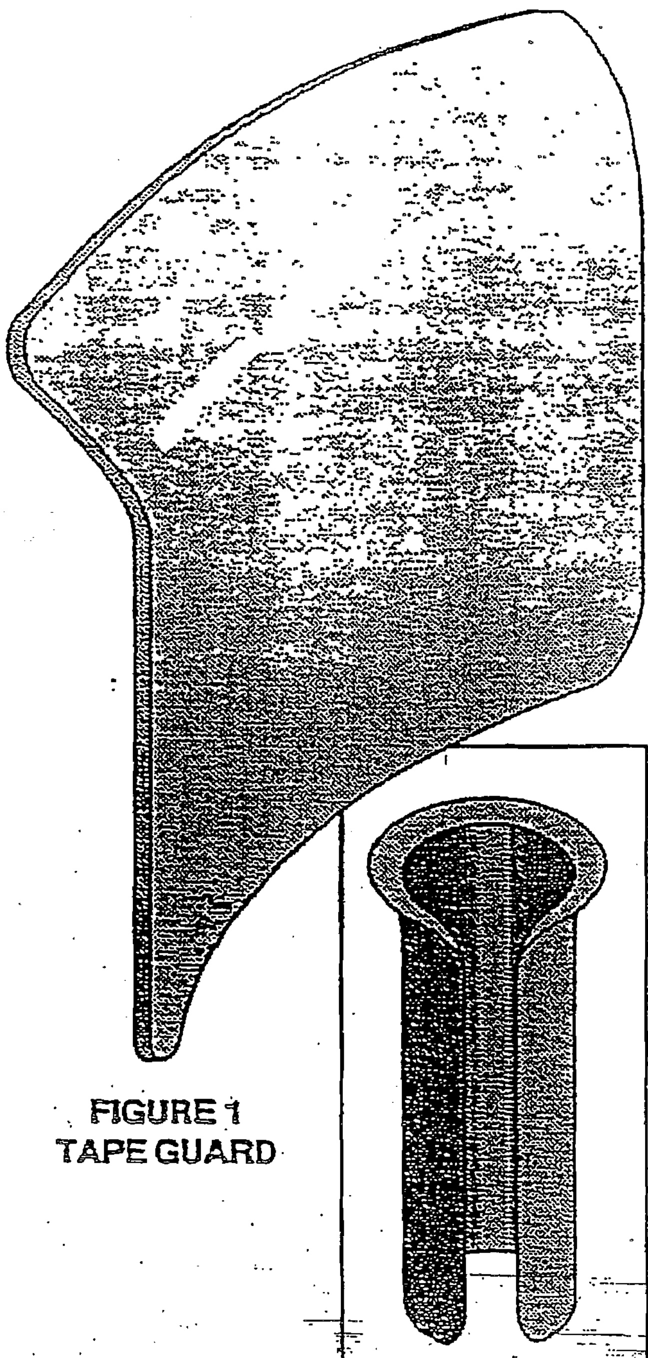


FIGURE 1
TAPE GUARD

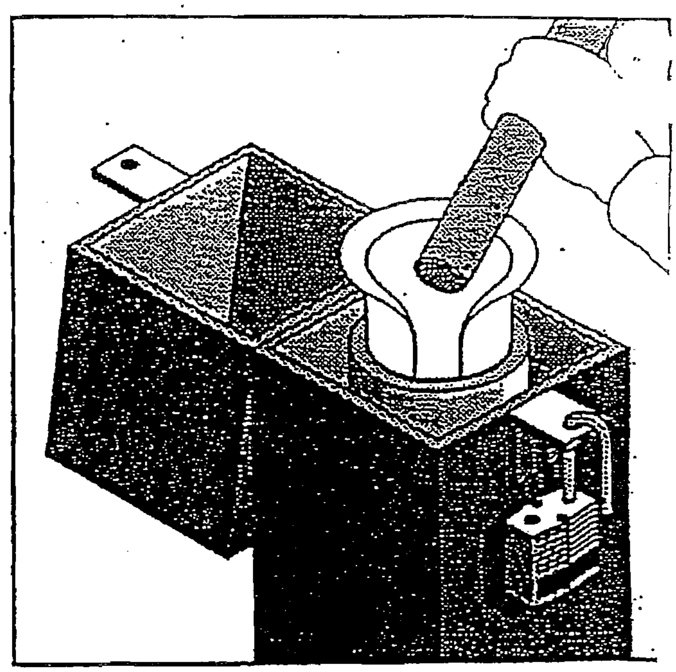


FIGURE 2
TAPE GUARD USAGE

The Keck Instruments ET-89 is a portable reel mounted device used to accurately measure water levels in a borehole. Water levels are detected by a 5/8" O.D. stainless steel probe attached to a 100 FT. Tefzel coated engineer's tape. The tape is graduated in 100ths of a foot with metric divisions on the reverse side. The ET-89 relies on fluid conductivity to determine the presence of water and emits on audible signal with light. Controls include a sensitivity adjustment to eliminate false readings due to cascading water or casing effect and a battery test switch.

Operational Procedure

1. Turn the instrument "On" and check the battery voltage by pressing the "Batt Test" button. A dim red light indicates a low battery and should be replaced.
2. Lower the probe down the well to the water surface, the light and buzzer should be activated. At this point adjust the probe sensitivity counter-clockwise until the light and buzzer turn off.
3. With the probe still in contact with the water, adjust the probe sensitivity until the light and buzzer barely activate. In this setting the probe will detect water level and not be effected by condensation from the casing well.
4. Water level measurements can now be taken from the top of the casing.
5. After completion of water level measurements the device should be properly stored.

Maintenance and Cleaning Procedures

1. Remove the three faceplate screws.
2. Release the faceplate using the sensitivity knob to pull the components out of the reel.
3. Make note of the battery location on the circuit board and the position in reel cavity.
4. Remove the 9 volt battery from the connector by grasping the battery and the black connector. Replace with new battery.
5. Position the battery in the notch of the circuit board and align the battery with the recessed slot in the reel.
6. Place the faceplate in the reel and replace the three retaining screws. Do not over tighten these screws.

Decontamination and Cleaning

The ET-89 can be cleaned with any detergent or lab soap such as Liquinox that does not effect polypropylene. The reel should not be submerged at any time but can be wiped with a damp cloth.

Please call our technical staff if further assistance is required at 1-800-542-5681.

Attachment E

Summary of Monitoring Well Information

Attachment E

MONITORING WELL INFORMATION
WAYNE DISPOSAL SITE #2 LANDFILL

WELL ID	PROGRAM(S)	T.O.C. ELEV.	SCREEN ELEV.	WELL DEPTH	DESIG.	STRATUM SCREENED	WELL PAIR
OB-1A	Part 115	705.99	579.9	126	UG	SILT/ROCK	--
OB-2A	Part 115/MCIX	701.30	587.8	114	DG	SAND	OB-44
OB-3	Part 115	708.99	577.9	131	DG	SAND	--
OB-4	Part 115	712.59	638.9	74	UG	SAND	--
OB-5	Part 115	705.20	603.8	101	DG	SAND	--
OB-6/OB-56	Part 115/Part 111	704.75	627.1	78	DG	SAND	--
OB-7	Part 115/MCIX	703.58	627	77	UG	SILT/SAND	OB-32
OB-8/OB-60	Part 115/Part 111	707.58	629	79	DG	SAND	--
OB-9	Part 115	701.20	614.1	87	DG	SAND	--
OB-10	Part 115	707.80	621	87	DG	SAND	--
OB-11A	Part 115/MCIX	698.99	611.4	88	DG	SAND	--
OB-12R	Part 115	707.84	620.6	87	DG	SAND	OB-55
OB-13/OB-57	Part 115/Part 111	703.27	619.9	83	DG	SAND	--
OB-14	Part 115	702.10	600.1	102	DG	SAND	--
OB-15	Part 115	707.63	617.3	90	DG	SAND	--
OB-16	Part 115	700.83	596.5	104	DG	SAND	--
OB-17/OB-51	Part 115/Part 111	708.28	626.2	82	DG	SAND	--
OB-18	Part 111 (MDWTP)	703.11	589.2	114	UG	CLAY/ROCK	--
OB-19R	Part 111 (MDWTP)	709.17	585.6	124	UG	ROCK	--
OB-20	Part 111/TSCA	706.28	609.9	96	DG	SAND	--
OB-21	Part 111(MDWTP)/TSCA	705.00	600.9	104	DG	SAND	OB-36
OB-22	Part 111	704.00	568.3	136	DG	SAND/ROCK	OB-24
OB-23A	Part 111(MDWTP)/TSCA	702.67	577.5	125	DG	SAND	--
OB-24	Part 111(MDWTP)/TSCA	704.59	614.4	90	DG	SAND	OB-22
OB-25	Part 111/TSCA	711.00	620	91	DG	SAND	OB-37
OB-26A	Part 111/TSCA	714.15	628.5	86	DG	SAND	OB-38
OB-27A	Part 111	708.27	636.5	72	DG	SAND	OB-28
OB-28	Part 111	709.00	583.9	125	DG	SAND	OB-27A
OB-29	Part 111	705.53	609.4	96	DG	SAND	OB-39
OB-30	Part 111	703.92	607.4	97	DG	SAND	--
OB-31AR	Part 111/MCIX	700.65	628.1	73	UG	SAND	OB-32
OB-32	Part 111/MCIX	701.49	565.3	136	UG	ROCK	OB-31A
OB-34A	Part 111/TSCA	712.04	617.8	94	DG	SAND	
OB-35A	Part 111	711.36	577.5	134	DG	ROCK	
OB-36	Part 111 (MDWTP)	702.13	572.1	130	DG	ROCK	OB-21
OB-37	Part 111	711.30	572.7	139	DG	ROCK	OB-25
OB-38	Part 111	714.10	573.4	141	DG	ROCK	OB-26A
OB-39	Part 111	707.55	561.9	146	DG	ROCK	OB-29
OB-40R	Part 111/TSCA	708.84	610.2	99	UG	SILT/SAND	--
OB-41	MCIX	701.89	562	140	DG	ROCK	--
OB-42	MCIX	717.25	624.4	93	DG	SAND	OB-43
OB-43	MCIX	717.46	595.1	122	DG	SAND	OB-42
OB-44	MCIX	701.27	639.5	62	DG	SAND	OB-2
OB-45	Part 115/MCIX	701.31	628	73	DG	SAND	OB-46
OB-46	MCIX	701.19	600	101	DG	SAND	OB-45
OB-47	Part 111 (MDWTP)	702.70	594.3	108	DG	SAND	--
OB-48	Part 111	708.70	614.2	94.5	DG	SAND	OB-49
OB-49	Part 111	To be installed				ROCK	OB-48
OB-50	Part 111	To be installed				SAND	
OB-51	Part 111	To be installed				SAND	
OB-52	Part 111	To be installed				SAND	
OB-53	Part 111	707.01	600.8	106.21	DG	SAND	
OB-54	Part 111	To be installed				SAND	
OB-55	Part 111	To be installed				ROCK	OB-12R
OB-58	Part 111	To be installed				SAND	OB-59
OB-59	Part 111	To be installed				ROCK	OB-58

UG = Upgradient Well DG = Downgradient Well

Attachment F

WELL WIZARD
Dedicated Sampling Systems

Installation, Operation and Maintenance User's Guide
Part No 34999

(This manual is on file at MDEQ-WHMD, Lansing, at Site II & enclosed via CD.)

Attachment G

Sample Container and Preservation Procedures

Attachment G.
Handling Requirements of Monitoring Parameters

Parameter	Perservation	Holding Time	Bottle Type	Minimum Volume
Total Phenolics	1,2	28 Days	Glass	0.5 L
Sulfate	2	28 Days	Plastic	50 ml*
Total Alkalinity	2	14 Days	Plastic	100 ml*
Fluoride	2	28 Days	Plastic	300 ml*
Chloride	2	28 Days	Plastic	50 ml*
Nitrate/Nitrite	1,2	48 Hrs	Plastic	0.5 L
Arsenic	3,5	6 Mos	Plastic	200 ml**
Cadmium	3,5	6 Mos	Plastic	200 ml**
Calcium	3,5	6 Mos	Plastic	200 ml**
Chromium	3,5	6 Mos	Plastic	200 ml**
Iron	3,5	6 Mos	Plastic	200 ml**
Potassium	3,5	6 Mos	Plastic	200 ml**
Lead	3,5	6 Mos	Plastic	200 ml**
Magnesium	2,3,5	6 Mos	Plastic	200 ml**
Manganese	2,3,5	6 Mos	Plastic	200 ml**
Molybdenum	2,3,5	6 Mos	Plastic	200 ml**
Nickel	2,3,5	6 Mos	Plastic	200 ml**
Sodium	3,5	6 Mos	Plastic	200 ml**
Zinc	3,5	6 Mos	Plastic	200 ml**
Cyanide	2,4	14 Days	Plastic	500 ml
Copper	3,5	6 Mos	Plastic	200 ml**
pH		Immediate	Plastic	25 ml
Bicarbonate	2	14 Days	Plastic	100 ml*
Carbonate	2	14 Days	Plastic	100 ml*
TOC	2,7	28 Days	Glass	100 ml
Specific Conductivity	2	28 Days	Plastic	100 ml
Volatile Organics	2,6	14 Days	Glass	2x40 ml

1) pH<2 with concentrated Sulfuric Acid
2) Store at 4 degrees Centigrade
3) pH<2 with nitric acid
4) pH>12 with sodium hydroxide
5) Filtered in the field using 0.45 micron membrane filters on the time of collection
6) 4 drops HCL, no headspace
7) pH<2 with hydrochloric acid

* Note: One liter for all of these parameters stored similarly
** Note: One liter for all of these parameters stored similarly

Attachment H

Ground Water Monitoring Parameter List

Attachment H

Ground Water Monitoring Parameter List

A. Primary Parameters

Benzene	1,2 Dichlorobenzene	Xylene
1,2 Dichloroethane	1,2 Dichloroethene	Ethylbenzene
Methylene Chloride	Toluene	Trichloroethene
1,1,1 Trichloroethane	Vinyl Chloride	1,1 Dichloroethane

PCB-1016[1]	**PCB-1221**[1]	**PCB-1231**[1]
PCB-1242[1]	**PCB-1248**[1]	**PCB-1254**[1]
PCB-1260[1]		

B. Secondary Parameters

Potassium	Sodium	Nickel
Chromium(t)	Lead	Molybdenum
Sulfate	Chloride	Bicarbonate
Carbonate	Arsenic	Cyanide[4]
Nitrate	Nitrite	Fluoride
Total Phenolics	Total Organic Carbon	Iron

C. Tertiary Parameters

Calcium[2]	Magnesium[2]	Copper[2]
Manganese[2]	Zinc[2]	Cadmium[2]
Silver	Mercury	Selenium
Barium	2,4-D	Endrin
Silvex	Methoxychlor	Toxaphene

D. Field Monitoring Parameters[3]

Specific Conductance Temperature pH

Notes:

1	PCB's to be analyzed in samples from wells OB-21, OB-23, OB-24, OB-34R and OBN-40R only.
2	Tertiary parameter that will be measured during detection monitoring.
3.	Parameter to be measured in field for all samples collected
4.	Amenable cyanide to be analyzed if cyanide is detected

Attachment I

Analytical Methods and Target Detection Limits

Attachment I

VOC Parameter	Detection Limit ppm (mg/l)	Method Reference
1,1-Dichloroethane	0.001	8260/8021
1,2-Dichloroethane	0.001	8260/8021
1,2-Dichloroethene	0.001	8260/8021
1,1,1-Trichloroethane	0.001	8260/8021
Trichloroethene	0.001	8260/8021
Vinyl Chloride	0.001	8260/8021
Methylene Chloride	0.005	8260/8021
1,2-Dichlorobenzene	0.001	8260/8021
Benzene	0.001	8260/8021
Toluene	0.001	8260/8021
Ethylbenzene	0.001	8260/8021
Xylenes (Total)	0.003	8260/8021
Indicator Parameter	**Detection Limit ppm (mg/l)**	**Method Reference**
Alkalinity (Total)	20	2320B
Bicarbonate Alkalinity	10	2320B
Carbonate Alkalinity	10	2320B
Chloride	1	4500-Cl E
Cyanide (Total)	0.005	4500-CN G
Fluoride	0.1	340.2
Nitrate/Nitrite	0.01	4500-NO3 F
pH	N/A	4500-H B
Phenolics (Total)	0.01	420.4/9066
Specific Conductivity	5(mmhos/cm)	2510B
Sulfate	2	ASTM D516-90
TOC	0.5	5310C
Metals	**Detection Limit ppm (mg/l)**	**Method Reference**
Arsenic	0.001	200.8/6020
Cadmium	0.0002	200.8/6020
Calcium	1	200.7/6010B
Chromium	0.001	200.8/6020
Copper	0.001	200.7/6010B
Iron	0.02	200.7/6010B
Lead	0.001	200.8/6020
Magnesium	1	242.1/7450
Manganese	0.005	200.8/6020
Molybdenum	0.025	200.7/6010B
Nickel	0.025	200.7/6010B
Potassium	0.1	200.7/6010B
Sodium	1	200.7/6010B
Zinc	0.01	200.7/6010B
PCB	**Detection Limit ppm (mg/l)**	**Method Reference**
PCB-1016	0.0001	8082
PCB-1221	0.0001	8082
PCB-1232	0.0001	8082
PCB-1242	0.0001	8082
PCB-1248	0.0001	8082
PCB-1254	0.0001	8082
PCB-1260	0.0001	8082

Methods referenced from:

1 Test Methods for Evaluating Solid Waste, USEPA SW-846
2 Standard Methods for the Examination of Water & Wastewater
3 USEPA Methods for Chemical Analysis of Water & Wastewater
4 Methods for Organic Analysis of Municipal & Industrial Wastewater
WHMD Operational Memo Gen-8, Revision 8, 12/22/06

Attachment I QA/QC Frequencies

Type	Description	Inorganics	Organics
Blank	Method or preparation	Minimum one per analytical batch*	Minimum one per analytical batch*
Duplicate (Inorganics)	Field and/or duplicate of sample	Minimum one per analytical batch	---
Laboratory Control Sample	Analyte fortified blank	Minimum one per analytical batch	Minimum one per analytical batch
Laboratory Control Sample Duplicate (if requested)	Analyte fortified blank	Minimum one per analytical batch	Minimum one per analytical batch
Matrix Spike	Analyte fortified blank	Minimum one per analytical batch	Minimum one per analytical batch
Matrix Spike	Duplicate of analyte fortified sample	---	Minimum one per analytical batch

The above is a general summary of quality control frequency.
A more complete definition of the above plus additional QC specific to each department will be found in the analytical method SOPs.

* Note: Maximum of 20 samples per analytical batch or monthly, whichever is more frequent.

Attachment J

Field Measurement Equipment and Procedures
Yellow Springs Instrument Co (YSI) Equipments Instructions
(pH, specific conductivity & temperature)

(This manual is on file at MDEQ-WHMD, Lansing & at Site II – enclosed via CD)

Attachment K

Current Laboratory's Quality Assurance Manual

(This manual is on file at Site II - & enclosed via CD)

Statistical Procedures for Ground Water Monitoring Program
Wayne Disposal, Inc

1.0 Introduction

The following statistical procedures are used to analyze the statistical significance of measured concentrations of ground water monitoring parameters at Wayne Disposal, Inc (WDI). This program was developed in accordance to meet the requirements of 40 CFR 264.97 and Rule 506 of the Administrative Rules for Part 111, Hazardous Waste Management, of the Natural Resources and Environmental Protection Act, 1995 PA 451, as amended.

2.0 Overview of Statistical Procedures

The statistical evaluation program for WDI is designed to signal statistically significant concentrations of monitoring parameters measured in samples collected quarterly or semi-annually from the wells in the monitoring well network. Different statistical techniques are used for different monitoring parameters depending on the nature of the data. The statistical comparisons are either intrawell (each well is compared to its own background) or based on the detection limit, which is generally the standard laboratory detection limit. When intrawell statistical comparisons are used, the statistical procedure is selected based on the degree that the background data are censored.

The monitoring parameters measured during each analysis are divided into four categories: primary parameters, secondary parameters, tertiary parameters, and field parameters (see Figure 1). The list of primary parameters is comprised of volatile organic compounds that are known to present within the waste. As these compounds do not generally occur in nature at measurable concentrations, a confirmed concentration above a statistically based detection limit for any single parameter will result in a statistically significant increase as defined by the operating license.

The secondary monitoring parameters are mainly inorganic parameters that are found in elevated concentrations within the leachate. As these parameters are naturally occurring, their presence in ground water may or may not be an indication of a release and it is often necessary to determine the significance of changes in concentration relative to estimates of the true background concentrations. In this program secondary parameters are used to detect a possible release in the following ways. First, a confirmed statistically significant change in the concentration of any two (or more) secondary parameters in a single well will result in a statistically significant increase as defined by the operating license. This approach is designed to detect relatively subtle changes in ground water quality as evidenced by several parameters at once. In addition, a confirmed, order of magnitude increase (10 times the background concentration) in the concentration any single parameter will also result in a statistically significant increase. This will ensure that a large increase in one secondary parameter is appropriately investigated.

The tertiary parameters are those parameters for which background has already been established. The tertiary parameters in this program are further subdivided into two groups: parameters that have an already established background but will not be measured during detection monitoring, and parameters that will continue to be measured during detection monitoring but will not be subjected to the statistical analyses described below. The former group is not being analyzed because they do not appear to be useful monitoring parameters. The analytical results from the latter group will be used to evaluate potential non-release related ground water quality changes, such as might be caused by well corrosion and grout contamination. These parameters will not be analyzed statistically because they are poor indicators of a release.

Field parameters are those parameters measured in the field during sample collection, mainly for the purpose of showing that ground water quality has stabilized during well purging. These parameters will not be analyzed statistically.

3.0 Description of Statistics for Detection Monitoring

The statistical tests to be used for all detection monitoring events are described in the following section. This section includes the definition and procedures for calculating "background", and the procedures for conducting the statistical analyses.

3.1 Parameters

The parameter list for the ground water monitoring program is presented on Figure 1. The following descriptions of background calculation and statistical analyses are presented separately for the primary and secondary parameters, respectively.

3.2 Background

The background statistics for all monitoring parameters are to be calculated using the methods described below. The recalculation of the moving background for secondary parameters, as described below, will also follow these procedures. For new wells, or replacement wells that cannot utilize the data from the replaced well, an interim background as defined in section 3.3 will be used for applicable secondary parameters until eight samples are collected. Then the background described below will apply.

Primary Parameters - The decision of whether or not there is a statistically significant increase in a primary parameter is essentially the decision of whether or not the parameter is present in the ground water. For all of the primary parameters the occurrence of the parameter above the laboratory's reported detection limit is considered to be a statistically significant event and re-sampling must be initiated to confirm or refute the occurrence.

Secondary Parameters - Determination of the initial intrawell background statistics was completed utilizing the first eight sampling events beginning in 1988. However, beginning at the end of 1995, each time four new analyses were completed, the oldest four measurements have been dropped from the database, the next four added, and the background statistics recomputed. This is repeated each year keeping about a six year lag between the background period and the detection monitoring samples.

If the program moves to semi-annual monitoring (such as in post-closure), the background will be updated every year until the moving background reaches the point where years with semi-annual sampling are to be included. Then the background will be updated every two years (after four new samples have been collected) and thus the moving background window will continue to lag at least six years behind.

The nature of the background statistics and the method of calculation of these statistics for the secondary parameters is based on the degree of censorship of each parameter at each well. The secondary parameter list includes parameters which are highly censored (at least half of the values are below detection limits), those which are moderately censored (more than half the values are above detection) and those which are essentially all above method detection limits (the method detection limits are defined in the operating license). Some parameters exhibit varying degrees of censorship at different wells.

If the background data for a parameter contains at least five detectable background values, but contains some non-detects, the non-detects will be alternately assigned values of zero and the detection limit. If all of the background values are above detection, the background statistics will be calculated from the background data as is. The mean and standard deviations will be calculated using the standard statistical equations for these quantities and the data will be analyzed using control charts as described below. In no case will a standard deviation of less than 10 percent of the mean be used in a statistical test. If the calculated background standard deviation is less than 10 percent of the mean, then 10 percent of the mean will be substituted for the background standard deviation.

If half or more of the intrawell background measurements are below detection limits (4 or more BDL values), then the background statistics will be calculated based on the proportion of values above method detection limits. This quantity will be used to conduct a test of proportions as described below.

3.3 Performance of Statistical Tests

The methods to be used for statistical analyses of all primary and secondary parameters that have a background as defined in Section 3.2 are described below. For new wells, the primary parameters will be evaluated as described below but the secondary parameters will be evaluated using the "interim" statistical procedures contained in Appendix A. For replacement wells, a decision must be made as to whether the existing background from the well replaced is appropriate for the new well. If it is, such as might be expected when a damaged well is replaced by a well screened in the same stratum, then the existing background can be used with the statistical tests described below. If the replacement well can not be placed in the same strata, or the old well is believed to have yielded unrepresentative results, then the replacement well is considered a new well for the purposes of statistical analyses and will be handled as described above.

Primary Parameters - For the primary parameters, any measured concentration of any parameter which is above the laboratory reported detection limit will initiate quadruplicate re-sampling for confirmation of the affected parameter(s), in accordance with the operating license. If the statistical failure is repeated, then a statistically significant increase is confirmed. If the apparent increase is not confirmed, then normal detection monitoring will be resumed.

Secondary Parameters - The statistical analysis of secondary parameters will be conducted by one of two statistical tests depending on the degree that the intrawell background data are censored. If more than half the data are above method detection limits then a control chart approach will be used. If at least half the background data are below detection limits, a test of proportions will be used to analyze the data. There is also a default provision to investigate a dramatic increase in any single parameter regardless of the results of outcome of the statistics.

If there are statistically significant increases for any two secondary parameters at any single well, and the increases represent less than a ten-fold increase over background, then WDI shall undertake the procedures identified in the operating license, including re-sampling in quadruplicate. In this case, both failures must be verified by re-sampling in order to confirm the statistical increase. If any single secondary parameter exhibits a ten-fold increase over background, then this occurrence must be verified by quadruplicate re-sampling. If the increase is confirmed then a statistically significant increase has occurred.

The statistical evaluation of moderately censored or uncensored secondary parameters will be conducted using intrawell statistical comparisons via a control chart approach. The combined Shewhart-CUSUM control chart will be used to analyze the statistical significance of the measured concentrations of secondary parameters. This approach consists of two statistical tests designed to detect different types of evidence of a release. The Shewhart limit is designed to detect a sharp increase in the concentration of a monitoring parameter in a single sample. The CUSUM limit is designed to detect gradual increases in the concentration of a parameter over time. The two techniques will be used as separate statistical tests. That is, failure of either test alone (or both) will signal a statistically significant increase for a given parameter. Therefore, if one parameter fails the CUSUM test and another exceeds the Shewhart limit, then an apparent statistically significant increase will have occurred and confirmation of both failures must be undertaken. Confirmation of an apparent failure of one of the two tests must be confirmed by an additional failure of that particular test.

The Shewhart control chart compares a detection monitoring concentration of a parameter to the intrawell background mean plus a selected number of standard deviations. The test is performed by calculating the standardized mean, Z, for the detection monitoring concentration. As individual samples are collected during each detection monitoring event, the standardized mean for each measured parameter is calculated by:

$$Z = (x_m - x_b)/s_b$$

where: x_b is the intrawell background mean

x_m is the measured concentration during detection monitoring

s_b is the standard deviation of the intrawell background

The value of Z is then simply compared to a selected value, U, which represents the number of standard deviations from the intrawell mean. The Shewhart limit (U), or upper control limit will be 4.5, as recommended in the Interim Final Guidance for Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities (USEPA, 1989). The statistical test is performed by simply comparing the value of Z to the value of U. If Z is greater than U then it is concluded that a statistically significant increase has occurred.

The Shewhart control chart will be used in the following manner. If a secondary parameter(s) exceeds the Shewhart limit and at least two secondary parameters fail a statistical test at any given well during a given sampling event, the well would be re-sampled in quadruplicate for the offending parameters, and the mean(s) of the quadruplicate analyses would be used to confirm whether the Shewhart limit(s) is exceeded. If there is confirmation, then it would be concluded that there has been a statistically significant increase. If the increase is not confirmed, any unconfirmed measurements would be dropped from the control chart and replaced with the means of the quadruplicates.

The CUSUM control chart is designed to detect a trend of increasing concentrations over time, regardless of whether the Shewhart limit is exceeded or not. In the CUSUM procedure, the cumulative sum of the values for Z - k are tabulated over time, each time a round of samples are analyzed. The value for Z is computed as described above, and k is a selected parameter. During each analysis subsequent to the background determination period, a value for Z - k is computed and added to the previous total. As long as the cumulative total of Z - k is a negative number the cumulative sum (S) remains zero. As positive values accumulate, the value for S is compared to a selected value, h. If S is greater than h, then a statistically significant event has occurred. The values used for k and h will be k = 1 and h = 5, respectively, as recommended (USEPA ,1989).

The CUSUM limit will be utilized in conjunction to the Shewhart limit and proportions test as follows. If the CUSUM limit is exceeded and at least two or more secondary parameters have failed a statistical test at any given well during any given sampling period, quadruplicate re-sampling of the well in question will be initiated. The mean values of the quadruplicate sample will then be used to re-compute S. If S again exceeds h, then the increase is confirmed. If the increase is not confirmed then the mean values of the quadruplicate sampling replace the results of the anomalous (unconfirmed) values within the CUSUM statistic for future analyses. These non-confirmed exceedances must be removed from the CUSUM control chart because their inclusion may cause additional false positive results when subsequent sample results are added to the cumulative sum.

For parameters that contain at least half non-detectable concentrations in the intrawell background database, a statistical test to determine the significance of the proportion of detectable occurrences during detection monitoring will be used. The test of proportions, which is based on the binomial distribution, is statistical test suited to this purpose. This statistical procedure analyzes the significance of an increase in the rate of detectable occurrences over time.

To implement the test of proportions, the proportion of detectable occurrences during the 8 background samples will be compared to the rate of detectable occurrences in the most recent 4 detection monitoring samples. The statistic is computed by the equation:

$$Z^* = \frac{P_m - P_b}{[\,p(1-p)(1/N_m + 1/N_b)]^{0.5}}$$

where:

P_m = proportion of detectable concentrations in the last four detection monitoring samples

P_b = proportion of detectable concentrations in the eight intrawell background samples

N_m = number of detection monitoring samples (4)

N_b = number of background samples (8)

p = weighted proportion defined as:

$$p = \frac{n_m + n_b}{N_m + N_b}$$

where:

n_m = number of detection monitoring samples above method detection limits

n_b = number of background samples above method detection limits

The value of Z* is then simple compared to a critical value, Z_c, obtained from standard tables for the normal variant, Z, at the desired level of significance. The test will be conducted at the 0.05 level of significance, therefore Z_c is equal to 1.645. Any value of Z* greater than Z_c signals a statistical failure for that parameter.

Each time a new detection monitoring sample is collected, the result would be added to the previous three samples for determining the proportion of detectable occurrences. Thus, both the background and detection monitoring proportions involve a moving window, with the background lagging at least six years behind the window of detection monitoring. If detection limits are lowered during the monitoring program, the proportion of detectable occurrences will be the proportion of results above the older background detection limit until the background is updated to include the new lower detection limits. For example, if the old detection limit was 20 and the new detection limit is 10, then only concentrations above 20 (even though a concentration of 11 or above is now "detectable") will be considered detectable until the moving background window is based on samples with a detection limit of 10.

WDI will use the proportions test as follows. If there is a statistically significant increase in any two secondary parameters at a particular monitoring well (i.e. two failures of the test of proportions or a combination of control chart and proportions test failures), then re-sampling in quadruplicate would be initiated to confirm the suspected increase. Confirmation would be completed if both failures are repeated.

To guard against the unlikely possibility of a large increase in a single secondary parameter going unflagged by the above statistical program, WDI will consider any concentration of a secondary parameter that is greater than 10 times the background concentration (or the reported detection limit for highly censored parameters) as a default violation of the statistical tests described above. This will ensure that clearly anomalous data are evaluated even if only a single secondary parameter is affected.

Attachment 10

Ambient AIr Monitoring Program Sampling and Analysis Plan

SITE 2

WAYNE DISPOSAL, IN C. (WDI)
&
MICHIGAN DISPOSAL WASTE TREATMENT PLANT (MDWTP)

BELLEVILLE, MI

AMBIENT AIR MONITORING PROGRAM

MI ACT 451, Part 111

Rule 299.9611

AMBIENT AIR MONITORING PROGRAM

MI Act 451, Part 111

Rule 299.9611

(Wayne Disposal – attachment #15) (Michigan Disposal – attachment # 14)

INTRODUCTION:

In accordance to the Michigan Department of Environmental Quality (MDEQ), Waste and Hazardous Materials Division (WHMD) Part 111, ambient air monitoring will be conducted as a requirement of the Hazardous Waste License. The ambient air monitoring plan is an attachment to the license and a stand alone document. The ambient air quality will be monitored at seven stations around the perimeter of the site, including six existing stations and one proposed station that will be added prior to the operation of landfill Cells VI-F&G. These locations are noted on the attached Figure 1. The ambient air monitoring program described will be used to characterize the air quality associated with both Michigan Disposal Waste Treatment Plant (MID 000724831) and Wayne Disposal, Inc. (MID 048090633) Site #2. All six sites are monitored for Polychlorinated Biphenyls (PCBs) using a polyurethane foam (PUF) sampler, metals using a high volume Total Suspended Particulate (TSP) sampler, and Volatile Organic Compounds (VOCs) using a sorbent tube sampler. Site 9 (82983) is a collocated site that has pairs of each sampling device. The AQD and WHMD recently approved the discontinuation of sampling for PM10 (particulate with a diameter of 10 microns and less). The sampling for all parameters will be conducted in accordance to the methods specified by the United States Environmental Protection Agency (USEPA) in Title 40 of the Code of Federal Regulations (CFR) Parts 50, 53, 58 and the

Toxic Organic Compendium Method, TO-17 for solid sorbent tubes. The sampling will be conducted on the prescribed sample days as determined by the (USEPA).

SAMPLING

Sampling for PCB's will be conducted with a high volume PUF sampler. Samples collected from the PUF sampler are analyzed and reported as total PCBs. Sampling for the PCB compounds will be conducted in adherence to the USEPA's Toxic Organic Compendium Methods TO-4A or TO-10A. The PUF samplers will operate every 12th day for a 24 hour period at an air sampling rate of approximately 200 to 280 lpm.

Metal concentrations will be determined from the samples collected in a reference method high volume TSP sampler. The sampling for multi-metals will adhere to the requirements of 40 CFR Part 50, Appendix G for the determination of lead. All sections referenced by Part 50, Appendix G will likewise be followed. Thenalysis will be performed using USEPA Reference Methods for lead and the other metals listed in the attached table to this monitoring plan. Quality control and assurance requirements specified in the method will be incorporated in the sampling protocol. Samples will be collected every 12 days for a twenty-four (24) hour period with a nominal flow rate of 50 cfm $\pm$ 10 cfm.

VOC's will be sampled utilizing a system of sorbent tubes capable of effectively collecting the listed compounds in the attached table. A constant flow sampling pump is operated at approximately 0.10 liters per minute (lpm). Samples will be collected at a flow rate adequate to reach the required limits of detection. Sampling will be conducted in adherence to the USEPA's Toxic Organic Compendium Method, TO-17 for solid sorbent tubes. Sampling will be conducted on an every 12 – day schedule.

QUALITY ASSURANCE

On each run day, samples from the collocated site shall be analyzed and reported to the MDEQ, AQD for the assessment of sampler precision. One sample day per month, one blank sorbent tube and metals filter shall accompany the samples to the collocated site , not have air pulled through it, then submitted to the laboratory as a "trip blanks". All laboratory quality assurance, such as the analysis of blanks and standards, shall be made available to the MDEQ upon request for the determination of accuracy. If any parameter that is analyzed by the laboratory and determined to be non-detectable, the value of the method detection limit for that compound divided by 2 (MDL/2) shall be reported. Staff from the MDEQ AQD and WHMD may audit the ambient air monitoring program, files, and samplers at their discretion.

REPORTING

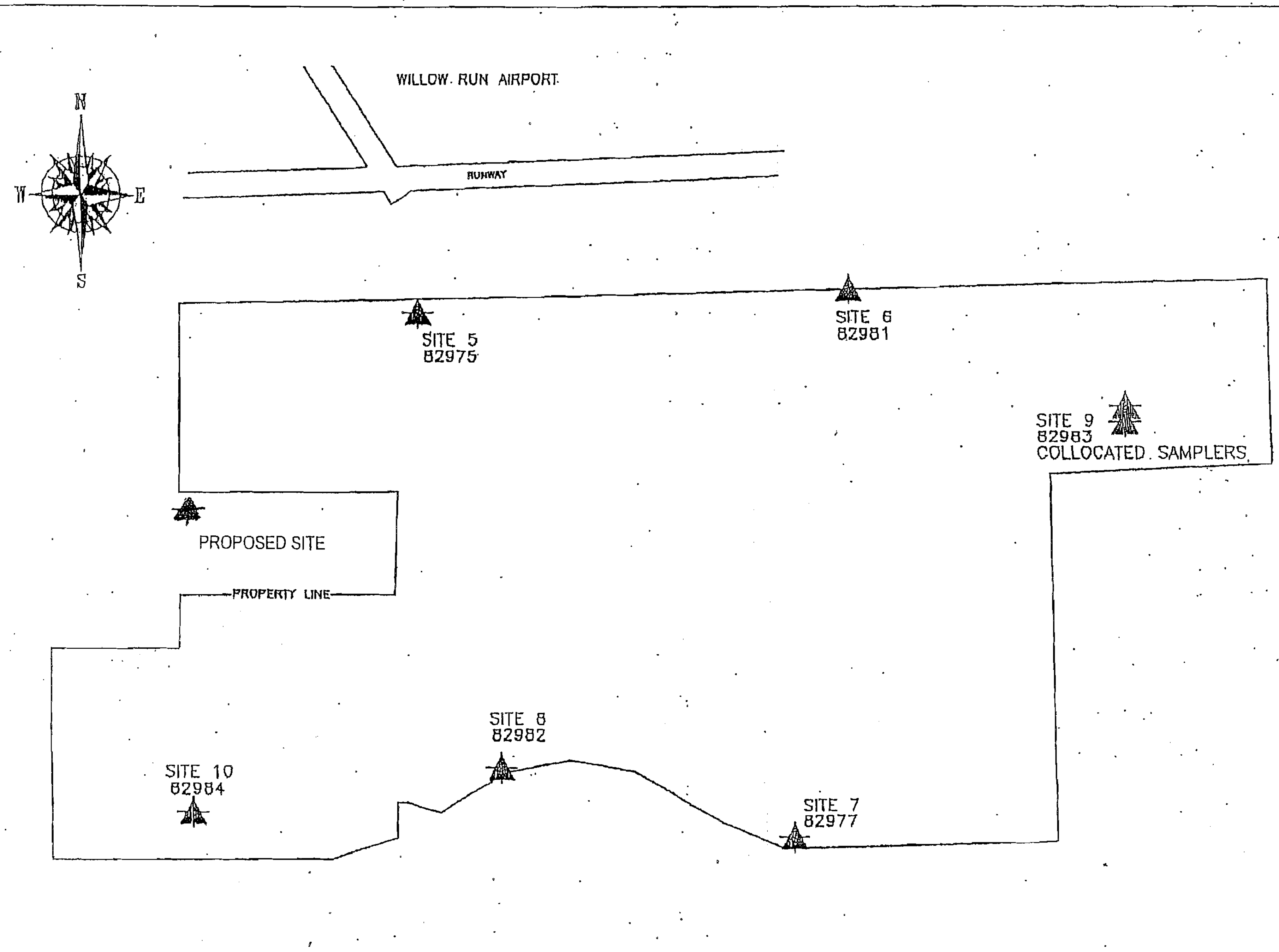
Within 60 days after the end of the month in which it was collected, all ambient air monitoring data will be reported in an acceptable electronic format to the MDEQ, AQD. The facility will keep copies of all ambient air data on-site for at least 3 years. A request can be made to the Chief of the WHMD to modify the monitoring plan if one year of sampling events show non-detectable levels of that parameter. The determination to alter the ambient air monitoring plan shall be made by staff from both the WHMD and the AQD. The final approval letter regarding any changes to the ambient air monitoring plan will be issued by the WHMD.

SITE 2 – AMBIENT AIR - MONITORING PARAMETERS (METALS and PARTICULATES)

COMPOUND	DETECTION LIMIT (ug/m^3)
CADMIUM	0.005
CHROMIUM	0.009
LEAD	0.025

SITE 2 – AMBIENT AIR - MONITORING PARAMETERS (ORGANIC COMPOUNDS)

COMPOUND	DETECTION LIMIT (ug/m^3)
BENZENE	0.04
CARBON TETRACHLORIDE	0.25
CHLOROFORM	0.05
ETHYLBENZENE	1.0
METHYLENE CHLORIDE	1.0
1,1-DICHLOROETHANE	1.0
1,1,1-TRICHLOROETHANE	1.0
TETRACHLOROETHENE	0.1
TRICHLOROETHENE	0.1
TOLUENE	1.0
XYLENE (TOTAL)	1.0
PCBs (TOTAL)	0.02



THE ENVIRONMENTAL QUALITY COMPANY

LOCATION: WAYNE DISPOSAL SITE NO.2 LANDFILL

TITLE: SITE LOCATIONS MICHIGAN DISPOSAL WASTE TREATMENT PLANT

SCALE: 1" = 800' | DATE: 02/16/01 | FILENAME: S2MICS1

Attachment D. Revisions to Soil Monitoring SAP

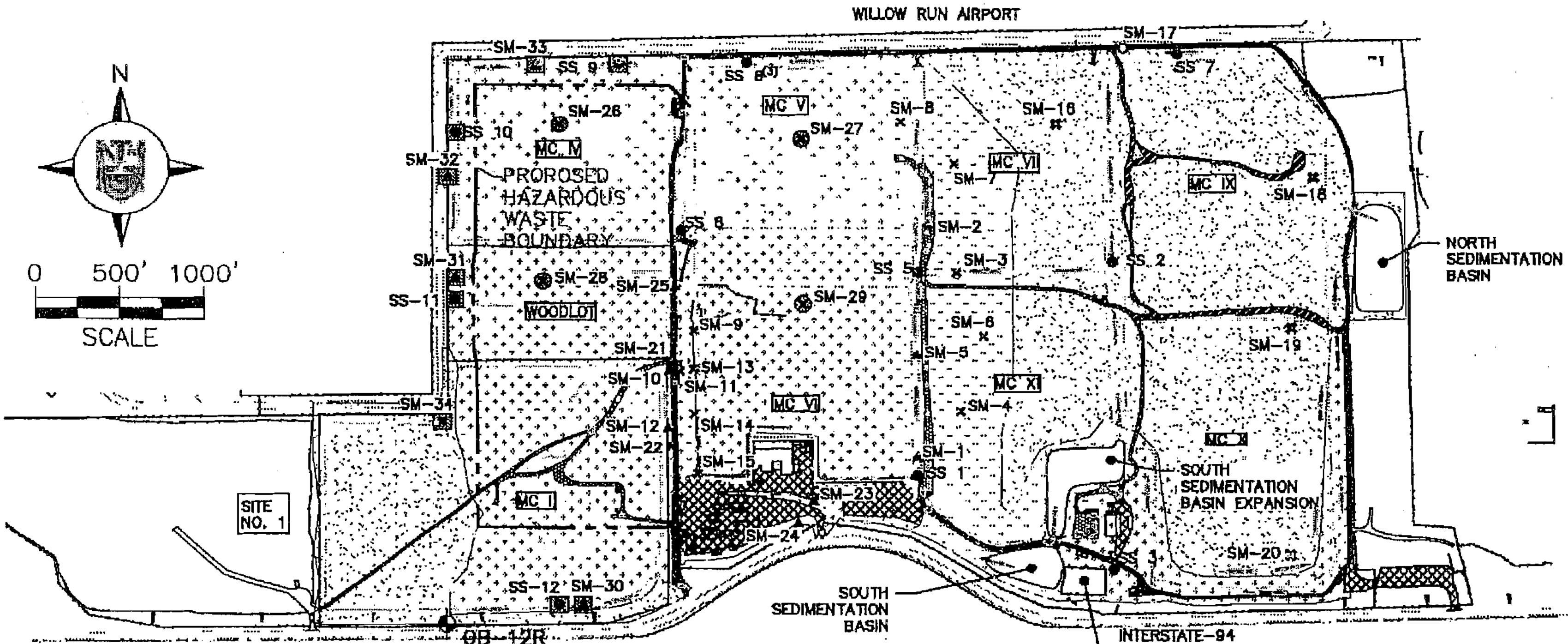
SM SAP does not apply to an off-site detection of PCBs in soil/sediments. In the event PCBs are detected and/or confirmed in off-site soil/sediments, WDI must notify the MDEQ in accordance with the General Operating Conditions of the Operating License for Reporting Noncompliance that may endanger human health or the environment

2.0 REVISIONS

WDI may revise this SM SAP and submit the revised plan to the Chief of the Waste and Hazardous Materials Division of the Michigan Department of Environmental Quality (WHMD/MDEQ) for review and approval prior to implementation.

3.0 SAMPLE LOCATIONS

Currently, there are twenty five sampling locations for the soil monitoring program. There are 20 soil sampling locations and five sediment sampling locations, identified as SM-1 through SM-25, on Figure 1, that also depicts the boundaries for Area A and Area B watersheds. Locations SM-26 through SM-34 will be added to the program post MC VI F&G construction and post-closure as indicated on Figure 1. The locations for the SM SAP samples have been surveyed and are marked in the field with a monument. With the development of Cell VI F&G and the eventual relocation of the waste transfer box, some soil sampling locations will be eliminated and/or relocated. Sediment sampling locations SM-30, SM-31, SM-32 and SM-33 and soil sampling location SM-34 will be added after Cell VI-F is constructed and four additional soil sampling locations (SM-26 through SM-29) will be added after final cover is installed.



LEGEND:

- UNPAVED ROADS–AREA A
- PERIMETER ROADS
- UNPAVED ROADS–AREA B
- PAVED SURFACES
- AREA A
- AREA B
- SS 1 — SURFACE WATER SAMPLING LOCATION
- SM 2 — SOIL SAMPLING LOCATION – AREA A
- SM 1 — SEDIMENT SAMPLING LOCATION – AREA A
- SM 16 — SOIL SAMPLING LOCATION – AREA B
- SM 17 — SEDIMENT SAMPLING LOCATION – AREA B
- SM 26 — SOIL SAMPLING LOCATION – POST CLOSURE
- SM 34 — SOIL SAMPLING LOCATION – POST MC VI F/G CONSTRUCTION
- SS 11 — SURFACE WATER SAMPLING LOCATION – POST MC VI F/G CONSTRUCTION
- SS 30 — SEDIMENT SAMPLING LOCATION – POST MC VI F/G CONSTRUCTION
- DIRECTION OF INTERIM SURFACE WATER FLOW
- DIRECTION OF SURFACE WATER FLOW – POST MC VI F/G CONSTRUCTION

NOTES:

1. ROADWAYS ARE SHOWN FOR REFERENCE ONLY AND MAY NOT REPRESENT THE ACTUAL ROADWAY DIMENSIONS.
2. IN THE MC VI ACTIVE FILLING AREA, AS INTERIM OR FINAL COVER ARE ADDED IN ACCORDANCE WITH THE EFFECTIVE PART 111 OPERATING LICENSE, WDI WILL DIRECT NON-CONTACT STORM WATER TO AREA A. THE STORM WATER STRUCTURES ASSOCIATED WITH REDIRECTING THE STORM WATER WILL BE INSPECTED AND MAINTAINED BY WDI IN ACCORDANCE WITH THE LICENSE INSPECTION SCHEDULE APPROVED UNDER THE LICENSE.
3. ANY REVISIONS TO THIS DRAWING REQUIRE THE APPROVAL OF THE MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY WASTE AND HAZARDOUS MATERIALS DIVISION. APPROVED REVISIONS MUST BE ATTACHED TO THE FOLLOWING DOCUMENTS: SOIL MONITORING SAP, SURFACE WATER MONITORING SAP, TRACKOUT MANAGEMENT SOP, FUGITIVE DUST MANAGEMENT SOP.
4. THE NSB, SSB AND LINED POND THEMSELVES ARE NOT PART OF AREA A OR AREA B.
5. SS-4 WAS PREVIOUSLY REMOVED FOR CONSTRUCTION. SM-9 THROUGH SM-15, SM-21, SM-22, SM-25, AND SS-8 WILL BE REMOVED. SM-26 THROUGH SM-31 AND SS-9 AND SS-10 WILL REPLACE THE SAMPLING LOCATIONS THAT ARE REMOVED.

NTH PROJECT No.: 62080376	DESIGNED BY: KRO	CHECKED BY: DLP	DRAWING SCALE: AS SHOWN	NTH Consultants, Ltd. Infrastructure Engineering and Environmental Services	WAYNE DISPOSAL, INC. SITE NO. 2 -MC VI F & G	SURFACE WATER AND SOIL MONITORING LOCATION PLAN	FIGURE: 1
CAD FILE NAME: 080376-SLP	DRAWN BY: KRO	INCEPTION DATE: 02/16/09	PLOT DATE: 1/6/2012		VAN BUREN TWP., WAYNE COUNTY, MICHIGAN		

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Attachment 11

Soil Monitoring Program Sampling and Analysis Plan

Section 33

SOIL MONITORING
SAMPLING AND ANALYSIS PLAN

Version 1.0	**December 2008**
Version 1.1	**February 2011**
Version 1.2	**September 2011**

SOIL MONITORING
SAMPLING AND ANALYSIS PLAN

WAYNE DISPOSAL, INC. SITE #2
MID 048 090 633

1.0 INTRODUCTION

This Soil Monitoring Sampling and Analysis Plan (SM SAP) identifies the procedures for monitoring on-site soil and ditch sediment samples at Wayne Disposal, Inc. (WDI), Site 2 during the active life of the hazardous waste disposal facility. The soil monitoring program described in the SM SAP is designed to test on-site soil and ditch sediments for the presence of polychlorinated biphenyls ("PCBs"). PCBs detected in the soils or sediments could potentially be transported by storm water into the sedimentation basins at the site. The storm water in the sedimentation basins is treated for PCBs prior to discharge to Quirk Drain in accordance with a National Pollution Discharge Elimination System (NPDES) Permit. This monitoring program is one of the checks on the engineered controls and operational procedures employed by WDI to detect an on-site release of hazardous waste or hazardous waste constituents as early as possible and allow WDI to initiate efforts to locate and control the source and prevent the off-site release of hazardous waste or hazardous waste constituents.

This SM SAP also prompts notification and response actions that WDI must take when an apparent or confirmed threshold level exceedance of PCBs in on-site soil/sediments occurs. This

SM SAP does not apply to an off-site detection of PCBs in soil/sediments. In the event PCBs are detected and/or confirmed in off-site soil/sediments, WDI must notify the MDEQ in accordance with the General Operating Conditions of the Operating License for Reporting Noncompliance that may endanger human health or the environment

2.0 REVISIONS

WDI may revise this SM SAP and submit the revised plan to the Chief of the Waste and Hazardous Materials Division of the Michigan Department of Environmental Quality (WHMD/MDEQ) for review and approval prior to implementation.

3.0 SAMPLE LOCATIONS

Currently, there are twenty five sampling locations for the soil monitoring program. There are 20 soil sampling locations and five sediment sampling locations, identified as SM-1 through SM-25, on Figure 1, that also depicts the boundaries for Area A and Area B watersheds. Locations SM-26 through SM-34 will be added to the program post MC VI F&G construction and post-closure as indicated on Figure 1. The locations for the SM SAP samples have been surveyed and are marked in the field with a monument. With the development of Cell VI F&G and the eventual relocation of the waste transfer box, some soil sampling locations will be eliminated and/or relocated. Two additional perimeter ditch samples (SM-30 and SM-31) will be added after Cell VI-F is constructed and four additional locations (SM-26 through SM-30) will be added after final cover is installed.

One grab sample of soil will be collected from within 10 feet of the surveyed monument from each of the respective soil monitoring locations. One sediment sample will be collected from within the ditch at each of the respective drainage ditch locations within 10 feet of the surveyed monument in a linear fashion. At the time of sampling, the exact location for each of the individual samples will be marked with a flag and a written description of the location (distance from monument and compass direction) will be recorded on the sample collection log so that a confirmation sample can be collected if necessary (see Section 5 below). Upon initiation of WDI's next routine sampling event, the flag will be moved to the new sampling location following the procedures described in this section of the SM SAP

4.0 SAMPLE FREQUENCY

The SM SAP samples are to be collected semiannually in March and September of each respective year.

5.0 SAMPLE COLLECTION

Samples from each of the 25 monitoring locations shown on Figure 1 are to be collected using a disposable hand trowel or other tool capable of excavating a short distance into the soil/sediment. Each individual sampling location is to be prepared by laying out an area approximately one-half foot square on the soil/sediment surface and carefully removing vegetation, sticks, rocks or other debris to expose a clear sampling surface. At each individual sampling location, one sample is to be collected by removing the top inch of soil/sediment from the one-half foot square area, placing the soil/sediment into a separate stainless steel bowl, disposable foil pan, or ziplock bag, gently mixing the soil/sediment in the selected type of container to homogenize the sample, and removing the homogenized soil/sediment from the container into clean glass sampling jars. A sample from each of the 25 sampling locations is to be submitted to the laboratory for PCB analysis.

Clean protective gloves must be worn during sample collection and must be replaced at each sample location. Care should be taken at all times when handling the samples. Each sample jar must be labeled with the sampling location, the time and date of the event, and the sampler's initials. If it is necessary to use non-disposable sampling equipment, the equipment will be decontaminated between sampling locations. In addition, one blind duplicate and one equipment blank for each piece of non-dedicated (if used) sampling equipment utilized in the sampling process (i.e. sample collection tools and homogenizing container) must be collected for each sampling event. The equipment blank must be collected by pouring clean de-ionized water over and/or into the decontaminated piece of equipment and collecting the rinsate in the appropriate jar for analysis. After collection, the samples must be stored in a clean cooler containing ice or ice packs. The coolers containing samples must be stored in a secure location, until being transported to the laboratory.

A sample collection log (Figure 2) must be filled out at each sampling location and any unusual conditions encountered must be noted. A chain of custody (COC) form must also be filled out for each sampling event. This COC must be filled out fully for each sample submitted for analysis and each person responsible for the handling of these samples must sign and date the form. When the samples are delivered to the laboratory and the lab has signed for their receipt, a copy of the COC must be retained on site in the Quality, Environment, Health and Safety (QEHS) Department records.

6.0 SAMPLE ANALYSIS

The samples from each of the 25 sampling locations will be analyzed for total PCBs where total PCBs equals the sum of the following PCB aroclors: PCB-1016, PCB-1221, PCB-1232, PCB-1242, PCB-1248, PCB-1254 and PCB-1260. The analytical method detection limit will be 0.1 mg/kg on a dry weight basis. Samples will be analyzed in accordance with USEPA SW-846 Method 8082. Samples will be analyzed within 40 days of collection to meet holding time requirements for the analytical method.

The laboratory quality control/quality assurance manual (QA/QC Manual) describing the required internal policies, guidelines and procedures of any WDI contract lab is contained in the Groundwater Sampling and Analysis Plan (GW SAP). WDI is to use this QA/QC Manual in evaluating the QA/QC standard operating procedures of any contract laboratory utilized for the purposes of this SM SAP and ensure that the laboratory employs generally acceptable practices that meet the specifications of the QA/QC Manual in the GW SAP.

7.0 DATA EVALUATION

The analytical data must be evaluated to determine whether there has been an apparent threshold level exceedance (ATLE). The applicable threshold level depends on whether the sample location is within Area A or Area B (see Figure 1). The threshold levels are defined as follows:

- Area A ATLE: Total PCBs (as defined in Section 6.0 of this SM SAP) at or above 0.75 mg/kg.

- Area B ATLE: Total PCBs (as defined in Section 6.0 of this SM SAP) at or above 0.1 mg/kg, the method detection limit for the PCB analyses.

8.0 RESPONSE ACTIONS

In the event of an ATLE, WDI must verbally notify the WHMD/MDEQ, Hazardous Waste Program Section staff immediately in accordance with the Environmental Monitoring Conditions of the Operating License and implement the procedures identified below to confirm the ATLE.

- Within 7 days of the ATLE, WDI must collect a verification sample at each soil sampling location for which an ATLE was reported. Each verification sample must be collected along the sides and bottom of the hole left by the prior sample. WDI must notify the WHMD/MDEQ prior to conducting verification sampling so that the WHMD/MDEQ can, if it chooses, split samples with WDI. .

If the ATLE is not confirmed by the additional sample analysis, WDI is to resume routine monitoring. If the ATLE is repeated upon analyzing the second sample a CTLE has occurred. In the event of a CTLE, WDI must notify the MDEQ in accordance with the Environmental Monitoring Conditions of the Operating License. Further, in the event of any CTLE, within 14 days of the CTLE, WDI is to collect the first phase of delineation samples to determine the extent of the areas exceeding the CTLE. Samples are to be collected and analyzed in accordance with the requirements in Sections 5.0 and 6.0. WDI must notify the WHMD/MDEQ prior to conducting delineation sampling so that the WHMD/MDEQ can, if it chooses, split samples with WDI.

Different approaches for locating delineation samples are required to be implemented depending on whether the CTLE has occurred:

- On top of closed landfills or other open areas.
- Along linear features such as drainage ditches or interior roads.

The approach for locating delineation samples for each of these scenarios is defined below. Before immediately and automatically implementing the defined delineation approach provided below, a visual evaluation of the area is to be completed to determine if there are features in the area that suggest a preferential pattern for the PCB exceedance (e.g. visible dust patterns, erosion gullies, vegetative cover or lack thereof, low areas, etc). If it is determined that a preferential deposition pattern is present, WDI must collect samples from those locations as appropriate. Dependent on the type and size of the feature, samples from preferential area(s) may be included as extra samples or as part of the grid sampling procedure discussed below if their locations allow. If the visual check shows no features suggesting that the PCB exceedance may be preferentially located, the following procedure is to be used to locate delineation samples.

For a CTLE on top of closed landfills or other open areas, a grid sampling strategy is to be employed as follows:

- A 100 by 100 foot grid, divided into 25 by 25 foot grid intervals, is to be centered over the CTLE location and sixteen soil samples are to be collected from the center of each 25 by 25 foot grid interval. Of the sixteen soil samples, the four step-out soil samples immediately adjacent to the CTLE location and the four corner soil samples from the 100 by 100 foot grid are to be analyzed for PCBs. The laboratory is to hold the remaining eight soil samples pending the results from the initial eight soil samples. Close communication with the laboratory will be required to insure that initial samples are analyzed quickly so that analysis of the additional samples for delineation, if necessary, can be completed without violating the holding time requirements of the PCB analytical method. WDI may voluntarily perform additional sampling within the bounds defined by the above procedure in order to refine the delineated boundary of the area exceeding the threshold limit defined in Section 7.0.

- If none of the eight initially analyzed soil samples contain PCBs above the threshold level defined in Section 7.0, the horizontal extent of the exceedance is considered to be the area inside the square drawn by connecting the four sample points immediately adjacent to the CTLE location.
- If any of the eight initially analyzed samples contain PCBs above the threshold level defined in Section 7.0, WDI is to do the following:
    - Contact the laboratory and request them to conduct PCB analysis on the soil samples that were collected and held for all locations that are contiguous to the PCB exceedance.
    - Within 14 days following WDI's determination that a PCB exceedance in a response soil sample has occurred, submit a work plan, based upon a grid or transect approach, to the WHMD/MDEQ for review and approval to identify the extent of the PCB contaminated area along with a schedule for completing the work.

For a CTLE along a linear feature, sampling is to occur as follows:

- For a CTLE in a drainage ditch, three samples are to be collected, one upstream and two downstream, at approximately 25 feet intervals, on each side of the CTLE (taking care to pick locations of sediment accumulation areas), assuming the linear feature extends the required length in each direction. If the linear feature does not extend the required length in either direction, sampling will occur at the largest possible interval before the end of the linear feature is encountered.
- For a CTLE along a roadway, two soil samples are to be collected by stepping out approximately 25 feet in both directions parallel to the roadway and two samples are to be collected from directly across the roadway if samples from the opposite side of the roadway area were not collected and analyzed as part of the original sampling.
- If none of the samples are above the threshold levels defined in Section 7.0, the extent of soil/sediments expected to exceed the remediation threshold of 1 ppm for Area A and .1 or the method detection limit for Area B, will be bounded by a 50-foot long area centered on the CTLE sampling location.
- If any of the samples are above the threshold levels defined in Section 7.0, WDI is to continue using the same approach, stepping out at 25 foot intervals (or the largest possible distance, whichever is less) in the direction of the linear feature to collect additional samples. This sample pattern is to be repeated until the first location is found that is below the applicable threshold level in Section 7.0 or until the linear feature terminates.

After the delineation phase has been completed by obtaining the delineation phase sampling results identifying the area of soil/sediments with CTLE(s), the analytical data will be evaluated and WDI is to submit a plan to remove soils/sediments and to determine the source(s) or expected source(s) of the PCBs to the WHMD/MDEQ for review and approval. The plan is to be submitted to the WHMD/MDEQ within 14 days of completing the delineation phase. WDI shall remove at least the top six inches of soil/sediments (WDI may voluntarily remove more) of all soils at or above 1.0 mg/kg in Area A and at or above the method detection limit in Area B, perform verification sampling to confirm that the underlying soils/sediments are below the applicable threshold limit identified in Section 7, and the placement of clean soils to replace the excavated soils. The plan submitted to WHMD/MDEQ need only include a schedule to complete the excavation, fill and verification sampling described above; a drawing that shows the delineation sampling results, the limits of the soil to be removed, and the approximate locations of the verification samples; the source of the clean fill material, except if WDI will deviate from the removing 6 inches of soil in response to the CTLE, in such case WDI shall propose the corrective measure/remedy; and the steps to be taken to identify and control the source(s) of the PCBs. The verification sample locations are to be selected in accordance with the MDEQ Sampling Strategies and Statistics Training Materials for Part 201 Cleanup Criteria.

9.0 REPORTING REQUIREMENTS

For semi-annual reports, the final data must be received from the laboratory, evaluated and transmitted to the WHMD/MDEQ within 60 days of sampling. The report is to include a narrative of the sampling event, a map showing the locations sampled, copies of the sampling logs, a tabular summary and discussion of the data, a discussion of field and laboratory QA/QC, a description of any ATLEs or CTLEs, any resampling conducted, and any additional actions taken and/or proposed as a result of the report findings.

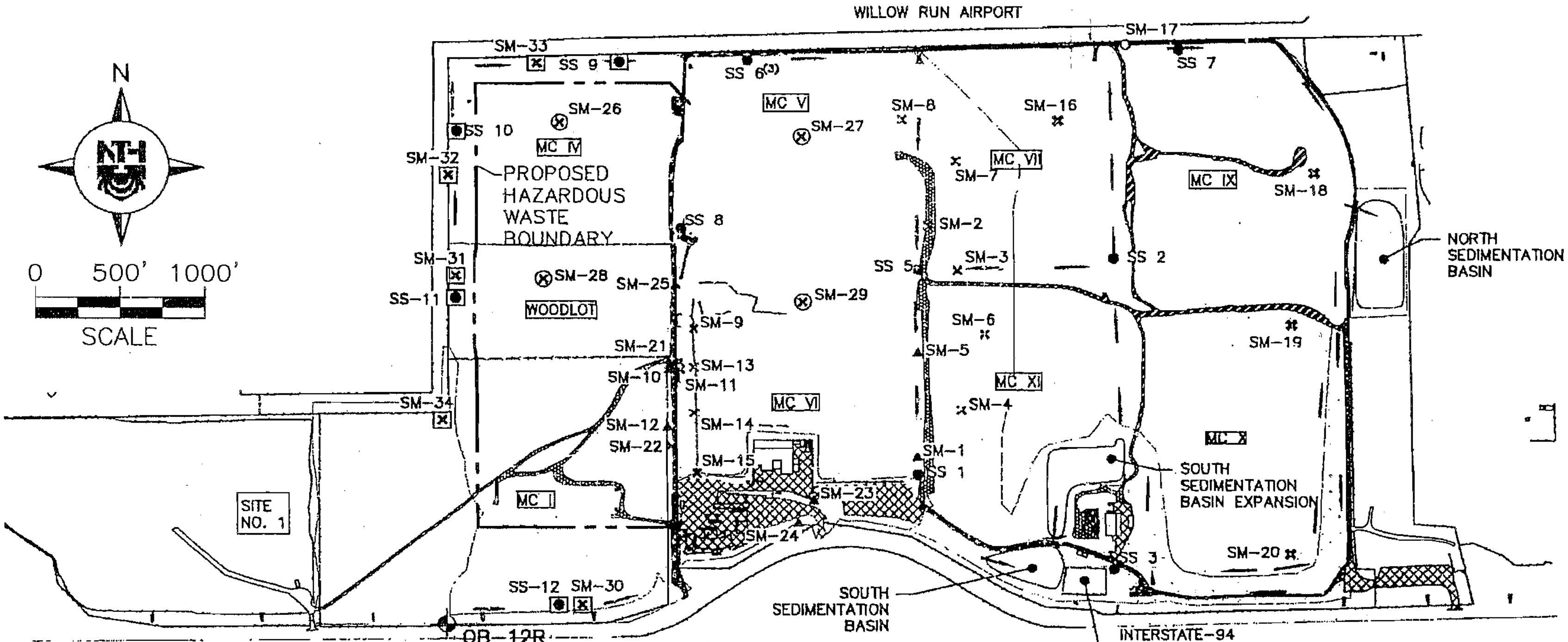
If a CTLE occurs, the data associated with the delineation phase, collected in accordance with Section 8.0, is to be received from the laboratory, evaluated, and transmitted to the WHMD/MDEQ within 45 days of the final sampling. The report is to include a narrative of the delineation sampling, copies of the sampling logs, a summary and discussion of the data, a drawing showing the delineation boundary, a schedule to perform soil removal (or an alternate plan, with schedule, in the event WDI proposes a remedy other than soil removal) and the steps to be taken to identify and control the source(s) of the PCBs.

Verification sampling data, collected to confirm that all soil/sediments exceeding the applicable threshold level has been removed in accordance with Section 8.0 is to be received from the laboratory, evaluated, and transmitted to the WHMD/MDEQ within 45 days following completion of the final round of verification sampling. The report is to include a narrative of the verification sampling, locations of all verification samples, copies of the sampling logs, a summary and discussion of the data, a drawing showing the limits of the excavation and the locations of the verification samples.

An annual summary report of the monitoring results must be submitted to WHMD/MDEQ by March 1 of the following year. At a minimum, the annual report must contain a map showing all locations sampled, a tabular summary and discussion of the analytical data collected during the previous year, a description of any threshold limit exceedances (i.e. ATLE and/or CTLE), any delineation and source investigation sampling conducted as a result of a CTLE, and any response actions performed to eliminate the source. Additionally, WDI must evaluate the sampling locations to determine whether the existing sample locations are adequate to effectively detect potential releases and prompt timely response activities.

10.0 RECORD KEEPING REQUIREMENTS

All analytical data and annual monitoring reports generated under this SM SAP must be stored on site within the QEHS filing system and be available to MDEQ staff for inspection.



LEGEND:

- UNPAVED ROADS-AREA A
- PERIMETER ROADS
- UNPAVED ROADS-AREA B
- PAVED SURFACES
- AREA A
- AREA B
- SS 1 SURFACE WATER SAMPLING LOCATION
- SM 2 SOIL SAMPLING LOCATION – AREA A
- SM 1 SEDIMENT SAMPLING LOCATION – AREA A
- SM 16 SOIL SAMPLING LOCATION – AREA B
- SM 17 SEDIMENT SAMPLING LOCATION – AREA B
- SM 26 SOIL SAMPLING LOCATION – POST CLOSURE
- SM 30 SOIL SAMPLING LOCATION – POST MC VI F/G CONSTRUCTION
- SS 11 SURFACE WATER SAMPLING LOCATION – POST MC VI F/G CONSTRUCTION
- DIRECTION OF INTERIM SURFACE WATER FLOW
- DIRECTION OF SURFACE WATER FLOW – POST MC VI F/G CONSTRUCTION

NOTES:

1. ROADWAYS ARE SHOWN FOR REFERENCE ONLY AND MAY NOT REPRESENT THE ACTUAL ROADWAY DIMENSIONS.
2. IN THE MC VI ACTIVE FILLING AREA, AS INTERIM OR FINAL COVER ARE ADDED IN ACCORDANCE WITH THE EFFECTIVE PART 111 OPERATING LICENSE, WDI WILL DIRECT NON-CONTACT STORM WATER TO AREA A. THE STORM WATER STRUCTURES ASSOCIATED WITH REDIRECTING THE STORM WATER WILL BE INSPECTED AND MAINTAINED BY WDI IN ACCORDANCE WITH THE LICENSE INSPECTION SCHEDULE APPROVED UNDER THE LICENSE.
3. ANY REVISIONS TO THIS DRAWING REQUIRE THE APPROVAL OF THE MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY WASTE AND HAZARDOUS MATERIALS DIVISION. APPROVED REVISIONS MUST BE ATTACHED TO THE FOLLOWING DOCUMENTS: SOIL MONITORING SAP, SURFACE WATER MONITORING SAP, TRACKOUT MANAGEMENT SOP, FUGITIVE DUST MANAGEMENT SOP.
4. THE NSB, SSB AND LINED POND THEMSELVES ARE NOT PART OF AREA A OR AREA B.
5. SS-4 WAS PREVIOUSLY REMOVED FOR CONSTRUCTION. SM-9 THROUGH SM-15, SM-21, SM-22, SM-25, AND SS-8 WILL BE REMOVED. SM-26 THROUGH SM-31 AND SS-9 AND SS-10 WILL REPLACE THE SAMPLING LOCATIONS THAT ARE REMOVED.

NTH PROJECT No.: 62080376	DESIGNED BY: KRO	CHECKED BY: DLP	DRAWING SCALE: AS SHOWN	NTH Consultants, Ltd. Infrastructure Engineering and Environmental Services	WAYNE DISPOSAL, INC. SITE NO. 2 -MC VI F & G	SURFACE WATER AND SOIL MONITORING LOCATION PLAN	FIGURE: 1
CAD FILE NAME: 080376-SLP	DRAWN BY: KRO	INCEPTION DATE: 02/16/09	PLOT DATE: 9/21/2011		VAN BUREN TWP., WAYNE COUNTY, MICHIGAN		

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Figure 2. Sample Collection Log for Soil Samples - WDI Site #2

Sample ID:	Sample Date:	Sample Time:
Sample Location:	**Sample Depth**	**Sampler:**
Soil Description/Comments*:		

Sample ID:	Sample Date:	Sample Time:
Sample Location:	**Sample Depth**	**Sampler:**
Soil Description/Comments*:		

Sample ID:	Sample Date:	Sample Time:
Sample Location:	**Sample Depth**	**Sampler:**
Soil Description/Comments*:		

Sample ID:	Sample Date:	Sample Time:
Sample Location:	**Sample Depth**	**Sampler:**
Soil Description/Comments*:		

* Note color and consistency and any sheen, odor or other relevant characteristics of the sample

Attachment 12

Surface Water Monitoring Program Sampling and Analysis Plan

Section 32

SURFACE WATER SAMPLING AND ANALYSIS PLAN

REVISION 3.0 – MARCH, 1996
REVISION 3.1- MAY, 1999
REVISION 3.2 – OCTOBER, 1999
REVISION 3.3 – OCTOBER, 2000
REVISION 3.4 – MARCH, 2001
REVISION 3.5 - JULY 2002
REVISION 3.6 – DECEMBER 2008
REVISION 3.7 – FEBRUARY 2011

SURFACE WATER SAMPLING AND ANALYSIS PLAN

WAYNE DISPOSAL, INC. SITE #2
MID 048 090 633

REVISION 3.0 – MARCH, 1996
REVISION 3.1- MAY, 1999
REVISION 3.2 – OCTOBER, 1999
REVISION 3.3 – OCTOBER, 2000
REVISION 3.4 – MARCH, 2001
REVISION 3.5 - JULY 2002
REVISION 3.6 – DECEMBER 2008
REVISION 3.7 – FEBRUARY 2011

1.0 INTRODUCTION

This Surface Water Sampling and Analysis Plan (SW SAP) identifies the procedures to be used for monitoring on-site surface water (storm water) samples from the perimeter ditches that convey on-site surface water run-off at Wayne Disposal, Inc. (WDI), Site 2 to the North and South Sedimentation Basins. All surface water collected in the two sedimentation basins is treated by sedimentation, filtration and activated carbon adsorption prior to discharge to Quirk Drain. The effluent from this treatment process is discharged into Quirk Drain in accordance with an effective National Pollutant Discharge Elimination System (NPDES) permit.

The surface water monitoring program described by this SW SAP is designed to test the quality of the on-site surface water to determine if hazardous waste or hazardous waste constituents are present within the surface water and prompt notification and response actions that WDI must take if an apparent or confirmed significant increase in a monitored parameter occurs. This monitoring program is one of the checks on the engineered controls and operational procedures employed by WDI to detect an on-site release of hazardous waste or hazardous waste constituents as early as possible and allow WDI to initiate efforts to locate and control the source and prevent the off-site release of hazardous waste or hazardous waste constituents.

2.0 REVISIONS

WDI may revise this SW SAP and submit the revised plan to the Chief of the Waste and Hazardous Materials Division of the Michigan Department of Environmental Quality (WHMD/MDEQ) for review and approval prior to implementation.

3.0 SAMPLE LOCATIONS

Surface water grab samples are currently collected from each of the six permanent locations shown on Figure 1 designated as SS-1, SS-2, SS-5, SS-6, SS-7, and SS-8. SS-3 is the effluent from the treatment system and is monitored in accordance with an effective NPDES permit for the facility. SS-4 was abandoned due to changes to the drainage system at the site. Location SS-8 will be abandoned during the construction of MC VI-F. Locations SS-9 and SS-10 will be added to the program MC-VI-F is constructed. Locations SS-11 and SS-12 will be added to the program when MC-VI-G is constructed. A description of each location, including its location with respect to being in "Area A" or Area B , is included on Table 1.

4.0 SAMPLE FREQUENCY

Each surface water sample location in the program are to be sampled quarterly following a rain event (defined as a 0.5 inches or more in 24 hours) when surface water is present within the ditches. Surface water samples will not be collected within the calendar quarter if there are no significant rain events that allow for the sampling to be completed.

5.0 SAMPLE COLLECTION

Surface water grab samples for each of the required parameters are to be collected from each of the six sampling locations. Samples for volatile organic compounds (VOCs) are to be collected first and require zero headspace (no air bubbles) and minimal agitation of the water sample. Samples for PCBs are collected next followed by total phenolics and then the remaining parameters. Duplicate samples must be collected at each sample location for VOCs, PCBs and metals. . The duplicate samples are to be held by the laboratory as potential confirmation samples to be analyzed in the event of an apparent statistically significant increase (ASSI) using the criteria defined in Section 7.0 of this SW SAP. The duplicate sample for PCBs must be extracted when it arrives at the laboratory and the extract held in case a confirmation analysis is required.

Samples are to be collected by dipping the bottles provided by the laboratory into the water and directly filling the containers. If site conditions do not allow for the bottles to be hand lowered into the surface water, the bottles can be inserted into a Teflon dipper and lowered, via the Teflon Dipper, into the surface water to collect the sample. If a Teflon dipper is used for sample collection, the dipper must be properly decontaminated between locations by washing the device with a laboratory grade non-phosphate detergent and rinsing thoroughly with clean deionized water. Care must be taken to ensure that any preservatives in the bottles are not spilled during sample collection. Field measurements of pH, specific conductance, temperature and dissolved oxygen are collected with calibrated field instruments at the time of sampling. WDI is to use the instructions for the use and maintenance of these instruments contained in the Groundwater Sampling and Analysis Plan for equipment used to collect field measurements under this SW SAP.

Protective gloves must be worn during sample collection and clean gloves must be used at each sample location.. Care should be taken at all times when handling the samples. Samples to be analyzed for volatile organic compounds require zero-headspace, no air bubbles and minimal agitation of the sample. Samples collected for metals analyses are not to be filtered as the metals analyses are "totals" analyses. Each sample container must be carefully labeled with the sampling location, time and date, and the sampler's initials. Field Quality Assurance/Quality Control samples must include:

- One trip blank in each cooler utilized for storing and shipping samples. The trip blank must be analyzed for VOCs and PCBs.

- One field blank for each day in which samples are collected. The field blank samples are to be collected by filling an identical set of sample bottles at a given location with clean deionized water. The field blank samples must be analyzed VOCs and PCB.
- One blind duplicate for each sampling event. The duplicate must be collected by filling an identical set of sample bottles at a given location and submitting them for an identical analysis.
- One equipment blank per sampling day for each piece of non-dedicated sampling equipment utilized in the sampling process (i.e. the Teflon dipper). The equipment blank must be collected by pouring clean deionized water over the decontaminated piece of equipment and collecting the rinsate in the appropriate jar for analysis. The equipment blank must be analyzed for VOCs and PCBs.

After collection, the samples must be stored in a clean cooler containing ice or ice packs. The coolers containing samples must be stored in a secure location until being transported to the laboratory.

A sample collection log (Figure 2) must be filled out at each sampling location and any unusual conditions (e.g. odors, sheens) encountered must be noted. A chain of custody (COC) form that lists each sample submitted to the laboratory must be fully filled out for each sampling event and each person who has custody of the samples, from sample collection through sample check-in, must sign and date the form. When the samples are delivered to the laboratory and the laboratory has signed for their receipt, a copy of this form must be retained on site in the Quality, Environment, Health and Safety (QEHS) Department records.

6.0 SAMPLE ANALYSIS

One surface water grab sample from each of the required sampling locations must be analyzed for the parameters listed on Table 2 using the analytical methods and method detection limits specified in Table 2. The potential confirmation duplicate samples from each location must be retained at the laboratory but need only be analyzed if an ASSI is detected in the first sample using the criteria described in Section 7.0 of this SW SAP.

In some cases the laboratory may not be able to attain the method detection limits specified due to factors such as sample dilution or matrix effects. If this is the case, the laboratory report must include an explanation for not achieving the specified method detection limits.

The laboratory quality control/quality assurance manual (QA/QC Manual) describing the required internal policies, guidelines and procedures of any WDI contract lab is contained in the WDI Groundwater Sampling and Analysis Plan (GW SAP). WDI is to use this QA/QC Manual in evaluating the QA/QC standard operating procedures of any contract laboratory utilized for the purposes of this SW SAP and ensure that the laboratory employs generally acceptable practices that meet the specifications of the QA/QC Manual in the GW SAP

7.0 DATA EVALUATION

The analytical data from the surface water samples is to be evaluated as follows:

- For VOCs, any reported concentration at or above the method detection limit is an apparent statistically significant increase (ASSI).

- For PCBs, the data will be evaluated as follows:
  - For samples obtained from Area B, any reported concentration at or above the method detection limit is an ASSI.
  - For samples obtained from Area A, any reported concentration at or above 0.5 mg/L is an ASSI.

- For metals, inorganic parameters, and pH, the data will be evaluated using the sign test as described in Attachment A. In addition, if a ten-fold increase in concentration is noted in any metal or inorganic parameter between sampling events in any of the individual grab samples, then there has been an ASSI.

8.0 RESPONSE ACTIONS

In the event of an ASSI, WDI must verbally notify the WHMD/MDEQ, Hazardous Waste Program Section staff immediately in accordance with the Environmental Monitoring Conditions of the Operating License and implement the procedures identified below to confirm the ASSI.

- If a VOC is present in a sample above its method detection limit, the duplicate sample must be analyzed.
- If a metal in any grab sample has met or exceeded ten times increase criteria identified in Section 7.0, an ASSI has occurred and the duplicate sample must be analyzed for the offending parameter(s) .
- If PCBs have met or exceeded the criteria identified in Section 7.0, an ASSI has occurred and the duplicate sample extract must be analyzed.
- If the sign test fails at any location then the sample location must be inspected closely and resampled as soon as there is water to sample and analyzed for all sign test procedures.

If the holding time for any sample or sample extract has been exceeded, the location where the ASSI sample was collected must be resampled as soon as there is water in the sample location and the sample must be analyzed.

If an ASSI is not repeated ,WDI will resume routine monitoring. If the ASSI is repeated upon analyzing the second sample, a confirmed statistically significant increase (CSSI) has occurred. In the event of a CSSI, WDI must notify the WHMD/MDEQ in accordance with the General Operating Conditions of the Operating License for Reporting Noncompliance that may endanger human health or the environment. Further, in the event of a CSSI, within 30 days of becoming aware of a CSSI, WDI must:

- Determine whether a discharge of hazardous waste and/or hazardous waste constituents to off-site surface waters is occurring, determine the source, and take immediate steps to eliminate and prevent any such discharge. WDI may demonstrate a source other than the licensed facility caused the CSSI or that the CSSI resulted from error in sampling, analysis or evaluation.
- Submit a report to the WHMD/MDEQ documenting WDI's investigation, response, and any further response actions proposed.

9.0 REPORTING REQUIREMENTS

For quarterly reports, the final data must be received from the laboratory, evaluated and the report transmitted to the WHMD/MDEQ within 60 days of sampling. The report must include a narrative description of the sampling event, a map showing the locations sampled, copies of the sampling logs, a tabular summary and discussion of the analytical data and the data statistics, a discussion of field and laboratory QA/QC, the field measurements collected (pH, specific conductance, temperature and dissolved oxygen), a description of any statistically significant events (i.e. ASSI and/or CSSI), any resampling or additional sampling conducted as a result of a CSSI, and any additional actions proposed as a result of the reported data.

In addition to the quarterly reports, an annual summary report of surface water monitoring results must be submitted to the WHMD/MDEQ by March 1 of the following year. At a minimum, the annual report must contain a map showing all locations sampled, a tabular summary and discussion of the analytical data collected during the previous year, a description of any statistically significant events (i.e. ASSI and/or CSSI), any resampling of additional sampling conducted as a result of a CSSI, and any additional actions proposed as a result of the reported data.

10.0 RECORD KEEPING REQUIREMENTS

All analytical data and quarterly and annual monitoring reports must be stored on site within the QEHS filing system and be available for inspection as required.

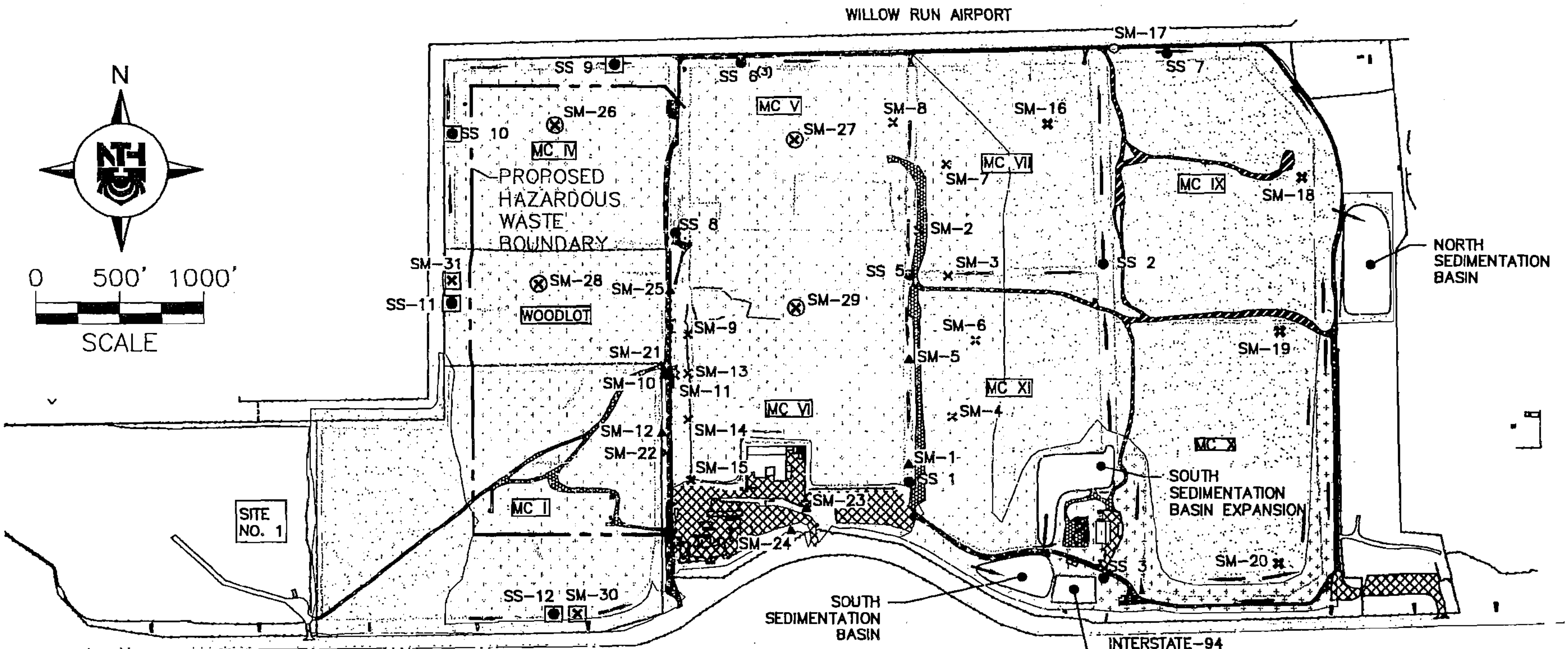
Table 1. Description of Surface Water Monitoring Locations

Sampling Location	Stormwater Run-Off Source Unique to Location	Area Designation
SS-1	east side of MC VI and west side of MC XI	A
SS-2	southeast corner of MC VII, northeast corner of MC XI part of west side of MC X and southeast cover drain of MC VII	B
SS-5	east side of MC V (and VI-E), west and part of south sides of MC VII and part of north side of MC XI	A
SS-6	north side of MC-V	A
SS-7	east side of MC VII, west side of MC IX, part of north side of MC IX, and northeast cover drain of MC VII	B
SS-8	east side of MC-IV and west side of MC-V (to be abandoned for VI F&G construction)	A
SS-9	north of MCI VI-F (to be added when VI-F ditch is constructed)	A
SS-10	west of MC VI-F (to be added when VI-F ditch is constructed)	A
SS-11	west of MC VI-G (to be added when cell VI-G is constructed)	A
SS-12	south of MC-1/VI-G (to be added when cell VI-G is constructed)	A
samples collected quarterly unless no significant precipitation events for the calendar quarter		

Table 2. Surface Water Monitoring Parameters - WDI Site #2

Parameters	MDL (mg/L)	Method	Ref
Indicator Parameters			
Alkalinity	20	2320B	1
Bicarbonate	10	2320B	2
Carbonate	10	2320B	2
Chloride	1	4500-Cl E	2
Nitrate	0.01	4500-NO3 F	2
pH	0.5-12.5	4500-H B	2
Specific Conductance	1	2510B	2
Sulfate	2	ASTM D516-90	2
Total Suspended Solids	4	2540D	2
Total Phenolics	0.01	420.2/9066	1,2
Total Cyanide	0.005	4500-CN G	1
Amenable Cyanide	0.01	4500-CN G	2
Metals			
Arsenic	0.001	6020	1
Barium	0.005	6020	1
Cadmium	0.0002	6020	1
Calcium	1	6010	1
Chromium (total)	0.001	6020	1
Chromium (hexavalent)	0.005	7196	1
Iron	0.02	6010	1
Magnesium	1	6010	1
Manganese	0.005	6020	1
Mercury	0.0002	7470	1
Selenium	0.001	6020	1
Silver	0.0002	6020	1
Sodium	1	6010	1
Zinc	0.01	6020	1

1. TEST METHODS FOR EVALUATING SOLID WASTE, USEPA SW-846
2. STANDARD METHODS FOR THE EXAMINATION OF WATER AND WASTEWATER, 20th Edition
3. USEPA METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTEWATER, 3/83



LEGEND:

- UNPAVED ROADS–AREA A
- UNPAVED ROADS–AREA B
- AREA A
- AREA B
- SS 1 SURFACE WATER SAMPLING LOCATION
- SM 2 SOIL SAMPLING LOCATION – AREA A
- SM 1 SEDIMENT SAMPLING LOCATION – AREA A
- SM 16 SOIL SAMPLING LOCATION – AREA B
- SM 17 SEDIMENT SAMPLING LOCATION – AREA B
- SM 26 SOIL SAMPLING LOCATION – POST CLOSURE
- SM 30 SOIL SAMPLING LOCATION – POST MC VI F/G CONSTRUCTION
- SS 11 SURFACE WATER SAMPLING LOCATION – POST MC VI F/G CONSTRUCTION
- DIRECTION OF INTERIM SURFACE WATER FLOW
- DIRECTION OF SURFACE WATER FLOW – POST MC VI F/G CONSTRUCTION
- PERIMETER ROADS
- PAVED SURFACES

NOTES:

1. ROADWAYS ARE SHOWN FOR REFERENCE ONLY AND MAY NOT REPRESENT THE ACTUAL ROADWAY DIMENSIONS.
2. IN THE MC VI ACTIVE FILLING AREA, AS INTERIM OR FINAL COVER ARE ADDED IN ACCORDANCE WITH THE EFFECTIVE PART 111 OPERATING LICENSE, WDI WILL DIRECT NON-CONTACT STORM WATER TO AREA A. THE STORM WATER STRUCTURES ASSOCIATED WITH REDIRECTING THE STORM WATER WILL BE INSPECTED AND MAINTAINED BY WDI IN ACCORDANCE WITH THE LICENSE INSPECTION SCHEDULE APPROVED UNDER THE LICENSE.
3. ANY REVISIONS TO THIS DRAWING REQUIRE THE APPROVAL OF THE MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY WASTE AND HAZARDOUS MATERIALS DIVISION. APPROVED REVISIONS MUST BE ATTACHED TO THE FOLLOWING DOCUMENTS: SOIL MONITORING SAP, SURFACE WATER MONITORING SAP, TRACKOUT MANAGEMENT SOP, FUGITIVE DUST MANAGEMENT SOP.
4. THE NSB, SSB AND LINED POND THEMSELVES ARE NOT PART OF AREA A OR AREA B.
5. SS-4 WAS PREVIOUSLY REMOVED FOR CONSTRUCTION. SM-9 THROUGH SM-15, SM-21, SM-22, SM-25, AND SS-8 WILL BE REMOVED. SM-26 THROUGH SM-31 AND SS-9 AND SS-10 WILL REPLACE THE SAMPLING LOCATIONS THAT ARE REMOVED.

NTH PROJECT No.: 62080376	DESIGNED BY: KRO	CHECKED BY: DLP	DRAWING SCALE: AS SHOWN	NTH Consultants, Ltd. Infrastructure Engineering and Environmental Services	WAYNE DISPOSAL, INC. SITE NO. 2 -MC VI F & G	SURFACE WATER AND SOIL MONITORING LOCATION PLAN	FIGURE: 1
CAD FILE NAME: 080376–SLP	DRAWN BY: KRO	INCEPTION DATE: 02/16/09	PLOT DATE: 2/8/2011		VAN BUREN TWP., WAYNE COUNTY, MICHIGAN		

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Figure 2. Sample Collection Log for Surface Water - WDI Site #2

Sample ID:	**Sample Date:**	**Sample Time:**
Sample Location:	**Sampling Method:**	**Sampler:**
Sample Description/Comments*:		
Field Measurements: pH ________ Specific Conductance _________ Temperature ______		

Sample ID:	**Sample Date:**	**Sample Time:**
Sample Location:	**Sampling Method:**	**Sampler:**
Sample Description/Comments*:		
Field Measurements: pH ________ Specific Conductance _________ Temperature ______		

Sample ID:	**Sample Date:**	**Sample Time:**
Sample Location:	**Sampling Method:**	**Sampler:**
Sample Description/Comments*:		
Field Measurements: pH ________ Specific Conductance _________ Temperature ______		

Sample ID:	**Sample Date:**	**Sample Time:**
Sample Location:	**Sampling Method:**	**Sampler:**
Sample Description/Comments*:		
Field Measurements: pH ________ Specific Conductance _________ Temperature ______		

* Note clarity of samples and any color, sheen, odor or other relevant characteristics of the sample

Attachment A
Statistical Monitoring Plan for Surface Water Monitoring

Wayne Disposal, Inc., Site #2
MID 048 090 633

Revision 1.0, December 1994
Revision 1.1, October, 1999

Statistical Monitoring Plan for Surface Water Monitoring

WDI Site #2 Hazardous Waste Landfill
MID 048 090 633

Revision 1.0, December 94
Revision 1.1, October 99

I. Introduction

The following statistical monitoring plan provides a description of the statistical procedures to be used for identifying a statistically significant increase of monitoring parameters in the surface water monitoring program for the above referenced facility. The program is intended to determine if hazardous waste constituents may be entering the storm water run-off from non-contact areas of the facility.

II. Statistical Evaluation

The statistical program provides two procedures to be used together for each set of monitoring data. The first procedure applies to the volatile organic and PCB compounds only and is not a true statistical test. For these compounds, any occurrence above the reported detection limit (which is a statistical quantity to some degree) is considered statistically significant. The second procedure is a comparison of the overall inorganic surface water quality to the average quality during a background period by using the sign test. This procedure is described in detail below.

Statistical Sign Test - The purpose of this statistical analysis of the surface water is to determine whether the overall surface water quality during a monitoring event is statistically different compared to "background" surface water quality. To determine the statistical significance of differences between monitoring and background samples, a test know as the sign test is used. This test applies to all inorganic parameters, which will generally be present in detectable concentrations. The sign test determines if enough of these parameters are higher than the background averages to conclude that there is a statistically significant difference in water quality.

The sign test will be performed at the 0.05 significance level to determine if the number of parameters that are present in the monitoring samples in higher concentrations than the background is statistically significant. To perform the sign test, the concentration of each inorganic monitoring parameter is compared to the background concentration for that sampling event. The current background concentrations utilized for the sign test are presented on Table 2. If the monitoring concentration is higher, then a "+" is assigned to that parameter; if the background concentration is higher then a "-" is assigned for that parameter; and if the concentration are equal then a "0" is assigned for that parameter. The total number of "+" parameters and the total number if "+" and "-" parameters are then used with the binomial probability table, Table 1, attached to this plan. To determine if the number of "+"parameters is statistically significant, the table is entered at n, the total number of "+" and "-" parameters and the corresponding value for y is determined for the largest number for alpha that is less than or equal to 0.05. This number y is the smallest number of "-" parameters that can be obtained without a statistically significant increase (e.g. if there are any less "-" parameters then there will be too many "+" parameters.) So the number of pluses is statistically significant if it is greater than the total number of pluses and minuses less the quantity y determined form the table. For instance, if there are eight parameters, the largest value of y corresponding to a value of alpha less than 0.05 is 1. Therefore, 8 - 1 = 7 plus values (or 8 plus values) would result in a failure of the test.

TABLE 1
BINOMIAL DISTRIBUTION
Alpha = P[X<y] for b(X;n,0.050)

n	y	Alpha	n	y	Alpha	n	y	Alpha	n	y	Alpha
1	0	0.5000	8	0	0.0039	12	0	0.0002	15	0	0.0000
1	1	1.0000	8	1	0.0352	12	1	0.0032	15	1	0.0005
			8	2	0.1445	12	2	0.0193	15	2	0.0037
2	0	0.2500	8	3	0.3633	12	3	0.0730	15	3	0.0176
2	1	0.7500	8	4	0.6367	12	4	0.1938	15	4	0.0592
2	2	1.0000	8	5	0.8555	12	5	0.3872	15	5	0.1509
			8	6	0.9648	12	6	0.6128	15	6	0.3036
3	0	0.1250	8	7	0.9961	12	7	0.0862	15	7	0.5000
3	1	0.5000	8	8	1.0000	12	8	0.9270	15	8	0.6964
3	2	0.8750				12	9	0.9807	15	9	0.8491
3	3	1.0000	9	0	0.0028	12	10	0.9968	15	10	0.9408
			9	1	0.0195	12	11	0.9998	15	11	0.9824
4	0	0.0625	9	2	0.0898	12	12	1.0000	15	12	0.9963
4	1	0.3125	9	3	0.2539				15	13	0.9995
4	2	0.6875	9	4	0.5000	13	0	0.0001	15	14	1.0000
4	3	0.9375	9	5	0.7461	13	1	0.0017	15	15	1.0000
4	4	1.0000	9	6	0.9102	13	2	0.0112			
			9	7	0.9805	13	3	0.0461			
5	0	0.0313	9	8	0.9980	13	4	0.1334			
5	1	0.1875	9	9	1.0000	13	5	0.2905			
5	2	0.5000				13	6	0.5000			
5	3	0.8125	10	0	0.0010	13	7	0.7095			
5	4	0.9687	10	1	0.0107	13	8	0.8666			
5	5	1.0000	10	2	0.0547	13	9	0.9539			
			10	3	0.1719	13	10	0.9888			
6	0	0.0156	10	4	0.3770	13	11	0.9983			
6	1	0.1094	10	5	0.6230	13	12	0.9999			
6	2	0.3437	10	6	0.8281	13	13	1.0000			
6	3	0.6562	10	7	0.9453						
6	4	0.8906	10	8	0.9893	14	0	0.0001			
6	5	0.9844	10	9	0.9990	14	1	0.0009			
6	6	1.0000	10	10	1.0000	14	2	0.0065			
						14	3	0.0287			
7	0	0.0078	11	0	0.0005	14	4	0.0898			
7	1	0.0625	11	1	0.0059	14	5	0.2120			
7	2	0.2266	11	2	0.0327	14	6	0.3953			
7	3	0.5000	11	3	0.1133	14	7	0.6047			
7	4	0.7734	11	4	0.2744	14	8	0.7880			
7	5	0.9375	11	5	0.5000	14	9	0.9102			
7	6	0.9922	11	6	0.7256	14	10	0.9713			
7	7	1.0000	11	7	0.8867	14	11	0.9935			
			11	8	0.9673	14	12	0.9991			
			11	9	0.9941	14	13	0.9999			
			11	10	0.9995	14	14	1.0000			
			11	11	1.0000						

Table 2.
Sign Test Background Data for Surface Water
Wayne Disposal, Inc. Site No. 2

Parameter	Units	Number of Values	Mean
Arsenic	mg/l	24	0.015
Barium	mg/l	24	0.64
Cadmium	mg/l	24	0.017
Calcium	mg/l	24	304
Chromium (total)	mg/l	24	0.06
Chromium (hexavalent)	mg/l	24	0.009
Iron	mg/l	24	46.4
Magnesium	mg/l	24	66
Manganese	mg/l	24	1.19
Mercury	mg/l	24	0.0007
Selemum	mg/l	24	0.0043
Silver	mg/l	24	0.01
Sodium	mg/l	24	28
Zinc	mg/l	24	0.54
Alkalinity (total)	mg/l	24	187
Alkalinity (bircarbonate)	mg/l	24	187
Alkalinity (carbonate)	mg/l	24	18
Chloride	mg/l	24	54
Fecal Coliforms	Count/100 ml	24	9637
Nitrate	mg/l	24	0.76
pH	Stnd. Units	24	7.5
Sulfate	mg/l	24	213
Tot. Susp. Solids	mg/l	21	2797

Notes:

Background data were complied from eight quarters during period from May 1989 to April 1991

Detection Limits values are used for data which are reported to be below the method detection limit.

Attachment 13

Leachate Monitoring Program Sampling and Analysis Plan

Section 28

LEACHATE MONITORING SAMPLING & ANALYSIS PLAN

WAYNE DISPOSAL, INC. SITE #2
MID 048 090 633

SAMPLING AND ANALYSIS PLAN FOR THE MONITORING OF LEACHATE AND LEACHATE LEVELS

WAYNE DISPOSAL, INC. SITE #2
MID 048 090 633

REVISION 3, MARCH 1996
REVISION 3.1, MAY 1999
REVISION 3.2, AUGUST 1999
REVISION 3.3, OCTOBER 2000
REVISION 3.4, FEBRUARY 2001
REVISON 3.5, MARCH 2001
REVISION 3.6, SEPTEMBER 2006
REVISION 3.7, NOVEMBER 2009
REVISION 3.8, FEBRUARY 2011

1.0 INTRODUCTION

The purpose of this document is to outline the procedures for monitoring leachate in compliance with current license and permit conditions and applicable regulations. Leachate monitoring includes the collection and analysis of leachate samples and monitoring leachate levels for the purpose of ensuring that leachate is effectively removed from operating and closed hazardous waste landfill cells.

Collection and analysis of leachate samples is conducted in order to characterize the leachate for the purpose of developing appropriate monitoring parameter lists for other monitoring programs such as groundwater and leak detection. Further, the composition of the leachate over time is an indication of the degree of stabilization of the wastes within the landfill.

Leachate level monitoring is necessary to ensure that leachate collection systems are functioning properly so as to limit the leachate head on the liner system. CFR 40 264.301(2) states that "The Regional Administrator will specify design and operating conditions in the permit to ensure that the leachate depth over the liner does not exceed 30 cm (1 foot)". Wayne Disposal, Inc. Site #2 monitors the volume of leachate pumped from each active and closed cell at the facility. The volume of leachate pumped from each cell per month is recorded in the operating log.

The following SAP describes how EQ maintains compliance with the conditions outlined above.

2.0 DESCRIPTION OF LEACHATE COLLECTION SYSTEMS

Leachate level control is a function of the design and operation of the leachate collection systems (LCS). Each LCS at WDI is designed to transmit leachate to the sump at rates sufficient to permit removal of leachate so that levels do not build up on the primary liner to a depth greater than one foot. The slope of the cell floor, permeability of granular materials, and the size and spacing of collector pipes are all taken into consideration in the design transmissivity of the LCS.

Once the leachate is conveyed to the collection sump, it must be removed at a rate sufficient to prevent leachate from backing up into the collection system to levels higher than one foot. The pumps are set within the sump beneath the level where the leachate conveyance pipes enter the sump (see Figure 1.). These 4" or 6" diameter HDPE pipes are directly on top of the liner. The pumps are set up on an automatic switch which turns the pump on when the leachate level in the sump rises to a certain level which is below the elevation of the pipes. As long as the pumps keep the leachate levels in the sump below the top of the leachate collection system, then compliance with the one foot head rule is maintained. Therefore, the key to compliance is maintaining an operating collection system in each cell. Frequent inspection and swift repairs of these systems are necessary to ensure that any mechanical problems are remedied in a timely manner.

The volume of leachate pumped out of each sump is recorded on a totalizing flow meter which is placed in line in the discharge line from the pump. Leachate is conveyed to the wastewater pretreatment plant on site.

3.0 LEACHATE LEVEL AND VOLUME MEASUREMENTS

The keys to maintaining compliance with leachate level and volume record keeping requirements are frequency of inspection and maintenance of each system. To ensure proper performance of the leachate collection system, weekly inspections of the sump areas must be conducted. Figure 2 is a checklist form for recording the results of this weekly inspection. The main components of this inspection are determining leachate levels in the sump, whether the pump/meter is operating correctly and the monthly volume of leachate. An outline of these procedures in the form of a flow chart is included on Figure 3. The procedures for the weekly inspection are as follows:

Step #1. PUMP/METER FUNCTION

a. Take meter reading from flowmeter and record on form. If the meter has moved since the last reading then proceed to Step 2. If not, then proceed to step 1.b.

b. Change pump switch to "hand" position listen for the sound of the pump turning on and check for meter advancement. Then change pump switch back to "auto" position.

c. If the meter moves then proceed to step 2.

d. If meter does not move then:

i. Determine if pump intake is below leachate level in sump. This is done by visual inspection (can you see the pump above the leachate) and by sound (the pump makes a distinctive noise when trying to draw in air). If the levels are down, then the inspection is completed and the results should be noted on the form.

ii. If the pump intake is below the leachate level then further investigation is necessary. These next steps must be conducted in accordance with a confined space permit issued by the QEHS Affairs Department. Record the apparent malfunction on the inspection form and report results to the Site Manager or his/her designee and proceed with steps 2 and 3.

Step #2. LEVEL MEASUREMENT

a. Measure the leachate level in sump from the top of the sump with an electronic water level sounding device.

b. Compare the depth to leachate with the minimum allowable depth listed on Figure 2. Determine whether the level is in compliance.

c. Record the result on the weekly inspection form.

d. Notify the Landfill or QEHS Manager immediately if the levels are found to be above the allowable level.

Step #3. REPAIRS

a. Unless a specific problem is evident from the inspection (e.g. the pump doesn't turn on), the following steps should be conducted:

   i. Remove the meter, switch back to "hand" position and check for flow.

   ii. If there is flow, then field clean the meter, replace and check for meter advancement. If the meter advances, then switch back to "auto" position. If not, take the meter in for repair or replacement.

iii. If there is no flow, then disconnect power to pump and remove pump and pump switch from the sump. Inspect the electrical cord and the pump switch. Replace the pump and test functions. If the pump or the switch still doesn't work, remove the pump, have it power washed and get it repaired/replaced.

iv. If the pump and meter are functional but no flow is observed then arrangements must be made to clean out the pipes.

v. All actions taken and any repairs/replacements conducted must be reported to the Landfill or QEHS Manager.

Note that pumping must continue as needed to keep leachate levels down even if the flow meter or the automatic pump switch is not functioning. If the meter is broken, note the time period in which there is no meter on line so that the missing volume data can be estimated. If the switch is bad, then the pump must be operated manually until the switch is fixed. The sump should be inspected daily to determine if pumping is required until the switch is fixed or until a pumping schedule suitable for maintaining the leachate level for that sump has been determined. If the pump itself is not working, then immediate steps must be made to replace and/or repair the pump. Spare parts and spare pumps must be kept in stock on site if they are not readily available from a reliable vendor.

The weekly inspection checklist forms are to be filed in the Landfill Manager's office. Also, the sumps must be inspected on a weekly basis for evidence of deterioration, etc. Any conditions noted that would require maintenance or repair should be noted on the weekly inspection form

(Figure 2) and reported to the Landfill Manager. Any repairs required on the sump or pump that is necessary to keep leachate levels in compliance must be given the highest priority.
On a monthly basis, the total volume recorded on the flow meters from each sump is summarized from the Weekly Inspection Checklist for Leachate Collection Systems onto an electronic spread sheet.

In addition to these inspections, periodic maintenance of the LCS is required. In particular, leachate clean-out pipes, where present, must be jetted once every two years unless experience indicates that a more or less frequent jetting program is necessary or adequate

4.0 LEACHATE SAMPLING AND ANALYSIS

Leachate samples are to be collected annually from each of the 16 currently collection sumps within Master Cells V, VI and VII as shown on Figure 4. When additional cells VI-E-NE, VI-F and VI-G are constructed and put into operation the leachate must be sampled in accordance with this plan as well. The samples are collected during the third quarter of each year. Samples are collected by lowering a clean stainless steel sampling bucket (or disposable bailer) down into the sump and retrieving a sample. New (or dedicated) nylon rope is used each time a sump is sampled. The stainless steel bucket must be decontaminated between each sample location with cleaning solution and a distilled water rinse.

The sample is then carefully decanted into appropriate sampling containers. Samples for VOC's are collected first while ensuring that no headspace is present within the sampling vials. Additional samples are then collected in order of decreasing volatility, semi-volatiles then total organic carbon then phenolics and finally metals and indicator parameters. Appropriate sample handling and container requirements are summarized on Figure 5. Metals are analyzed as "total metals" quantity; no filtration is required.

Protective gloves must be worn during sample collection and care should be taken to prevent spills on skin or clothing. Each sample container must be carefully labeled with the sampling location, time and date, identity of preservatives contained within and the sampler's initials. After collection, the samples shall be stored in a clean cooler containing ice or ice packs. The coolers containing samples must be stored in a secure location, on-site, until they are transported to the laboratory.

Field Quality Assurance/Quality Control samples must include:

- One trip blank for every ten samples collected. The trip blank must be stored in the cooler utilized for storing and shipping samples. The trip blank must be analyzed for VOCs.
- One field blank for each ten samples collected. The field blank samples are to be collected by filling an identical set of sample bottles at a given location with clean deionized water. The field blank samples must be analyzed VOCs.
- One blind duplicate for each sampling event. The duplicate must be collected by filling an identical set of sample bottles at a given location and submitting them for an identical analysis.
- One equipment blank per sampling day for each piece of non-dedicated sampling equipment utilized in the sampling process (i.e. the stainless steel bucket. The equipment

blank must be collected by pouring clean deionized water over the decontaminated piece of equipment and collecting the rinsate in the appropriate jar for analysis. The equipment blank must be analyzed for VOCs.

A sample collection log (Figure 6) must be filled out at each sampling location. The log must be filled out to include the location, date, time, identity of sampler and a description of any unusual conditions encountered must be noted. A chain of custody form must be filled out for each sampling event. This form must be filled out fully for each sample submitted for analysis and each person responsible for the handling of these samples must sign and date the form. When the samples are delivered to the laboratory and the lab has signed for their receipt, a copy of this form must be retained on site in the operating record and another copy forwarded to QEHS Department.

Except as described below, each sample must be analyzed for the parameters listed on Figure 7, which also contains the analytical methods and targeted method detection limits. Exceptions to this are as follows: 1) The PCB's listed on Figure 5 are only analyzed in samples from Master Cell VI. and 2) In order to fully characterize the leachate, each of the leachate sumps in MC V, MC VI-A (AN & AS) through VI-E and MC VII must be analyzed for a modified list of 40 CFR 264 Appendix IX parameters on a rotating basis. The list is considered "modified" as dioxins and furans are analyzed at screening levels as opposed to a breakdown of the specific cogeners. Analysis of the cogeners requires the use of a specialty laboratory and the ultra-low detection limits have no practical use in this leachate characterization. Each year, two of the leachate samples must be analyzed for the modified list of Appendix IX parameters. The two cells sampled will change each year until all are sampled and then the process will be repeated throughout the operation of the facility. New cells will not be analyzed for the Appendix IX constituents until they have been producing leachate for at least one year. A list of Appendix IX parameters along with corresponding analytical methods and detection limits are presented on Figure 8. It is recognized that in most cases the detection limits shown on Figures 7 and 8 will not be attained due to sample dilutions and matrix effects.

Laboratory Quality control frequencies and precision/accuracy requirements are provided in the Groundwater Sampling and Analysis Plan for this facility, which includes the Quality Assurance Manual for the contract laboratory. This manual describes the internal policies, guidelines and procedures of Trimatrix and is not intended to describe the specific details of this particular monitoring program. Rather, we use this document as a guideline in evaluating Trimatrix's QA/QC and standard operating procedures to ensure that generally acceptable practices are employed.

5.0 REPORTING REQUIREMENTS

Within 60 days after each sampling event is completed, the analytical results must be submitted to MDEQ along with a summary of QA/QC data and the sampling documentation forms. The monthly leachate volumes as well as a summary of the leachate level data should be included in this submittal. In addition to the reporting requirements described above, an annual leachate report must be filed with the MDEQ by March 1 of the following year. In this report, annual leachate production rates, leachate head levels and leachate analytical results are to be evaluated and summarized. This summary must also include a description of any non-compliances and associated corrective actions and of any major maintenance activities (such as jetting of leachate lines).

The leachate analytical data must be evaluated with respect to the need to refine secondary collection and groundwater monitoring programs by summarizing, in table form, the rate of detection and concentration of leachate monitoring parameters. The results of this summary will be compared to groundwater and leak detection parameter lists. Any parameter that is found in more than 50% of the leachate samples and/or in concentrations greater than 1 mg/L will be considered for inclusion in the leak detection and/or groundwater monitoring program(s). WDI will recommend whether to include such a parameter based on its chemical properties and any other relevant information.

Leachate volume and head level information must be evaluated in graphical and/or tabular form, respectively. Monthly and annual volumes for each cell must be plotted to determine if there are increases in production rates that should be evaluated. The head levels must be presented to show the dates and results of head measurements and identify any periods where heads exceed the 1 foot limit as well as the duration of the exceedance and the cause and correction of the exceedance.

SCHEMATIC OF LEACHATE COLLECTION SUMP ARRANGEMENT
WAYNE DISPOSAL SITE #2 HAZARDOUS WASTE LANDFILL

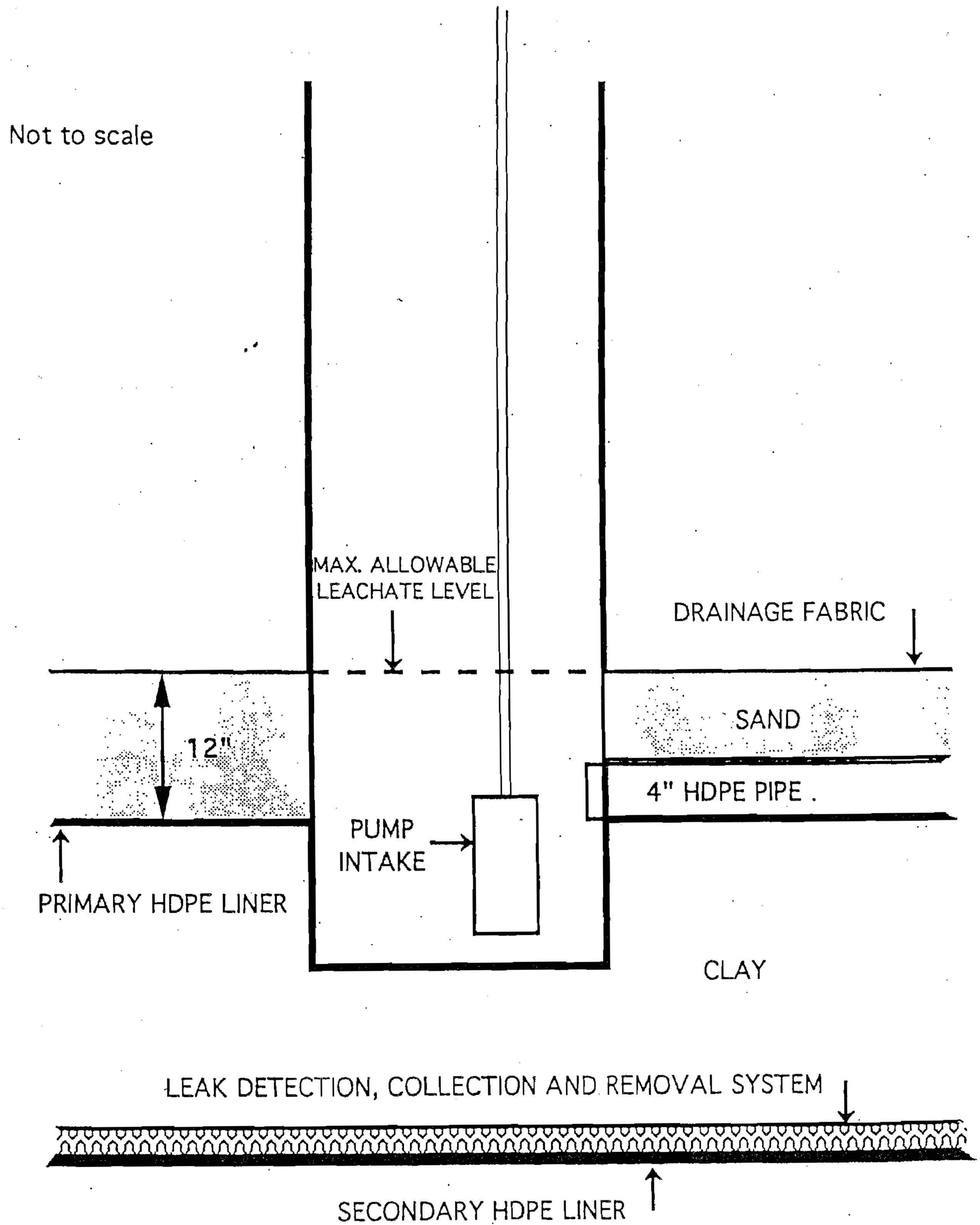

Figure 1

WEEKLY INSPECTION CHECKLIST FOR LEACHATE COLLECTION SYSTEMS
WAYNE DISPOSAL, INC. SITE #2 HAZARDOUS WASTE LANDFILL MASTER CELLS

Inspector: ______________________________

Date: ______________________________

CELL	METER READING	METER ADVANCE?		COMPLIANCE DEPTH TO LEACHATE (FT)	ACTUAL DEPTH TO LEACHATE (FT)	LEVEL IN COMPLIANCE?		PUMP FUNCTIONING?		METER FUNCTIONING?	
		Y	N			Y	N	Y	N	Y	N
V-A				68.8							
V-B				62.5							
V-C				55.9							
V-E				61.2							
VI-AS				127.0							
VI-AN				128.3							
VI-B				135.2							
VI-C				102.12							
VI-D				130.9							
VI-ENE				Not Yet Constructed							
VI-ENW				80							
VI-ESW				26							
VI-ESE				37							
VI-CONTACT											
VII-A				37.5							
VII-BN				49.3							
VII-BS				51.8							
VII-C				46.2							

COMMENTS/ACTIONS TAKEN: ______________________________

NOTE: REPORT ITEMS NEEDING IMMEDIATE ATTENTION TO THE SITE MANAGER

Leachate Compliance Levels updated on 9/27/06 for MC-VI based upon top of manhole elevations

FIGURE 2

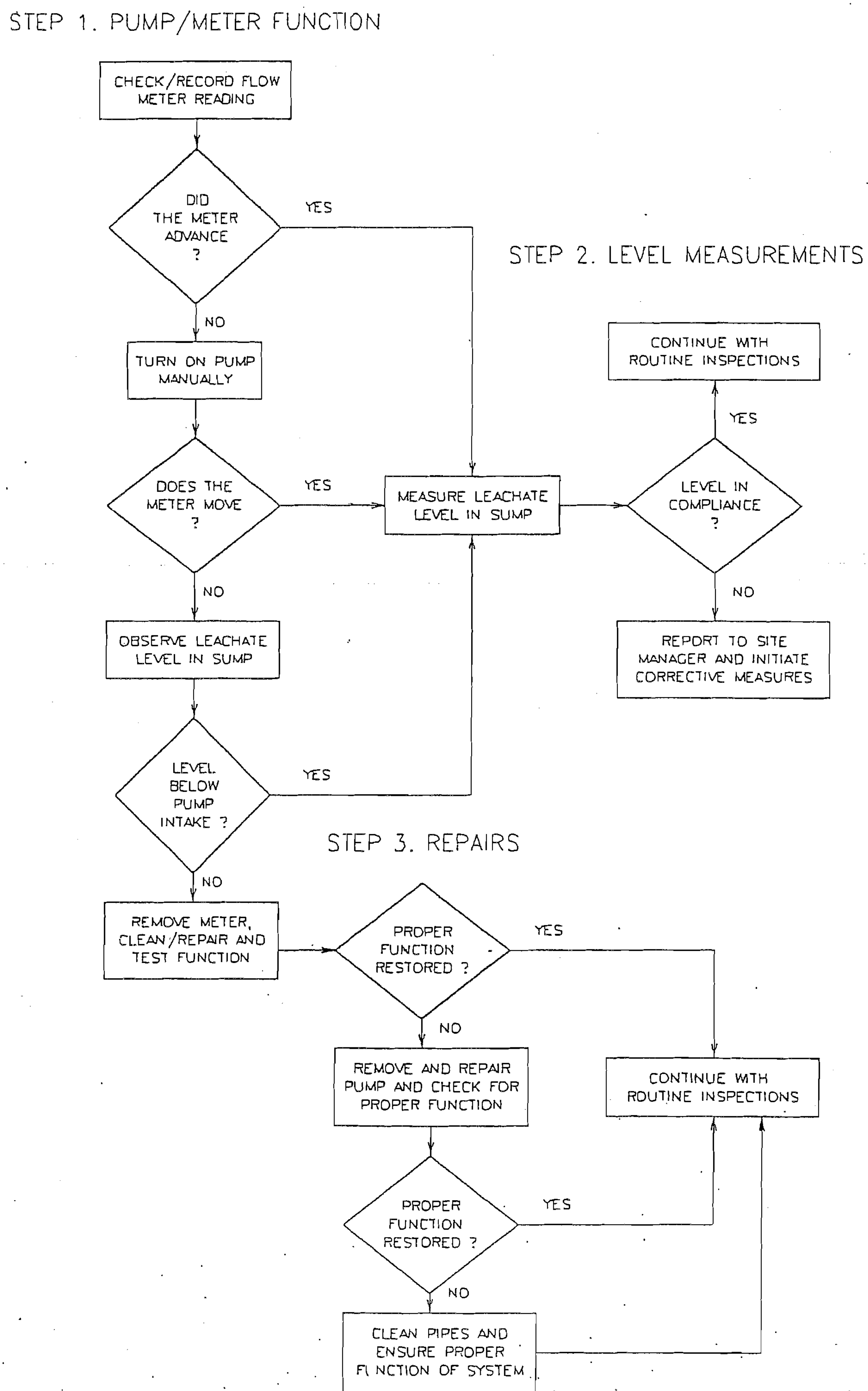
STEP 1. PUMP/METER FUNCTION
CHECK/RECORD FLOW METER READING
DID THE METER ADVANCE ?
YES
NO
TURN ON PUMP MANUALLY
DOES THE METER MOVE ?
YES
NO
OBSERVE LEACHATE LEVEL IN SUMP
LEVEL BELOW PUMP INTAKE ?
YES
NO
STEP 2. LEVEL MEASUREMENTS
MEASURE LEACHATE LEVEL IN SUMP
LEVEL IN COMPLIANCE ?
YES
CONTINUE WITH ROUTINE INSPECTIONS
NO
REPORT TO SITE MANAGER AND INITIATE CORRECTIVE MEASURES
STEP 3. REPAIRS
REMOVE METER, CLEAN/REPAIR AND TEST FUNCTION
PROPER FUNCTION RESTORED ?
YES
NO
REMOVE AND REPAIR PUMP AND CHECK FOR PROPER FUNCTION
CONTINUE WITH ROUTINE INSPECTIONS
PROPER FUNCTION RESTORED ?
YES
NO
CLEAN PIPES AND ENSURE PROPER FUNCTION OF SYSTEM

Figure 3.

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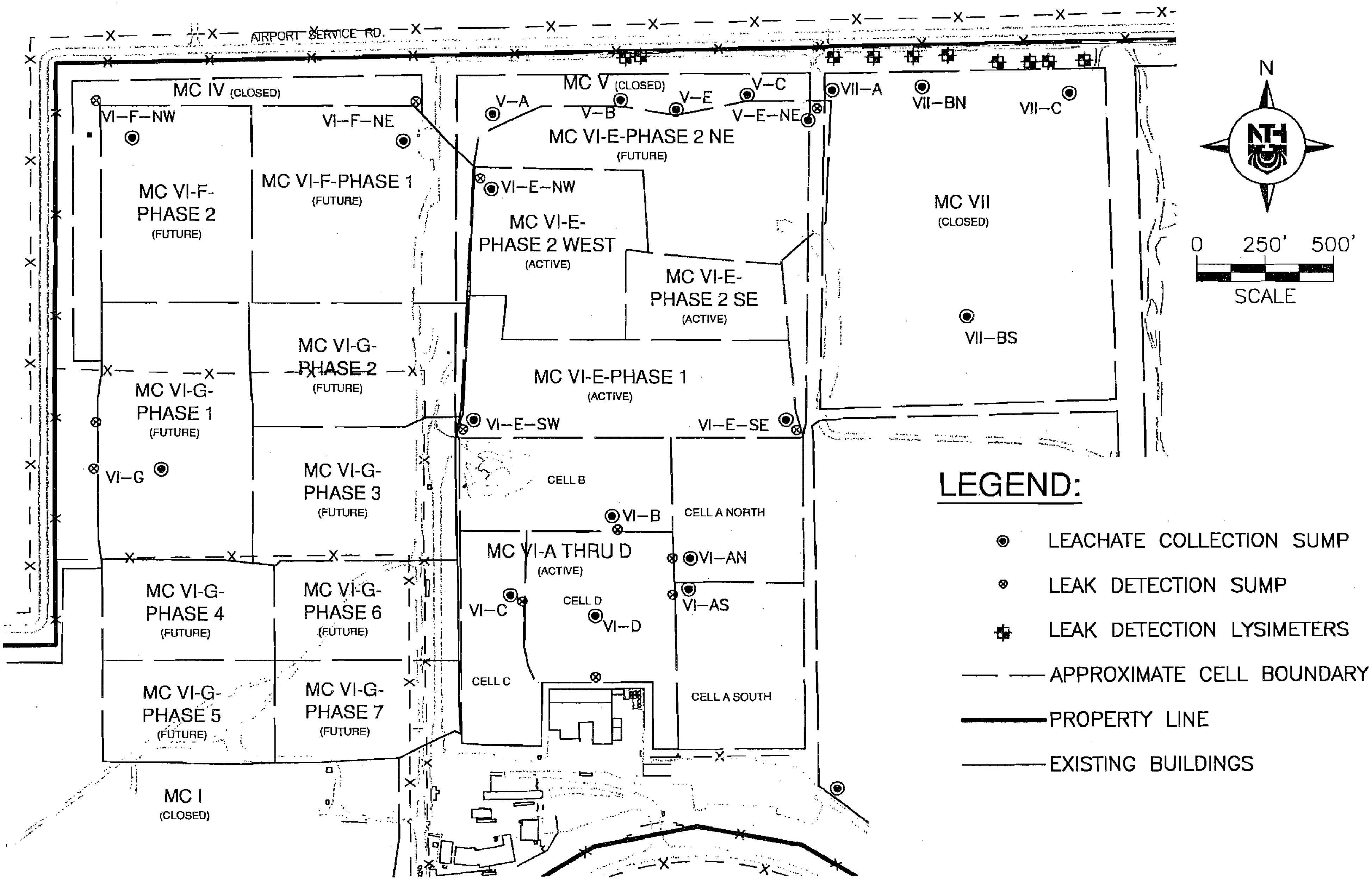


NTH PROJECT No.: 62-080376-00	DESIGNED BY: KRO	CHECKED BY: DLP	DRAWING SCALE: AS SHOWN	NTH Consultants, Ltd. Infrastructure Engineering and Environmental Services	LEACHATE COLLECTION & LEAK DETECTION LOCATIONS	FIGURE: 4
CAD FILE NAME: 080376-LCS	DRAWN BY: KRO	INCEPTION DATE: 1/27/2011	PLOT DATE: 2/8/11		WAYNE DISPOSAL, INC. SITE NO. 2 VAN BUREN TWP., WAYNE COUNTY, MICHIGAN	

Figure 5. Handling Requirements of Monitoring Parameters

Parameter	Perservation	Holding Time	Bottle Type	Minimum Volume
Total Phenolics	1,2	28 Days	Glass	500 ml
Sulfate	2	28 Days	Plastic	50 ml*
Alkalinity	2	14 Days	Plastic	100 ml*
Chloride	2	28 Days	Plastic	50 ml*
Total Phosphorus	1,2	28 Days	Plastic	200 ml***
Total Cyanide	4	14 Days	Plastic	500 ml
Nitrate/Nitrite	1,2	48 Hours	Plastic	500 ml
Kjeldahl Nitrogen	1,2	28 Days	Plastic	200 ml***
Aluminum	3,5	6 Mos	Plastic	200 ml**
Antimony	3,5	6 Mos	Plastic	200 ml**
Arsenic	3,5	6 Mos	Plastic	200 ml**
Barium	3,5	6 Mos	Plastic	200 ml**
Beryllium	3,5	6 Mos	Plastic	200 ml**
Cadmium	3,5	6 Mos	Plastic	200 ml**
Calcium	3,5	6 Mos	Plastic	200 ml**
Chromium	3,5	6 Mos	Plastic	200 ml**
Chromium, Hexavalent	2,5	24 Hrs	Plastic	100 ml
Cobalt	3,5	6 Mos	Plastic	200 ml**
Copper	3,5	6 Mos	Plastic	200 ml**
Iron	3,5	6 Mos	Plastic	200 ml**
Potassium	3,5	6 Mos	Plastic	200 ml**
Lead	3,5	6 Mos	Plastic	200 ml**
Magnesium	3,5	6 Mos	Plastic	200 ml**
Manganese	3,5	6 Mos	Plastic	200 ml**
Mercury	3,5	6 Mos	Plastic	200 ml**
Molybdenum	3,5	6 Mos	Plastic	200 ml**
Nickel	3,5	6 Mos	Plastic	200 ml**
Selenium	3,5	6 Mos	Plastic	200 ml**
Silver	3,5	6 Mos	Plastic	200 ml**
Sodium	3,5	6 Mos	Plastic	200 ml**
Thallium	3,5	6 Mos	Plastic	200 ml**
Tin	3,5	6 Mos	Plastic	200 ml**
Vanadium	3,5	6 Mos	Plastic	200 ml**
Zinc	3,5	6 Mos	Plastic	200 ml**
pH		Immediate	Plastic	25 ml
Bicarbonate	2	14 Days	Plastic	100 ml*
Carbonate	2	14 Days	Plastic	100 ml*
Total Organic Carbon	1,7	28 Days	Glass	100 ml
Chemical Oxygen Demand	1,2	28 Days	Glass	250 ml
Specific Conductivity	2	28 Days	Plastic	100 ml
Semi-Volatile Organics	2	14 Days	Glass/Teflon	1000 ml
Volatile Organics	2,6	14 Days	Glass/Teflon	2x40 ml
PCBs	2	7 Days-Extraction	Glass	2 L
	2	40 Days-Analysis	Glass	40 ml

1) pH<2 with concentrated Sulfuric Acid
2) Store at 4 degrees Centigrade
3) pH<2 with nitric acid
4) pH>12 with sodium hydroxide
5) Filtered in the field or lab using 0.45 micron membrane filters on the daily of sample collection
6) 4 drops HCL, no headspace
7) pH<2 with hydrochloric acid

* Note: One liter for all these parameters stored similarly
** Note: One liter for all these parameters stored similarly
*** Note: One liter for all these parmeters stored similarly

Figure 6. Sample Collection Log for Leachate - WDI Site #2

Sample ID:	Sample Date:	Sample Time:
Sample Location:	Sampling Method:	Sampler:
Observations/Comments*:		

Sample ID:	Sample Date:	Sample Time:
Sample Location:	Sampling Method:	Sampler:
Observations/Comments*:		

Sample ID:	Sample Date:	Sample Time:
Sample Location:	Sampling Method:	Sampler:
Observations/Comments*:		

Sample ID:	Sample Date:	Sample Time:
Sample Location:	Sampling Method:	Sampler:
Observations/Comments*:		

Sample ID:	Sample Date:	Sample Time:
Sample Location:	Sampling Method:	Sampler:
Observations/Comments*:		

* Note anything unusual in the sample or conditions of or near the riser pipe

FIGURE 7 ORGANIC COMPOUNDS FOR LEACHATE MONITORING

VOLATILE ORGANIC PARAMETERS (8260)	MDL (mg/L)	SEMI-VOLATILE ORGANIC PARMETERS (8270)	MDL		MDL
Acetone	0.010	Acenapthene	0.010	Hexachlorobenzene	0.010
Bromodichloromethane	0.001	Acenapthylene	0.010	Hexachlorobutadiene	0.010
Bromoform	0.001	Anthracene	0.010	Hexachlorocyclopentadiene	0.010
Bromomethane	0.005	Benzidene	0.080	Hexachloroethane	0.010
Carbon Tetrachloride	0.001	Benzo(a)anthracene	0.010	Indeno (1,2,3-cd) pyrene	0.010
Chlorobenzene	0.001	Benzo(b)fluoranthene	0.010	Isophorone	0.010
Chloroethane	0.005	Benzo(k)fluoranthene	0.010	2-Methylnapthalene	0.010
2-Chloroethylvinyl Ether	0.010	Benzo(ghi)perylene	0.010	Napthalene	0.010
Chloroform	0.001	Benzoic Acid	0.050	2-Nitroaniline	0.050
Chloromethane	0.001	Benzo(a)pyrene	0.010	3-Nitoraniline	0.050
Dibromodifluoromethane	0.001	Benzyl alcohol	0.010	4-Nitroaniline	0.050
1,2 Dichlorobenzene	0.001	Bis (2-chloroethoxy) methane	0.010	Nitrobenzene	0.010
1,3 Dichlorobenzene	0.001	Bis (2-chloroethyl) ether	0.010	N-Nitrosodiphenylamine	0.010
1,4 Dichlorobenzene	0.001	Bis (2)chloroisopropyl) ether	0.010	N-Nitroso-di-n-propylamine	0.010
Dichlorodifluoromethane	0.001	Bis (2-ethylhexyl) phthalate	0.010	Phenanathrene	0.010
1,1-Dichloroethane	0.001	4-Bromo phenyl ether	0.010	Pyrene	0.010
1,2-Dichloroethane	0.001	Butyl benzyl phthalate	0.010	1,2,4-Trichlorobenzene	0.010
1,1-Dichloroethene	0.001	4-Chloroaniline	0.010	4-Chloro-3-methylphenol	0.010
1,2-Dichloroethene	0.001	2-chloronapthene	0.010	2-Chlorophenol	0.010
1,2 Dichloropropane	0.001	4-Chlorophenyl phenyl ether	0.010	2,4-Dichlorophenol	0.010
1,3 Dichloropropene	0.001	Chrysene	0.010	2,4-Dimethylphenol	0.010
1,1,2,2 Tetrachloroethane	0.001	Dibenz (a,h) anthracene	0.010	4,6-Dinitro-2-methylphenol	0.050
Tetrachloroethane	0.001	Dibenzofuran	0.010	2,4-Dinitrophenol	0.050
Tetrachloroethene	0.001	Di-n-butyl phthalate	0.010	2-Methylphenol	0.010
1,1,2-Trichloroethane	0.001	1,2-Dichlorobenzene	0.010	3-Methylphenol	0.010
1,1,1-Trichloroethane	0.001	1,3-Dichlorobenzene	0.010	4-Methylphenol	0.010
Trichloroethene	0.001	1,4-Dichlorobenzene	0.010	2-Nitrophenol	0.010
Trichlorofluoromethane	0.005	3,3'-Dichlorobenzene	0.020	4-Nitrophenol	0.050
Vinyl Chloride	0.005	Diethyl pthalate	0.010	Pentachlorophenol	0.050
Methylene Chloride	0.005	Dimethyl pthalate	0.010	Phenol	0.010
Methyl Ethyl Ketone	0.050	2,4-Dinitrotoluene	0.010	2,4,5-Trichlorophenol	0.010
Benzene	0.001	2,6-Dinitrotoluene	0.010	2,4,6-Trichlorophenol	0.010
Toluene	0.001	Di-n-octyl phthalate	0.010		
Ethylbenzene	0.001	Fluoranthene	0.010		
Total Xylenes	0.003	Fluorene	0.010		
4-Methyl-2-Pentanone	0.005				
Isobutyl Alcohol	1.000				
1,4-Dioxane	0.020				
PCB's (Method 8082)					
PCB-1016	0.0001	PCB-1232	0.0001	PCB-1248	0.0001
PCB-1221	0.0001	PCB-1242	0.0001	PCB-1254	0.0001
PCB-1260	0.0001				

FIGURE 7. METHODS AND DETECTION LIMITS

PARAMETER	MDL (mg/L)	METHOD
TOTAL PHENOLICS	0.05	9066
SULFATE	2	ASTM D516-90
TOTAL ALKALINITY	10	2320B
CHLORIDE	1.0	4500-Cl E
KJELDAHL NITROGEN	20.0	351.2
NITRATE/NITRITE	0.05	4500-NO3 F
TOTAL PHOSPHORUS	0.05	4500-P E
TOTAL CYANIDE	0.01	4500-CN G
ALUMINUM	0.2	6010/6020
ANTIMONY	0.05	6020
ARSENIC	0.002	6020
BARIUM	0.02	6010/6020
BERYLLIUM	0.005	6010/6020
CADMIUM	0.005	6020
CALCIUM	0.5	6010
CHROMIUM	0.02	6010/6020
HEX. CHROMIUM	0.25	7196
COBALT	0.02	6010/6020
COPPER	0.02	6010/6020
IRON	0.02	6010
LEAD	0.04	6020
MAGNESIUM	0.5	6010
MANGANESE	0.005	6010/6020
MERCURY	0.0002	7470
MOLYBDENUM	0.10	6010/6020
NICKEL	0.02	6010/6020
POTASSIUM	0.2	6010
SELENIUM	0.002	7741/6020
SILVER	0.01	6020/7760
SODIUM	0.5	6010
THALLIUM	0.05	6020/7841
TIN	0.5	6020
VANADIUM	0.02	6010/6020
ZINC	0.02	6010/6020
pH	N/A	4500-H B
BICARBONATE	5.0	2320B
CARBONATE	5.0	2320B
TOTAL ORGANIC CARBON	0.2	5310C
CHEMICAL OXYGEN DEMAN	10.0	5220D
SPEC. CONDUCTANCE	5.0	2510B
SEMI-VOLATILE ORGANICS*	**	8270
VOLATILE ORGANICS*	**	8260
PCB's	**	8082

* see attached lists of compounds

** detection limits are compound dependent

FIGURE 8. METHODS AND DETECTION LIMITS FOR APPENDIX IX PARAMETERS

Constituent	Method	Detection Limit	Unit
Cyanide, Total	9012	0.01	mg/L
Sulfide	9030	10	mg/L
Antimony	6010/6020	0.05	mg/L
Arsenic	7061	0.002	mg/L
Barium	6010	0.02	mg/L
Beryllium	6010	0.005	mg/L
Cadmium	6010	0.005	mg/L
Chromium	6010	0.02	mg/L
Cobalt	6010	0.02	mg/L
Copper	6010	0.02	mg/L
Lead	6010	0.04	mg/L
Mercury	7470	0.0002	mg/L
Nickel	6010/6020	0.02	mg/L
Selenium	7741	0.002	mg/L
Silver	6010	0.01	mg/L
Thallium	6010	0.05	mg/L
Tin	6010	0.20	mg/L
Vanadium	6010	0.02	mg/L
Zinc	6010	0.02	mg/L
Aldrin	8081	0.05	ug/L
alpha-BHC	8081	0.05	ug/L
beta-BHC	8081	0.05	ug/L
delta-BHC	8081	0.05	ug/L
gamma-BHC (Lindane)	8081	0.05	ug/L
Chlordane	8081	0.50	ug/L
4,4'-DDD	8081	0.10	ug/L
4,4'-DDE	8081	0.10	ug/L
4,4'-DDT	8081	0.10	ug/L
Dieldrin	8081	0.10	ug/L
alpha-Endosulfan	8081	0.05	ug/L
beta-Endosulfan	8081	0.10	ug/L
Endosulfan sulfate	8081	0.10	ug/L
Endrin	8081	0.10	ug/L
Endrin aldehyde	8081	0.10	ug/L
Heptachlor	8081	0.05	ug/L
Heptachler epoxide	8081	0.05	ug/L
Isodrin	8081	0.05	ug/L
Kepone	8081	0.10	ug/L
Methoxychlor	8081	0.05	ug/L
Toxaphene	8081	1.0	ug/L
PCB-1016	8082	0.50	ug/L
PCB-1221	8082	0.50	ug/L
PCB-1232	8082	0.50	ug/L
PCB-1242	8082	0.50	ug/L
PCB-1248	8082	0.50	ug/L
PCB-1254	8082	0.50	ug/L
PCB-1260	8082	0.50	ug/L
Disulfoton	8270	2.00	ug/L
Methyl parathion	8270	0.50	ug/L
Thionazin*	8270	10.0	ug/L
Parathion	8270	0.50	ug/L
Phorate	8140	2.00	ug/L

FIGURE 8. METHODS AND DETECTION LIMITS FOR APPENDIX IX PARAMETERS

Constituent	Method	Detection Limit	Unit
2,4-dichlorophenoxy-acetic acid	8150	0.50	ug/L
2,4,5-TP (Silvex)	8150	0.50	ug/L
2,4,5-T	8150	0.50	ug/L
Acetone	8260	0.010	mg/L
Benzene	8260	0.001	mg/L
Bromodichloromethane	8260	0.001	mg/L
Bromoform	8260	0.001	mg/L
Bromomethane	8260	0.001	mg/L
2-Butanone	8260	0.050	mg/L
Carbon disulfide	8260	0.050	mg/L
Carbon Tetrachloride	8260	0.001	mg/L
Chlorobenzene	8260	0.001	mg/L
Chloroethane	8260	0.001	mg/L
2-Chloroethylvinyl ether	8260	0.010	mg/L
Chlormethane	8260	0.001	mg/L
Dibromochloromethane	8260	0.001	mg/L
1,2-Dichlorobenzene	8260	0.001	mg/L
1,3-Dichlorobenzene	8260	0.001	mg/L
1,4-Dichlorobenzene	8260	0.001	mg/L
1,1-Dichloroethane	8260	0.001	mg/L
1,2-Dichloroethane	8260	0.001	mg/L
1,1-Dichloroethene	8260	0.001	mg/L
1,2-Dichloroethene (total)	8260	0.001	mg/L
1,2-Dichloropropane	8260	0.001	mg/L
cis-1,3-Dichloropropene	8260	0.001	mg/L
trans-1,3-Dichloropropene	8260	0.001	mg/L
Ethylbenzene	8260	0.001	mg/L
2-Hexanone	8260	0.050	mg/L
Methlene Chloride	8260	0.005	mg/L
4-Methyl-2-pentanone	8260	0.050	mg/L
Styrene	8260	0.001	mg/L
1,1,2,2-Tetrachloroethane	8260	0.001	mg/L
Toluene	8260	0.001	mg/L
1,1,1-Trichloroethane	8260	0.001	mg/L
1,1,2-Trichloroethane	8260	0.001	mg/L
Trichloroethene	8260	0.001	mg/L
Vinyl acetate	8260	0.050	mg/L
Vinyl chloride	8260	0.001	mg/L
Xylenes (total)	8260	0.003	mg/L
Acetonitrile	8260	0.050	mg/L
Acrolein	8260	0.100	mg/L
Acrylonitrile	8260	0.050	mg/L
2-Chloro-1,3-butadiene (Chloroprene)	8260	0.050	mg/L
3-Chloropropene(Allyl Chloride)	8260	0.010	mg/L
1,2-Dibromo-3-chloropropane	8260	0.010	mg/L
1,2-Dibromomethane	8260	0.001	mg/L
trans-1,4-Dichloro-2-butene	8260	0.005	mg/L
Dichlorodifluoromethane	8260	0.010	mg/L
1,4-dioxane	8260	0.020	mg/L
Ethyl methacrylate	8260	0.300	mg/L
Iodomethane	8260	0.050	mg/L
Isobutyl alcohol	8260	1.0	mg/L

FIGURE 8. METHODS AND DETECTION LIMITS FOR APPENDIX IX PARAMETERS

Constituent	Method	Detection Limit	Unit
Methacrylonitrile	8260	0.010	mg/L
Methyl methacrylate	8260	0.010	mg/L
Propionitrile	8260	0.100	mg/L
1,1,1,2-Tetrachloroethane	8260	0.001	mg/L
Trichlorofluoromethane	8260	0.001	mg/L
1,2,3-Trichloropropane	8260	0.001	mg/L
Acetopheneone	8270	0.010	mg/L
2-Acetylaminofluorene	8270	0.010	mg/L
4-Aminobiphenyl	8270	0.010	mg/L
Aniline	8270	0.010	mg/L
Aramite	8270	0.010	mg/L
Chlorobenzilate	8270	0.010	mg/L
Diallate	8270	0.010	mg/L
Dimethoate	8270	0.010	mg/L
p-(Dimethylamino)azobenzene	8270	0.010	mg/L
7,12-Dimethylbenz[a]anthracene	8270	0.010	mg/L
3,3'-Dimethylbenzidine	8270	0.040	mg/L
alpha, alpha-Dimethyphenethlamine	8270	0.100	mg/L
1,3-Dinitrobenzene	8270	0.010	mg/L
Diphenylamine*	8270	0.010	mg/L
Ethyl methanesulfonate	8270	0.010	mg/L
Farmphur	8270	0.010	mg/L
Hexachlorodibenofurans	8270	0.010	mg/L
Hexachlorodibenzo-p-dioxins	8270	0.010	mg/L
Hexachloropropene	8270	P/A	mg/L
Isosafrole	8270	0.010	mg/L
Methapyrilene	8270	0.010	mg/L
3-Methylcholanthrene	8270	0.080	mg/L
Methyl methanesulfonate	8270	0.040	mg/L
1,4-Naphthoquinone	8270	0.010	mg/L
1-Naphthylamine	8270	0.010	mg/L
2-Naphthylamine	8270	0.010	mg/L
5-Nitro-o-toluidine	8270	0.010	mg/L
4-Nitroquinoline-1-oxide	8270	0.010	mg/L
N-Nitroso-di-n-butylamine	8270	0.010	mg/L
N-Nitrosodiethylamine	8270	0.010	mg/L
N-Nitrosodimethylamine	8270	0.010	mg/L
N-Nitrosomethylethlamine	8270	0.010	mg/L
N-Nitrosomorpholine	8270	0.010	mg/L
N-Nitrosopyrrolidine	8270	0.010	mg/L
N-Nitrosopiperdine	8270	0.010	mg/L
Pentachlorobenzene	8270	0.010	mg/L
Pentachlorodibenzofurans	8270	0.010	mg/L
Pentachlorodibenzo-p-dioxins	8270	0.010	mg/L
Pentachloroethane	8270	0.010	mg/L
Pentachloronitrobenzene	8270	0.010	mg/L
Phenacetin	8270	0.010	mg/L
p-Phenylene diamine	8270	0.010	mg/L
2-Picoline	8270	0.080	mg/L
Pronamide	8270	0.080	mg/L
Pyridine	8270	0.130	mg/L
Safrole	8270	0.010	mg/L

FIGURE 8. METHODS AND DETECTION LIMITS FOR APPENDIX IX PARAMETERS

Constituent	Method	Detection Limit	Unit
Sulfotepp**	8270	0.010	mg/L
1,2,4,5-Tetrachlorobezene	8270	0.010	mg/L
Tetrachlorodibenzofurans	8270	0.010	mg/L
Tetrachloroibenzo-p-dioxins	8270	0.010	mg/L
o-Toluidine	8270	0.010	mg/L
o,o,o,-Triethylphosphorothioate	8270	0.010	mg/L
1,3,5-Trinitrobenzene	8270	0.010	mg/L
Tris (2,3-dibromopropyl) phosphate	8270	0.200	mg/L
2,6-Dichlorophenol	8270	0.010	mg/L
Dinoseb	8270	0.020	mg/L
Hexachlorophene	8270	0.080	mg/L
3-Methylphenol	8270	0.010	mg/L
2, 3,4,6-Tetrachlorophenol	8270	0.010	mg/L
Acenaphthene	8270	0.010	mg/L
Acenaphthylene	8270	0.010	mg/L
Anthracene	8270	0.010	mg/L
Benzidine	8270	0.080	mg/L
Benzo (a) anthracene	8270	0.010	mg/L
Benzo (b) fluoranthene	8270	0.010	mg/L
Benzo (k) fluoranthene	8270	0.010	mg/L
Benzo (ghi) perylene	8270	0.010	mg/L
Benzoic acid	8270	0.050	mg/L
Benzo (a) pyrene	8270	0.010	mg/L
Benzyl alcohol	8270	0.010	mg/L
Bis (2-chloroethoxy) methane	8270	0.010	mg/L
Bis (2-chloroethyl) ether	8270	0.010	mg/L
Bis (2-chloroisopropyl) ether	8270	0.010	mg/L
Bis (2-ethylhexyl) phthalate	8270	0.010	mg/L
4-Bromophenyl phenyl ether	8270	0.100	mg/L
Butyl benzyl phthalate	8270	0.010	mg/L
4-Chloroaniline	8270	0.010	mg/L
2-Chloroaphthalene	8270	0.010	mg/L
4-Chlorophenyl phenyl ether	8270	0.010	mg/L
Chrysene	8270	0.010	mg/L
Dibenz (a,h)anthracene	8270	0.010	mg/L
Dibenzofuran	8270	0.010	mg/L
Di-n-butyl phthalate	8270	0.010	mg/L
1,2-Dichlorobenzene	8270	0.010	mg/L
1,3-Dichlorobenzene	8270	0.010	mg/L
1,4-Dichlorobenzene	8270	0.010	mg/L
3,3'-Dichlorobenzidine	8270	0.020	mg/L
Diethyl phthalate	8270	0.010	mg/L
Dimethyl phthalate	8270	0.010	mg/L
2,4-Dinitrotoluene	8270	0.010	mg/L
2,6-Dintrotoluene	8270	0.010	mg/L
Di-n-octyl phthalate	8270	0.010	mg/L
Fluoranthene	8270	0.010	mg/L
Fluorene	8270	0.010	mg/L
Hexachlorobenzene	8270	0.010	mg/L
Hexachlorobutadiene	8270	0.010	mg/L
Hexachlorocyclopentadiene	8270	0.010	mg/L
Hexachloroethane	8270	0.010	mg/L

FIGURE 8. METHODS AND DETECTION LIMITS FOR APPENDIX IX PARAMETERS

Constituent	Method	Detection Limit	Unit
Indeno (1,2,3-cd) pyrene	8270	0.010	mg/L
Isophorone	8270	0.010	mg/L
2-Methylnaphthalene	8270	0.010	mg/L
Naphthalene	8270	0.010	mg/L
2-Nitroaniline	8270	0.050	mg/L
3-Nitroaniline	8270	0.050	mg/L
4-Nitroaniline	8270	0.050	mg/L
Nitrobenzene	8270	0.010	mg/L
N-Nitrosodiphenylamine*	8270	0.010	mg/L
N-Nitroso-di-n-propylamine	8270	0.010	mg/L
Phenanthrene	8270	0.010	mg/L
Pyrene	8270	0.010	mg/L
1,2,4-Trichlorobenzene	8270	0.010	mg/L
4-Chloro-3-methylphenol	8270	0.010	mg/L
2-Chlorophenol	8270	0.010	mg/L
2,4-Dichlorophenol	8270	0.010	mg/L
2,4-Dimethylphenol	8270	0.010	mg/L
4,6-Dinitro-o-cresol	8270	0.050	mg/L
2,4-Dinitrophenol	8270	0.010	mg/L
2-Methylphenol	8270	0.010	mg/L
4-Methylphenol	8270	0.010	mg/L
2-Nitrophenol	8270	0.010	mg/L
4-Nitrophenol	8270	0.050	mg/L
Pentachlorophenol	8270	0.010	mg/L
Phenol	8270	0.010	mg/L
2,4,5-Trichlorophenol	8270	0.010	mg/L
2,4,6-Trichlorophenol	8270	0.010	mg/L

Attachment 14

Leak Detection Monitoring Program Sampling and Analysis Plan

Section 29

LEAK DETECTION, COLLECTION AND REMOVAL SYSTEMS SAMPLING & ANALYSIS PLAN

MASTER CELL VI
WAYNE DISPOSAL, INC. SITE #2
MID 048 090 633

SAMPLING AND ANALYSIS PLAN FOR LEAK DETECTION, COLLECTION AND REMOVAL SYSTEMS

MASTER CELL VI
WAYNE DISPOSAL, INC. SITE #2
MID 048 090 633

REVISION 4.1, MAY 1999
REVISION 4.2, AUGUST 1999
REVISION 4.3, OCTOBER 2000
REVISION 4.4, FEBRUARY 2001
REVISION 4.5, MARCH 2001
REVISION 4.6, SEPTEMBER 2006
REVISION 4.7, OCTOBER 2009
REVISION 4.8, FEBRUARY 2011

1.0 INTRODUCTION

The following sampling and analysis plan outlines the standard procedures for measuring flow volumes and for the collection and analysis of samples of the liquids collected from the leak detection, collection and removal system (LDCRS) in Master Cell VI. There are currently eight LDCRS sumps, one for each for five of the cells within Master Cell VI: VI-A South, VI-A North, VI-B, VI-C and VI-D, and three in MC VI-E (VI-E-SE, VI-E-SW and VI-E-NW). The locations of these sumps are shown on Attachment A. Five additional LDCRS sumps will located in MC VI-E (VI-E-NW), MC-VI-F and MC-G however these will not be operational until these cells are constructed and begin to receive waste.

This document has been prepared to direct the efforts of monitoring personnel in the collection of samples and volume measurements so as to meet the requirements of the Operating Licnese issued under Part 111 of Michigan Act 451 for the facility and to ensure sound practices for the collection of these data.

This plan must be revised if there are any changes to the equipment or procedures contained herein. All proposed changes must be submitted to the Waste and Hazardous Materials Division (WHMD) of the Michigan Department of Environmental Quality (MDEQ) for review and approval prior to implementation.

2.0 PUMPING/SAMPLING EQUIPMENT

Each LDCRS sump must be equipped with a Grundfos Redi-Flo2™ submersible pump with a Redi-Flo2 controller package and totalizing flow meter, or alternative pumping equipment that is approved by the WHMD. The installation and operating instructions for this system are included in Attachment B. These pumps were selected for the following attributes: 1) they are composed of stainless steel and Teflon and thus have low potential to impact the quality of environmental samples, 2) the pumps are designed to collect groundwater samples with minimal aeration or perturbation of the sample and, 3) with the controller package the pumping rates are adjustable with high rates for removing liquids from the sump and low rates for sampling. Any alternative pump system installed in the LDCRS should have similar attributes for pumping and for collecting samples.

The reinforcement of the LDCRS in Master Cell VI subcell A-North completed in August, 2006 required the installation of a Black Hawk Model 101 pump system. This system was selected for its ability to draw water from a suction tube that extends through the 1-inch diameter slipline. The installation and operating instructions for this system are included in Attachment B.

The discharge tube for the pumps is composed of HDPE. At the surface, this tube is connected to a stainless steel or PVC discharge tube with the flow meter in line. The opening at the top of each LSCRS riser must be tightly covered with a cap in which the discharge tube and electrical cable penetrate through sealed ports. The discharge tube and electrical cable must be configured such that it does not come into contact with the ground surface and such that the end hava a valve that is protected. Any changes to the configuration of the LDCRS riser pipe as the waste surface ascends must ensure that the sampling tube is not susceptible to contamination.

3.0 VOLUME AND FIELD MEASUREMENTS

The volume of liquids removed from each LDCRS must be recorded weekly on Attachment C. The volume readings from the flow meters are generally collected during the weekly inspection. At the end of each month, Attachment C must be submitted to the QEHS Department for recording and evaluation. The weekly volume data must be evaluated each month to determine the average flow rate produced on a gallons-per-acre-per day basis..

In addition to the weekly volume recording, each LDCRS must be inspected on a weekly basis to ensure that there is no evidence of damage or tampering that could allow waste or waste constituents to have entered the system. The weekly/after storm inspection form in the Inspection Plan is used for documenting these inspections. This form must be fully completed with evidence of malfunctioning equipment or other potential problems described in detail.

Once per month, a sample of the water from each LDCRS sump must be field tested for pH and specific conductivity. These values must be recorded on Attachment C. The monthly volume data and field parameter data must be submitted to the QEHS Department at the end of each month.

4.0 COLLECTION OF SAMPLES

Unless there is an insufficient amount of liquid generated by a LDCRS during a month's time (time between monthly purging/volume recording events), samples must be collected for analysis on a quarterly basis from each LDCRS sump. In addition, any sump which yields volumes above the maximum expected volume (see Section 7.1) during a monthly purging/volume recording event must be sampled and analyzed for the quarterly parameter list. Further, any time a monthly field specific conductivity value exceeds the maximum expected value (see Section 7.1) a sample must be collected and analyzed for quarterly parameters, unless the conductivity measurement was made during the collection of the quarterly sample for that sump.

Prior to collecting the samples, the sump must be pumped until a minimum of 20 gallons are removed in order to ensure that the lines have been flushed (this is approximately 3 tubing volumes) unless the production rate of the sump indicates that less than 20 gallons will be available. Prior to sampling the flow rate of the pump must be throttled back to the minimum deliverable flow rate and then the samples are collected. The sump then must be pumped until dry.

Samples are collected within Wayne Disposal, Inc, nitrogen glove box. Prior to sampling, the glove box is purged with nitrogen for approximately 20 minutes. The sample containers are placed within the box during purging. The glove box is connected to the LDCRS pumps with a fitting that allows new Tygon tubing to be used for each sample. At the time of sampling, the flow from the LDCRS is diverted into the glove box by turning the valve on the back of the box. All containers are then filled within the box while under positive pressure from the nitrogen. All containers are closed before opening the glove box to remove them.

During the sample event, specific conductance and pH of the liquid must be measured on a sample of the liquid. The volume purge data and pH/conductance data for each sump must be recorded on the Attachment C.

Samples for VOC's are collected first while ensuring that no headspace is present within the sampling vials. Next, fill the bottles for total organic carbon, total phenolics and dissolved metals in that order. Finally, collect the remaining miscellaneous samples (e.g. sulfate, chloride, etc.). All samples are to be collected in the appropriate containers with the appropriate preservatives as outlined on Attachment D, "Handling Requirements of Monitoring Parameters." Care must be taken to ensure that preservatives are not spilled during sampling. Samples for dissolved metals may be field filtered with an in-line 0.45 micron filter cartridge and acidified to pH < 2 with HNO_3, or, filtered and preserved at the laboratory upon delivery.

A trip blankand a field blank for VOC analyses must be maintained and submitted for analysis for each 10 samples collected and/or for each day samples are collected. In addition, one blind duplicate samples must be submitted for complete analyses for every other sampling event (two per year). Each sample container must be carefully labeled with the sampling location, time and date, identity of preservatives contained within and the sampler's initials. After collection, the samples shall be stored in a clean cooler containing ice or ice packs. The coolers containing samples must be stored in a secure location until transport to the laboratory.

5.0 ANALYTICAL PROCEDURES

Each sample is to be analyzed for the parameters listed on Attachment E, "Method Detection Limits for Organic and Inorganic Parameters." The analytical methods and targeted method detection limits must be those specified in WHMD Operational Memo Gen-8. If a revised Memo Gen-8 is published Attachment E must be modified (if necessary) to be consistent with the revisions. Laboratory Quality control frequencies and precision/accuracy requirements are provided in the Quality Assurance Manual for the current contract laboratory, TriMatrix, which is contained in the Groundwater Sampling and Analysis Plan for this facility. This manual describes the internal policies, guidelines and procedures of Trimatrix. This manual is not intended to describe the specific details of this particular monitoring program. Rather, we are to use this document as a guideline in evaluating Trimatrix's QA/QC and standard operating procedures to ensure that generally acceptable practices are employed.

6.0 RECORD KEEPING

In addition to the inspection/volume measurement forms contained in Attachment C and the weekly inspections, there are three other items required to ensure adequate record keeping for the LDCRS monitoring program. First, a field notebook must be maintained during sampling which includes, at a minimum, the identity of sampling personnel, the dates and time when samples are collected, a description of the sampling event (i.e. routine monthly, etc.), volume meter readings, and any pertinent observations of sample characteristics or sampling environment. Second, an equipment inventory, repair and maintenance log must be maintained in the Engineering Field Office at the site. This log shall contain the serial numbers of all sampling equipment and a record of any repairs, maintenance, calibration or replacement of this equipment. Finally, a chain of custody form must be filled out for each sampling event. A sample copy is included as Attachment F. This form must be filled out fully for each sample submitted for analysis and each person responsible for the handling of these samples must sign and date the form. When the samples are delivered to the laboratory and the lab has signed for their receipt, a copy of this form must be retained. Copies of these forms must then be transmitted to the QEHS Department along with volume records.

7.0 DATA ANALYSIS AND REPORTING

Data analysis and reporting are required for both the volume data and the analytical data. Both volume and analytical data are evaluated statistically to determine if there has been a significant change.

7.1 Volume Rate Analysis

Volume data must be evaluated monthly to determine an average daily flow rate in gallons-per-acre-per-day (gpad). This is done by utilizing the following formula:

Flow Rate (gpad) = (Total Volume (gal)/Time (days))/Area of LDCRS (acres)

Areas, in acres, for the seven LDCRS are as follows: VI-AS (7.65), VI-AN (5.83), VI-B (6.13), VI-C (4.87) VI-D (7.24), VI-ESE (8.9), VI-ESW (4.6) and VI-ENW (9.4). Areas, in acres, for the future LDCRS for VI-ENE is expected to be 3.8. Areas for Cells VI-F and VI-G will be calculated based on final design drawings.

Experience with LDCRS volume rate data suggest the following behaviors are expected: 1) volume rates generally decrease over time, 2) the rates are dependent on filling rates and initial moisture content of the compacted clay component of the area being filled, and 3) short term fluctuations in rates (e.g. weekly or daily) may be large compared to average monthly rates. Evaluating the volume rate data as an indication of performance of the primary liner must take into account the expected behavior of LDCRS.

The volume data for each individual LDCRS are evaluated by comparing each monthly rate to a maximum expected rate which is based on a moving window to account for trends or fluctuations. The maximum expected rate is defined as the mean plus three standard deviations calculated from the previous two years data for each sump individually. It must be noted that an exceedance of the maximum expected rate may be a normal response to an increase in the filling rate or the return to active filling over an area which has not received waste for a period of time. The volume data must be routinely reported to MDEQ with the quarterly analytical data. However, if the monthly volume yields a rate greater than the maximum expected rate then a sample must be collected and analyzed for the parameters listed on Attachment E as soon as practical (allowing time for sump to recharge). The MDEQ must be notified of the nature of the exceedance and the intention to sample. Steps should also be taken to determine if increases in flow rate corresponds to filling rates or filling location as these may apply to the affected cell.

7.2 Evaluation of Field Specific Conductance Data

The monthly specific conductance data from each LDCRS sump must be evaluated for increases compared to recent data. This is done by comparing the measured specific conductance to the mean plus three standard deviations calculated from the previous eight conductance measurements from that sump. If the measured conductance exceeds this quantity then a sample must be collected and analyzed for the parameters listed on Attachment E as soon as practical unless the conductance measurement was collected at the time of the quarterly sample collection. The MDEQ must be notified of the nature of the exceedance and the intention to sample.

7.3 Analytical Data Evaluation

All quarterly analytical results must be evaluated statistically and reported to the Waste and Hazardous Materials Division of the MDEQ within 60 days of the completion of each sampling event. The statistical program for the LDCRS monitoring results is presented in Attachment G. In addition to the use of statistics to evaluate the occurrence of organic compounds, WDI also tracks the concentrations of all other monitoring parameters within a database. This database should be updated upon receipt of each set of analytical results and observed for unusual data points or trends. The quarterly report must also include a description of the sampling events, a table of the volume measurements and a summary of the QA/QC information both field and laboratory.

7.4 Annual Report

An annual report describing the sampling events, a summary of the QA/QC information, sampling documentation, an evaluation of the volume records (graphical and tabular) and analytical results and a summary of any non-compliance or maintenance items that occurred during the previous year must be prepared. This annual report must be submitted to MDEQ by March 1 of the following year.

8.0 DECONTAMINATION PROCEDURES

While the landfill cells are in operation, sampling of the LDCRS requires that the sampling vehicle drive into active cells and, in some cases onto the waste. For this reason, it is important that the sampling vehicle and equipment are properly decontaminated after sampling. The sampling vehicle must be power-washed by the mobile decon unit both outside and inside prior to leaving the cell area. All disposable PPE used by sampling personnel should be removed and disposed of in an appropriate receptacle at this time as well. The glove box should be cleaned with TSP or other non-organic detergent both inside and out on at least a quarterly basis.

Attachment G - LDCRS Statistical Monitoring Plan

STATISTICAL EVALUATION

The statistical program for LDCRS monitoring utilizes Nonparametric Prediction Limits (NPPLs) to evaluate the monitoring data. In order to balance false positive and statistical power with this test, resamples are used, the number of which are determined by the number of sampling points and the number of background observations. Since there is no "upgradient" in the LDCRS system, and there was no substantial pre-waste disposal sampling program, the definition of background is not defined in a traditional sense. Thus the use of resamples is selected somewhat arbitrarily (see below).

The NPPL is defined as the highest concentration of a monitoring parameter detected in a background sample. For parameters that are never detected in the background, the NPPL is defined as the reported detection limit. Since the parameters to be analyzed statistically are all organic compounds, the reported detection limit, as listed on Attachment E of the LDCRS Sampling and Analysis Plan are the NPPLs. Therefore, any reported concentration of an Attachment E parameter at or above these limits is considered an apparent statistically significant increase.

If an Attachment E compound is detected, then the NPPL been exceeded and WDI will immediately notify the Waste Management Division (WMD) of the Michigan Department of Environmental Quality (MDEQ) and arrange resampling as soon as possible to confirm or refute the apparent statistically significant increase. Quadruplicate samples will be collected for confirmation purposes and analyzed for the offending parameter(s). Since these quadruplicates are not independent samples, it does not constitute a multiple resampling as defined by the NPPL test. Thus the quadruplicate samples constitute a single resampling. If three of the four quadruplicate samples are clean, then the statistical increase is not confirmed. If two or more of the quadruplicates contain the compound of interest the apparent increase will be deemed confirmed and WDI shall respond in accordance with the current Operating License.

ATTACHMENT A

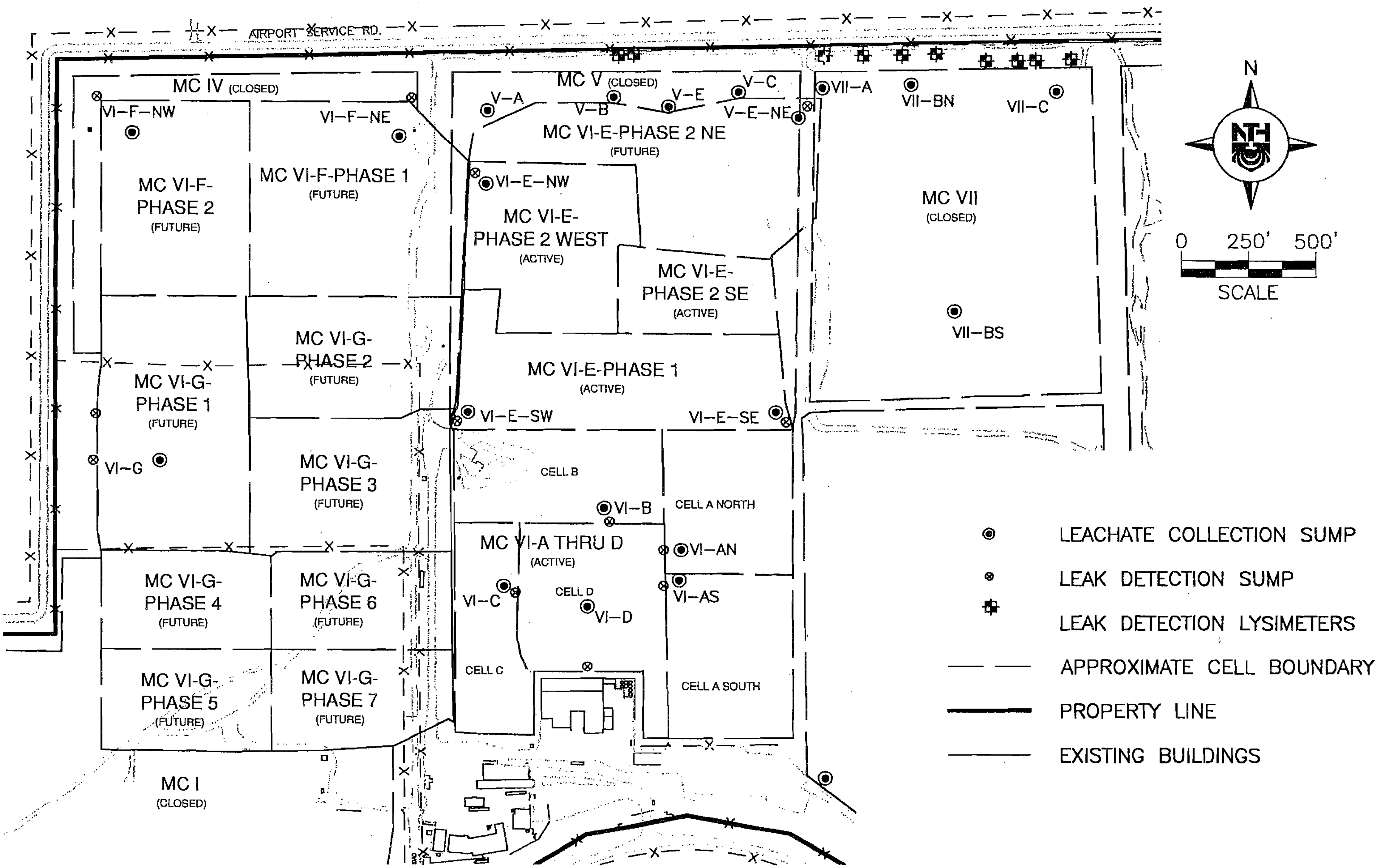
Sump Location

ATTACHMENT B

Installation & Operating Instructions

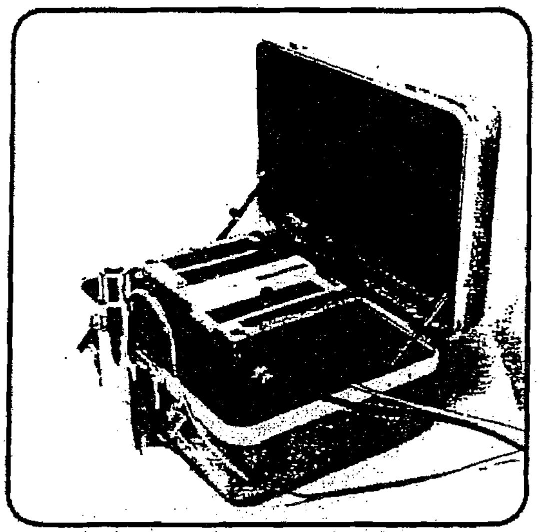
For Gundfs & Blackhawk

J:\62\62080376\Reports\Env\LIC\080376-LCS.dwg



NTH PROJECT No.: 62-080376-00	DESIGNED BY: KRO	CHECKED BY: DLP	DRAWING SCALE: AS SHOWN	NTH Consultants, Ltd.	LEACHATE COLLECTION & LEAK DETECTION LOCATIONS	ATTACHMENT: A
CAD FILE NAME: 080376-LCS	DRAWN BY: KRO	INCEPTION DATE: 1/27/2011	PLOT DATE: 2/8/11	Infrastructure Engineering and Environmental Services	WAYNE DISPOSAL, INC. SITE NO. 2 VAN BUREN TWP., WAYNE COUNTY, MICHIGAN	

Redi-Flo2



Installation and Operating Instructions

GRUNDFOS

SAFETY WARNING

Adherence To Environmental Regulations

When handling and operating the Redi-Flo2 system, all environmental regulations covering the handling of hazardous material must be observed. When the pump is taken out of operation, great care should be taken to ensure that the pump contains no hazardous material that might cause injury to human health or to the environment.

Motor Fluid

The pump motor is filled with approximately .85 ounces (25 milliliters) of contaminant-free water. During operation, it is possible that a very small portion of this water could be replaced by the fluid being pumped. Therefore, there is a potential risk for cross contamination if used in portable applications. A filling syringe is provided with each pump to simplify the replacement of this water with clean water.

Returning A Pump For Service

Only pumps that are certified as uncontaminated will be accepted by GRUNDFOS for servicing. GRUNDFOS must receive this certification prior to receiving the pump. If not, GRUNDFOS will refuse to accept delivery of the pump. In these cases, all costs incurred in returning the product to the customer will be paid by the customer.

Electrical Hazards

The Redi-Flo2 pumping system is not approved for Class I, Division I, Group D locations as specified by the National Electrical Code (NEC). Consult local authorities and regulations if you have any doubt about its suitability for a specific application.

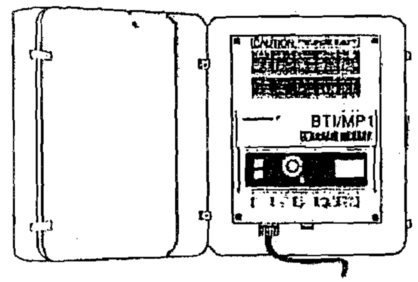
PRE-INSTALLATION CHECKLIST

Components of Your Redi-Flo2

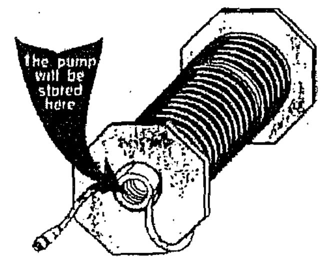
Your Redi-Flo2 Environmental Pumping system should contain the following components:

A. Converter in a protective carrying case
B. MP1 pump and motor with motor lead

A



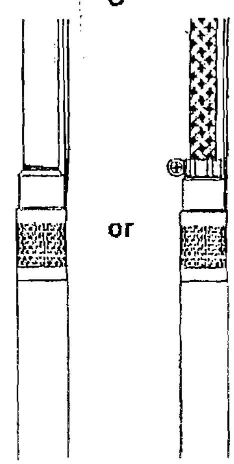
B



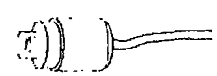
To operate the system you will also need:

C. Hose or pipe to connect to the pump and lower it into the well
D. An electrical plug to connect the converter power cord to your portable generator (or other power source)
E. Some type of safety cable (and attachments) for lowering and lifting the pump

C

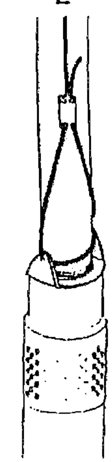


D



(The exact type of plug used will depend upon your generator).

E



ASSEMBLING THE Redi-Flo2

Assembly Instructions

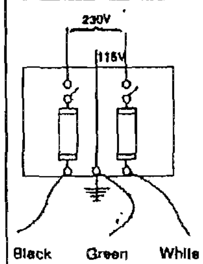
All electrical work should be performed by a qualified electrician in accordance with the latest edition of the National Electrical Code, local codes and regulations.

1

Unpack the components of the Redi-Flo2 system. The MP1 pump will be packed in the center of the motor lead roll.

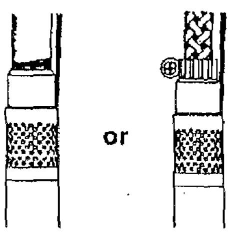
2

Strip the cord jacket and insulation from the ends of the converter power cord. Consult your local electrician to connect the leads to the electrical plug. (The ground wire should be connected to the elongated plug terminal and single phase 230 volt power should be measured across the black and white leads.)



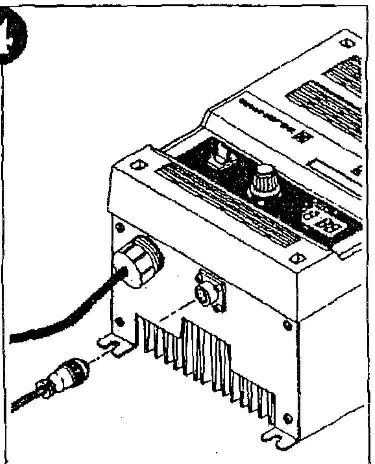
If the converter connects directly to a permanent power supply, consult your local electrician to connect the wires as shown.

3



Connect the MP1 pump to the pipe or hose through which the fluid will be pumped. If a hose is connected, a compression coupling should be used to ensure a strong, watertight fit. A safety cable may be attached to the pump (using a special bracket), as well as a plastic spiral flex clamp to secure the wire. A check valve may also be fitted to prevent liquid from flowing back into the pump after it is turned off (backflow prevention).

4



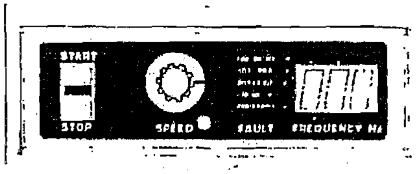
Fit the motor lead plug into the converter. Fit the converter plug into the generator (or other power source).

OPERATING THE Redi-Flo2

Starting

The Redi-Flo2 is easy to operate. Simply:

1. Submerge the pump in water.
2. Start the generator (or other power source).
3. If the generator has a circuit breaker, turn it on.
4. Check the frequency display on the front of the converter. It should read "0" (zero). If it doesn't, refer to the Troubleshooting section on pages 13-14.
5. If this is the first time the converter is being used or it has not been used for more than six months, leave the converter on for at least 15 minutes before proceeding to step 6.
6. Set the converter's speed dial near the middle of the dial (12 o'clock position).
7. Start the pump by pressing the **Start/Stop** switch into the "Start" position.
8. Adjust the pump performance by turning the speed dial.



Stopping

To stop the pump, press the **Start/Stop** switch on the converter to the "Stop" position. There is no need to reduce the pump speed first. Turn the POWER OFF at the generator ***BEFORE*** removing the motor lead from the converter.

Operating Conditions

To ensure the Redi-Flo2 operates properly, follow these guidelines:

- The MP1 pump must be installed vertically with the discharge end pointing upwards.
- The electrical voltage to the converter must always be between 190 and 253 volts (single phase, AC).
- The motor and pump must always be completely submerged in fluid to ensure lubrication of the shaft seal and cooling of the motor.
- While the pump is pumping, the distance down from the ground level to the level of the water in the well must not be greater than 270 feet.
- If the pump is used in a well larger than 4" in diameter, a shroud should be used around it to ensure proper motor cooling.
- The temperature of the water being pumped should be between 34°F and 86°F (1°C and 30°C).

Purging A Well

If the pump is being used to purge a well, start it at the maximum speed. Do not stop the pump until the pumped water contains no visible particles (to avoid blockage within the pump).

Thawing A Frozen Pump

If the liquid in the pump is frozen so the motor shaft cannot rotate, lower it into water and start it at the slowest speed. Continue to operate the pump at this speed for about 10 minutes, at which time it will be thawed and ready for operation.

Dismantling & Reassembling

The MP1 pump can be dismantled and reassembled quickly and easily by referring to the diagram on page 11 and following these steps:

DISMANTLING

1. Shut the pump off using the converter's Start/Stop switch.
2. Turn the generator (or other power supply) OFF.
3. Disconnect the motor lead from the converter.
4. Remove the pipe or hose connected to the pump (OPTIONAL).
5. Remove the Set Screw (position 12 in the diagram on page 11). Grasp the Inlet Screen (position 1) and slowly but forcefully pull it up over the Pump Housing (position 2).

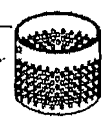
DO NOT ALLOW THE INLET SCREEN TO SCRAPE THE INSULATION FROM THE MOTOR LEADS.

6. Unscrew and remove the Pump Housing (counterclockwise when viewed from the top). This will expose the impeller assembly (guide vanes, wear rings, etc.), which can now be removed by hand for extended cleaning or replacement.

REASSEMBLY

To reassemble the MP1 pump, refer to the diagram on page 11 and:

1. Make sure the motor lead is not connected to the converter.
2. Return the impeller assembly components (guide vanes, wear rings, etc.) to the shaft in the proper order.
3. Screw the Pump Housing (position 2) back onto the top of the pump. If all of the impellers and chambers were replaced correctly, the Pump Housing should screw on easily. Hand tighten.
4. Slip the Inlet Screen (position 1) back over the Pump Housing. Screw the Set Screw (position 12) back into the Inlet Screen.

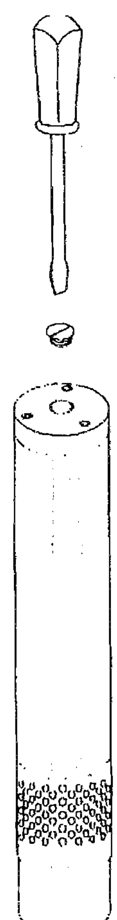


MAKE SURE YOU LINE UP THE MOTOR LEAD WITH THE RECESSED AREA IN THE PUMP HOUSING TO AVOID SCRAPING THE INSULATION FROM THE LEADS

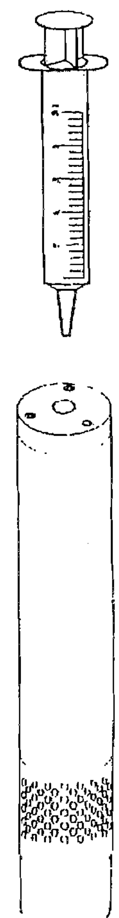
Replacement Of Motor Fluid

If the pump is moved from well to well, it should be thoroughly decontaminated prior to being installed in the next well. In addition to cleaning the individual components inside and outside, the water in the pump motor should be replaced using the syringe that came with your pump. This can be accomplished through the following steps:

1. Shut the pump off using the converter's Start/Stop switch.
2. Turn the generator (or other power supply) OFF.
3. Unplug the pump from the converter.
4. Turn the pump and motor upside down.



5. Use a flat screwdriver to remove the filling screw on the bottom of the motor.



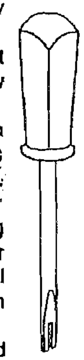
6. Empty the water from the motor and refill it using contaminant-free water and the syringe that came with your MP1 pump. The water level should be even with the bottom edge of the screw hole.
7. Replace and tighten the filling screw.
8. Turn the pump over several times, then remove the filling screw again to let any trapped air escape (if air is left inside the motor, the life of the motor will be shortened). Add more water, if necessary.
9. Replace and tighten the filling screw.

Replacing the Motor Lead

To replace the motor lead, refer to the diagram on page 11 and follow these steps:

REMOVING THE OLD MOTOR LEAD

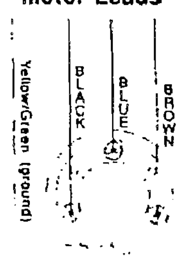
1. Make sure the power is turned **OFF**, the converter is turned **OFF**, and the motor lead is not connected to the converter.
2. Loosen and remove the Set Screw (position 12) from the Inlet Screen (position 1).
3. Slide the Inlet Screen off the pump. If you plan to use this motor lead again, be careful not to scrape insulation from it as the Inlet Screen is removed.
4. Loosen and remove the Pump Housing (position 2). Remove the impeller assembly (impellers, guide vanes, etc.).
5. Refer to the illustration on page 8. Use the special Motor Lead Screwdriver (shown at right) that came with your new motor lead to loosen and remove the Motor Lead Screw (position 14) for the ground lead (green/yellow wire).
6. Pull up on the ground lead to remove it. Using a small screwdriver and precision electronics pliers, pry up and remove the Teflon® Washer (position 15) and Brass Washers (position 16) from inside the enlarged Ground Motor Screw (position 13). Remove the Ground Motor Screw.
7. Use an allen wrench (2.5 mm) to remove the two Motor Screws (position 19) holding the Suction Interconnector (position 10) in place. Remove the Suction Interconnector but be very careful to note which of its slots is lined up with which motor lead -- this will be very helpful during reassembly. You may wish to scratch a mark on both the Suction Interconnector and the motor to aid in matching them up later.
8. Refer to the illustration at the bottom of this page. Use the special Motor Lead Screwdriver to loosen and remove the remaining Motor Lead Screws (position 14).
9. Pull up on each of the leads to remove them. Make a note which color conductor comes out of each hole -- **this is a MUST** when installing the new motor lead. Using a small screwdriver and precision electronics pliers, unscrew and remove the Teflon ® Washer (position 15) and the Grommet (position 17).



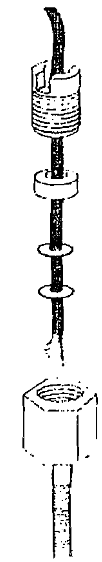
INSTALLING THE NEW MOTOR LEAD

10. Ensure the motor lead holes are clean and free of moisture.
11. String the Inlet Screen (position 1) onto the motor lead.
12. String the motor lead components (shown at right) onto the end of each motor lead wire (except the yellow/green ground wire).
13. For each wire, place the Crimped Pin (position 18) down into the motor lead hole. Press the Grommet (position 17) and Teflon ® Washer (position 15) down around the lead.

Be sure to reconnect the lead wires in their previous pattern so that in clockwise order they are **black-blue-brown** as shown at left.

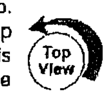


14. While pushing the lead down into the motor lead hole, use the special Motor Lead Screwdriver to tighten the Motor Lead Screw (position 14) into place. Repeat for the other two lead wires.
15. Replace the Suction Interconnector (position 10). Replace the Ground Motor Screw (position 13). Since the ground wire will be attached to this screw, you will want to put it into the hole that will cause the least amount of twisting to the wire.
16. Replace and tighten the two Motor Screws (position 19) with an allen wrench.
17. Repeat steps 12-14 for the ground motor lead. Note on the illustration (at right) that the ground lead uses two Brass Washers (position 16) instead of a Grommet and Crimped Pin.
18. Return the impeller assembly to the top of the Suction Interconnector (position 10). Refer to the diagram on page 11 for the proper sequence.
19. Screw the Pump Housing (position 2) back onto the Suction Interconnector.
20. Position the motor lead in the recessed area of the Pump Housing.
21. Carefully push the Inlet Screen (position 1) over the Pump Housing and the Suction Interconnector.



BE VERY CAREFUL TO AVOID SCRAPING THE INSULATION FROM THE MOTOR LEAD AS THE INLET SCREEN IS FITTED.

22. Line up the screw hole in the Inlet Screen with the screw hole in the Pump Housing. Fit and tighten the Set Screw (position 12).
23. Connect the motor lead to the converter and test the rotation of the pump. Submerge the pump in water, start it at its slowest speed and make sure the pump shaft is turning counterclockwise (when viewed from the top). If the rotation is incorrect, switching any two power leads (with POWER OFF) will correct the problem.



24. Reconnect the hose or pipe.

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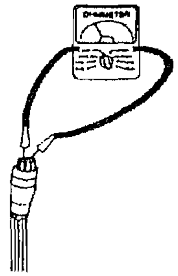
Periodic Motor Inspection

If the pump is operating at a decreased capacity and the impeller assembly components (impellers, guide vanes, etc.) do not appear to be the cause, the motor should be checked. A checklist of things to examine includes:

- Check the fluid level inside the motor (refer to page 6). Replace and refill as necessary.
- Inspect the outside of the motor for cracks, dents, etc.
- Remove the Inlet Screen (position 1), Pump Housing (position 2), and the impeller assembly (guide vanes, wear rings, etc.). Try to spin the motor shaft by hand. It should spin freely. If it does not, the motor must be replaced.
- Check the winding and insulation resistance of the motor and lead.

Winding Resistance



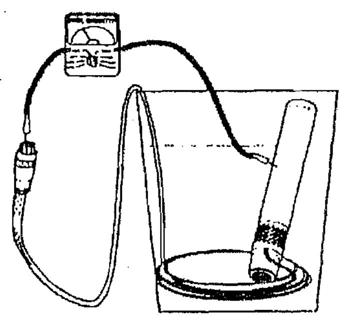
Turn off the power and disconnect the motor lead from the converter. Using an ohmmeter, set the scale to R X 1. Zero-adjust the meter and measure the resistance between any two power conducting leads (prongs on the motor lead plug).

If the ohm value is too low, the motor may be shorted. If too high, the motor windings or the leads may be open.

Lead Length	Ohm Value
0 feet	3.0 - 3.5 Ω
50 ft	3.6 - 4.1 Ω
75 ft	3.9 - 4.4 Ω
100 ft	4.2 - 4.7 Ω
125 ft	4.5 - 5.0 Ω
150 ft	4.8 - 5.3 Ω
175 ft	5.1 - 5.6 Ω
200 ft	5.4 - 5.9 Ω
250 ft	6.0 - 6.5 Ω
300 ft	6.6 - 7.1 Ω

Insulation Resistance

Turn the power off and disconnect the motor lead from the converter. Use a megohmmeter or megger (1 Meg = 1 M = 1 million). Zero-adjust the meter and measure the resistance between any power conducting leads (prongs on the motor lead plug) and ground. A good way to accomplish this (as shown at right) is to submerge the motor lead and MP1 pump in a bucket of water. Touch one lead of the megohmmeter to the pump and one to a motor lead.

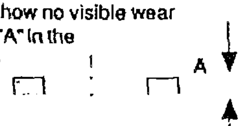


If the ohm value is lower than 2MΩ, the motor is defective and must be replaced.

Checking Components For Wear

The pump components should be periodically checked to ensure they are still within their minimum operating tolerances (illustrated below).

Impeller (position 5) .... The impellers should show no visible wear.
Guide Vane (position 3) .... The guide vanes should show no visible wear
Wear Ring (position 4) .... The minimum thickness ("A" in the illustration) should never be less than 1.0 mm



In addition, visually check all components for cracks, corrosion, or wear.

Storage Requirements

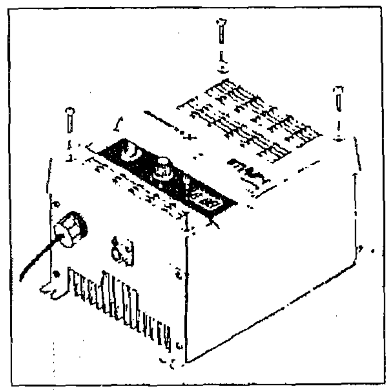
The pump should be thoroughly cleaned before storage to ensure no contamination is present. Both the pump and the converter should be stored in a clean and dry area in the following temperature range:

-20°C to +50°C
or
0°F to 120°F

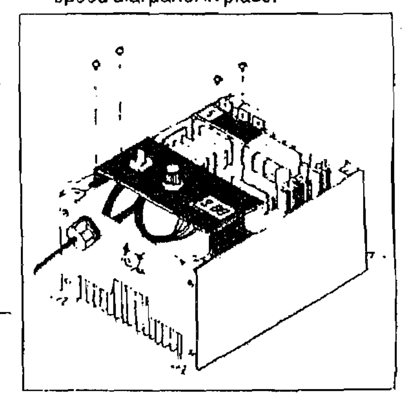
Replacing the Converter Fuses

The converter fuses can be replaced by following these steps:

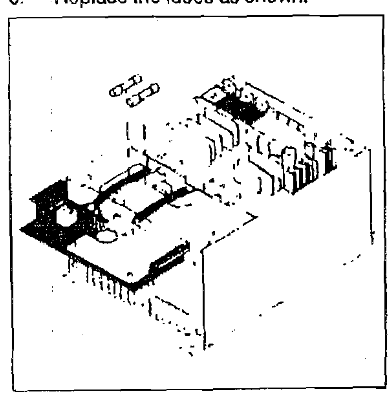
1. Turn the **POWER OFF.**
2. Disconnect the converter from the power source.
3. Wait at least 3 minutes to give the capacitors time to discharge any remaining voltage.
4. Remove the four screws holding the front cover of the converter in place and remove the front cover.



5. Remove the four screws holding the speed dial panel in place.



6. Replace the fuses as shown.



NOTE:
The BTI/MP1 converter uses two T30A, type FERRAZ fuses.

PARTS LIST

Pump Components

Position No.	Part Description	Number Used
1	Inlet Screen	1
2	Pump Housing	1
3	Guide Vane	2
4	Wear Ring	2
5	Impeller	2
6	Spacer Ring	2
7	Wear Plate	2
8	Motor Lead Assembly	4
9	Shaft	1
10	Suction Interconnector	1
11	Stator Housing	1
12	Set Screw	1
13	Ground Motor Screw	1
14	Motor Lead Screw	4
15	Teflon® Washer	4
16	Brass Washer	2
17	Grommet	3
18	Crimped Pin	3
19	Motor Screw	3

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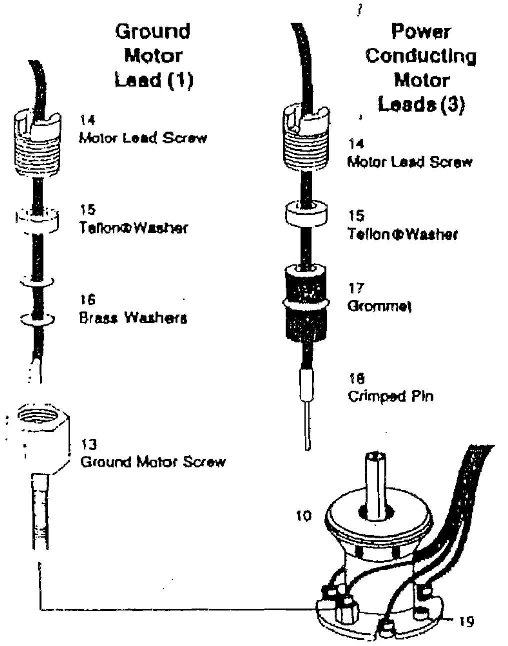
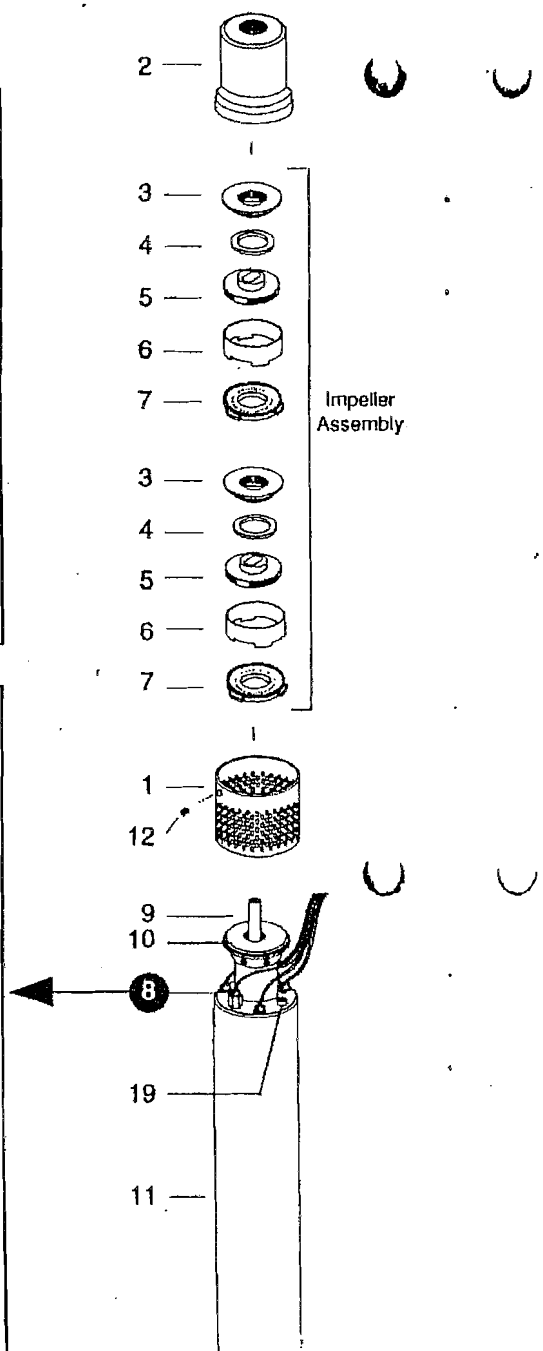
MOTOR LEAD ASSEMBLY (position 8)



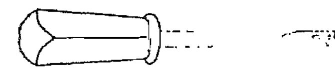


Service Kits, Service Tools, and Motor Leads

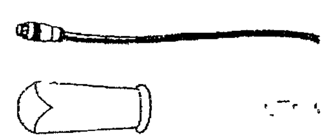
Replacement parts, service tools, and motor leads are available using the following part numbers:

Service Kits: Position No. In Diagram	Part Description	No. In Kit	Part Number
3	Guide Vane	2	125061
4	Wear Ring	2	
5	Impeller	2	
6	Spacer Ring	2	
7	Wear Plate	2	

Service Tools	Part Number
Special Motor Lead Screwdriver	SV0370
Syringe (to refill motor)	ID6066

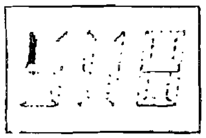
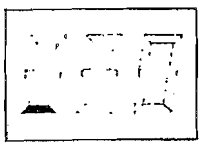
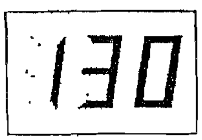
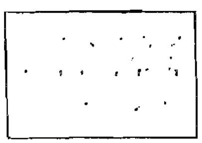


Motor Leads		Part Number
All motor leads come with a Converter Plug attached and a special Motor Lead Screwdriver	50 foot length	1A 5081
	75 " "	1A 5082
	100 " "	1A 5083
	125 " "	1A 5084
	150 " "	1A 5085
	175 " "	1A 5086
	200 " "	1A 5087
	250 " "	1A 5088
	300 " "	1A 5089



TROUBLESHOOTING

The converter will shut itself off if any major faults occur, and signal (on the converter display) the cause of the fault. These include:

If the display shows this:	The fault is:	Which is caused by:	To correct, simply:
	**Function Loss**	• A thermal cut-out or shutdown	Wait until the motor has cooled to a normal temperature. Restart the motor using the on/off switch on the converter.
		• Defective motor lead or pump • Momentary problem (transient fault)	1. Reset the converter and restart it. If it shuts down again, then ... 2. Switch off the power supply. Turn the power supply back on and restart the converter. If the converter shuts down again, the pump or the motor lead may be defective. If the converter **doesn't** shut down again, it was probably a transient fault (momentary power surge, etc.). **IF ALL CHECKS INDICATE THAT THE PUMP IS O.K., THEN THE CONVERTER MAY BE DEFECTIVE**
	**Overvoltage**	• The input voltage is too high • There was a momentary power surge	1. Reset the converter and restart it. If it shuts down again, then ... 2. Reduce the voltage coming into the converter (refer to the "Technical Data" section on the following pages for operating ranges).
	**Low Line**	• The input voltage is too low • There was a momentary voltage drop	1. Reset the converter and restart it. If it shuts down again, then ... 2. Increase the voltage coming into the converter (refer to the "Technical Data" section on the following pages for operating ranges).
	**Power Supply**	The power supply is defective	Check the voltage of the incoming power supply (should be between 190-253 V).
	**Pump Problem** (If numbers climb only to about 50 - 130)	• The pump shaft is locked • One of the 3 motor leads is not making contact with the motor	1. Turn the speed dial to maximum frequency. If this results in a **Function Loss**, follow the troubleshooting instructions listed above. 2. If you **don't** get a Function Loss, the problem is with the converter.
	**No Display = No Power**	• The converter is not being supplied with power • The power being supplied is a very low voltage • The internal fuses are defective	1. Check the amount of the incoming voltage. If it is within allowable limits (190 - 253 V), then ... 2. Flip the generator circuit breaker (if it has one) to the "ON" position. Reset the converter and restart it. If the converter still shows no display, then ... 3. Switch the power supply off. Check the fuses in the converter and replace if necessary. If the fuses are OK, then ... 4. Check the electrical plugs to ensure all connections are made properly.

TECHNICAL SPECIFICATIONS

Converter Specifications

Power

Supplied By Generator/Power Supply

Voltage:	Single phase, 230 volt (+ or - 10%)
Frequency:	50-60 Hz (+ or - 2%)
Maximum Current:	10 amps

Produced By Converter

Output Voltage:	3 phase 25 volts to 3 phase 220 volt
Frequency:	46 - 400 Hz
Maximum Current:	5.5 amps
Internal Fuse:	2 each of T 30 A, type FERRAZ

Connections

Motor Lead Connector:	AMP CPC Plug, Type 206429-1
Power Cable:	Type SJOW, 14 AWG, 10' long

Dimensions and Weight

Dimensions:	Case is 9"x14"x18.5"
Net Weight:	25 lbs

Operating Conditions

Ambient Temperature:	32°F to 104°F (0° to 40° C)
Relative Air Humidity:	Maximum 95%
Radio Noise Filter:	Noise may occur when the converter is connected to the municipal electrical supply. It can be eliminated by adding a filter, such as a Siemens filter, type B 84112-B-A 120/20 A.

Storage Conditions

Ambient Temperature:	-13°F to 149°F (-25° to 65°C)
Relative Air Humidity:	Maximum 50% at 104°F (40°C) unlimited Maximum 90% at 68°F (20°C) for periods not exceeding 30 days per year. 75% annual average Non-condensing

Performance

Acceleration Time:	0 to 400 Hz in 10 seconds
Deceleration Time:	400 to 0 Hz in 10 seconds

Motor/Pump Specifications

Power

Input Power:	1.5 Kw (2 Horsepower)
Voltage:	3 phase, 220 volts at 400 Hz
Maximum Current:	5.5 amps
Motor Protection:	Thermal overload - Thermik Geratebau, Series SY6 Disconnect Temperature: 176°F (80°C) Rate Current: 5 amps Current Overload - Incorporated into converter

Connections

Discharge Port:	1/2" Female NPT
Net Weight:	5.5 lbs (includes pump)
Available Lead Lengths:	50, 75, 100, 125, 150, 175, 200, 250, and 300 feet

Operating Conditions

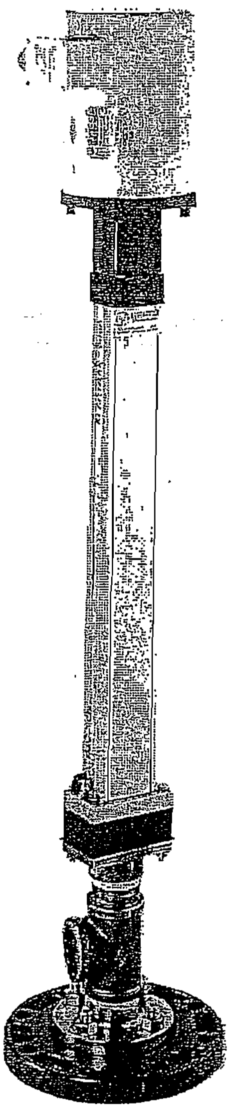
Max. Fluid Temp.:	86°F (30°C)
Min. Fluid Temp.:	34°F (1°C)

Dimensions and Weight

Dimensions:	(Including pump and motor) 11.3"x1.81" diameter
Net Weight:	5.5 lbs.

Installation and Operation Guide

Anchor Electric Piston Pump®



BLACKHAWK®
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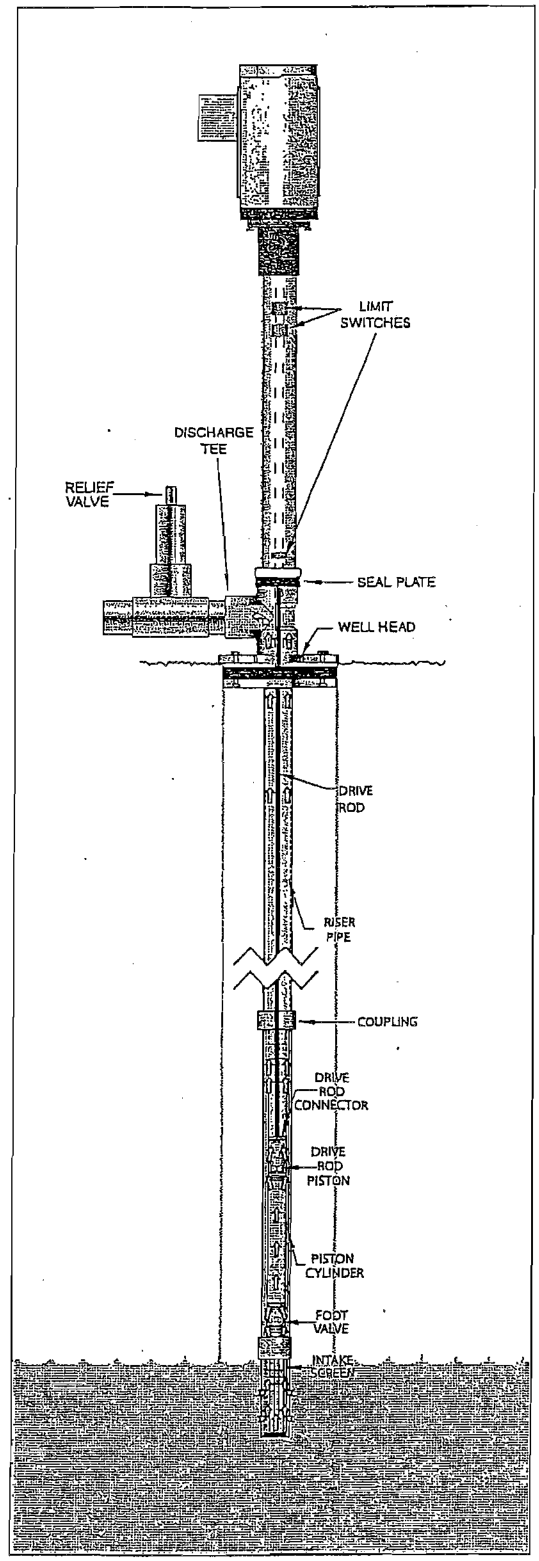
SECTION 1

SHIPMENT INSPECTION

Take an inventory of the components; pump cylinder, top head drive motor assembly, drive rod and piston. This Anchor Pump® should remain in it's shipping carton until it is ready to be installed. You will find a separate pump control box. It should be securely mounted at or near the well.



Installation Materials

1. 10′ rise pipe, NPT Thread on each end

   or

   HDPE riser pipe with stainless steel NPT transition fitting
2. Stainless steel couplings
3. Hoisting cable
4. 12″ Pipe nipple for transition at well seal and discharge tee

Tools for Installation

1. Chained channel lock
2. Pipe wrenches
3. Vice grips
4. 1/2″ Wrench
5. 11/16″ Wrench
6. 5/8″ Wrench
7. Tape measure
8. Water level indicator
9. Hacksaw
10. File and sand paper

SECTION 2

PRE-INSTALLATION CHECKLIST

Before beginning installation, the following checks should be made.

A Condition of the well.

If the pump is to be installed in a new well, the well should be fully developed and bailed or blown free of drill cuttings and pipe casing debris. The construction of the Anchor Pump® makes it resistant to abrasion; however no pump, made of any material, can forever withstand the destructive wear that occurs when constantly pumping sandy fluid. Determine the actual depth of the well, the static water level in the well, and the draw down level at the pumps maximum capacity. The pump selection and setting depth should be based on this data. The inside diameter of the well casing should be checked to ensure that it is not smaller than the pump.

B Condition of the fluid.

Anchor Pumps® are designed for fluids up to 200°F (PV.C pipe up to 140° and steel pipe up to 200°. Fluids can be viscous up to #6 fuel oil, have tar pitch consistency or contain gas.

C Installation Depth.

Place pump one (1) foot above the bottom of the well. Remember not to block pump intake.

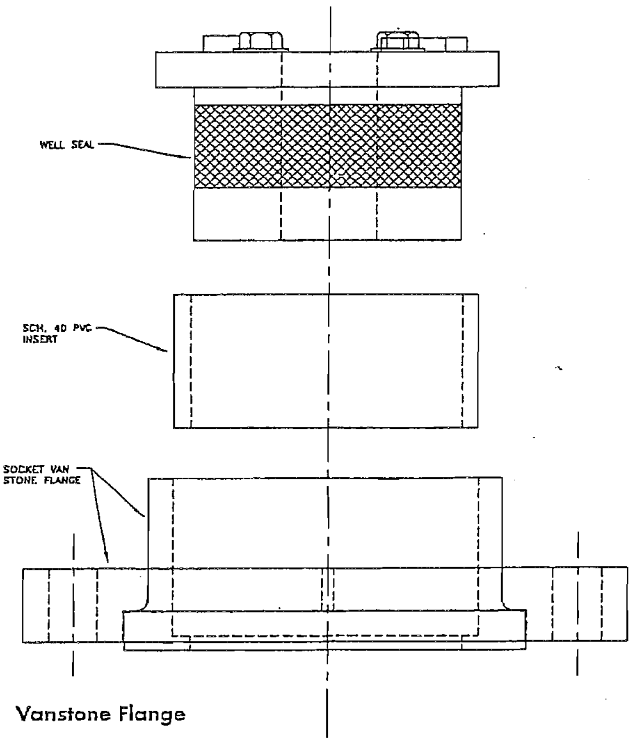
D Power supply.

The drive motor power demand is noted on the name plate of the Anchor Pump® electric motor. Power supply can be 115V, 230V, 1HP or 220V/460V, 3HP. Power is converted by the VFD control to either 230V, 3hp or 460V, 3HP power to run the drive motor.

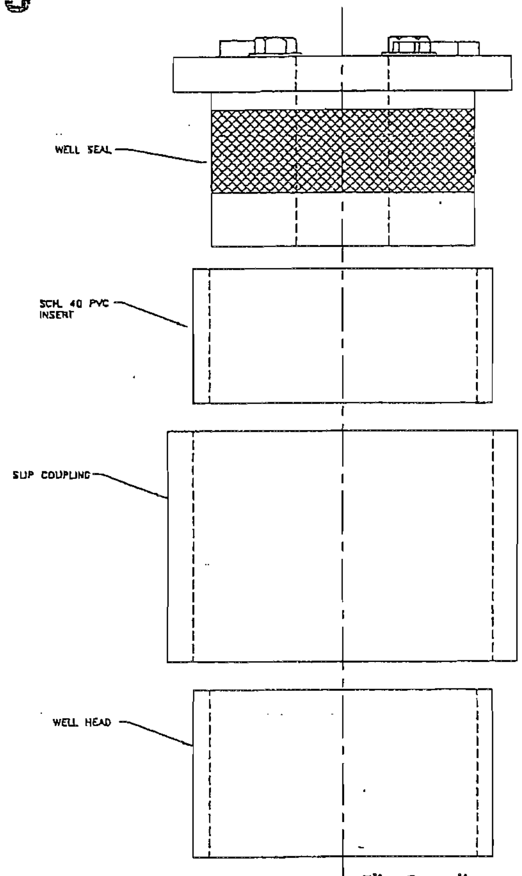
Installation

Step 1

Wellhead Preparation: Three Choices of Wellheads



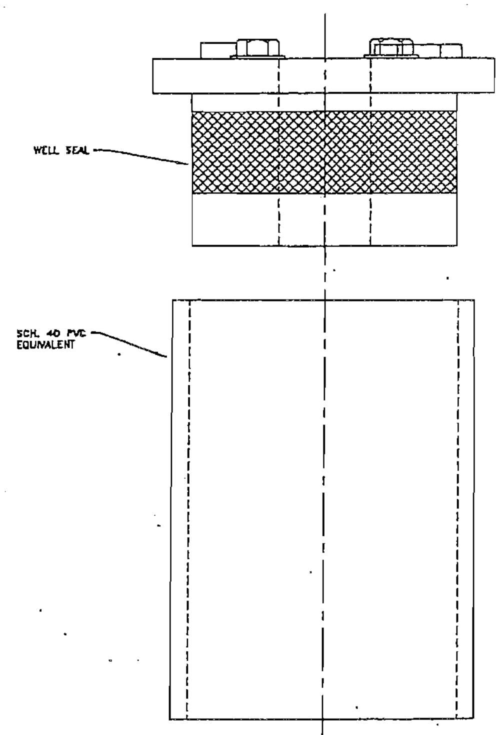
Vanstone Flange



Slip Coupling

Prepare top head well casing by removing all debris, caps or other closures, thus opening well, tank or sump for pump installation. Three typical well casing completions.

*Well casings may be vertical or horizontal.



Well Casing

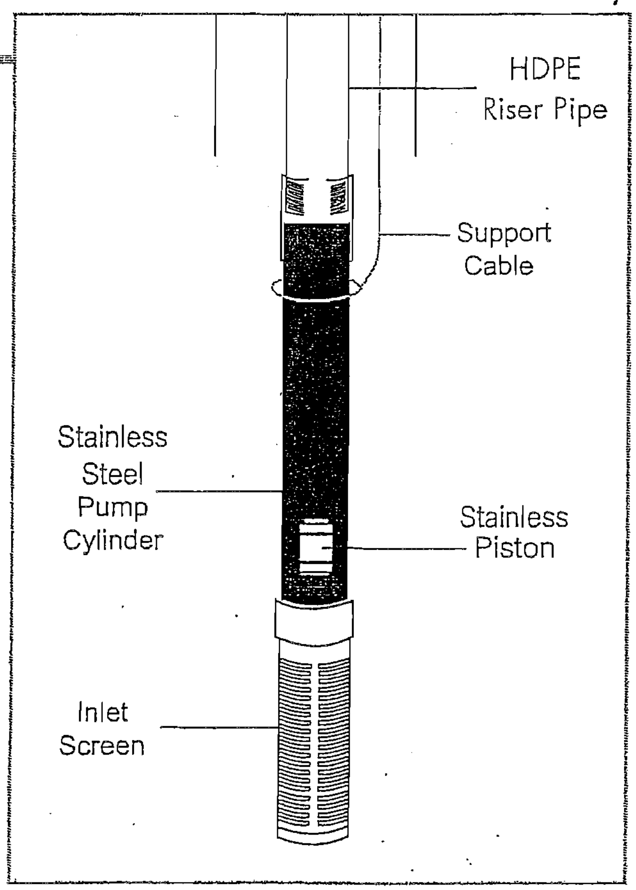
INSTALLATION CONT.

Step 2

ANCHOR PUMP FOOT VALVE CYLINDER INSTALLATION

- Attach foot valve cylinder assembly to bottom section of riser pipe.
- Note: Recommend attaching a support cable.
- Note: If using liquid level control device refer to separate installation sheet.

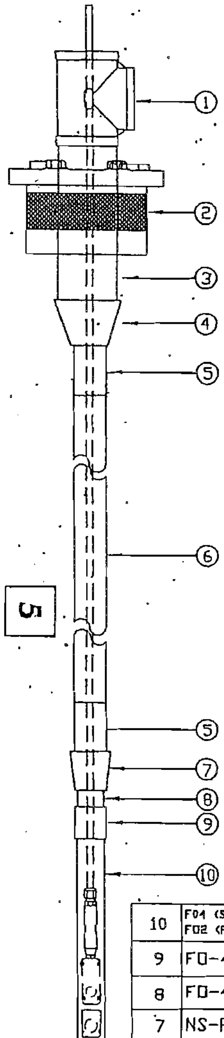
Foot Valve Assembly



NOTE: When using HDPE, make sure the pistons are put in before attaching foot valve to HDPE pipe.

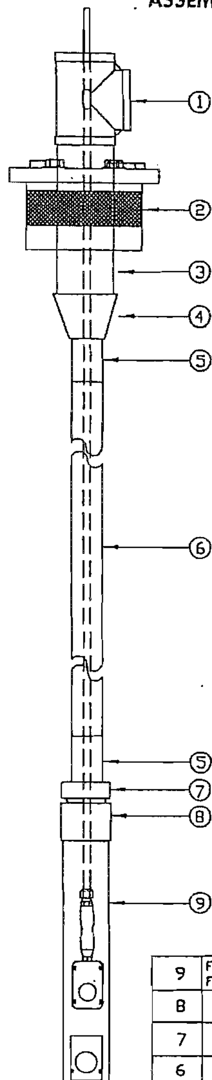
ANCHOR PUMP RISER PIPE INSTALLATION

F125E HDPE PIPE ASSEMBLY



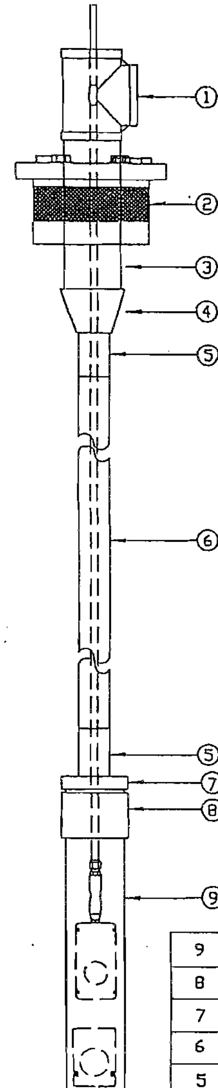
ITEM	PART NUMBER	DESCRIPTION
10	F04 (SS) F02 (PVC)	SS 1 1/4" FOOT VALVE ASSEMBLY PVC 1 1/4" FOOT VALVE ASSEMBLY
9	FD-40-7003	1 1/4" SS COUPLING (SUPPLIED WITH FOOT VALVE)
8	FD-40-7017	1 1/4" SS CLOSE NIPPLE (SUPPLIED WITH HDPE KIT)
7	NS-PD001	1 1/2" X 1 1/4" SS RED COUPLING (SUPPLIED WITH HDPE KIT)
6		1 1/2" HDPE PIPE (NOT SUPPLIED)
5	FD-40-8055	1 1/2" SS HDPE TRANSITION FITTING (SUPPLIED WITH HDPE KIT)
4	FD-40-8056	2" X 1 1/2" SS RED COUPLING (SUPPLIED WITH HDPE KIT)
3	SE-40-7002	2" X 15" SS PIPE (SUPPLIED WITH HDPE KIT)
2		WELL SEAL SIZE VARIES
1	SA-40-7001	SS 2" TEE

F200E HDPE PIPE ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION
9	F24 (SS) F22 (PVC)	SS 2" FOOT VALVE ASSEMBLY PVC 2" FOOT VALVE ASSEMBLY
8	FD-40-7000	2" SS COUPLING (SUPPLIED WITH FOOT VALVE)
7	FD-40-8057	2" X 1 1/2" SS REDUCING BUSHING (SUPPLIED WITH HDPE KIT)
6		1 1/2" HDPE PIPE (NOT SUPPLIED)
5	FD-40-8055	1 1/2" SS HDPE TRANSITION FITTING (SUPPLIED WITH HDPE KIT)
4	FD-40-8056	2" X 1 1/2" SS RED COUPLING (SUPPLIED WITH HDPE KIT)
3	SE-40-7002	2" X 15" SS NIPPLE (SUPPLIED WITH HDPE KIT)
2		WELL SEAL SIZE VARIES
1	SA-40-7001	SS 2" TEE

F300E HDPE PIPE ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION
9	F34 (SS)	SS 3" FOOT VALVE ASSEMBLY
8	FD-40-7004	3" SS COUPLING (SUPPLIED WITH FOOT VALVE)
7	FD-40-8058	3" X 1 1/2" SS REDUCING BUSHING (SUPPLIED WITH HDPE KIT)
6		1 1/2" HDPE PIPE (NOT SUPPLIED)
5	FD-40-8055	1 1/2" SS HDPE TRANSITION FITTING (SUPPLIED WITH HDPE KIT)
4	FD-40-8056	2" X 1 1/2" SS RED COUPLING (SUPPLIED WITH HDPE KIT)
3	SE-40-7002	2" X 15" SS NIPPLE (SUPPLIED WITH HDPE KIT)
2		WELL SEAL SIZE VARIES
1	SA-40-7001	SS 2" TEE

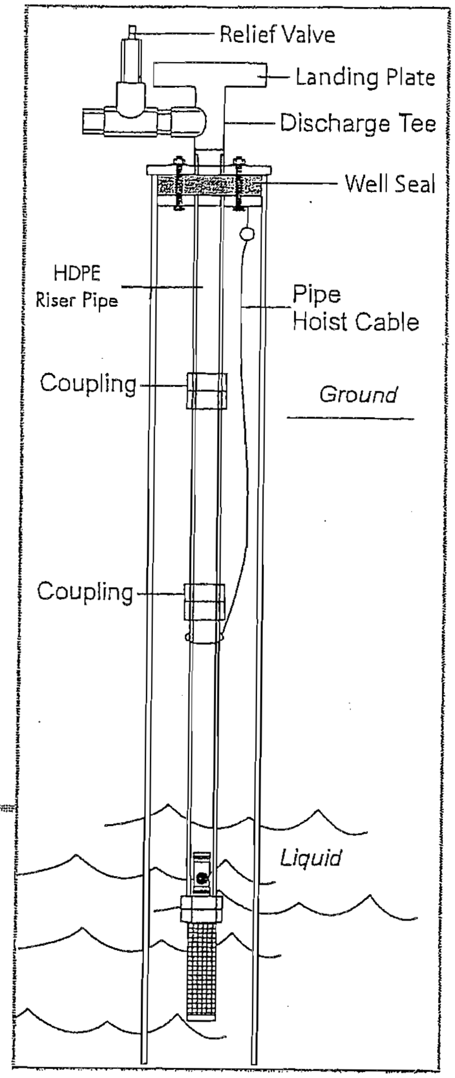
INSTALLATION CONT.

Step 4

ANCHOR PUMP RISER PIPE & WELL CAP INSTALLATION

a. Install all riser pipe until inlet screen is at specified depth and attach well cap onto riser pipe.
b. Attach cable to the bottom of the well cap.
c. Attach well cap to top of wellhead.
d. This riser pipe is to be suspended from the well head, not to be standing on bottom of well, tank or sump.

If using hard riser pipe it is recommended that maximum 10' pipe lengths with NPT Threads on both ends and threaded stainless steel couplings to be used for riser pipe.



Step 5

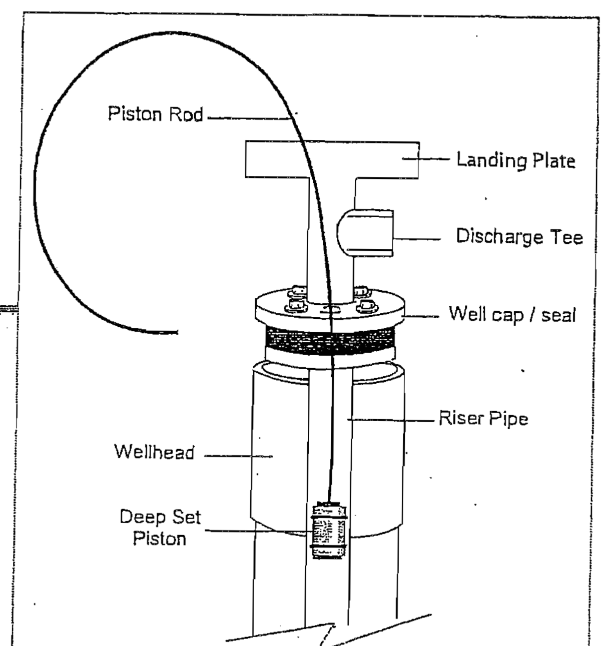
DRIVE ROD/PISTON INSTALLATION

A. Uncoil piston-rod-assembly
(Lay coil out in open area.)
(Caution: Coil under tension!)

B. Attach Drive Piston

C. Slide drive piston down riser pipe to bottom.

Note: Piston will have much more resistance for the final 2-3 ft. of install.

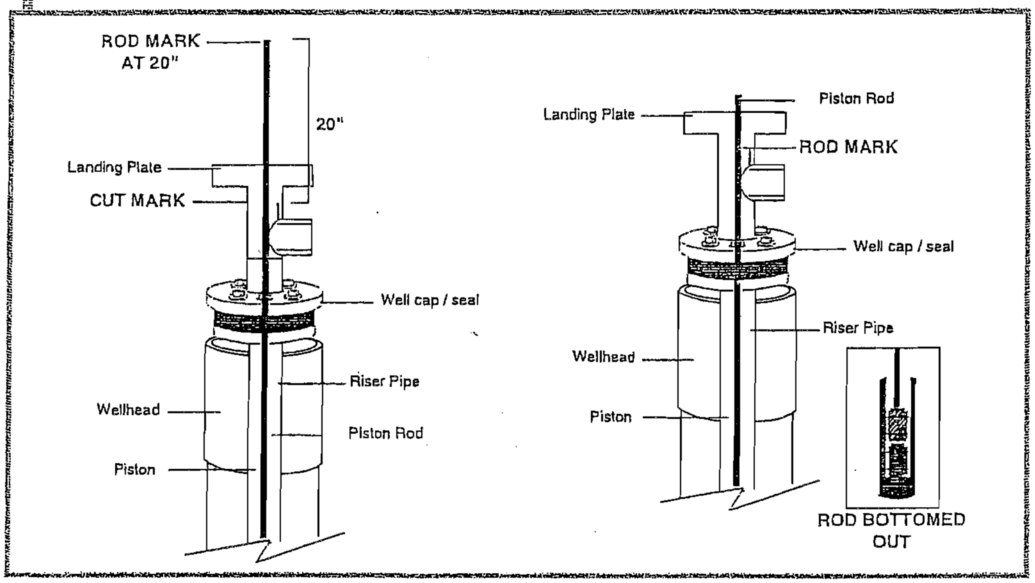


INSTALLATION CONT.

Step 6

CONNECTION OF ROD TO TOP HEAD DRIVE MOTOR ASSEMBLY

Hand pump well by moving the fiberglass drive rod up and down in the downhole foot valve cylinder assembly to ensure that the pump is pumping liquid.



A. Rod bottomed out – Mark rod at top of discharge tee. Clean and sand rod.

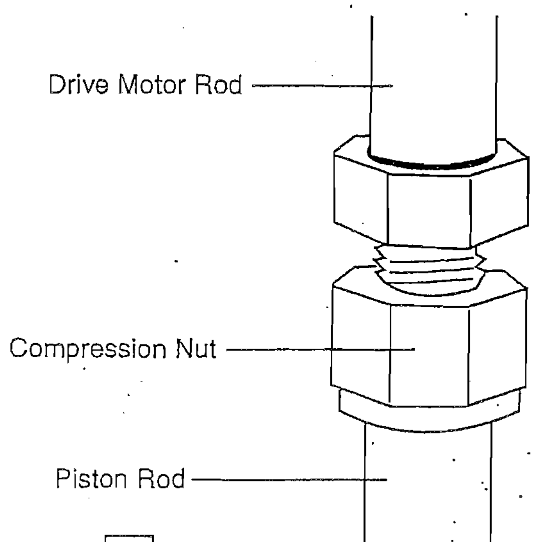
B. Lift rod up and cut 20" below mark.

Step 7

ATTACH COMPRESSION FITTING TO CUT END OF ROD AND SCREW INTO DRIVE MOTOR ROD

Attach ferrule and compression fitting to squared cut end of fiberglass rod. Make sure fiberglass compression ferrule digs deep into fiberglass drive rod to secure fiberglass piston.

A. Cut and square rod.
B. Rough-up finish with sandpaper.
C. Attach compression fitting to cut end of rod and screw into drive motor rod.
D. Excessively tighten nut.
E. Loosen nut to check that ferrule has crimped into rod.
F. Reattach to motor.



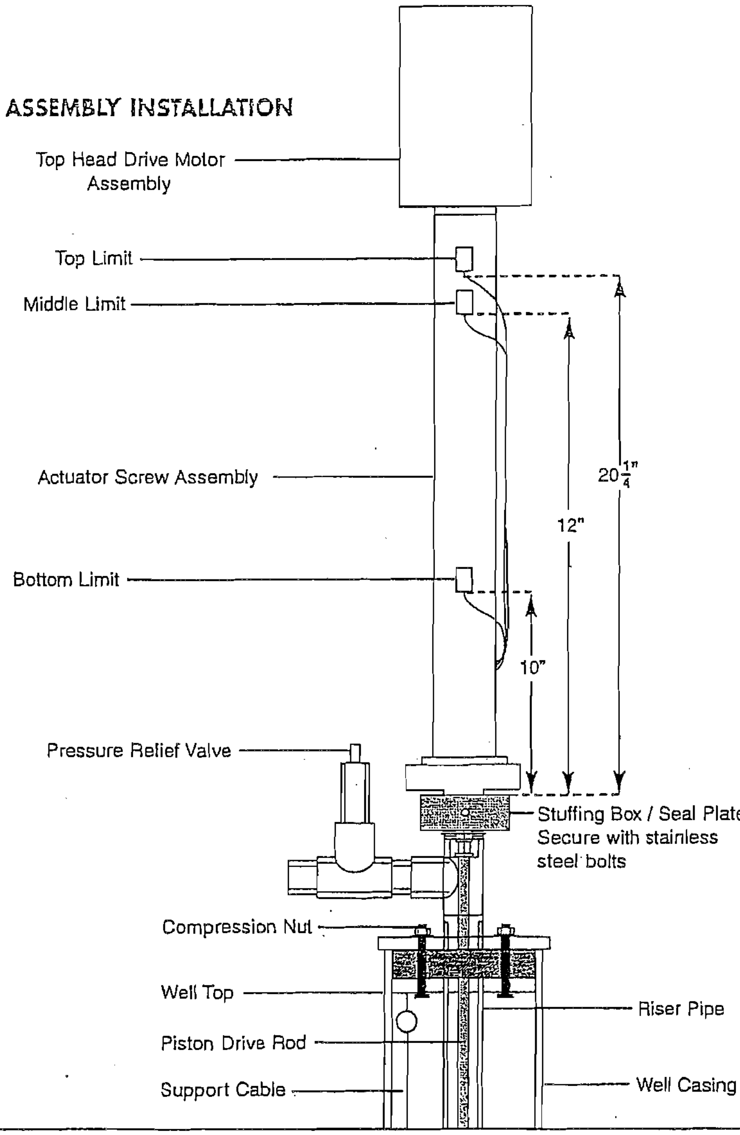
INSTALLATION CONT.

ANCHOR PUMP® TOP HEAD DRIVE MOTOR ASSEMBLY INSTALLATION

Step 8

Note: Before installing drive motor into well, refer to Electrical Control Panel Instructions (Section 5-7).

A. Install top head drive motor assembly onto well top.
B. Secure the well head landing plate with 4 bolts.
C. Attach Power supply/control panel.



SCM SUB-MICRO DRIVE INSTALLATION

LIMIT SWITCH SETUP

LIMIT SWITCH (NOTE 1)	TYPE	DISTANCE FROM TOP OF BASE PLATE TO BOTTOM OF SWITCH	TERMINAL CONNECTION
Bottom	Normally Open	10"	13E
Middle	Normally Open	12"	13A
Top	Normally Open	20.25"	13A

PARAMETER SETTINGS

SPEED	101gpm	102gpm	103gpm	SPM (Strokes per Min.)
60	1.35	3.27	7.37	20.06
50	1.19	2.89	6.53	19.98
40	1.02	2.47	5.58	19.03
30	0.82	1.98	4.47	16.75
20	0.58	1.40	3.16	12.75
10	0.30	0.73	1.65	6.97

SECTION 4

POWER SUPPLY

There are Five Typical Electric Drive Motor Control Panels.

–ELECTRIC DRIVE MOTOR REFER TO SECTION 5 FOR SEPARATE INSTALLATION AND OPERATION SHEET OF THE DRIVE MOTOR AND CONTROL PANEL SUPPLIED FOR JOB.

1. VFD Control only
2. NEMA 4 enclosure - Stop / Start
3. NEMA 4 enclosure - Auto restart, (start on power up.)
4. NEMA 4 enclosure - Auto restart, Level Control, Stroke Counter.
5. NEMA 4 enclosure - Auto restart, High Level Tank Shut Off, Stroke Delay Timer.

*Control Panels can be customized to application.

SECTION 5

ANCHOR ELECTRIC STARTUP

MOTOR ROTATION IS VERY IMPORTANT

Drive Unit not installed yet (The easiest and best way to check for rotation)

1. Set the drive on the ground with at least two feet of room for the rod to move in and out.
2. Pull the rod out by hand at least one foot. If you can not pull the rod out by hand turn the motor counterclockwise till it is extended at least one foot.
3. Make sure power feed is disconnected and wire up the feed and the motor as shown on the schematics. Be sure to connect the feed and motor ground to the drive.
4. Turn the power and drive switch on.
5. If the motor does not move. Read the LOGO! screen:
   - If the screen says **"ALARM HIGH TANK LEVEL"** it will not pump until the high tank level signal is removed.
   - If the screen says **"STROKE DELAY"** see "Changing LOGO! Stroke Delay and Stroke Dwell Time" sheet and set Parameter 11, "TH" to 00:00.
   - If the screen says **"STROKE DWELL"** turn the stroke dwell switch to **OFF**.
   - If the screen says **"LOW LEVEL"** set the Auto/Hand selector switch to Hand mode. This will bypass the level control and the screen should now display **"HAND RUN"**

5. The rod should move in toward the motor first and then cycle out and in. The motor should first rotate clockwise as seen from above the motor.
6. If the rod moves in toward the motor first the rotation is correct. Go to step #9.

continued

7. If the rod moves out away from the motor first the rotation is wrong. Turn the drive switch and the power off. **WAIT THREE MINUTES** Switch two of the motor leads, either at the motor T1 and T3 or U and W at the SUB-Micro (AC Tech). **Do not switch the power feed wires or L1, L2, L3 this will not reverse the rotation.**
8. Return to step #4
9. Turn the drive switch and power off. Connect the sucker rod and install drive unit on the well.
10. If the Auto/Hand selector switch was set to Hand mode reselect the Auto mode. The level control can not work unless the Auto/Hand selector switch is in the Auto mode.

Drive Unit installed on well

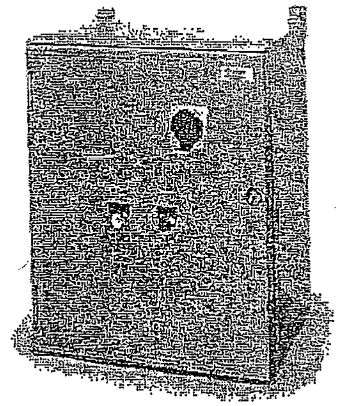
(We do not recommend checking for rotation with the drive Unit installed.)

1. Make sure power feed is disconnected and wire up the feed and the motor as shown on the schematics. Be sure to connect the feed and motor ground to the drive.
2. If it is not possible to see motor rotation, remove any piping from the discharge tee. You will be able to see the rod moving inside the tee.
3. Turn the power and drive switch on. The motor should first rotate clockwise as seen from above the motor.
4. If the motor does not move. Read the LOGO! screen:
   - If the screen says **"ALARM HIGH TANK LEVEL"** it will not pump until the high tank level signal is removed.
   - If the screen says **"STROKE DELAY"** see "Changing LOGO! Stroke Delay and Stroke Dwell Time" sheet and set Parameter 11, "TH" to 00:00.
   - If the screen says **"STROKE DWELL"** turn the stroke dwell switch to **OFF**.
   - If the screen says **"LOW LEVEL"** set the Auto/Hand selector switch to Hand mode. This will bypass the level control and the screen should now display **"HAND RUN"**
5. If the rod moves up first or clockwise the rotation is correct. Go to step #8
6. If the rod moves down first or counter clockwise the rotation is wrong. Turn the drive switch and the power off. **WAIT THREE MINUTES** Switch two of the motor leads, either at the motor T1 and T3 or U and W at the SUB-Micro (AC Tech). **Do not switch the power feed wires or L1, L2, L3 this will not reverse the rotation.**
7. Return to step #3
8. Turn the drive switch and power off.
9. If the Auto/Hand selector switch was set to Hand mode reselect the Auto mode. The level control can not work unless the Auto/Hand selector switch is in the Auto mode.

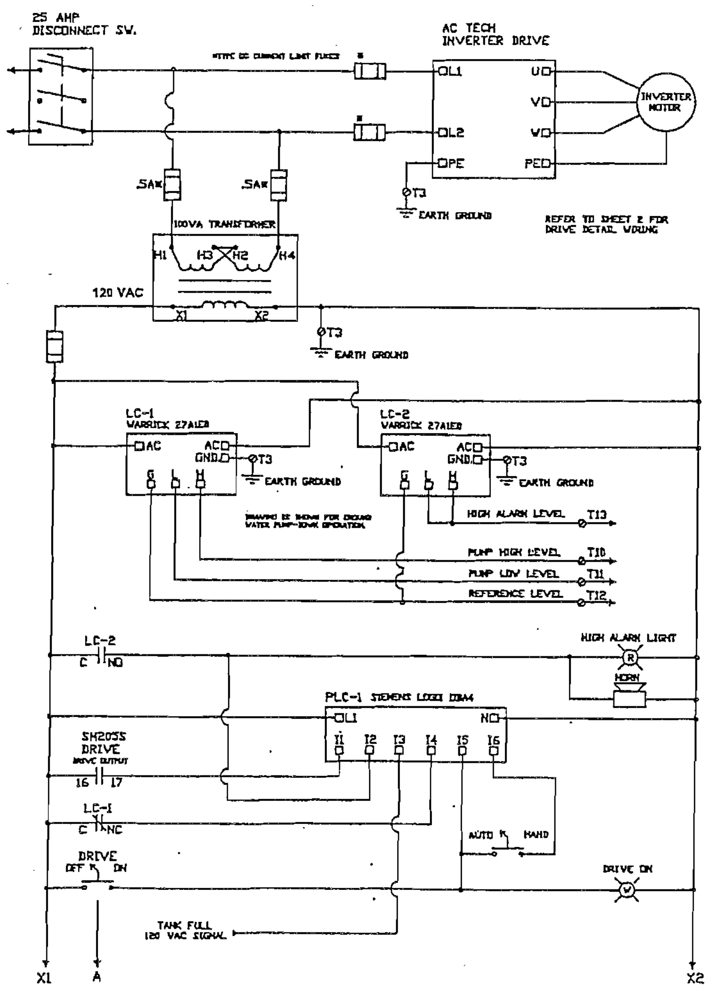
OPERATION

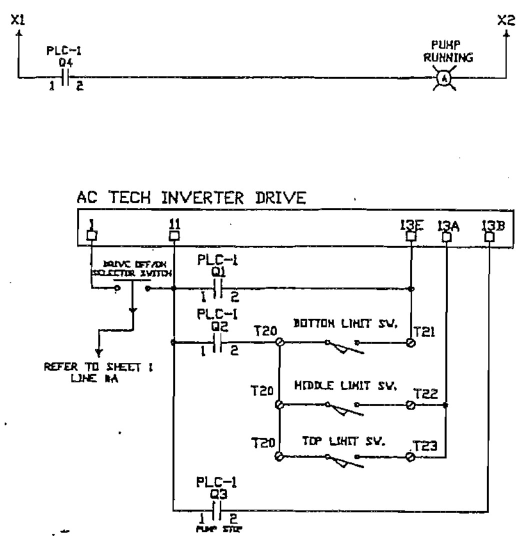
The Anchor Pump® and system should be periodically checked for fluid quality, pressure, drawdown, cycle rate, and performance of the stuffing box.

1. Visually inspect Anchor Pump® operation.
2. Check liquid discharge.
3. Check power connections.
4. Check seal plate relief ports.
5. Check piston seal.
   - Turn off power.
   - Remove power line from drive motor.
   - Disconnect pump driver from wellhead.
   - Disconnect pump driver from drive rod.
   - Extract piston rod from well.
   - Inspect piston seal and, if worn replace.
   - Reinstall.

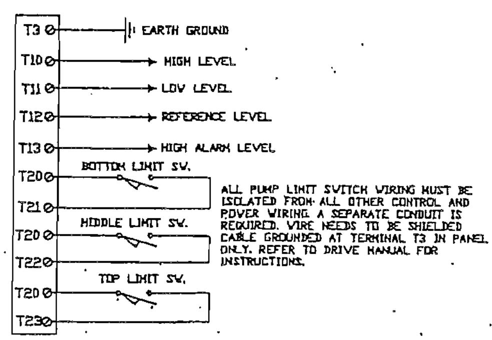


Control Panel

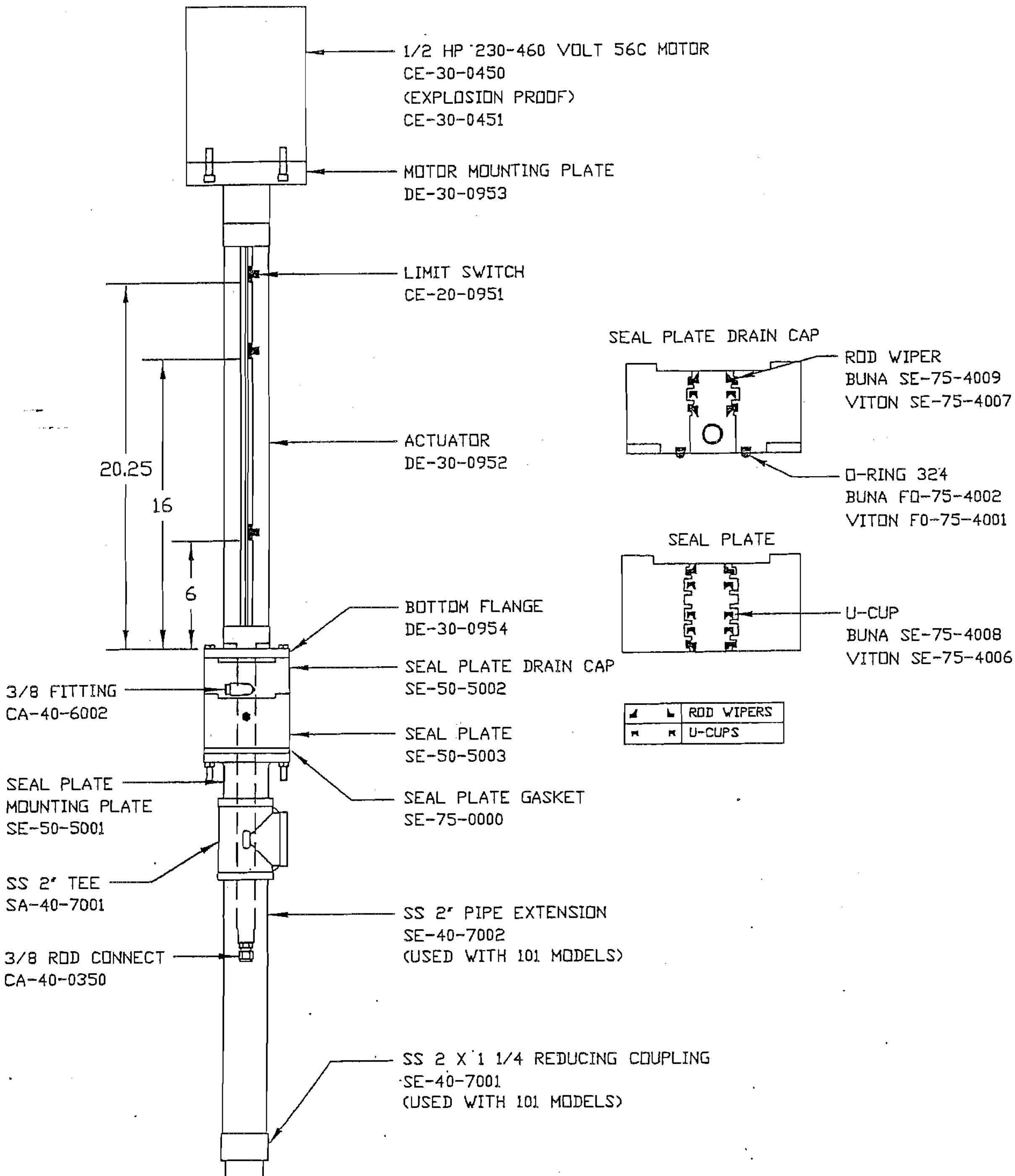




FIELD TERMINAL STRIP CONNECTION SUMMARY



DRIVE MOTOR ASSEMBLY



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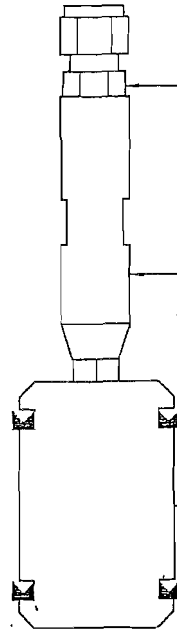
SECTION 8

DRIVE PISTON ASSEMBLY PARTS - SEAL KIT

CHK	ASSEMBLY TYPE	SEAL KIT NUMBER
	101 BUNA	P01DSB
	101 VITON	P01DSV
	102 BUNA	P02DSB
	102 VITON	P02DSV
	103 BUNA	P03DSB
	103 VITON	P03DSV



SECTION 9

Anchor Pump Troubleshooting Guide

OBSERVATION	CAUSE	SOLUTION
- Pump not operating	- No power	- Check to see that power supply is on, and that all connections are sound.
	- Variable Frequency Drive (VFD) fault	- Check VFD fault description in VFD booklet. If unable to get pump operating based upon booklet instructions.
- Electric driver not cycling properly	- Parameter settings or limit switch settings incorrect	- Remove electric driver from discharge tee (or well top). Disconnect down hole drive rod. Lay driver in dry flat space with room for rod to cycle in and out. Run system with provided control panel. If not cycling properly, check the limit switch positions and parameter settings on VFD and adjust if necessary.
- Pump driver operating (cycling), but not pumping liquid	- Restricted liquid discharge	- Check for closed valve, clogged discharge, or any other obstruction. Remove obstruction and restart pump.
	- Intake Plug	
	- Piston drive disconnected	- Reconnect down hole drive rod to electric drive rod. If separated at compression fitting, a replacement drive rod ferrule will be required. (Ferrules cannot be re-crimped.)
	- Drive piston not in pump cylinder	

continued

Anchor Pump Troubleshooting Guide continued

OBSERVATION	CAUSE	SOLUTION
	- Down hole drive rod may have been cut incorrectly - Riser pipe string may have a leak - No liquid at pump intake (down hole) to pump	- Perform inflation (glove) test. Disconnect liquid discharge hose/pipe from pumps discharge tee. Hold latex glove (or other inflatable object) over discharge tee mouth. Seal with a tight grip. Allow pump to operate. - Remove and re-cut or adjust rod length as per installation instructions. - Check pipe connections and check for cracks or leaks. Repair or replace compromised pipe or fittings. - Check to make sure that there is liquid to pump.
- *With drive rod and drive piston out of riser pipe, fill riser pipe with water.* Water drains out quickly	- Foot valve assembly/pipe string not water tight	- Remove riser pipe and footvalve assembly and inspect, replace, and/or repair.
- Water stays in riser pipe *(and drive rod and drive piston have been deemed OK)*	- Foot valve assembly/pump intake may be clogged	- Use drive rod extension poker to displace footvalve check ball and thus back flush foot valve and intake area. - If back flushing does not work, then remove riser pipe and footvalve assembly and inspect, replace, and/or repair.
- Drive rod / drive piston assembly tough to remove from footvalve assembly / riser pipe.	- Pump intake may be clogged	- Follow directions for clogged intake foot valve.
- Pump driver moving erratically when operating.	- Loose connections - Down hole drive rod length incorrect	- Check all connections to be sure they are tight. - Check rod length and adjust as per installation instructions.
- Pumped liquid in driver - Stuffing box drain port leakage.	- Pump driver exposed (submersed) to water - Stuffing box seals worn	- Replace stuffing box seals.

continued

Anchor Pump Troubleshooting Guide continued

CHANGING LOGO! STROKE DELAY AND STROKE DWELL TIME

Stroke delay allows the pump to be off for a time than on for a time (B11; TH and TL). Stroke dwell stops the pump at each up stroke for a given time it is selected by a Short, Medium and Long selector switch.

1. Press the "DOWN ARROW" once or twice to show the date and time.
2. Press "ESC".
3. Press "DOWN ARROW" to select "Set Param".
4. Press "OK".
5. Use the "UP ARROW" and "DOWN ARROW" to select:
   a) "B11" for stroke delay.
   b) "B33", "B34" and "B35" for short, medium or long dwell.
   c) Press "OK".
   d) For stroke delay use the "LEFT ARROW" and "RIGHT ARROW" to move between "TH" (time stopped) and "TL" (time running). Use the "UP ARROW" and "DOWN ARROW" to change the times. The time to the left of the ":" is hours and the numbers to the right of ":" is minutes. "Ta" should be ignored. If you do not wish to use stroke delay set "TH" to 00:00 and "TL" to 99:00.
   e) For stroke dwell use the arrows to move the cursor on "T", the numbers to the left of the ":" are minutes and the number to the right are seconds.
6. Press "OK" when finished.
7. Press "ESC" to get to main screen
8. Press "ESC" again.
9. Press the "UP ARROW" arrow to return to the message screen.

TROUBLESHOOTING SCM ELECTRIC DRIVE

1. Turn on the power and make sure that the LOGO! "Q1" momentary closes 3 seconds after being powered up. "Q2" closes after 4 seconds and "Q3" opens after 5 seconds. If "Q3" does not open after 7 seconds see below:
2. Read the LOGO! screen. If the screen says "ALARM HIGH TANK LEVEL" it will not pump until the high tank level is removed. This can be forced by removing the LOGO! I3 wire. Otherwise if the switch is turned to hand it will run. The LOGO! screen will say what condition the pump is in.
3. If the LOGO! screen says "STROKE DELAY" see "Changing LOGO! Stroke Delay and Stroke Dwell Time" sheet and set Parameter 11, "TH" to 00:00.
4. If the LOGO! screen says "STROKE DWELL" turn the stroke dwell switch to OFF.
5. If the LOGO! screen says "LOW LEVEL", at the Warrick Level control short "G", "L", and "H" together it should run now and it was not running because the water level was not high enough.

continued

TROUBLESHOOTING SCM CONTROL PANELS

Troubleshooting SCM Control Panels

1. Check Motor rotation. The power disconnect to the panel needs to be turned off for three minutes before each test. The correct rotation is clockwise looking at the motor from the top. See "ELECTRIC ANCHOR STARTUP" for details.
2. Turn on the power and make sure the drive switch is on.
3. If there is a wire connected to LOGO! I3 make sure there is not a 110 volt signal to it. This is the TANK FULL input. On panels with OBA4 LOGO!'s they will display "TANK FULL" when there is a signal. If there is a 110 volt signal the pump will not pump until the tank is emptied or the signal removed.
4. If there is a wire connected to LOGO! I4 make sure there is not a 110 volt signal to it. This is the LOW LEVEL input. On panels with OBA4 LOGO!'s they will display "LOW LEVEL" when there is a signal. If there is a 110 volt signal see step 10 for details.
5. Check limit switches for conductivity. Remove wires from terminal blocks in panel and test wires that come from the limit switches. The switches are normally open and close with a signal from a magnet. If limits have conductivity without a signal from a magnet or sporadic conductivity with a signal from a magnet replace limit switches. See actuator drawings for part numbers.
6. Check for 12 VDC at AC-Tech 1, 11, 13E, 13A, and 13B. AC-Tech 2 is the common lead.
7. If there is 12 VDC at 13B the pump will not run. That is the stop signal which comes from LOGO! Q3. Look at LOGO! Inputs.
8. If there is 12 VDC at 13E and 13A the pump will not run. Check limit switch conductivity again. 13E is the start signal from the LOGO! Q1 and the reverse signal from the bottom limit switch. 13A is the reverse signal from the middle and top limit switches. The AC-Tech can not run with two reverse signals.
9. To test the AC-Tech. Turn off the power disconnect to the panel. Label and remove the motor leads from the AC-Tech U, V, W, and PE. Label and remove 13E, 13A, and 13B. Turn on the power disconnect and the drive switch. Using a jumper wire touch 11 to 13E. The AC-Tech should display speed. Using a jumper wire touch 11 to 13A. The AC-Tech should count down then back up to speed. If the AC-Tech tests good turn off power disconnect and reconnect all wires.
10. To test Warrick. Label and remove probe wires from terminals T10, T11, and T12. The NC contact should be sending a 110 volt signal to LOGO! I4. On panels with OBA4 LOGO!'s they will display "LOW LEVEL" when there is a signal. Make sure power and drive switch are on. Jumper terminals on lower part of Warrick G, L, and H all together. The 110 volt signal now should not be at LOGO! I4. Remove the jumper going to H and the signal should still not be at LOGO! I4. Remove the jumper going to L and signal should now be back to LOGO! I4. If the Warrick tests good and Level control does not work properly there is a problem with the probes.

If you still have problems call Blackhawk at 630-469-4916.

LIMITED WARRANTY

Anchor Pumps® manufactured by Blackhawk Environmental Company (Blackhawk) are warranted to the original user only to be free of defects in material and workmanship for a period of 12 months from date of manufacture. Blackhawk's liability under this warranty shall be limited to repairing or replacing at Blackhawk's option, without charge, F.O.B. Blackhawk's factory, any product of Blackhawk manufacture. Blackhawk will not be liable for any costs of removal, installation, transportation, or any other charges which arise in connection with a warranty claim. Products which are sold but not manufactured by Blackhawk are subject to the warranty provided by the manufacturer of said products and not by Blackhawk's warranty. Blackhawk will not be liable for damage or wear to said products by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, or if the product was not installed in accordance with Blackhawk's printed installation and operating instructions.

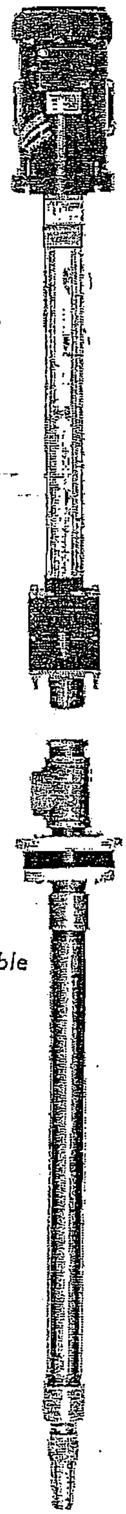
To obtain service under this warranty, the defective product must be returned to Blackhawk together with proof of purchase and installation date, failure date, and supporting installation data. Unless otherwise provided, contact will be made to Blackhawk for instructions prior to return of defective product. Any defective product to be returned to Blackhawk must be sent freight prepaid; documentation supporting the warranty claim and/or a Return Material Authorization must be included if so instructed.

Blackhawk will not be liable for any incidental or consequential damages, losses, or expenses arising from installation, use or any other causes. There are not expressed or implied warranties, including merchantability or fitness for a particular purpose, which extend beyond those warranties described or referred to above.

Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages and some jurisdictions do not allow limitations on how long implied warranties may last. Therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction.

Anchor Electric Piston Pump® Model 101E

Patented Top-Head-Drive Piston Pump



Flow Range
0-1.35 US GPM 5.1 LPM
Operational Depth
804 Ft. 245 M with 1 hp motor
Well Casing Size
Minimum 2 In. 4.85 CM

Description

The Anchor Electric Piston Pump Model 101E is powered by electricity. The control motor is located at surface grade for easy installation and maintenance. Power to the pump is direct from grade through the sucker rod assembly. The pump removes water and product (e.g. oil, solvents, leachate) from a two (2) inch (4.85 cm) diameter well casing or greater to depths of 804 feet (245 meters) with a 1 hp motor. The fluid inlet is located at the bottom of the pump intake cylinder and removes water or product to 0 submergence depth.

Performance and Technical Data

Performance

Operational Depth	804'
Flow Range	0 to 1.35 US GPM / 5.1 LPM 1,900 US GPD / 7,300 LPD
Discharge per Stroke	.05 US Gallons per stroke Note: flow does not vary with depth
Motor	1/2 or 1 hp
Power Supply	120 or 230 Volt Single Phase or 230 or 460 Volt Three Phase
Maximum Discharge Pressure	348 PSI
Maximum Lift	804 feet of water or 348 PSIG Variable speed (stroke) control adjusts to well conditions; liquid drawn down to top of strainer.

Technical

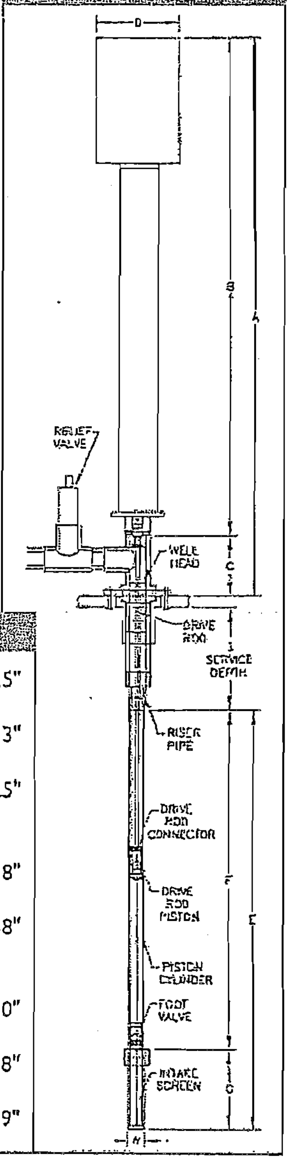
Stroke Length	12" (30.48 cm)
Maximum External Diameter	2.9" (7.37 cm)
Total Cylinder Length	30" (76.2 cm)
Connection of Riser Pipe	1-1/4" (3.18 cm)
Connection to Sucker Rod	7/16" - 20
Recommended Internal Diameter of Bore Hole	2-3" (4.85 - 7.62 cm) or greater diameter
Weight of Cylinder	8 lbs.
Discharge Size	2" NPT
Installation	Unit can be installed vertically or horizontally
Driver Weight	40 lbs.
Driver Rod Weight	12 lbs./100'
Foot Valve Assembly Weight	8 lbs.
Minimum Well Casing Size	2"*

* Up to 1000 feet.

Anchor Electric Piston Pump®

Model 101E

Pump Dimensions



Dimensions (in inches)

A	Above Well Height	48.5"
B	Driver Height	43"
C	Discharge Tee & Well Seal Height	5.5"
D	Driver Diameter	8"
E	Foot Valve Assembly Length	38"
F	Foot Valve Length	30"
G	Intake Screen Length	8"
H	Downhole Diameter	1.9"

Materials of Construction:

(Materials of construction can be modified to meet specific applications)

Above Ground

Drive Motor	Stainless Steel/Aluminum
Seal Plate	Delrin®
Seal Plate Seals	Nitrile/Viton
Relief Valve	Stainless Steel
Discharge Tee	PVC
Well Head	Steel

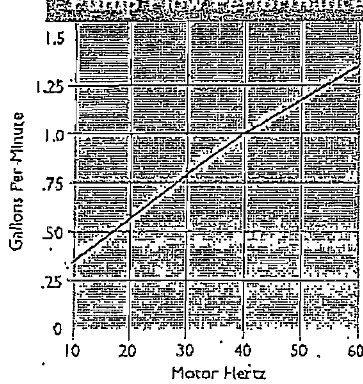
Downhole

Drive Rod	Fiberglass
Drive Rod Connector	Stainless Steel
Drive Piston Seal	Nitrile/Viton
Drive Piston Check Ball	Stainless Steel
Drive Piston	Delrin®
Piston Cylinder	Stainless Steel/PVC
Foot Valve Check Ball	Stainless Steel
Foot Valve	Stainless Steel
Intake Screen	Stainless Steel/PVC

Available Options

- ✓ Level Control Systems
- ✓ Hazardous Duty Components
- ✓ Metered Flow Control
- ✓ Flow Measurement
- ✓ Variable Frequency Drive
- ✓ SCADA Capability

Anchor 101E Electric Pump Flow Performance



* Up to 1000 feet.

BLACKHAWK TECHNOLOGY COMPANY • 21W161 HILL AVE., GLEN ELLYN, IL 60137 • P: 630.469.4916 • F: 630.469.4896
www.blackhawkco.com

ATTACHMENT C

Monthly Volume & pH/Conductance Data Form

WAYNE DISPOSAL SITE #2

LEAK DETECTION SYSTEM PUMPING AND SAMPLING RECORD

DATE:____

MASTER CELL:____________________CELL: ________________

NAME:____

DATE OF LAST READING:______________________________

METER READING PRIOR TO PUMPING:____________________

METER READING AFTER PUMPING:_______________________

SUMP PUMPED DRY? YES__________NO__________

VOLUME PUMPED (gallons):___________________________

SPECIFIC CONDUCTANCE:______________pH______________

CONDITION OF SUMP/METER: __________________________

____

____

____

OTHER COMMENTS (INCLUDE DESCRIPTION OF SAMPLE IF ANY UNUSUAL CHARACTERISTICS ARE OBSERVED) :____________________

____

____

____

____

NOTE: THIS RECORD MUST BE FILED IN QEHS FILES

ATTACHMENT D

Handling Requirements of Monitoring Parameters

Handling Requirements of Monitoring Parameters

Parameter	Code	Perservation	Holding Time	Bottle Type	Minimum Volume
Total Phenolics	PHN	1,2	28 Days	Glass	0.5 L
Sulfate	SO4	2	28 Days	Plastic	50 ml*
Alkalinity	ALK	2	14 Days	Plastic	100 ml*
Chloride	CL-	2	28 Days	Plastic	50 ml*
Nitrate/Nitrite	NPN	1,2	48 Hrs	Plastic	0.5 L
Aluminum	AL	3,5	6 Mos	Plastic	200 ml**
Antimony	SB	3,5	6 Mos	Plastic	200 ml**
Arsenic	AS	3,5	6 Mos	Plastic	200 ml**
Barium	BA	3,5	6 Mos	Plastic	200 ml**
Beryllium	BE	3,5	6 Mos	Plastic	200 ml**
Cadmium	CD	3,5	6 Mos	Plastic	200 ml**
Calcium	CA	3,5	6 Mos	Plastic	200 ml**
Chromium	CR	3,5	6 Mos	Plastic	200 ml**
Chromium, Hexavalent	CR6	2,5	24 Hrs	Plastic	100 ml
Cobalt	CON	3,5	6 Mos	Plastic	200 ml**
Copper	CU	3,5	6 Mos	Plastic	200 ml**
Iron	FE	3,5	6 Mos	Plastic	200 ml**
Potassium	K	3,5	6 Mos	Plastic	200 ml**
Lead	PB	3,5	6 Mos	Plastic	200 ml**
Magnesium	MG	2,3,5	6 Mos	Plastic	200 ml**
Manganese	MN	2,3,5	6 Mos	Plastic	200 ml**
Mercury	HG	3,5	6 Mos	Plastic	200 ml**
Molybdenum	MO	2,3,5	6 Mos	Plastic	200 ml**
Nickel	NI	2,3,5	6 Mos	Plastic	200 ml**
Selenium	SE	3,5	6 Mos	Plastic	200 ml**
Silver	AG	3,5	6 Mos	Plastic	200 ml**
Sodium	NA	3,5	6 Mos	Plastic	200 ml**
Thallium	TL	3,5	6 Mos	Plastic	200 ml**
Tin	SN	3,5	6 Mos	Plastic	200 ml**
Vanadium	VA	3,5	6 Mos	Plastic	200 ml**
Zinc	ZN	3,5	6 Mos	Plastic	200 ml**
pH	pH		Immediate	Plastic	25 ml
Bicarbonate	BAL	2	14 Days	Plastic	100 ml*
Carbonate	CAL	2	14 Days	Plastic	100 ml*
TOC	TOC	7	28 Days	Glass	100 ml
Specific Conductivity	CON	2	28 Days	Plastic	100 ml
Total Cyanide	TCN	2,4	14 Days	Plastic	500 ml
Amenable Cyanide	ACN	2,4	14 Days	Plastic	500 ml
Volatile Organics	VOC	2,6	14 Days	Glass	2x40 ml
PCBs	PCB	2	7 Days-Extraction	Glass	2 L
		2	40 Days-Analysis	Glass	40 ml

1) pH<2 with concentrated Sulfuric Acid
2) Store at 4 degrees centigrade
3) pH<2 with nitric acid
4) pH>12 with sodium hydroxide
5) Filtered in the field using 0.45 micron membrane filters on the time of collection
6) 4 drops HCL, no headspace
7) pH<2 with hydrochloric acid

* Note: One liter for all of these parameters stored similarily
** Note: One liter for all of these parameters stored similarily

ATTACHMENT E

Method Detection Limits for Organic & Inorganic Parameters

METHOD DETECTION LIMITS FOR INORGANIC PARAMETERS

PARAMETER	MDL (mg/L)	METHOD REFERENCE
TOTAL PHENOLICS	0.01	9066
SULFATE	2	ASTM D516-90
TOTAL ALKALINITY	10	2320B
CHLORIDE	1.0	4500-Cl E
NITRATE/NITRITE	0.01	4500-NO3 F
ALUMINUM	0.05	6020/202.2
ANTIMONY	0.001	6020/7041
ARSENIC	0.001	7061/6020
BARIUM	0.005	6010/6020
BERYLLIUM	0.001	6010/6020
CADMIUM	0.0002	6020/7131
CALCIUM	1.0	6010
CHROMIUM	0.001	6010/6020
HEX. CHROMIUM	0.005	7196
COBALT	0.015	6020/6010
COPPER	0.01	6010/6020
IRON	0.02	6010
LEAD	0.001	7421/6020
MAGNESIUM	1.0	6010
MANGANESE	0.005	6010/6020
MERCURY	0.0002	7470
MOLYBDENUM	0.025	6010/6020
NICKEL	0.002	6010/6020
POTASSIUM	0.1	6010
SELENIUM	0.001	7741/6020
SILVER	0.0002	6020/7760
SODIUM	1.0	6010
THALLIUM	0.002	6020/7841
TIN	0.2	6010/6020
VANADIUM	0.002	6010/6020
ZINC	0.01	6010/6020
pH	N/A	150.1
BICARBONATE	10	2320B
CARBONATE	10	2320B
TOTAL CYANIDE	0.005	4500-CN G
CYANIDE	0.005	4500-CN G
TOTAL ORGANIC CARBON	0.2	5310C
SPEC. CONDUCTANCE	5 (umhos/cm)	2510B

Note: Detection limits meet those in MDEQ Operational Memo Gen-8 Revision 8 - 12/22/06. This table should be revised in the event Op Memo Gen-8 is updated

References:
Methods referenced from TEST METHODS FOR EVALUATING SOLID WASTE, USEPA SW-846, STANDARD METHODS FOR THE EXAMINATION OF WATER AND WASTEWATER, 20th Edition, and USEPA METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTEWATER, 3/83 and METHODS FOR ORGANIC ANALYSIS OF MUNICIPAL AND INDUSTRIAL WASTEWATER, 10/84

METHOD DETECTION LIMITS - ORGANIC ANALYSIS

Parameter	Method Reference	Detection Limit (mg/l)
Acetone	8260B	0.020
Bromodichloromethane	8260B	0.001
Bromoform	8260B	0.001
Bromomethane	8260B	0.005
Carbon tetrachloride	8260B	0.001
Chlorobenzene	8260B	0.001
Chloroethane	8260B	0.005
2-Chloroethylvinyl Ether	8260B	0.010
Chloroform	8260B	0.001
Chloromethane	8260B	0.001
Dibromodifluoromethane	8260B	0.001
1,2 Dichlorobenzene	8260B	0.001
1,3 Dichlorobenzene	8260B	0.001
1,4 Dichlorobenzene	8260B	0.001
Dichlorodifluoromethane	8260B	0.001
1,1-Dichloroethane	8260B	0.001
1,2-Dichloroethane	8260B	0.001
1,1-Dichloroethene	8260B	0.001
1,2-Dichloroethene	8260B	0.001
1,2 Dichloropropane	8260B	0.001
cis-1,3 Dichloropropene	8260B	0.001
trans-1,3 Dichloropropene	8260B	0.001
1,1,1,2, Tetrachloroethane	8260B	0.001
1,1,2,2, Tetrachloroethane	8260B	0.001
Tetrachloroethene	8260B	0.001
1,1,2-Trichloroethane	8260B	0.001
1,1,1-Trichloroethane	8260B	0.001
Trichloroethene	8260B	0.001
Trichlorofluoromethane	8260B	0.001
Vinyl Chloride	8260B	0.001
Methylene Chloride	8260B	0.005
2- Butanone (MEK)	8260B	0.005
Benzene	8260B	0.001
Toluene	8260B	0.001
Ethylbenzene	8260B	0.001
Total Xylenes	8260B	0.003
PCB-1016	8082	0.0001
PCB-1221	8082	0.0001
PCB-1232	8082	0.0001
PCB-1242	8082	0.0001
PCB-1248	8082	0.0001
PCB-1254	8082	0.0001
PCB-1260	8082	0.0001

Note: Detection limits meet those in MDEQ Operational Memo Gen-8 Revision 8 - 12/22/06. This table should be revised in the event Op Memo Gen-8 is updated

Reference: Methods referenced from TEST METHODS FOR EVALUTION SOLIDS WASTE, USEPA SW-846

ATTACHMENT F

Chain-of-Custody

TriMatrix Laboratories, Inc.

5560 Corporate Exchange Court SE Grand Rapids, MI 49512
Phone (616) 975-4500 Fax (616) 942-7463
www.trimatrixlabs.com

Chain of Custody Record

COC No. 115809

Page ____ of ____

For Lab Use Only

Cart

VOA Rack/Tray

Receipt Log No.

Project Chemist

Laboratory Project No.

Client Name	Project Name
Address	Client Project No. / P.O. No.
	Invoice To ☐ Client ☐ Other (comments)
Phone	Contact/Report To
Fax	

Analyses Requested

PRESERVATIVES
- A NONE pH~7
- B HNO_3 pH<2
- C H_2SO_4 pH<2
- D 1+1 HCl pH<2
- E NaOH pH>12
- F ZnAc/NaOH pH>9
- G MeOH
- H Other (note below)

Container Type (corresponds to Container Packing List)

Test Group	Matrix Code	Laboratory Sample Number		Sample ID	Cooler ID	Sample Date	Sample Time	COMP	GRAB	Matrix	Number of Containers Submitted										Total	Sample Comments
			1																			
			2																			
			3																			
			4																			
			5																			
			6																			
			7																			
			8																			
			9																			
			10																			

Sampled By (print)	How Shipped? Hand Carrier________	Comments
Sampler's Signature	Tracking No.	

Company	1. Relinquished By Date Time	2. Relinquished By Date Time	3. Relinquished By Date Time
	1. Received By Date Time	2. Received By Date Time	3. Received For Lab By Date Time

ATTACHMENT G

Statistical Program for the LDCRS

Attachment G - LDCRS Statistical Monitoring Plan

STATISTICAL EVALUATION

The statistical program for LDCRS monitoring utilizes Nonparametric Prediction Limits (NPPLs) to evaluate the monitoring data. In order to balance false positive and statistical power with this test, resamples are used, the number of which are determined by the number of sampling points and the number of background observations. Since there is no "upgradient" in the LDCRS system, and there was no substantial pre-waste disposal sampling program, the definition of background is not defined in a traditional sense. Thus the use of resamples is selected somewhat arbitrarily (see below).

The NPPL is defined as the highest concentration of a monitoring parameter detected in a background sample. For parameters that are never detected in the background, the NPPL is defined as the reported detection limit. Since the parameters to be analyzed statistically are all organic compounds, the reported detection limit, as listed on Attachment E of the LDCRS Sampling and Analysis Plan are the NPPLs. Therefore, any reported concentration of an Attachment F parameter at or above these limits is considered an apparent statistically significant increase.

If an Attachment E compound is detected, then the NPPL been exceeded and WDI will immediately notify the Waste Management Division (WMD) of the Michigan Department of Environmental Quality (MDEQ) and arrange resampling as soon as possible to confirm or refute the apparent statistically significant increase. Quadruplicate samples will be collected for confirmation purposes and analyzed for the offending parameter(s). Since these quadruplicates are not independent samples, it does not constitute a multiple resampling as defined by the NPPL test. Thus the quadruplicate samples constitute a single resampling. If three of the four quadruplicate samples are clean, then the statistical increase is not confirmed. If two or more of the quadruplicates contain the compound of interest the apparent increase will be deemed confirmed and WDI shall respond in accordance with the current Operating License.

Attachment 15

Lysimeter Monitoring Program Sampling and Analysis Plan

Section 30

LYSIMETER MONITORING SAMPLING AND ANALYSIS PLAN

WAYNE DISPOSAL SITE #2 HAZARDOUS WASTE LANDFILL
MID 048 090 633

REVISION 2.0 – January, 1995
REVISION 2.1 – May, 1999
REVISION 2.2- October 2000
REVISION 2.3 – October 2009

LYSIMETER MONITORING SAMPLING AND ANALYSIS PLAN

WAYNE DISPOSAL SITE #2 HAZARDOUS WASTE LANDFILL
MID 048 090 633

REVISION 2.0 – January, 1995
REVISION 2.1 – May, 1999
REVISION 2.2- October 2000
REVISION 2.3 – October 2009

1.0 INTRODUCTION

The following sampling and analysis plan outlines the procedures to be used for the collection and analysis of samples from the suction lysimeters present beneath the hazardous waste management areas (HWMA) of Master Cells V and VII at Wayne Disposal Site #2 Hazardous Waste Landfill. The lysimeter monitoring program functions as an early leak detection program beneath the lowest point (leachate collection sumps) of the HWMA subcells within these Master Cells. There are ten lysimeters in place. They were installed as five pairs so that adequate volume could be extracted for samples at each location. Pairs are located beneath cells V-B, VII-A, VII-B and VII-C (2 pairs identified as VII-C west and VII-C east). The locations of the lysimeters are shown on Figure 1.

This sampling and analysis plan has been prepared to direct the efforts of monitoring personnel in the collection and analysis of samples so as to meet the requirements of Michigan Act 451, Part 111 for the facility and to ensure sound practices for the collection of these data. This plan must be revised if there are any changes to the procedures contained herein. Any proposed changes must be submitted to the Waste & Hazardous Materials Division (WHMD) of the Michigan Department of Environmental Quality (MDEQ) for review and approval before the changes are implemented..

2.0 DESCRIPTION OF EQUIPMENT

The lysimeters were placed beneath the cell by angle drilling at an angle of approximately 65° from vertical to a depth approximately 50 feet below ground surface and at least 5 feet below the lowest point of the bottom of the cell. A drawing of a typical installation is shown on Figure 2. The suction lysimeter system consists of a lysimeter, which takes in the moisture from the surrounding soil, vacuum tubing, and because of the depth, a transfer vessel at mid-depth. The lysimeters were manufactured by Timco Manufacturing and are composed entirely of Teflon™, as is the tubing and transfer vessel. There is a 2-inch PVC casing attached to the transfer vessel. The "sand-pack" placed around the lysimeter is a silica flour slurry. The whole system is cased in a 6-inch steel casing to within four feet of the lysimeter assembly. Bentonite pellets were used to seal the lysimeter and silica pack from possible seepage from above. At the surface there are three lines with stop-cocks: (one with a pressure gauge) for pressurizing the lysimeter, one to pressurize the transfer vessel and one for transmitting the sample.

3.0 SAMPLE COLLECTION PROCEDURES

Samples of the water collected by the lysimeters are collected on a semi-annual basis. The sampling process involves applying a vacuum to the system to draw moisture into the lysimeter, transferring the water from the lysimeter to the transfer vessel and then applying pressure to the transfer vessel to drive the sample to the surface. This is generally a 3-day process. During the first day, check to make sure the gauge is in working order. Then, set the initial vacuum by opening the stop-cock on the line with the pressure gauge and applying 10-20 psi using a hand pump. Close the stop-cock. On the second day, repeat this process. To sample the system on the third day, hook-up a breathable quality compressed air tank or nitrogen tank to the line with the gauge. Open the stop-cocks on each line. Apply about 8-10 psi for 2-3 minutes. Hook-up the compressed gas tank to the transfer vessel pressure line and apply 25-30 psi. The sample will be discharged from the sample line. Collect the samples and close the stopcocks. Samples from pairs may be composited if insufficient sample is collected from a single lysimeter.

Protective gloves must be worn during sample collection and care should be taken to ensure minimal agitation/aeration of the samples. The vials must be filled completely with zero head-space. Each sample container must be carefully labeled with the sampling location, time and date, and the sampler's initials. After collection, the samples must be stored in a clean cooler containing ice or ice packs. The coolers containing samples must be stored in a secure location until transport to the laboratory.

A field blank must be collected with each lysimeter sample collected. A trip blank must be maintained for each day the lysimeters are sampled. Due to the difficulty in getting enough sample for analysis, duplicate samples are not collected for the lysimeter monitoring program.

A chain of custody form must be filled out for each sampling event. This form must be filled out fully for each sample submitted for analysis and each person responsible for the handling of these samples must sign and date the form. When the samples are delivered to the laboratory and the lab has signed for their receipt, a copy of this form must be forwarded to the QEHS Department.

4.0 SAMPLE ANALYSIS

Each sample must be analyzed for the parameters listed on Figure 3, which also contains the analytical methods and targeted method detection limits. Laboratory Quality control frequencies and precision/accuracy requirements are provided in the Quality Assurance Manual for the current contract laboratory, TriMatrix Laboratories, which is contained in the Groundwater Sampling and Analysis Plan for this facility. This manual describes the internal policies, guidelines and procedures of TriMatrix. This manual is not intended to describe the specific details of this particular monitoring program. Rather, we are to use this document as a guideline in evaluating the current laboratory's QA/QC and standard operating procedures to ensure that generally acceptable practices are employed.

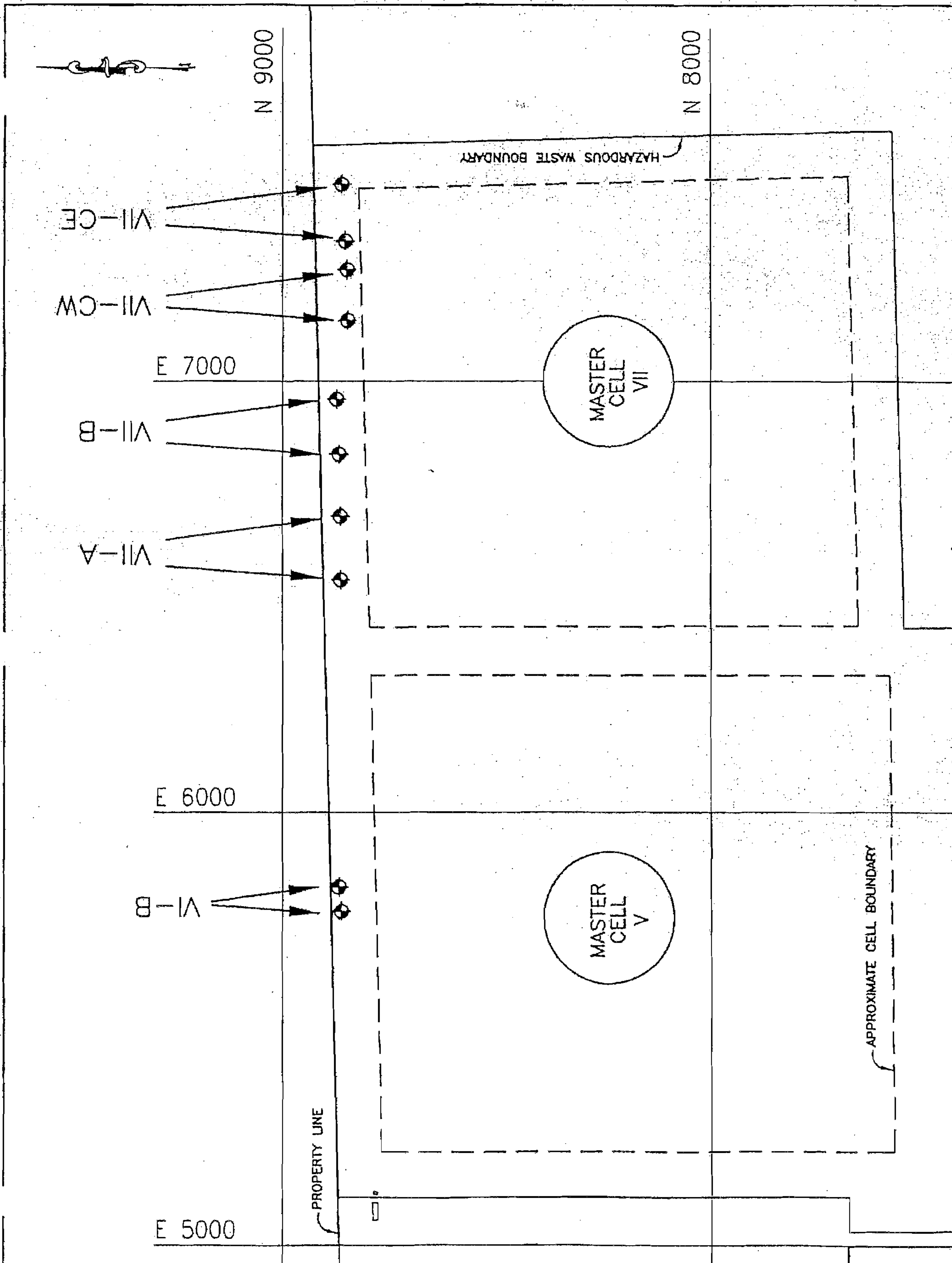
5.0 RECORD KEEPING AND INSPECTION REQUIREMENTS

There are two items required to ensure adequate record keeping for the lysimeter monitoring program. First, the lysimeter sampling and inspection log (Figure 4) must be filled out at each sampling location during each sampling event. The log must include the identity of sampling personnel, the dates and time when samples are collected, a description of the sampling event, and any pertinent observations of sample characteristics or sampling environment. In addition, this form must be used to record an inspection of the lysimeter outlet including the pressure gauges, stopcocks and the outer protective casing. Second, a chain of custody form must be filled out for each sampling event, as described above. This form must be filled out fully for each sample submitted for analysis and each person responsible for the handling of these samples must sign and date the form.

6.0 DATA EVALUATION AND REPORTING REQUIREMENTS

The data must be received from the laboratory, evaluated and transmitted to the MDEQ within 60 days of sampling. The statistical analysis of the data is identical to that for the LDCRS monitoring program and is provided as Attachment A. An apparent statistically significant increase identified by the statistical test must be reported to MDEQ within 24 hours. An apparent statistically significant increase must be confirmed or refuted by resampling. In general, the lysimeters do not recharge for at least several months. Any lysimeter yielding an apparent statistically significant must be resampled within 3 months unless insufficient sample can be collected. If there is insufficient sample within 3 months this result must be reported to MDEQ along with a schedule for attempting the next sample. . Confirmed statistically significant increases must also be transmitted immediately to the MDEQ.

The semi-annual reports must include a description of the sampling event, a summary of field and laboratory QA/AC information, the field logs and a summary of any non-compliances or maintenance performed.



THE ENVIRONMENTAL QUALITY COMPANY	LOCATION: WAYNE DISPOSAL SITE #2		TITLE: LYSIMETER LOCATION PLAN
	SCALE: 1" = 300'	DATE: 10/11/95	FILENAME: WDS2LYS

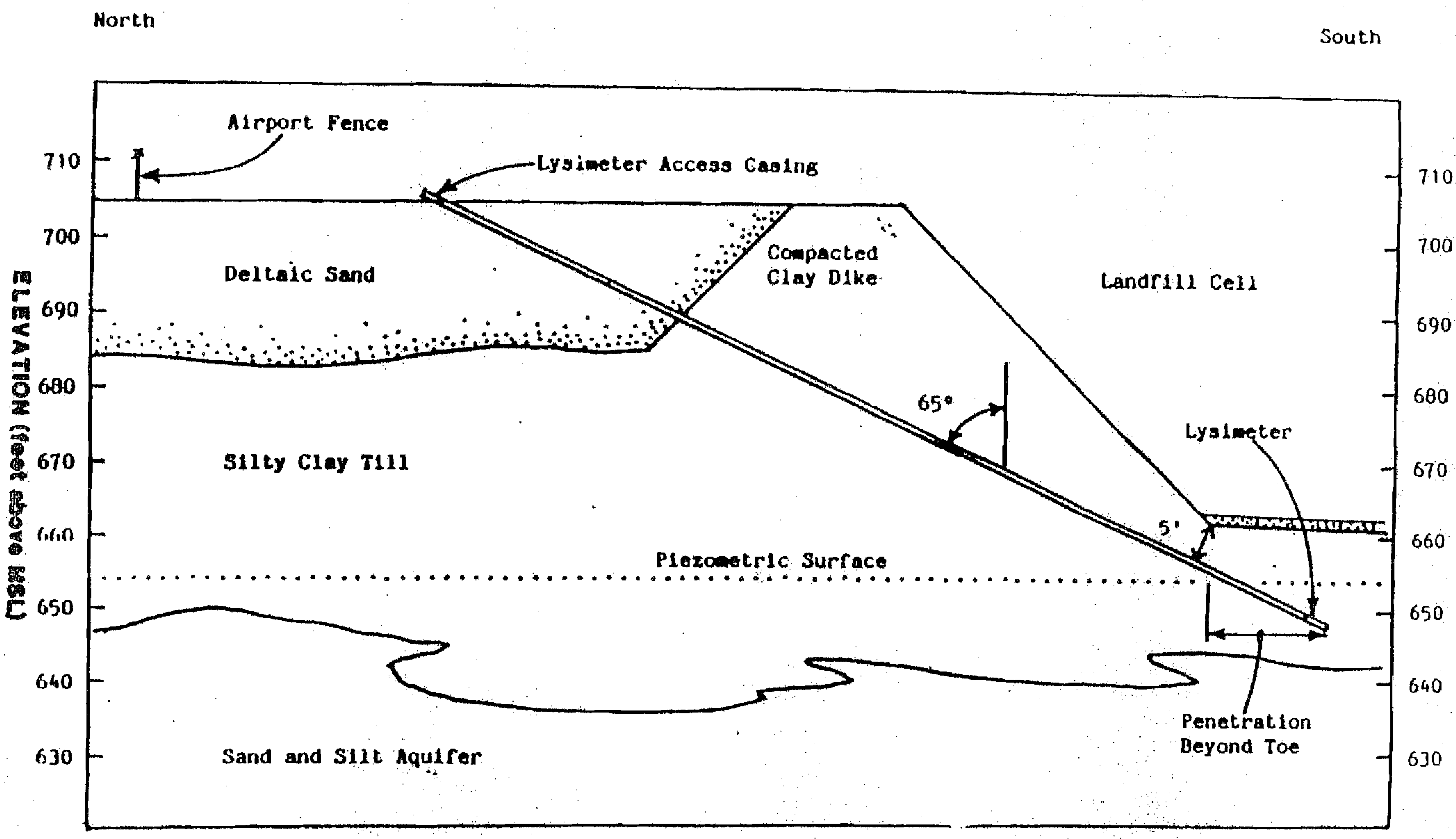


Figure 2

Lysimeter Installation Geometry at Wayne Disposal.

(HORIZONTAL NOT TO SCALE)

FIGURE 3. METHOD DETECTION LIMITS - ORGANIC ANALYSIS

Parameter	Method Reference	Detection Limit (mg/l)
Acetone	8260B	0.020
Bromodichloromethane	8260B	0.001
Bromoform	8260B	0.001
Bromomethane	8260B	0.005
Carbon tetrachloride	8260B	0.001
Chlorobenzene	8260B	0.001
Chloroethane	8260B	0.005
2-Chloroethylvinyl Ether	8260B	0.010
Chloroform	8260B	0.001
Chloromethane	8260B	0.001
Dibromodifluoromethane	8260B	0.001
1,2 Dichlorobenzene	8260B	0.001
1,3 Dichlorobenzene	8260B	0.001
1,4 Dichlorobenzene	8260B	0.001
Dichlorodifluoromethane	8260B	0.001
1,1-Dichloroethane	8260B	0.001
1,2-Dichloroethane	8260B	0.001
1,1-Dichloroethene	8260B	0.001
1,2-Dichloroethene	8260B	0.001
1,2 Dichloropropane	8260B	0.001
cis-1,3 Dichloropropene	8260B	0.001
trans-1,3 Dichloropropene	8260B	0.001
1,1,1,2, Tetrachloroethane	8260B	0.001
1,1,2,2, Tetrachloroethane	8260B	0.001
Tetrachloroethene	8260B	0.001
1,1,2-Trichloroethane	8260B	0.001
1,1,1-Trichloroethane	8260B	0.001
Trichloroethene	8260B	0.001
Trichlorofluoromethane	8260B	0.001
Vinyl Chloride	8260B	0.001
Methylene Chloride	8260B	0.005
2- Butanone (MEK)	8260B	0.005
Benzene	8260B	0.001
Toluene	8260B	0.001
Ethylbenzene	8260B	0.001
Total Xylenes	8260B	0.003

Note: Detection limits meet those in MDEQ Operational Memo Gen-8 Revision 8 - 12/22/06. This table should be revised in the event Op Memo Gen-8 is updated

Reference: Methods referenced from TEST METHODS FOR EVALUTION SOLIDS WASTE, USEPA SW-846

Figure 4. Lysimeter Sample Collection and Inspection Log - WDI Site #2

Sample ID:	Sample Date:	Sample Time:
Sample Location:	**Sampling Method:**	**Sampler:**
Sample Description/Comments*:		
Inspection Items: (indicate by checkmark if OK, comment if not)		
Pro-Casing:____________	Gauge:_______________	Stopcocks:_________________________

Sample ID:	Sample Date:	Sample Time:
Sample Location:	**Sampling Method:**	**Sampler:**
Sample Description/Comments*:		
Inspection Items: (indicate by checkmark if OK, comment if not)		
Pro-Casing:____________	Gauge:_______________	Stopcocks:_________________________

Sample ID:	Sample Date:	Sample Time:
Sample Location:	**Sampling Method:**	**Sampler:**
Sample Description/Comments*:		
Inspection Items: (indicate by checkmark if OK, comment if not)		
Pro-Casing:____________	Gauge:_______________	Stopcocks:_________________________

Sample ID:	Sample Date:	Sample Time:
Sample Location:	**Sampling Method:**	**Sampler:**
Sample Description/Comments*:		
Inspection Items: (indicate by checkmark if OK, comment if not)		
Pro-Casing:____________	Gauge:_______________	Stopcocks:_________________________

* Note clarity of samples and any color, sheen, odor or other relevant characteristics of the sample

Attachment A
Statistical Analysis

Attachment A – Lysimeter Statistical Monitoring Plan

INTRODUCTION

The following statistical monitoring plan provides a description of the statistical procedures used for identifying a statistically significant increase of monitoring parameters in the lysimeter monitoring program at WDI. The program is intended to provide an early warning that hazardous waste constituents may be penetrating the liner systems of cells V-B, VII-A, VII-B and VII-C East and VII-C West.

STATISTICAL EVALUATION

The statistical program for lysimeter monitoring utilizes Nonparametric Prediction Limits (NPPLs) to evaluate the monitoring data. In order to balance false positive and statistical power with this test, resamples are used, the number of which are determined by the number of sampling points and the number of background observations. Since there is no "upgradient" in the lysimeter network, and there were pre-waste disposal samples collected from these devices, the definition of background is not defined in a traditional sense. Thus the use of resamples is selected somewhat arbitrarily (see below).

The NPPL is defined as the highest concentration of a monitoring parameter detected in a background sample. For parameters that are never detected in the background, the NPPL is defined as the reported detection limit. Since the parameters to be analyzed statistically are all volatile organic compounds, the reported detection limit, as listed on Figure 3 of the Lysimeter Sampling and Analysis Plan are the NPPLs. Therefore, any reported concentration of a Figure 3 parameter at or above these limits is considered an apparent statistically significant increase.

If a Figure 3 compound is detected, then the NPPL been exceeded and WDI will immediately notify the Waste Management Division (WMD) of the Michigan Department of Environmental Quality (MDEQ) and arrange resampling as soon as possible to confirm or refute the apparent statistically significant increase. Quadruplicate samples, if there is sufficient volume, will be collected for confirmation purposes and analyzed for the offending parameter(s). Since these quadruplicates are not independent samples, it does not constitute a multiple resampling as defined by the NPPL test. Thus the quadruplicate samples constitute a single resampling. If three of the four quadruplicate samples are clean, then the statistical increase is not confirmed. If two or more of the quadruplicates contain the compound of interest the apparent increase will be deemed confirmed and WDI shall respond in accordance with the current Operating License.

Attachment 16

Sedimentation Basin Monitoring Program Sampling and Analysis Plan

Section 31

SEDIMENTATION BASIN SAMPLING AND ANALYSIS PLAN

WAYNE DISPOSAL, INC., SITE #2 MID 048 090 633

REVISION 3.0 – MARCH, 1996
REVISION 3.1 – MAY, 1999
REVISION 3.2 – OCTOBER 2000
REVISION 3.3 – MARCH 2001
REVISION 3.4-JULY 2002
REVISION 3.5 – DECEMBER 2008
REVISION 3.6 – SEPTEMBER 2011

SEDIMENTATION BASIN SAMPLING AND ANALYSIS PLAN

WAYNE DISPOSAL, INC., SITE #2 MID 048 090 633

1.0 INTRODUCTION

This Sedimentation Basin Sampling and Analysis (SB SAP) plan identifies the procedures to be used for monitoring sediment samples from the north sedimentation basin (NSB), the south sedimentation basin (SSB), and, after it is constructed, the northwest sedimentation basin (NWSB) at Wayne Disposal, Inc. (WDI), Site 2. The sedimentation basins receive on-site surface water (storm water) run-off primarily from unpaved areas and final cover systems of the facility via a network of open ditches and subsurface pipes. The sedimentation basins do not receive run-off from active hazardous waste disposal cells. All surface water collected in the sedimentation basins is treated by sedimentation, filtration and activated carbon adsorption prior to discharge to Quirk Drain. The effluent from this treatment process is discharged into Quirk Drain in accordance with a National Pollutant Discharge Elimination System (NPDES) permit. This monitoring program is one of the checks on the engineered controls and operational procedures employed by WDI to detect an on-site release of hazardous waste or hazardous waste constituents as early as possible and allow WDI to initiate efforts to locate and control the source and prevent the off-site release of hazardous waste or waste constituents.

The monitoring program described in this SB SAP is designed to monitor the chemical quality of the sediments that have accumulated in the bottom of each basin over time. Monitoring the composition of certain parameters within the sediment is done to determine if hazardous waste or hazardous waste constituents are present. This monitoring program is one of the checks on the engineered controls and operational procedures employed by WDI to detect an on-site release of hazardous waste or hazardous waste constituents as early as possible and allow WDI to initiate efforts to locate and control the source and prevent the off-site release of hazardous waste or hazardous waste constituents. The SB SAP, in addition to describing the monitoring program prompts notification and response actions that WDI must take if an apparent or confirmed significant increase in a monitored parameter occurs.

2.0 REVISION

WDI may revise this SB SAP and submit the revised plan to the Chief of the Waste and Hazardous Materials Division of the Michigan Department of Environmental Quality (WHMD/MDEQ) for review and approval prior to implementation.

3.0 SAMPLE LOCATIONS

Each sedimentation basin is divided into six sections as shown in Figures 1, 2 and 3 for the SSB, NSB and NWSB, respectively. One grab sample is collected at random locations within each section of each basin during each sampling event. The locations for each sampling point are to be measured using a GPS or equivalent method and the coordinates listed on the sample log (Figure 3) included in this plan.

4.0 SAMPLE FREQUENCY

All sedimentation basins are to be sampled on an annual basis. The sampling event will include the SSB, NSB and the NWSB (after construction) and should be scheduled in the spring at approximately the same time each year.

5.0 SAMPLE COLLECTION

For each basin, a grab sample is to be collected from each section of each basin shown in Figures 1, 2, and 3. In addition, a representative composite sample from each basin is to be created by combining equal portions from each grab sample from the basin. Sufficient volume of sediment must be collected at each grab sample location such that there is adequate volume to 1) perform the required grab sample analysis, 2) contribute a portion to the composite sample and 3) have enough left over sample to used by the laboratory for a confirmation of an apparent statistically significant increase of PCBs, if necessary. Confirmation procedures are specified in Section 8.0 of this document.

The individual grab samples from each section of each basin are to be collected from a small rowboat utilizing a Ponar grab-type sampler or an auger sampler with an extension. The person conducting the sampling will position the boat at one of the sampling locations, lower the sampling device and retrieve a sample. The sample will then be removed from the sampler and placed directly into the appropriate container using a clean Teflon hand trowel. The composite sample from each respective basin is to be collected by placing equal volumes of collected sediment from each individual grab sample location within the respective basin into a stainless steel bowl or disposable foil pan. After equal portions from all grab sample locations from the respective basin have been collected and placed into the bowl/pan, the sediment in the bowl is to be gently mixed to homogenize the sample, and then placed into an appropriate container.

Clean protective gloves must be worn during sample collection and clean gloves must be used at each sample location. Care should be taken at all times when handling the samples to avoid sample cross-contamination. Each sample container must be labeled with the sampling location, the time and date of the sampling event, and the sampler's initials. The sample collection log (Figure4) is to be filled out at each sampling location and any unusual conditions (e.g. odors, sheens) encountered are to be noted. In addition, a chain of custody (COC) form is to be filled out for each sampling event. The COC is to be filled out fully for each sample submitted for analysis and each person handling the samples must sign and date the form. When the samples are delivered to the laboratory and the laboratory has signed for their receipt, a copy of this form is to be retained on site in the Quality, Environment, Health and Safety (QEHS) Department records. After collection, the samples are to be stored in a clean cooler containing ice or ice packs. The coolers containing samples are to be stored in a secure location, until being transported to the laboratory.

All non-dedicated sampling equipment is to be thoroughly cleaned and decontaminated between sample locations by scrubbing with a brush and rinsing with de-ionized water to remove all visible soil/sediment material.

Field Quality Assurance/Quality Control samples collected for each sampling event, including confirmation sampling events, include:

- One trip blank for each cooler utilized for storing and shipping PCB samples. The trip blank is to be analyzed for PCBs.
- One blind duplicate for each sampling event. The duplicate sample is to be analyzed for the identical set of parameters as the samples. The duplicate is to be collected by filling an identical set of sample containers at a given location and submitting them for an identical analysis.
- One equipment blank per sampling day for each piece of non-dedicated sampling equipment utilized in the sampling process (i.e. sample collection tool/ponar and/or composite sample collection bowl/foil pan). The equipment blank is to be collected by pouring clean de-ionized water over the decontaminated piece of equipment and collecting the rinsate in the appropriate container for analysis. The equipment blank is to be analyzed for the identical set of parameters as the samples.

6.0 SAMPLE ANALYSIS

Each grab sample from the SSB, NSB and NWSB is to be analyzed for the parameters listed in Table 1 identified as grab sample parameters. The analytical methods and method detection limits specified are also listed on Table 1. Each composite sample from each basin is to be analyzed for all of the PCB aroclors listed on Table 1 using the analytical methods and method detection limits specified. In addition, all grab samples must also be extracted for PCB analyses but only analyzed if necessary as confirmation samples per Section 8.0. In some cases, the laboratory may not attain the method detection limits specified due to sample dilutions and matrix effects. If this is the case, the laboratory report must include an explanation for not achieving the specified method detection limits.

The laboratory quality control/quality assurance manual (QA/QC Manual) describing the required internal policies, guidelines and procedures of any WDI contract lab is contained in the Groundwater Sampling and Analysis Plan (GW SAP). WDI is to use this QA/QC Manual in evaluating the QA/QC standard operating procedures of any contract laboratory utilized for the purposes of this SB SAP and ensure that the laboratory employs generally acceptable practices that meet the specifications of the QA/QC Manual in the GW SAP.

7.0 DATA EVALUATION

The analytical data from the sedimentation basin samples is to be evaluated as follows:

- For a SSB or NWSB PCB composite sample, an apparent statistically significant increase (ASSI) has occurred if the total concentration of the PCB compounds listed in Table 1 is greater than or equal to 1 mg/kg on a dry-weight basis.
- For a NSB PCB composite sample, an ASSI has occurred if the total concentration of the PCB compounds listed in Table 1 is greater than or equal to the method detection limit.
- For metals, phenols (all sedimentation basins), and total and amenable cyanide (south and northwest sedimentation basins only), the data will be evaluated using graphical trend analysis. An ASSI for any parameter has occurred if increasing concentrations are noted for any individual parameter in four consecutive sampling events and/or a ten-fold increase in concentration is noted in any parameter between sampling events in any of the

individual grab samples. If four consecutive samples show increasing concentrations, WDI must determine the difference between the first and fourth sample concentrations and determine if this quantity is greater than 10 percent of the mean of the concentration of those four measurements for that parameter. If the difference is greater than 10 percent of the mean then an ASSI is reported. If the difference is less than 10 percent of the mean then no ASSI will be reported.

8.0 RESPONSE ACTIONS

In the event of an ASSI, WDI is to verbally notify WHMD/MDEQ, Hazardous Waste Program Section staff immediately, give them an opportunity to split confirmation samples, and implement the procedures identified below to confirm the ASSI. Confirmation samples must be collected and submitted for analysis within 7 days of providing notification of an ASSI.

- For the composite PCB samples, procedures to determine if a CSSI has occurred are as follows. The additional grab samples collected in each section of the basin that were sent to the lab and extracted are to be analyzed for PCBs. If any of the grab samples for which PCBs are detected are above the action levels defined in Section 7.0 (i.e. the ASSI is repeated), then a CSSI will have been confirmed for that section of the basin that the grab sample represented.
- For the metals, total and amenable cyanide, and phenols grab samples, procedures to determine if a confirmed statistically significant increase (CSSI) has occurred are as follows. Any section of the basins for which an ASSI is reported for metals, total and

amenable cyanide, and/or phenols is to be resampled by collecting four additional samples within the section of the basin with the ASSI. If the concentrations in two of the four confirmation samples are equal to or greater than the original sample, then the increase is a confirmed statistically significant increase (CSSI).

In the event an ASSI is not repeated, WDI will resume routine monitoring. In the event an ASSI is repeated upon analyzing the second sample, a confirmed statistically significant increase (CSSI) has occurred. In the event a CSSI has occurred, WDI must notify WHMD/MDEQ in accordance with the General Operating Conditions of the Operating License for reporting noncompliance that may endanger human health or the environment. Further, within 30 days of becoming aware of a CSSI, WDI must implement the following actions depending upon the CSSI parameter and the CSSI location:

- For a metals CSSI in either basin and/or a phenolics, total cyanide, or amenable cyanide CSSI in the SSB or NWSB, submit a work plan for WHMD review and approval to delineate the extent of contamination in the basin, identify and eliminate the source of the contamination, and determine if concentrations are sufficiently elevated to require removal of sediments from the impacted basin. Guidance regarding determining whether or not removal of contaminated sediments is required is provided in Attachment 3 of the Remediation and Redevelopment Division's (RRD) Operational Memorandum No 4.
- For a PCB CSSI in the SSB or NWSB, submit a work plan to delineate and/or remove sediments from the impacted basin for the WHMD/MDEQ review and approval.

- For a PCB CSSI in the NSB, immediately implement a source assessment program by collecting quarterly grab samples for PCB analysis from each respective section of the basin for a minimum of one year and perform a trend analysis using the data.
  - If PCBs are detected above a concentration of 1 mg/kg in any individual sediment grab sample during any quarterly sampling event, submit a work plan within 30 days of the detection to delineate and/or remove sediments in the impacted basin for WHMD review and approval. In addition, WDI will submit to the WHMD/MDEQ for review and approval a work plan that provides for additional storm water sampling and analysis to identify the source of the PCBs in the NSB sediments and, depending upon the results from the additional storm water monitoring, recommend actions to eliminate the source and/or conduct additional source investigation.
  - If the PCB results from the required quarterly sampling are less than 1 mg/kg, continue to collect quarterly sediment grab samples for PCB analysis from each respective section of the basin until the one year period and the trend analysis of the data is complete. If PCBs are detected subsequent to the CSSI in any two grab samples from the basin, WDI will submit to the WHMD/MDEQ for review and approval within 30 days of the second detection a work plan that provides for additional storm water sampling and analysis to identify the source of the PCBs in the NSB sediments and, depending upon the results from the additional storm water monitoring, recommend actions to eliminate the source and/or conduct additional source investigation and removal.

WDI may voluntarily remove sediments from any sedimentation basin without WHMD/MDEQ approval if WDI verbally notifies WHMD/MDEQ, Hazardous Waste Program Section staff of the removal at least five days in advance of the removal and performs the removal in compliance with all applicable laws. In the event WDI chooses to voluntarily remove sediments from either basin in response to an ASSI or CSSI, all source investigation and removal requirements defined above shall still be implemented.

9.0 REPORTING REQUIREMENTS

A final SB SAP Report (Report) documenting the annual sampling under this plan, including the data received from the laboratory, is to be submitted to the WHMD/MDEQ within 60 days of each sampling event. All Reports must include a narrative description of the sampling event, a map of each respective basin showing each location sampled, copies of the sampling logs, a tabular summary and discussion of the data, the trend analysis calculations and discussion of the trend analysis results, a description of any ASSI and/or CSSI, as applicable, and any resampling conducted, and/or any additional actions required and/or recommended as a result of the Report findings. In addition to this report, an annual summary report of sedimentation basin monitoring results must be submitted to RMD/MDEQ by March 1 of the following year

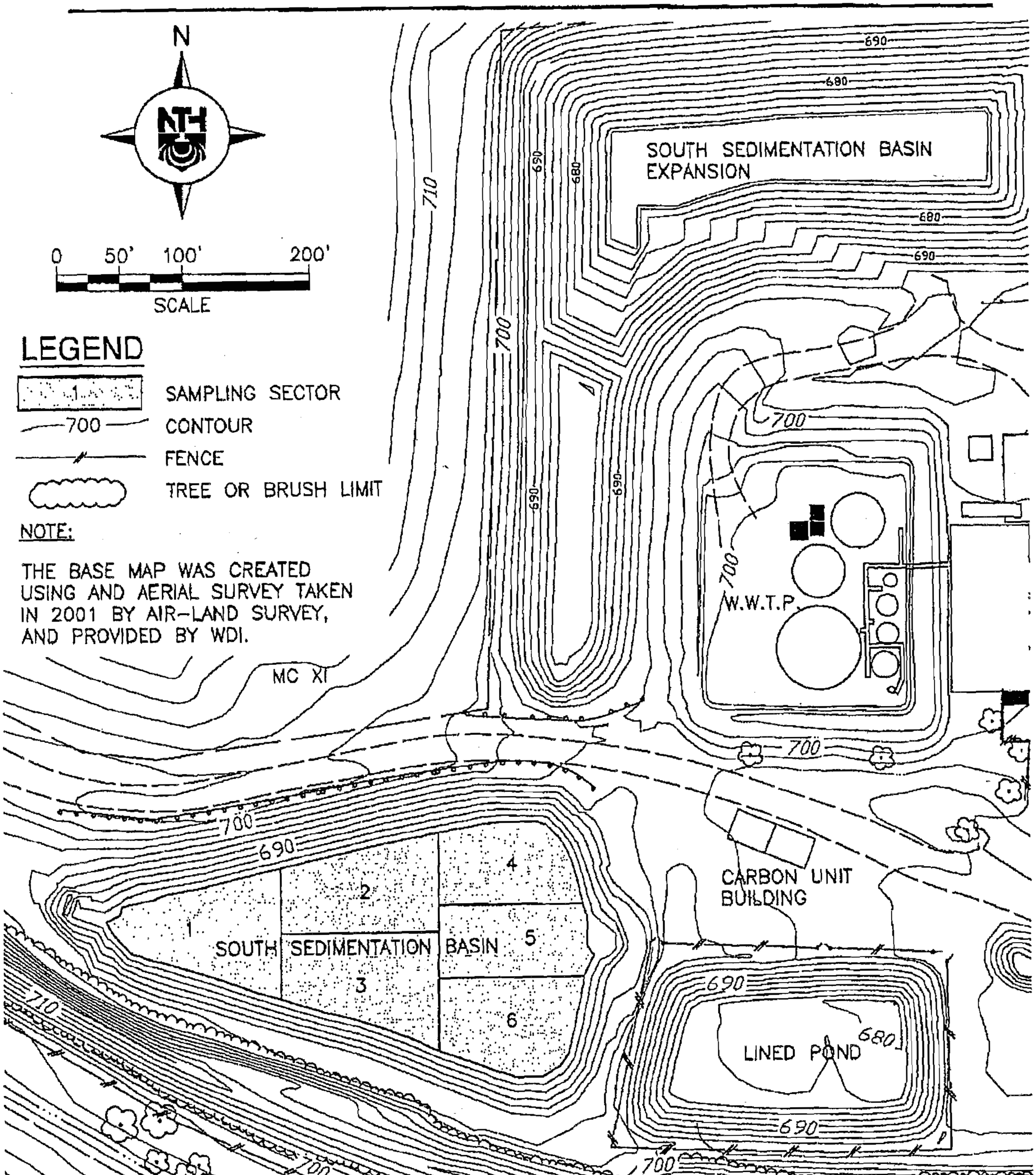
10.0 RECORD KEEPING REQUIREMENTS

All analytical data and Reports generated under this SB SAP must be stored on site within the QEHS filing system and be available to MDEQ staff for inspection.

Table 1. Sedimentation Basin monitoring Parameters

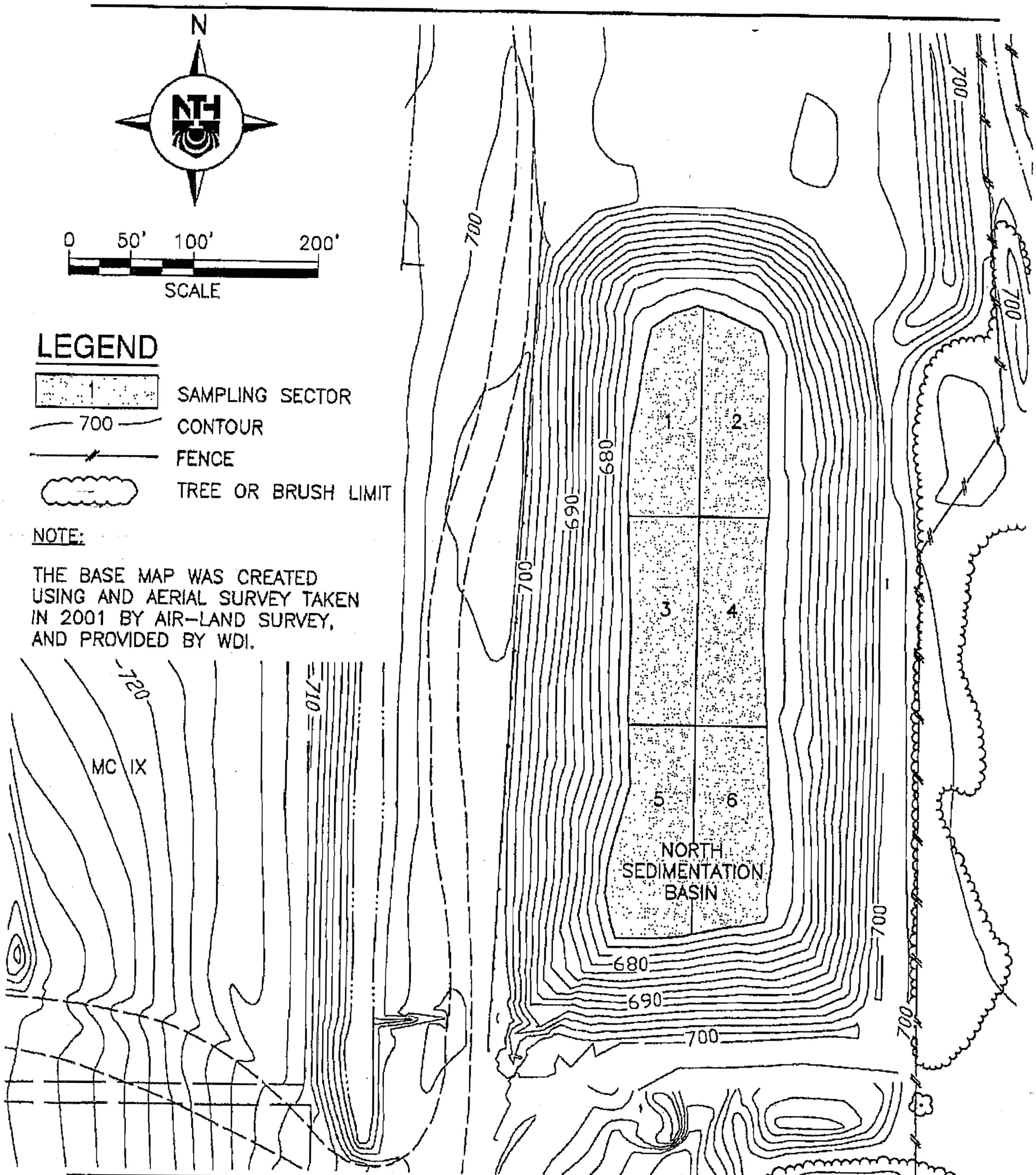
Grab Sample Parameters	RL[1] (mg/Kg)[2]	Approved Method[3]
Arsenic	0.5	6020
Barium	1	6020
Cadmium	2	6010
Chromium (total)	1	6010
Cobalt	2	6010/6020
Copper	1	6010/6020
Iron	5	6010
Lead	5	6010/6020
Mercury	0.05	7471
Molybdenum	5	6010/6020
Nickel	5	6010/6020
Selenium	0.2	6020
Silver	0.1	6010
Vanadium	1	6010/6020
Zinc	5	6010/6020
Total Phenolics[5]	0.4[4]	9066
Total Cyanide[5]	0.1[4]	9012
Amenable Cyanide[5]	NA	9012
Composite Sample Parameters		
PCB-1016	0.1	8082
PCB-1221	0.1	8082
PCB-1232	0.1	8082
PCB-1242	0.1	8082
PCB-1248	0.1	8082
PCB-1254	0.1	8082
PCB-1260	0.1	8082

1 - Reporting Limits from Operational Memo Gen-8 Revision 8
2 - Dry Weight Basis
3 - Test Methods For Evaluating Solid Waste, USEPA SW-846
4 - Target Detection Limits from RRD Operational Memorandum No. 2
5 - South Sedimentation Basin Only



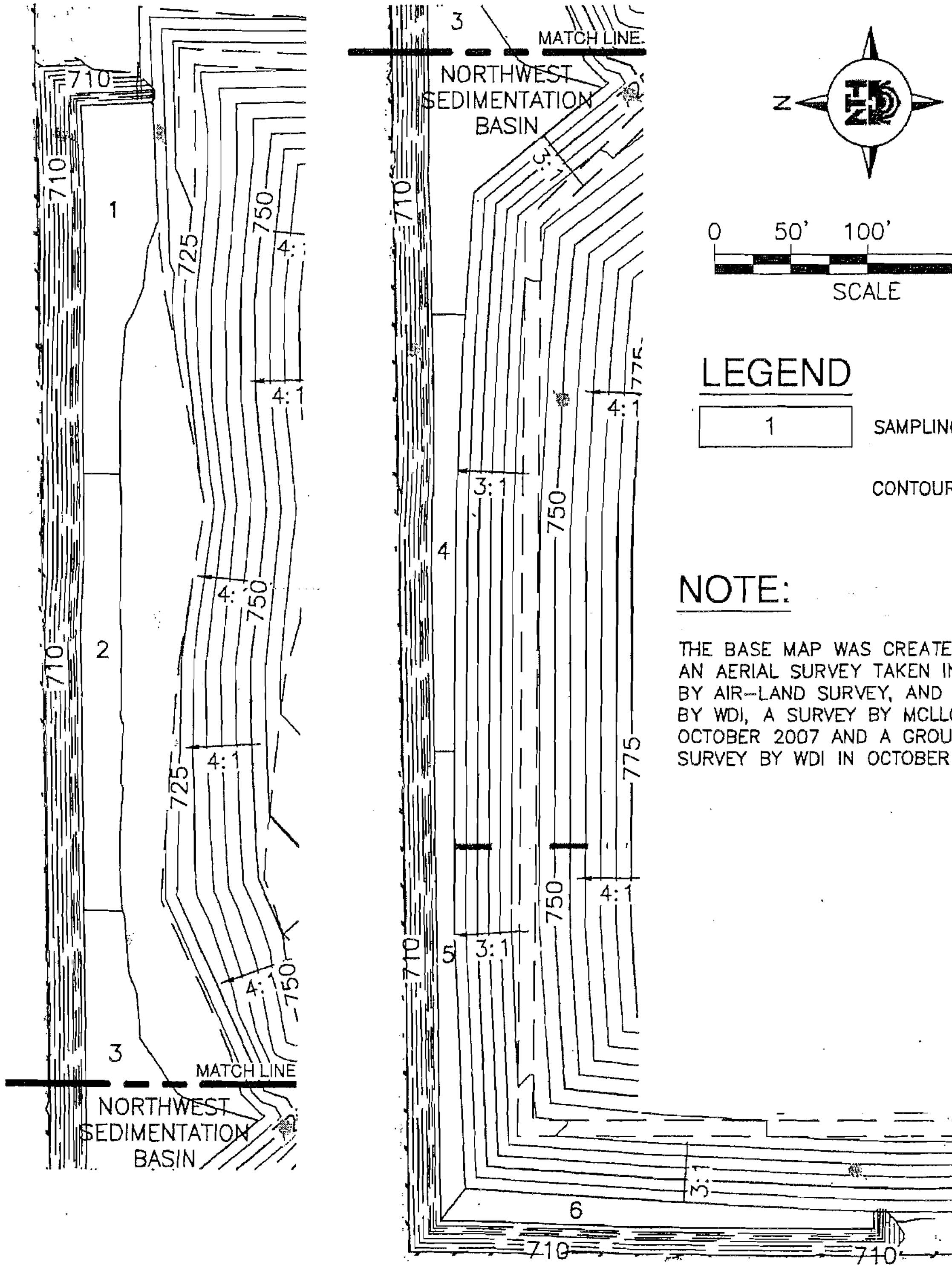
NTH PROJECT No.: 13-050921-07	CAD FILE NAME:	NTH Consultants, Ltd. Infrastructure Engineering and Environmental Services	SOUTH SEDIMENTATION BASIN MONITORING SAMPLE SECTORS	FIGURE 1
DESIGNED BY: KRO	PLOT DATE: 10/31/08			
DRAWN BY: KRO	DRAWING SCALE: AS SHOWN		WAYNE DISPOSAL SITE NO. 2 BELLEVILLE, MICHIGAN	
CHECKED BY: RBM	INCEPTION DATE: 10/30/08			

J:\Cad\13\Site 2 - SWMP\SAMPLING LOCATIONS\FIGURE 1-2 SED.dwg



NTH PROJECT No.: 13-060821-07	CAD FILE NAME:	NTH Consultants, Ltd. Infrastructure Engineering and Environmental Services	NORTH SEDIMENTATION BASIN MONITORING SAMPLE SECTORS	FIGURE 2
DESIGNED BY: KRO	PLOT DATE: 10/31/06			
DRAWN BY: KRO	DRAWING SCALE: AS SHOWN		WAYNE DISPOSAL SITE NO. 2 BELLEVILLE, MICHIGAN	
CHECKED BY: RBM	INCEPTION DATE: 10/30/06			

J:\Cad\13\Site 2 - SWMP\SAMPLING LOCATIONS\FIGURE 1-2 SED.dwg



LEGEND

1	SAMPLING SECTOR
	CONTOUR

NOTE:

THE BASE MAP WAS CREATED USING AN AERIAL SURVEY TAKEN IN 2001 BY AIR-LAND SURVEY, AND PROVIDED BY WDI, A SURVEY BY MCLLC IN OCTOBER 2007 AND A GROUND SURVEY BY WDI IN OCTOBER 2008.

NTH PROJECT No: 13-080921-03	CAD FILE NAME: FIGURE 3 SED	NTH Consultants, Ltd. Infrastructure Engineering and Environmental Services	NORTHWEST SEDIMENTATION BASIN MONITORING SAMPLE SECTORS	FIGURE: 3
DESIGNED BY: DC	PLOT DATE: 9/21/2011			
DRAWN BY: RMLII	DRAWING SCALE: AS SHOWN		WAYNE DISPOSAL, INC. SITE NO. 2 - MC VI F&G VAN BUREN TWP., WAYNE COUNTY, MICHIGAN	
CHECKED BY: DC	INCEPTION DATE: 02/16/09			

J:\13\Site 2 – SWMP\SAMPLING LOCATIONS\FIGURE 3 SED.dwg

Sample Collection Log for Sediments - WDI Site #2

Sample ID: (Basin, Sector #)	Sample Date:	Sample Time:
Sample Location: (x,y coordinates)	Sampling Method:	Sampler:
Sample Description/Comments*:		

Sample ID: (Basin, Sector #)	Sample Date:	Sample Time:
Sample Location: (x,y coordinates)	Sampling Method:	Sampler:
Sample Description/Comments*:		

Sample ID: (Basin, Sector #)	Sample Date:	Sample Time:
Sample Location: (x,y coordinates)	Sampling Method:	Sampler:
Sample Description/Comments*:		

Sample ID: (Basin, Sector #)	Sample Date:	Sample Time:
Sample Location: (x,y coordinates)	Sampling Method:	Sampler:
Sample Description/Comments*:		

* Include any unusual characteristics such as color, sheen, odor, etc.

Figure 4.

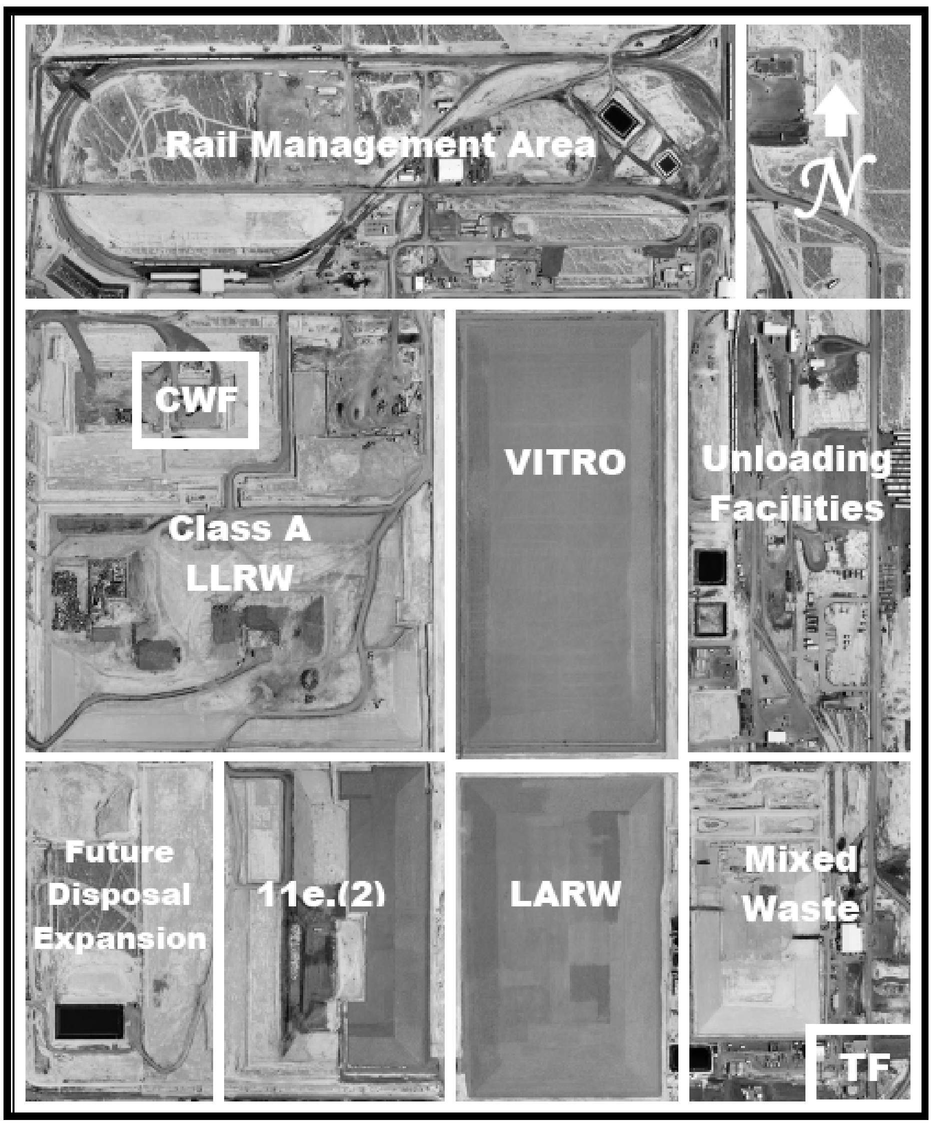
Appendix C-3:

Energy*Solutions* – Clive, Utah

Bulk Waste Disposal and Treatment Facilities
Waste Acceptance Criteria

Revision 7

(Includes Class A LLRW, Mixed Waste, and 11e.(2) Disposal Embankments)



Corporate Office
423 West 300 South, Suite 200
Salt Lake City, UT 84101
Phone: (801) 649-2000
Fax: (801) 537-7345

Disposal and Treatment Facility
Interstate 80, Exit 49
Clive, UT 84029
Phone: (435) 884-0155
Fax: (435) 884-3549

TABLE OF CONTENTS

SECTION 1

INTRODUCTION

1.1 PURPOSE

Energy*Solutions* has developed this Bulk Waste Disposal and Treatment Facilities – Waste Acceptance Criteria (BWF WAC) document to assist waste generators and their contractors by providing information about the capabilities and requirements of Energy*Solutions*' disposal and treatment facilities. Energy*Solutions* is authorized to receive:

- Class A Low-Level Radioactive Waste (LLRW)
- NORM/NARM
- Class A Mixed LLRW (i.e., radioactive and hazardous)
- 11e.(2) Byproduct Material
- PCB Radioactive, and
- Other various forms and types of radioactive wastes

The BWF WAC provides information on Energy*Solutions*' waste acceptance processes including:

- Waste characterization and profiling,
- Pre-shipment sampling and analysis,
- Waste packaging, transportation and delivery,
- Waste receipt, verification sampling and acceptance, and
- Waste treatment and disposal

These waste acceptance criteria collectively pertain to the Bulk Waste and Treatment Facilities which are described in detail below. The BWF WAC does not apply to Energy*Solutions*' Containerized Waste Facility (CWF). Please refer to the CWF WAC which can be downloaded from Energy*Solutions*' website at www.energysolutions.com.

1.2 SCOPE

Numerous state and federal agencies regulate the management, transportation, treatment and disposal of radioactive and hazardous materials. This document provides guidance on Energy*Solutions*' waste acceptance process and should be used in conjunction with current copies of Energy*Solutions*' licenses, permits and applicable state and federal regulations. These license, permits, and regulations take precedence over any information contained in this document. Generators may request variances from the BWF WAC on a case-by-case basis. Energy*Solutions* will evaluate such requests and provide written notification to the generator if the variance is approved.

Energy*Solutions*' licenses and permits along with links to applicable parts of the Utah Radiation Rules are included on Energy*Solutions*' website at www.energysolutions.com. In addition, Appendix A of this document contains a list of contact information for both Energy*Solutions* and the State of Utah. For additional information, representatives of Energy*Solutions*' Business Development Department are available to answer any questions and can be contacted at (801) 649-2000.

1.3 RESPONSIBILITIES

The generator is responsible to characterize, classify, schedule, manifest, package and transport waste shipments to Energy*Solutions*' disposal facility in accordance with the BWF WAC, licenses, permits, and applicable state and federal regulations. For waste classification, generators must have in place a quality control program to ensure compliance with the waste classification requirements. The generator or authorized representative must complete and submit a Radioactive Waste Profile Record to Energy*Solutions* for review and approval prior to shipment. Additional forms and certifications may also be required such as the Special Nuclear Material Exemption Certification, the PCB Waste Certification, and the Land Disposal Restriction Notification and/or Certification. Section 4 details the waste profiling process. The generator or authorized representative should be available to resolve issues that arise associated with waste shipments.

Energy*Solutions* is responsible to safely and compliantly receive, treat (if applicable), and dispose of waste shipments in accordance with all applicable permits, licenses, and regulations. Energy*Solutions* will provide disposal and/or treatment certificates upon request from the generator. In addition, Energy*Solutions* will contact the generator to resolve non-conforming waste shipments or discrepancies with the contractual terms and conditions associated in accordance with the receipt and management of waste shipments.

SECTION 2

SITE AND FACILITY DESCRIPTION

2.1 SELECTION OF THE CLIVE DISPOSAL SITE LOCATION

The initial selection of the Energy*Solutions* disposal site location dates back to the late 1970s when the Department of Energy (DOE) and the State of Utah began the cleanup of an abandoned uranium mill site. The Vitro mill site, located in central Salt Lake City, was one of the first sites cleaned up under the DOE Uranium Mill Tailings Remediation Action (UMTRA) Program.

The DOE investigated 29 sites to identify the safest permanent disposal site for these materials. After eight years of characterization and evaluation of several sites, the DOE selected the Clive site located in Utah's West Desert approximately 75 miles west of Salt Lake City. The site's remote location, low precipitation, naturally poor groundwater, and low-permeability clay soils were some of the attractive qualities of the area. From 1984 to 1988, the Vitro tailings were relocated to Clive and placed in an above-ground disposal cell.

Since acquiring land adjacent to the Vitro disposal embankment and obtaining a disposal license, the vision of Energy*Solutions*' Clive facility has been to provide a private disposal option for material from cleanups and generators of radioactive waste in separate disposal embankments similar to those used for DOE's Vitro project. The Clive site has received waste from cleanups carried out across the country including projects by the Environmental Protection Agency (EPA), DOE, Department of Defense, and private companies. The initial disposal license was for Naturally Occurring Radioactive Material (NORM). Since 1988, Energy*Solutions*' Radioactive Material License (RML) has been amended several times, expanding the types of radioactive materials to include low-level radioactive waste (LLRW), in addition to NORM.

2.2 LICENSES, PERMITS, AND AUTHORIZATIONS

Energy*Solutions* is permitted, licensed, and authorized to receive, treat, and dispose Class A LLRW, NORM/NARM, Class A Mixed LLRW, 11e.(2) Byproduct Material, Special Nuclear Material based on concentration limits, as well as Polychlorinated Biphenyl (PCB) Radioactive Waste, and PCB Mixed Waste in accordance with the following documents:

- ➢ Radioactive Material License (RML) Number UT 2300249, as amended
  - Class A LLRW as defined in Utah Administrative Code R313-15-1008
  - Class A Mixed LLRW (radioactive and hazardous)
  - NORM/NARM
  - Special Nuclear Material (concentration based limits)

- ➢ 11e.(2) Byproduct Material License Number UT 2300478, as amended
  - 11e.(2) Byproduct Material as defined by the Atomic Energy Act, as amended

- ➢ State-Issued Part B Permit Number UTD982598898, as amended
  - Storage, treatment, and disposal of Mixed Waste
  - Authorizes disposal of specific types of PCB regulated waste in the Mixed Waste disposal facility

- ➢ Groundwater Quality Discharge Permit Number UGW450005, as amended
  - Authorizes disposal of specific types of PCB regulated waste in the Class A LLRW disposal facility

- ➢ Special Nuclear Material (SNM) Exemption Order issued by the NRC, as amended
  - Authorizes receipt, storage, treatment, and disposal of waste containing SNM based on concentration limits rather than mass limits

- ➢ TSCA Coordinated Approval issued by the EPA Region 8, as amended
  - PCB Radioactive and PCB Mixed Waste (40 CFR Part 761)

Section 3 details the various waste types and waste forms that are acceptable at Energy*Solutions*. Waste streams that are subject to multiple regulations must meet the requirements for each applicable regulation.

2.3 SITE LOCATION AND ACCESS

Energy*Solutions*' operations are conducted on and adjacent to Section 32, Township 1 South, Range 11 West, SLM, Tooele County, Utah. The facility is about 75 miles west of Salt Lake City and about three miles south of Interstate 80, Exit 49. The site is conveniently accessed by both highway and rail transportation. The disposal site mailing address is:

Energy*Solutions* LLC
Clive Disposal Site
Interstate 80, Exit 49
Clive, UT 84029 (84083 if using Fed Ex)
Phone: (435) 884-0155

Energy*Solutions* receives waste shipped via bulk truck, containerized truck, enclosed truck, bulk railcars, rail boxcars, and rail intermodals. The transportation access allows Energy*Solutions* to operate throughout the entire year. The disposal site is accessed by the Union Pacific Railroad at Energy*Solutions*' private siding. Energy*Solutions* uses more than ten miles of track and three locomotives for railcar management. Covered railcar rotary dumper and covered railcar decontamination facilities allow for the efficient unloading, decontamination and return of rail shipments.

2.4 DISPOSAL AND TREATMENT FACILITIES

The design and operation of the Energy*Solutions* disposal site provides a long-term disposal solution with a minimal need for active maintenance after closure. Energy*Solutions* uses an above-ground engineered disposal cell. The design of these cells is patterned after DOE and EPA specifications for the VITRO disposal embankment. Each licensed disposal embankment meets or exceeds the applicable regulatory requirements.

Figure 2-1 shows the locations of Energy*Solutions*' waste treatment, disposal, and operations areas at the Clive facility. Energy*Solutions*' waste operations are managed as three facilities:

- "Bulk Waste Facility" (BWF) – including Mixed Waste, LARW, 11e.(2) and Class A LLRW
- "Containerized Waste Facility" (CWF) – located within the Class A LLRW area
- "Treatment Facility" (TF) – located in the southeast corner of the Mixed Waste area

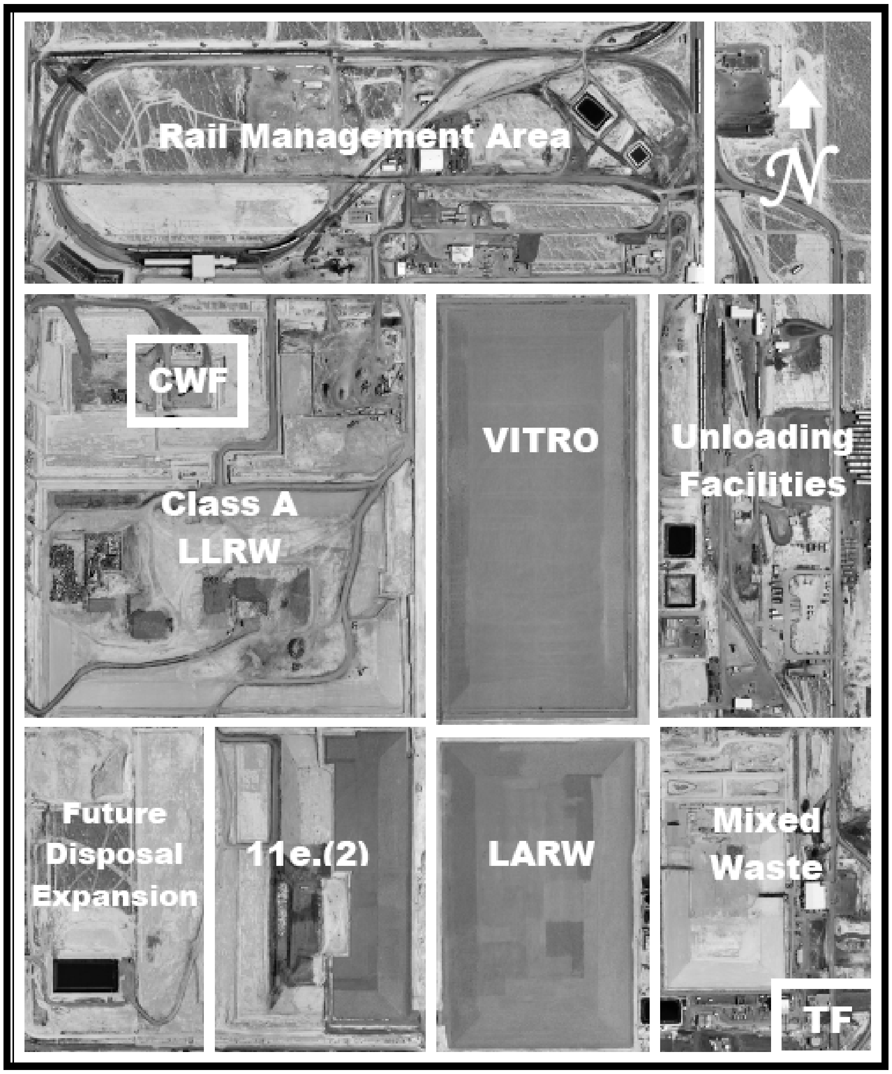


Figure 2-1. Energy*Solutions'* Disposal and Treatment Facilities

Bulk Waste Facility

Waste shipped for direct disposal that is compliant with the ALARA Criteria described below is managed at Energy*Solutions*' Bulk Waste Facility (BWF). Such waste is either removed from the container or filled with a grout-like mixture to minimize void spaces. Waste that is removed from the shipping container is typically compacted into 12-inch soil lifts. Waste that consists of debris items that do not have a dimension small enough to be compacted into the 12-inch soil lifts are disposed of using grout in a different disposal area within the BWF. Waste is directly disposed at the Class A LLRW, Mixed Waste, or 11e.(2) disposal embankments. Bulk containers (e.g., intermodals, gondolas, etc.) and non-bulk containers (e.g., drums, boxes, etc.) are acceptable for receipt at the BWF.

The Bulk Waste Facility (BWF) includes the following disposal embankments and structures:

- Class A LLRW and NORM disposal embankment
- 11e.(2) Byproduct Material disposal embankment
- Mixed Waste disposal embankment for LDR compliant solid waste
- Intermodal unloading facility for unloading and staging bulk waste shipments for disposal
- Railcar Rollover facility for unloading and staging bulk waste shipments for disposal
- Rail Wash Facility for decontamination, surveying, and releasing of railcars
- Container Wash Facility for decontamination, surveying and releasing of bulk containers

Containerized Waste Facility

Waste shipped for direct disposal exceeding Energy*Solutions*' ALARA Criteria is managed at the Containerized Waste Facility (CWF). Waste must be packaged in disposal containers (e.g., drums, boxes, liners, etc.) instead of bulk containers (e.g., intermodals, gondolas, etc.) for shipments to the CWF since Energy*Solutions* will not remove such waste from its container due to the elevated dose rates. Please refer to Energy*Solutions*' CWF WAC for information on shipping waste to the CWF.

Shipments to the CWF typically are shipped in a shielded transportation package such as a cask as illustrated in Figure 2-2.

Figure 2-2. Cask Shipment at the Containerized Waste Facility

Treatment Facility

Waste shipped to Energy*Solutions* for treatment or liquid solidification prior to disposal is managed at Energy*Solutions*' Treatment Facility. The Treatment Facility is shown in Figure 2-1 as "TF". The

Treatment Facility is designed for radioactive waste that requires treatment for RCRA constituents and for liquid radioactive wastes requiring solidification prior to disposal. Energy*Solutions*' Mixed Waste treatment and solidification capabilities include:

- Chemical Stabilization – Including oxidation, reduction, neutralization and deactivation.
- Amalgamation – For the treatment of elemental mercury.
- Macroencapsulation – For the treatment of radioactive lead solids, RCRA metal-containing batteries and hazardous debris.
- Microencapsulation – To reduce the leachability of hazardous constituents in mixed wastes that are generally dry, fine-grained materials such as ash, powders or salts.
- Liquid Solidification – For the solidification of radioactively contaminated liquids such as aqueous solutions, oils, antifreeze, etc. to facilitate land disposal. Mixed waste liquids can also be treated and solidified at the Treatment Facility.
- Vacuum Thermal Desorption of Organic Constituents - For the thermal segregation of organic constituents from wastes including wastes with PCBs. Waste containing PCB liquids is also acceptable for VTD treatment. The organic liquid condensate must be treated prior to final disposal. The non-liquid waste residue will be further treated for metal contaminates (if required) and disposed at the Mixed Waste embankment.
- Debris Spray Washing – To remove contaminants from applicable hazardous debris.

Each of these treatment technologies are discussed in further detail in Section 3.1.3.

Currently, all waste processed at the Treatment Facility are disposed in the Mixed Waste disposal embankment. The Treatment Facility includes open and covered waste storage areas for storing, sampling, and staging Mixed Waste shipments, including the following buildings and areas:

- Mixed Waste Operations Building
- Mixed Waste Treatment Building
- Liquids Storage Building
- Mixed Waste storage, staging and sampling areas

2.5 ALARA CRITERIA FOR THE BULK WASTE AND TREATMENT FACILITIES

Energy*Solutions* has implemented an "As Low As Reasonably Achievable" (ALARA) Criteria to minimize worker exposures. The ALARA Criteria is not a license condition but is used as the primary distinction between waste that is acceptable for direct disposal at the BWF and CWF. Wastes with higher dose rates exceeding the ALARA Criteria are disposed at the CWF where waste packages are directly disposed without sampling and actual waste handling. Conversely, wastes with dose rates less than the

ALARA Criteria may be disposed at the BWF since the waste is sampled and, in most cases, removed from the shipping container.

As shown in the table below, these ALARA Criteria define allowable external contact dose rates and loose surface contamination limits for waste managed at the BWF.

External Contact Dose Rate	Removable Surface Contamination On Exterior Surfaces of Debris
< 200 mR/hr on manifested container < 500 mR/hr on external, accessible surfaces of waste in container < 80 mR/hr on contact of unshielded bulk containers with resin	< 500 dpm α/100 cm^2 < 50,000 dpm β,γ/100 cm^2

External Contact Dose Rate Limits

The external contact dose rate limit of 200 mR/hr applies to the manifested container (e.g., drums/boxes on a flatbed truck or enclosed van, bulk containers such as intermodals, sealands, cargo containers, etc.). For example, if drums or boxes are shipped in a bulk container, such as an intermodal, and the intermodal is manifested as the strong, tight container, then the external contact dose rate of 200 mR/hr applies to the intermodal and not to the drums or boxes inside the intermodal. The drums and boxes in this case would be considered waste and must not contain any item with dose rates exceeding 500 mR/hr on the external, accessible surfaces of the item.

The dose rate for debris items such as pipes should only be measured on the exterior surfaces and on the plane surface of the opening of the pipe to demonstrate compliance with the ALARA Criteria. For example, the internal pipe surfaces may exceed the 500 mR/hr dose limit only if the surface plane to the opening of the pipe is less than 500 mR/hr. Shield plates used to cover the opening of the pipe should not be used solely to lower the dose rates below the criteria since Energy*Solutions* is required to remove or penetrate into the debris items to fill internal voids with grout material.

Another example is DAW placed into 55 gallon drums and compacted into pucks. The dose rate criteria apply to the external surfaces of the puck itself and not to the DAW inside the puck.

Resin External Contact Dose Rate Limits

Resins shipped in bulk containers must comply with the ALARA Criteria. This is due to the required resin blending process that necessitates worker proximity to the waste. Resins shipped in disposal containers such as drums, boxes, liners, etc. may be acceptable at the BWF for grouting if the container is compliant with the ALARA Criteria for non-bulk packages. Resins shipped to the BWF must be shipped under a Waste Profile specific for resins unless specifically approved in writing by Energy*Solutions*. Resins with dose rates that exceed these limits must be disposed at the CWF.

Removable Surface Contamination Limits

The same ALARA principles apply to the removable surface contamination limits. The main concern is controlling loose contamination on the exterior surfaces of debris items removed from the container. Fixatives may be applied to the debris items to reduce the removable contamination levels below the specified limits.

Requests for Exceptions

Requested exceptions to the ALARA Criteria are evaluated on a case-by-case basis. For example, Mixed Waste exceeding the ALARA Criteria will be evaluated since the CWF cannot accept Mixed Waste for disposal. Generators must provide radiation and contamination surveys of the container and/or waste item when requesting approval to exceed the ALARA Criteria. Dose rate measurements at one foot from the waste should be provided on the radiation survey. The transportation mode and manifested package information should also be included with the request. The generator must receive written approval for exemptions to the ALARA Criteria prior to shipment of the waste.

SECTION 3

WASTE CRITERIA

3.1 ACCEPTABLE RADIOACTIVE WASTES

The type, form, and quantity of LLRW, NORM, 11e.(2) byproduct material, and mixed waste that Energy*Solutions* can receive for treatment and disposal is governed by the various licenses and permits under which Energy*Solutions* operates. Energy*Solutions* has been issued an Agreement State Radioactive Material License (License #UT 2300249, as amended) by the Utah Division of Radiation Control (DRC). This license authorizes Energy*Solutions* to receive Class A LLRW, NORM, and NARM waste. Energy*Solutions* has been issued a separate license to receive and dispose of uranium and thorium mill tailings byproduct material as defined by section 11e.(2) of the Atomic Energy Act of 1954, as amended.

The Utah Division of Solid and Hazardous Waste (DSHW) issued Energy*Solutions* a State-Issued Part B Permit (Permit #UT 982598898, as amended) to treat and dispose of hazardous waste which is also contaminated with LLRW, NORM, or NARM wastes (mixed waste). Early in 1999, Energy*Solutions* received a Permit modification which authorized the receipt and disposal of PCB Radioactive and PCB Mixed wastes. In 2002, Energy*Solutions* received a TSCA Coordinated Approval from the EPA to expand PCB receipt and disposal options. The TSCA Coordinated Approval has been subsequently expanded to include additional types of PCB radioactive and PCB mixed wastes.

3.1.1 Class A Low-Level Radioactive Waste

Energy*Solutions* is authorized to receive Class A Low-Level and Mixed Low-Level Radioactive Waste. These wastes must be classified in accordance with the requirements of the Utah Administrative Code (UAC) R313-15-1008, Classification and Characteristics of Low-Level Radioactive Waste. Utah rule R313-15-1008 is similar to the NRC Waste Classification requirements in 10 CFR 61.55 with the addition of Radium-226. Generators must have in place a quality control program to ensure compliance with the waste classification requirements and prepare and retain with manifest documentation a record documenting the generator's waste classification analysis. Shippers and generators should also review NRC IE Bulletin No. 79-19 to ensure compliance with applicable training requirements in managing LLRW.

The information provided below is a summary of the waste classification regulations and how generators must classify their LLRW prior to shipment to Energy*Solutions*. Further guidance is provided in NRC's "Branch Technical Position on Concentration Averaging and Encapsulation", as amended (BTP). All generators shipping LLRW to Energy*Solutions* must comply with the NRC's BTP as specified in Condition 16 of the Radioactive Material License.

Determination of waste class involves two considerations. First, consideration must be given to specific long-lived radionuclides listed in Table I of UAC R313-15-1008. Second, consideration must be given to specific short-lived radionuclides listed in Table II of UAC R313-15-1008. The waste is Class A if the radionuclides listed in either Table I or Table II are not present in the waste. Both tables are provided below.

The concentration limits for determining waste class are given in curies per cubic meter with the exception of the following Table I radionuclides which are given in nanocuries per gram: alpha-emitting transuranic radionuclides with a half-life greater than five years, Pu-241, Cm-242, and Ra-226. The following bullets outline the steps for determining waste class per R313-15-1008.

Classification Tables from UAC R313-15-1008

Table I

Radionuclide	Ci/m^3	nCi/g
C-14	8	
C-14 (act)	80	
Ni-59 (act)	220	
Nb-94 (act)	0.2	
Tc-99	3	
I-129	0.08	
Alpha-emitting transuranics > 5 year half-life		100
Pu-241		3,500
Cm-242		20,000
Ra-226		100

- When the waste does not contain any radionuclides listed in either Table I or II, it is Class A.
- When the concentration does not exceed 0.1 times the value in Table I, the waste is Class A.
- When the concentration exceeds 0.1 times the value in Table I, but does not exceed the value in Table I, the waste is Class C. Energy*Solutions* is not authorized to receive Class B and Class C waste.
- For wastes containing mixtures of radionuclides listed in Table I, the total concentration shall be determined by the sum of fractions rule as illustrated in the example below.
- When the waste does not contain any of the radionuclides listed in Table I, classification shall be determined based on the concentrations shown in Table II.

Table II

Radionuclide	Column 1 Ci/m^3	Column 2 Ci/m^3	Column 3 Ci/m^3
Total of all radionuclides < 5 year half-life	700	*	*
H-3	40	*	*
Co-60	700	*	*
Ni-63	3.5	70	700
Ni-63 (act)	35	700	7,000
Sr-90	0.04	150	7,000
Cs-137	1	44	4,600

* There are no limits established for these radionuclides in Class B or C wastes. Practical considerations such as the effects of external radiation and internal heat generation on transportation, handling, and disposal will limit the concentrations for these wastes. These wastes shall be Class B unless the concentrations of other radionuclides in Table II determine the waste to be Class C independent of these radionuclides.

- When the concentration does not exceed the value in Column 1 of Table II, the waste is Class A.
- When the concentration exceeds the value in Column 1 but does not exceed the value in Column 2 of Table II, the waste is Class B.
- When the concentration exceeds the value in Column 2 but does not exceed the value in Column 3 of Table II, the waste is Class C.
- For wastes containing mixtures of the radionuclides listed in Table II, the total concentration shall be determined by the sum of fractions rule.

For waste material that contains more than one radionuclide, the waste must be classified by applying the sum of fractions rule described in UAC R313-15-1008(1)(g). This rule states:

> "For determining classification for waste that contains a mixture of radionuclides, it is necessary to determine the sum of fractions by dividing each radionuclide's concentration by the appropriate limit and adding the resulting values. The appropriate limits shall all be taken from the same column of the same table. The sum of fractions for the column shall be less than 1.0 if the waste class is to be determined by that column."

The following examples demonstrate the application of the sum of fractions rule in determining waste class.

EXAMPLE #1: A generator has one 55 gallon container of soil contaminated with plutonium-238, radium-226, uranium-234, uranium-235, uranium-238, cesium-137, and strontium-90. The density of the soil is 1.6 g/cm^3 and is used to convert concentration units from pCi/g to Ci/m^3. The radionuclide concentration in the container is as follows:

Radionuclide	**Container Concentration (pCi/g)**	**Container Concentration (Ci/m^3)***	**Table I Class A Concentration Limit (pCi/g)**	**Table II Class A Concentration Limit (Ci/m^3)**
Pu-238	3,000	4.8 E-03	10,000	- -
Ra-226	6,000	9.6 E-03	10,000	- -
U-238	5,000	8.0 E-03	- -	- -
U-235	1,100	1.8 E-03	- -	- -
U-234	5,000	8.0 E-03	- -	- -
Sr-90	5,000	8.0 E-03	- -	0.04
Cs-137	8,000	1.3 E-02	- -	1

* The soil density (1.6 g/cm^3) is used to convert from pCi/g to Ci/m^3.

The sum of fractions rule is applied to the container according to the radionuclides listed in Table I and II as follows:

$$\text{Table I:} \quad \frac{3.0E+03}{1.0E+04}+\frac{6.0E+03}{1.0E+04}=9.0E-01$$

$$\text{Table II:} \quad \frac{8.0E-03}{4.0E-02}+\frac{1.3E-02}{1.0E+00}=2.6E-02$$

Based on the sum of fractions rule, the waste in this container is determined to be Class A waste (i.e., 90 percent of the Class A limit for Table I radionuclides). This container is acceptable for disposal at Energy*Solutions* since it meets the sum of fractions rule. The uranium radionuclides are not included in the sum of fractions calculation since these radionuclides are not included in Table I or II of R313-15-1008.

EXAMPLE #2: A generator has one 55 gallon container of Dry Active Waste (DAW) contaminated with americium-241, technetium-99, europium-155, colbalt-58, and cesium-135. The density of the DAW is 0.25 g/cm^3 and is used to convert Table II units from pCi/g to Ci/m^3. The radionuclide concentration in the container is as follows:

Radionuclide	Container Concentration (pCi/g)	Container Concentration (Ci/m^3)*	Table I Class A Concentration Limit (pCi/g)	Table II Class A Concentration Limit (Ci/m^3)
Am-241	6,000	1.5 E-03	10,000	- -
Tc-99	900,000	2.3 E-01	0.3 Ci/m^3	- -
Eu-155	150,000	3.8 E-02	- -	700
Co-60	100,000	2.5 E-02	- -	700
Cs-135	500,000	1.3 E-01	- -	- -

* The DAW density (0.25 g/cm^3) is used to convert from pCi/g to Ci/m^3.

The sum of fractions rule is applied to the container according to the radionuclides listed in Table I and II as follows:

$$\text{Table I:} \quad \frac{6.0E+03}{1.0E+04}+\frac{2.3E-01}{3.0E-01}=1.4E+00$$

$$\text{Table II:} \quad \frac{3.8E-02}{7.0E+02}+\frac{2.5E-02}{7.0E+02}=9.0E-05$$

Based on the sum of fractions rule, the waste in the DAW container exceeds the Table I Class A concentration limit and would not be acceptable at Energy*Solutions*. Note that Cs-135 is not included in the sum of fractions calculation since this radionuclide is excluded in Table I or II of R313-15-1008.

<u>Waste Classification Labels on Packages</u>

All waste packages containing LLRW, including Mixed LLRW, must be labeled either "Class A Unstable" or "Class AU" and appropriately marked in Block 16 of the Uniform Low-Level Radioactive Waste Manifest Form 541. There are no State or Federal regulations that prescribe the size or color of the classification labels. The Utah DRC, however, requires that each package be labeled with a minimum of 0.5-inch lettering in contrasting color (refer to the "Generator Site Access Permit Enforcement Policy - Utah Division of Radiation Control", as amended). This requirement also applies to bulk packaging (e.g., intermodals, gondolas, etc.).

LLRW Compact Export Approval

Energy*Solutions*' disposal site is not classified as a LLRW compact site under the Federal Low-Level Radioactive Waste Policy Act, as amended. Condition 9A of the Radioactive Material License requires generators to demonstrate that the LLRW has been approved for export to Energy*Solutions* prior to the initial shipment of waste. Approval is required from the LLRW compact of origin, or for states unaffiliated, the state of origin. This license condition only applies to non-DOE generators of LLRW and excludes Mixed LLRW. In addition, Energy*Solutions* is not authorized to receive LLRW from the Northwest Compact. Please contact Energy*Solutions* for assistance in complying with this license condition.

3.1.2 NORM/NARM Waste

Energy*Solutions*' Radioactive Material License allows receipt and disposal of Naturally Occurring or Accelerator-Produced Radioactive Material (NORM/NARM). NORM/NARM does not include Byproduct, Source, or Special Nuclear Material and generally contains radionuclides in the uranium and thorium decay series. Since NORM/NARM waste is not considered LLRW, the waste classification regulations do not apply.

3.1.3 Class A Mixed Low-Level Radioactive Waste

Energy*Solutions* is authorized to receive Class A Mixed Low-Level Radioactive Waste (Mixed Waste) for (1) disposal, or (2) treatment and disposal. Mixed Waste is defined by Energy*Solutions*' State-Issued Part B Permit (# UTD982598898) as:

> Waste defined by the Low Level Radioactive Waste Policy Act, Public Law 96-573; this is radioactive waste not classified as high-level radioactive waste, transuranics waste, spent nuclear fuel, or byproduct material as defined by section 11e.(2) of the Atomic Energy Act, and contains hazardous waste that is either listed as a hazardous waste in Subpart D of 40 CFR 261 and/or exhibits any of the hazardous waste characteristics identified in Subpart C of 40 CFR 261, or hazardous waste which also contains naturally occurring radioactive materials.

In accordance with 40 CFR 268.7, a Land Disposal Restriction Notification and/or Certification must accompany each shipment of Mixed Waste. This includes former hazardous wastes that have been treated to remove the Hazardous Waste Codes.

3.1.3.1 Acceptable Hazardous Waste Codes

The specific EPA Hazardous Waste Codes that may be received by Energy*Solutions* are identified in its Statue-Issued Part B Permit. A copy of this permit is included on Energy*Solutions*' web site at www.energysolutions.com or on the Utah Division of Solid and Hazardous Waste web site at www.hazardouswaste.utah.gov/HWBranch/CFFSection/EnvirocarePermit.htm. The following Utah Hazardous Waste Codes are not acceptable at Energy*Solutions*: F999 and P999.

3.1.3.2 LDR Compliant Mixed Waste

Mixed Waste must be analyzed to determine if treatment is required prior to disposal. Mixed Waste that is determined to be compliant with the Land Disposal Restriction (LDR) treatment standards specified in 40 CFR 268 may be directly disposed in Energy*Solutions*' Mixed Waste disposal embankment. Energy*Solutions* is required to verify LDR compliance for all Mixed Waste streams prior to disposal.

Condition 14.B of the Radioactive Material License prohibits Energy*Solutions* from disposing of characteristic Mixed Waste after treatment in the LLRW disposal embankment. Energy*Solutions* has extended this condition to Mixed Waste treated by generators at their facility. The waste profile must describe the waste as having undergone treatment. As a result, any waste that at the point of generation was considered a hazardous waste per 40 CFR 261 will be disposed of in the Mixed Waste disposal embankment. As noted above, an LDR Certification must be included with the shipping paperwork for treated Mixed Waste (including formerly characteristic or listed hazardous waste).

3.1.3.3 Mixed Waste Requiring Treatment

Energy*Solutions* may also receive Mixed Waste that requires treatment in order to comply with LDR treatment standards. Energy*Solutions* is approved under the State-Issued Part B Permit to operate a mixed waste treatment facility. Mixed Waste that is not LDR compliant may be treated by Energy*Solutions* using one of the following treatment technologies or methods:

- Chemical Stabilization, Oxidation, Reduction, Neutralization, and Deactivation
- Macroencapsulation of hazardous debris or radioactive lead solids
- Debris Spray Washing
- Microencapsulation
- Thermal Treatment of Organics
- Mercury Treatment (Amalgamation)

<u>Chemical Stabilization</u>

Chemical stabilization involves the addition of approved chemical reagents in accordance with a waste-specific treatment formula and is performed in mixers at Energy*Solutions*' Treatment Facility. Formula additions of waste, reagents, and water involve the following chemical processes to chemically bind contaminants to reduce their ability to leach from the waste.

- Stabilization (STABL)
- Deactivation (DEACT)
- Neutralization (NEUTR)
- Oxidation (CHOXD)
- Reduction (CHRED)

Formula development may also be applied to Mixed Waste with very low levels of organic contaminants that require chemical destruction in order to meet total concentration based standards versus a leach standard as determined by the Toxicity Characteristic Leaching Procedure (TCLP) test. Mixed Waste requiring chemical stabilization may be sized and homogenized using various equipment including shredders, vibrating screens, and mixers. In order to evaluate chemical compatibility with the stabilization treatment process, generators shipping waste with Hazardous Waste Codes D001, D002, or D003 must provide a list of specific chemicals in each container with the shipping paperwork.

Macroencapsulation of Hazardous Debris and Radioactive Lead Solids

Mixed Waste consisting of hazardous debris may be macroencapsulated in accordance with the "Alternative Treatment Standards for Hazardous Debris" as specified in 40 CFR 268.45. Figure 3-1 illustrates macroencapsulation of hazardous debris in a container using a polymer or performed in-cell using pozzolanic material. Treatment of hazardous debris via macroencapsulation must meet the following criteria:

> "Macroencapsulation of hazardous debris requires application of surface coating materials such as polymeric organics (e.g., resins and plastics) or use of a jacket of inert inorganic materials to substantially reduce surface exposure to potential leaching media" (40 CFR 268.45).

In order for hazardous debris to qualify for this alternative treatment, the waste must comply with the debris definition in 40 CFR 268.2(g).

> "Debris means solid material exceeding a 60 mm particle size that is intended for disposal and that is: A manufactured object; or plant or animal matter; or natural geologic material. However, the following materials are not debris: Any material for which a specific treatment standard is provided in Subpart D, Part 268, namely lead acid batteries, cadmium batteries, and radioactive lead solids; Process residuals such as smelter slag and residues from the treatment of waste, wastewater, sludges, or air emission residues; and intact containers of hazardous waste that are not ruptured and that retain at least 75% of their original volume. A mixture of debris that has not been treated to the standards provided by § 268.45 and other material is subject to regulation as debris if the mixture is comprised primarily of debris, by volume, based on visual inspection" (emphasis added).

Figure 3-1. Macroencapsulation of Hazardous Debris

Therefore, packaged waste subject to macroencapsulation (MACRO) may contain other material that does not meet the debris definition (e.g., paint chips, scale, etc.) to the extent that the mixture is "comprised primarily of debris". Consistent with the ALARA principle, this definition provides generators with flexibility in managing waste streams requiring treatment without having to sort and segregate non-debris items prior to treatment. However, as noted in 40 CFR 268.2(h), "deliberate mixing of other hazardous material with debris to change its treatment classification (i.e., from waste to hazardous debris) is not allowed under the dilution prohibition in § 268.3."

Radioactive Lead Solids (RLS) are another type of hazardous waste that requires treatment via macroencapsulation. Radioactive Lead Solids include, but are not limited to, all forms of lead shielding and other elemental forms of lead. There are no size criteria for RLS unlike the 60 mm particle size requirement for hazardous debris. As such, smaller forms of RLS such as lead shot or fines require macroencapsulation prior to disposal.

Energy*Solutions*' MACRO treatment capability accommodates any size or weight of hazardous debris, thus enabling the generator to reduce the amount of time and cost associated with preparing waste packages for shipment. Generators with large debris over 20,000 pounds requiring macroencapsulation will provide the following information to Energy*Solutions* for review during the waste acceptance process: drawings, photographs, dimensions, weight, description of access ports to internal voids, radiological dose rate and contamination levels, and loading plans.

Debris Spray Washing

Debris Spray Washing is another alternative treatment option utilized by Energy*Solutions* to treat hazardous debris. High pressure water is sprayed at the debris surface to remove hazardous constituents to a "clean debris surface". This treatment technology is best if used on non-porous debris such as metal. ''Clean debris surface'' criteria are specified in 40 CFR 268.45:

> "Clean debris surface means the surface, when viewed without magnification, shall be free of all visible contaminated soil and hazardous waste except that residual staining from soil and waste consisting of light shadows, slight streaks, or minor discolorations, and soil and waste in cracks, crevices, and pits may be present provided that such staining and waste and soil in cracks, crevices, and pits shall be limited to no more than 5% of each square inch of surface area."

Microencapsulation

Microencapuslation (MICRO) is a technology used on Mixed Waste to reduce the leachability of the hazardous constituent. The types of Mixed Waste most suitable for MICRO include, but are not limited to, ash, powders, and salts. MICRO involves the combining of waste with molten polyethylene to form a material that does not leach hazardous constituents in excess of established TCLP treatment standards. Mixed Waste is placed into the mixer with polyethylene. These are mixed at a high frequency with shear and frictional forces until the polyethylene melts and mixes with the waste to create a microencapsulated waste form. The treatment system includes size separation, size reduction, and a waste dryer for waste preparation prior to treatment.

Thermal Treatment of Organics

Mixed Waste streams contaminated with organic hazardous constituents are among the most difficult waste streams to treat. The LDR treatment standards are expressed in terms of total organic concentrations (i.e., mg/kg) versus TCLP concentration based standards. As such, treatment of organic contaminated waste streams requires either destruction or removal of the organic constituent from the waste.

Energy*Solutions* utilizes Vacuum-Assisted Thermal Desorption technology (VTD) to treat organic contaminated waste streams including waste streams containing PCBs. Waste containing PCB liquids is also acceptable for VTD treatment.

Mixed Waste streams are heated in the VTD system at sufficient temperatures to volatize the organic constituents which are then condensed and collected as a liquid. The thermally treated residue is then sampled to verify LDR compliance. In some cases, the treatment residue will require additional treatment to stabilize hazardous metals prior to disposal. The organic liquid condensate will require further treatment to comply with LDR treatment standards.

Mercury Treatment

Elemental mercury contaminated with radioactive materials must be treated via amalgamation per 40 CFR 268.40. Amalgamation of elemental mercury involves the mixing of reagents with the mercury to produce a non-liquid, semi-solid amalgam that reduces the potential emissions of elemental mercury vapors to the air. The Utah DSHW also requires the amalgamation treatment to reduce the leachability of elemental mercury to below the characteristic concentration limit of 0.2 mg/L TCLP. This requirement applies to amalgamated mercury treated at either Energy*Solutions*' Treatment Facility or treated at another facility and shipped to Energy*Solutions* for disposal. Generators may ship elemental mercury contaminated with radioactive materials to Energy*Solutions* for treatment and disposal.

Energy*Solutions* is also capable of treating both Low (< 260 ppm Hg) and High Mercury Subcategory waste streams (≥ 260 ppm Hg). Waste streams containing Low Subcategory Mercury must be treated to less than 0.025 mg/L TCLP mercury. The EPA requires High Mercury Subcategory waste streams be treated thermally by incinerating (IMERC) or retorting (RMERC). Energy*Solutions* has received a site-specific treatment variance from the Utah Solid and Hazardous Waste Control Board to treat High Mercury Subcategory waste streams via stabilization instead of IMERC or RMERC. Consequently, waste streams containing High Subcategory Mercury are treated via stabilization and analyzed post-treatment to ensure the TCLP mercury results are less than 0.2 mg/L.

Hazardous debris that is contaminated with mercury may be macroencapsulated in accordance with the "Alternative Treatment Standards for Hazardous Debris" as specified in 40 CFR 268.45. Elemental mercury must be removed from hazardous debris to the maximum extent practical including, but not limited to, draining pumps, hoses, pipes, etc. and wiping excessive mercury from external surfaces.

3.1.4 11e.(2) Byproduct Material

Energy*Solutions* is licensed by the Utah DRC to receive and dispose of 11e.(2) byproduct material as defined by the Atomic Energy Act, as amended. 11e.(2) byproduct material is defined as the tailings or waste produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content. Shipments of 11e.(2) waste will be managed and disposed of in a separate disposal embankment specifically licensed and designed for this material.

3.1.4.1 Radionuclide Concentration Limits

Energy*Solutions* may accept 11e.(2) byproduct material with an average concentration in any transport vehicle (truck or railcar) not to exceed 4,000 pCi/g for natural uranium or for any radionuclide in the Radium-226 series, 60,000 pCi/g for Thorium-230, or 6,000 pCi/g for any radionuclide in the thorium decay series. Energy*Solutions*' 11e.(2) Byproduct Material License does not require a sum of fractions calculation. The concentration limits are based on the average concentration of the 11e.(2) byproduct material over the transport vehicle upon receipt and not each individual container on the transport vehicle.

3.1.4.2 Acceptable Forms of 11e.(2) Byproduct Material

In addition to soil and soil-like 11e.(2) byproduct material, Energy*Solutions* may accept 11e.(2) contaminated debris. The generator must certify in the Radioactive Waste Profile Record that the debris was either generated during the cleanup of an 11e.(2) facility or is an integral part of the operations of extraction or concentration of uranium or thorium.

All debris must be less than 10 inches in at least one dimension and no longer than 12 feet in any dimension. Debris that exceeds this size limit (e.g., 11e.(2) oversize debris) is not acceptable for disposal under the 11e.(2) license. Generators with 11e.(2) contaminated debris that are unable to size the debris prior to shipment must contact Energy*Solutions*' Customer Service representative to make necessary arrangements for Energy*Solutions* to size the debris upon receipt.

Shipments of 11e.(2) byproduct material containing free liquid will be considered nonconforming and managed in accordance with Energy*Solutions*' 11e.(2) license.

3.1.4.3 Certification of 11e.(2) Byproduct Material

Energy*Solutions* requires that each generator or owner certify in writing that the waste is 11.e(2) byproduct material as defined by the Atomic Energy Act, as amended. Specifically, the generator or owner must certify that the waste materials are tailings or waste produced by extraction or concentration of uranium or thorium from any ore processed primarily for its source material content. The generator or owner must also certify that the waste material does not contain any other radioactive waste or hazardous waste. The generator or owner must provide the following information as it relates to the 11e.(2) byproduct material:

- License under which the waste was processed
- Licensee that was issued the license
- License issue and/or expiration date
- Issuing agency
- Type of license
- Volume of tailings

The generator or owner must attach to the certification a list of all radiological and non-radiological constituents in the waste and the maximum and average concentrations of such constituents. Energy*Solutions* will perform an independent verification as to the accuracy of the information contained in the certification.

3.1.4.4 Shipping Paperwork for 11e.(2) Byproduct Material

Although 11e.(2) byproduct material is specifically excluded from the definition of Low-Level Radioactive Waste; Energy*Solutions* requires that all shipments be manifested using the Uniform Low-Level Radioactive Waste Manifest (NRC Forms 540 and 541). However, 11e.(2) byproduct material does not have to be classified in accordance with the requirements of URC R313-15-1008. Generators may enter "N/A" in column 16 of the NRC Form 541 for Waste Classification.

3.1.5 Special Nuclear Material

Condition 13 of the Radioactive Material License incorporates the Special Nuclear Material Exemption issued by the NRC. Under specified conditions, the exemption allows Energy*Solutions* to possess waste containing SNM in greater mass quantities than prescribed in 10 CFR Part 150 without obtaining an NRC license pursuant to 10 CFR Part 70. The conditions are based on concentration limits of SNM in the waste and have been established by the NRC to ensure criticality safety. Special Nuclear Material (SNM) is defined in the UAC R313-12-3 as:

> Plutonium, uranium-233, uranium enriched in the isotope 233 or in the isotope 235, and other material that the U.S. Nuclear Regulatory Commission, pursuant to the provisions of Section 51 of the Atomic Energy Act of 1954, as amended, determines to be Special Nuclear Material, but does not include source material; or any material artificially enriched by any of the foregoing but does not include source material.

Each generator shipping waste containing SNM (i.e., uranium enriched in U-235, U-233, Pu-236, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, Pu-243, or Pu-244) must complete and sign Energy*Solutions*' SNM Exemption Certification form as part of the waste profiling process. A copy of this form must also accompany each radioactive waste manifest for waste streams that contain any of the above isotopes. The SNM Exemption Certification form lists specific requirements that must be met in order for Energy*Solutions* to receive and accept waste containing any amount of SNM.

The NRC developed the SNM Exemption conditions based on criticality studies and independent calculations. A variety of scenarios were analyzed to determine limiting criticality conditions for waste materials containing SNM. The NRC determined that several conditions in addition to concentration limits would be required to assure criticality safety. A discussion of their approach is documented in the *Safety Evaluation Report Regarding the Proposed Exemption from Requirements of 10 CFR Part 70* (SER) (Docket 40-8989). Specific guidance from the SER is included in this section.

The following information provides general guidance on completing the SNM Exemption Certification form. These guidelines are grouped into four sections similar to the sections on the form.

3.1.5.1 Condition 1 - Percent Enrichment of Uranium-235

The first section contains a table that lists U-235 concentration limits and related measurement uncertainty values for four different scenarios. These scenarios allow for different enrichments, waste configurations and commingling with moderating material in different percentages. The measured concentrations and associated uncertainties of U-235 in individual waste containers at time of receipt must not exceed the values listed in the RML, Condition 13. Generators with low SNM concentrations relative to the specified limits may select the most restrictive scenario which allows more flexibility in demonstrating compliance with other conditions in the SNM Exemption. Check "Not Applicable" if the waste does not contain enriched U-235. Other SNM isotopes including U-233, Pu-236, and Pu-238 through Pu-244 and their associated limits are also listed.

The measurement uncertainty values listed in the last column of the table represent a maximum allowable concentration limit rather than a percentage value. The NRC provides the following guidance in the SER:

> Staff considers that a reasonable measurement uncertainty value (one-sigma) would be in the range of 15 percent. Staff used 30 percent (two-sigma) in calculating the operational limit to increase the confidence level that the concentration of the waste based on a measurement

> would not exceed the subcritical value. Other radiochemistry techniques may be used to quantify the concentration of these radionuclides. These techniques typically have lower measurement uncertainty levels, but introduce sampling uncertainty. The measurement uncertainty levels are included in condition 1 and represent 15 percent of the maximum concentration value. A concentration value was used for the measurement uncertainty rather than a percentage value to allow greater flexibility for generators with waste having very low SNM concentrations.

3.1.5.2 Condition 2 – Specified Limits for Waste Containing SNM

Each generator must certify to all five conditions listed in this section and provide justification based on process knowledge, physical observations, and/or testing. These conditions are categorized as follows:

- SNM Isotope Concentration Limits
- Spatial Distribution Requirements
- Bulk Chemical Limits
- Unusual Moderator Limits
- Soluble Uranium Limits

These conditions require the generator to adequately characterize the waste in terms of the range and variability of SNM concentrations in the waste.

<u>SNM Isotope Concentration Limits</u>

Condition 2.a requires the generator to certify that concentrations of SNM in individual waste containers do not exceed the applicable U-235 concentration limit and the concentration limits for all isotopes listed in Table 1 of the SNM Exemption Certification form. Generators must certify that measurement uncertainty values from radiological testing are less than the maximum allowable concentration values listed in Table 1. As previously stated, a concentration value was used for the measurement uncertainty rather than a percentage value to allow greater flexibility for generators with waste having very low SNM concentrations.

<u>Spatial Distribution Requirements</u>

Condition 2.b requires the generator to certify that the SNM is homogeneously distributed throughout the waste or that the SNM concentrations in any contiguous mass of 600 kilograms (1,323 lbs) do not exceed on average the specified limits. This certification may be based on process knowledge or testing of the waste. The SER provides the following guidance on verifying spatial distribution of SNM:

> Knowledge of the process by which the waste was generated or laid down may assure that the concentration varies smoothly throughout the volume with a maximum in a known location. It is then only necessary to measure the concentration at this maximum plus other measurements confirming smooth variation. In other cases where a smooth variation in SNM concentration in the waste is not present, additional measurements and characterization will be needed.

If spatial distribution of SNM in the waste is not known through process knowledge, generators may be able to certify to this requirement by using the following example.

EXAMPLE: A generator's waste stream contains less than 10 percent enriched U-235. Based on the limits in Condition 1, the corresponding U-235 concentration limit is 1,900 pCi/g. The mass of U-235 at a concentration of 1,900 pCi/g in 600 kg of waste can be calculated using the specific activity for U-235 ($2.16X10^6$ pCi/g) as follows:

$$\frac{1{,}900\,\frac{pCi}{g} \times 600{,}000\,g}{2.16X10^6\,\frac{pCi}{g}} = 527.8\ g\ U235$$

If the total mass of U-235 per container does not exceed the mass of U-235 in 600 kg of waste at 1,900 pCi/g, then compliance with the spatial distribution requirement can be achieved. Therefore, for this example, the mass of U-235 in the waste containers must not exceed 527.8 grams. Compliance with DOT regulations must also be met for shipments containing SNM.

Radioactive liquid waste containing SNM may also be accepted for solidification prior to disposal provided the SNM concentration does not exceed the SNM concentration limits specified in Condition 1. For containers of liquid waste with more than 600 kg of waste, the total activity (pCi) in the manifested container must not exceed the SNM concentration in Condition 1 times 600 kg of waste. For example, the maximum activity of Pu-239 in any manifested container of liquid waste is 6.0 mCi as shown below:

$$10{,}000\,\frac{pCi}{g} \times 600{,}000\ g = 6.0x10^9\ pCi = 6.0\,mCi\ Pu\text{ - }239$$

The maximum activity of SNM in the liquid waste is limited by the volume of liquid shipped in a container and the concentration of SNM in the waste. Consequently, to comply with this condition, the Pu-239 concentration allowed in the liquid waste decreases as the size of the shipping container increases.

Bulk Chemical Requirements

Condition 2.c excludes wastes containing "pure forms" of chemicals containing carbon, fluorine, magnesium, or bismuth in bulk quantities except as allowed by the conditions in Section 1 (e.g., a pallet of drums, a B-25 box). By "pure forms," it is meant that mixtures of the above elements such as magnesium oxide, magnesium carbonate, magnesium fluoride, bismuth oxide, etc. do not contain other elements. Demonstration of compliance with this condition may be based on process knowledge or testing.

The exclusion of bulk quantities of these chemicals in waste containing SNM is based on the criticality studies conducted by Oak Ridge National Laboratories (ORNL) for the NRC. The ORNL studies used silicon dioxide (SiO_2) to represent the waste matrix in performing criticality calculations. Additional studies were performed replacing the silicon in the SiO_2 matrix with other common elements and determined that the above chemicals produced more reactive systems. Therefore, the NRC implemented this condition to restrict waste forms that contain pure forms of these chemicals.

Unusual Moderator Limits

Condition 2.d limits the total quantities of beryllium, hydrogenous material enriched in deuterium, or graphite to one percent or less of the total weight of the waste (except as allowed by the conditions in

Section 1). Information supporting this requirement may be based on process knowledge, physical observations, or testing. The following explanation from the SER provides the basis for this limit:

> Unusually effective neutron moderating materials, such as beryllium, graphite, or heavy water, could provide a more reactive matrix. Previous evaluations have shown that the presence of large amounts of beryllium can permit criticality to occur at lower concentrations of SNM in soil. Therefore, limiting unusual moderators is required to assure the effectiveness of the SNM concentration limits in maintaining criticality safety. Because prohibiting unusual moderators could result in problems demonstrating compliance, staff decided to set a finite maximum limit on unusual moderators.

Soluble Uranium Limits

Condition 2.e limits highly soluble forms of uranium in waste packages to 350 grams of uranium-235 or 200 grams of uranium-233. If the waste contains mixtures of U-233 and U-235, the waste must meet the sum of the fractions rule on a container basis. Highly soluble forms of uranium include, but are not limited to: uranium sulfate, uranyl acetate, uranyl chloride, uranyl formate, uranyl fluoride, uranyl nitrate, uranyl potassium carbonate, and uranyl sulfate. Compliance with this condition may be based on process knowledge or testing.

This condition is based on an evaluation performed by the NRC to determine mechanisms that could increase the concentration of SNM in the waste. The SER identifies one such mechanism which involves the potential for highly soluble uranium to be readily leached with water and concentrate in the waste. Generators must evaluate each waste stream to determine the chemical composition of uranium in the waste and to ensure that the presence of highly soluble forms of uranium do not exceed the mass limits specified above.

3.1.5.3 Condition 3 – Characterization of Waste Containing SNM

The NRC developed specific pre-shipment requirements that have been implemented into the waste profiling process. Energy*Solutions* reviews this information to determine if the pre-shipment waste characterization and assurance plan is complete and that the supporting information is sufficient to demonstrate compliance with all SNM Exemption requirements. This section describes the information that must be attached to the Waste Profile and includes the following items:

- Waste Description
- Waste Characterization Summary
- Uniformity Description
- Manifest Concentration

Condition 3.a requires the generator to describe how the waste was generated, the physical form of the waste, and the uranium chemical composition. The uranium chemical composition of the waste is required to support condition 2.e which limits highly soluble forms of uranium. If compliance with this requirement cannot be demonstrated by process knowledge, approved laboratory methods are available to determine the uranium leaching characteristics of the waste.

Condition 3.b requires the generator to describe how the waste was characterized, the range of SNM concentrations, and the analytical results with error values used to develop the concentration ranges. This information is required to support Conditions 1, 2.a, and 2.b. Generators must sufficiently sample and characterize the waste to ensure that the SNM concentrations do not exceed the specified limits and that the SNM is homogeneously distributed throughout the waste.

A description of the spatial distribution of SNM in the waste is required by Condition 3.c. This description supports the certification of Condition 2.b. The NRC provides guidance in the SER to assist generators in demonstrating compliance with this requirement. Section 3.3.3.2 contains the related NRC guidance.

Condition 3.d requires a description of the methods that will be used to determine the SNM concentrations on the manifests. If concentrations of SNM are significantly lower than the specified limits or the SNM is uniformly distributed throughout the waste, generators are not necessarily required to perform direct measurements on every container. Appropriate methods such as scaling factors may be used in these instances. As SNM concentrations approach the limits, however, generators must perform more extensive characterization to determine the range and variability of SNM in the waste. The following NRC guidance is provided in the SER:

> Where the concentration is a small fraction of the concentration limit and characterization results indicate relatively small variation in that concentration, using scaling factors would be an appropriate method to determine SNM concentrations in individual waste containers. However, where the concentration of SNM approaches the concentration limit or the characterization results indicate large variations in SNM containers, using direct measurements on each package would be an appropriate method to determine SNM concentrations in individual waste containers.

Waste packages that contain elevated concentrations of SNM must be characterized by direct measurements which should involve sampling and/or radiological testing procedures for individual packages.

3.1.5.4 Condition 4 – Generator's Certification

The generator's certification of compliance is required in the final section. Each generator must certify that the information provided on the SNM Exemption Certification form is complete, true, and accurate. The form and all supporting information must be attached to the Waste Profile upon submission to Energy*Solutions*. In addition, the SNM Exemption Certification form must be included with each waste manifest. The information supporting the form, however, should not be included with the manifest.

3.1.6 Polychlorinated Biphenyl (PCB) Radioactive Waste

Energy*Solutions* is authorized to receive and dispose of most types of PCB/radioactive and PCB/mixed wastes defined by the EPA in 40 CFR 761. The EPA issued Energy*Solutions* a TSCA Coordinated Approval for receipt and disposal of drained PCB Articles and PCB Containers that contained PCBs at concentrations equal to or greater than 500 ppm. Wastes received under the TSCA Coordinated Approval must be disposed in the Mixed Waste disposal embankment. All PCB waste shipped to the Mixed Waste disposal facility must be accompanied with a Uniform Hazardous Waste Manifest. As required by 40 CFR 761, the Uniform Hazardous Waste Manifest must include the date the PCB waste was removed from service. Articles and containers of PCB waste must also be dated with the removed from service date per 40 CFR 761.65(c)(8). Empty PCB containers that contained PCBs at concentrations less than 500 ppm may be disposed in the Class A LLRW Facility; however, this waste will require a Uniform Hazardous Waste Manifest and include the removed from service date on each outer container. A Uniform Hazardous Waste Manifest is not required for any other PCB wastes disposed at the Class A LLRW Facility.

The following sections describe the types of PCB waste categories acceptable for disposal at the Class A LLRW or Mixed Waste disposal embankments. Asterisks indicate PCB waste categories that require disposal in Energy*Solutions*' Mixed Waste disposal embankment.

Energy*Solutions*' Ground Water Quality Discharge Permit (GWQDP) and State-Issued Part B Permit prohibit the receipt of any PCB liquids except for 1) intact, non-leaking PCB Small Capacitors or 2) PCB waste that will be treated via VTD. Shipments of PCB wastes containing unauthorized free liquids will not be accepted by Energy*Solutions* unless re-profiled to a VTD waste stream. Generators shipping PCB wastes in re-usable containers must be lined to prevent PCB contamination on the internal surfaces of the container. Containers contaminated with PCBs will be returned to the shipper as a PCB Container.

3.1.6.1 PCB Remediation Waste

PCB Remediation waste is waste containing PCBs as a result of a spill, release, or other unauthorized disposal, at the following concentrations: (1) Materials disposed of prior to April 18, 1978, that are currently at concentrations ≥ 50 ppm PCBs, regardless of the concentration of the original spill; (2) materials which are currently at any volume or concentration where the original source was ≥ 500 ppm PCBs beginning on April 18, 1978, or ≥ 50 ppm PCBs beginning on July 2, 1979; and (3) materials which are currently at any concentration if the PCBs are spilled or released from a source not authorized for use under this part. PCB remediation waste means soil, rags, and other debris generated as a result of any PCB spill cleanup, including, but limited to soil, gravel, dredged materials, such as sediments, settled sediment fines, and aqueous decantate from sediment, sewage sludge containing < 50 ppm PCBs, buildings and other man-made structures (such as concrete floors, wood floors, or walls) porous surfaces, and non-porous surfaces. Unless sampled and analyzed in accordance with 40 CFR 761.283, .286, or .292, the PCB waste shall be assumed to contain ≥ 50 ppm PCBs (40 CFR 761.61(a)(5)(i)(B)(2)(i)).

<table>
<tr><th>PCB Remediation Waste Category</th><th>Definition</th><th>Acceptable</th></tr>
<tr><td>Non-liquid Cleaning Materials and PPE</td><td>Includes non-porous surfaces and other non-liquid materials such as rags, gloves, booties, other disposable PPE, and similar materials resulting from PCB cleanup activities.</td><td rowspan="2">Yes</td></tr>
<tr><td>< 50 ppm or
< 100 μg/100 cm²</td><td>PCB Remediation waste containing < 50 ppm or < 100 μg/100 cm².</td></tr>
<tr><td>≥ 50 ppm or
≥ 100 μg/100 cm²</td><td>PCB Remediation waste containing ≥ 50 ppm or ≥ 100 μg/100 cm².</td><td>Yes*</td></tr>
</table>

* Requires disposal in Energy*Solutions*' Mixed Waste disposal embankment.

3.1.6.2 PCB Bulk Product Waste

PCB Bulk Product waste is waste derived from manufactured products containing PCBs in a non-liquid state, at any concentration where the concentration at the time of designation for disposal was ≥ 50 ppm PCBs. PCB Bulk Product waste includes bulk wastes or debris from the demolition of buildings and other man-made structures manufactured, coated, or serviced with PCBs.

PCB Bulk Product Waste Category	Definition	Acceptable
Presumed or known to leach < 10 μg/L PCBs	Plastics (such as plastic insulation from wire or cable; radio, television and computer casings; vehicle parts; or furniture laminates); preformed or molded rubber parts and components; applied dried paints, varnishes, waxes or other similar coatings or sealants; caulking; Galbestos; non-liquid building demolition debris; or non-liquid PCB bulk product waste from the shredding of automobiles or household appliances from which PCB small capacitors have been removed (shredder fluff). Other PCB Bulk Product waste that leaches PCBs at < 10 ug/L of water measured using a procedure used to simulate leachate generation.	Yes
Presumed or known to leach ≥ 10 μg/L PCBs	Paper or felt gaskets, fluorescent light ballasts with PCBs in the potting material ≥ 50 ppm	Yes*

* Requires disposal in Energy*Solutions*' Mixed Waste disposal embankment.

3.1.6.3 PCB Articles

A PCB Article is any manufactured article, other than a PCB Container, that contains PCBs and whose surfaces have been in direct contact with PCBs. A "PCB Article" includes capacitors, transformers, electric motors, pumps, pipes and any other manufactured item (1) which is formed to a specific shape or design during manufacture, (2) which has end use functions dependent in whole or in part upon its shape or design during end use, and (3) which has either no change of chemical composition during its end use or only those changes of composition which have no commercial purpose separate from that of the PCB Article.

Energy*Solutions* received a TSCA Coordinated Approval from the EPA to receive and dispose of drained PCB Articles. PCB Articles must be drained of all liquid to the maximum extent practical but in no case shall the liquid exceed one percent of the waste volume (all free liquid must be absorbed). PCB Articles that have been drained must be filled with sufficient absorbent material to absorb all remaining liquid. Some PCB Articles also require flushing with solvents for a specified time period (e.g., PCB Transformers). Energy*Solutions* is also able to process PCB Large Capacitors and leaking PCB Small Capacitors through VTD.

The following table lists the various types of PCB Articles and whether the material is acceptable for disposal in either the mixed waste disposal embankment or LLRW disposal embankment.

PCB Articles Category		Definition	Acceptable
PCB Transformers		Any transformer that contains ≥ 500 ppm PCBs.	Yes*[1]
PCB Capacitors (Intact and non-leaking)		Any capacitor that contains ≥ 500 ppm PCBs. Capacitor is a device for accumulating and holding a charge of electricity and consisting of conducting surfaces separated by a dielectric. Assume PCBs ≥ 500 ppm in a capacitor of unknown concentration made prior to July 2, 1979. Assume PCBs < 50 ppm in a capacitor made after July 2, 1979.	--
	PCB Small Capacitors	A capacitor which contains less than 3 lbs of dielectric fluid. A capacitor whose total volume is less than 100 cubic inches may be considered to contain less than 3 lbs of dielectric fluid. Includes fluorescent light ballasts containing intact and non-leaking PCB small capacitors and PCB potting material (< 50 ppm).	Yes*
	PCB Large High or Low Voltage Capacitors	A large high voltage capacitor contains 3 lbs or more of dielectric fluid and which operates at or above 2,000 volts. A large low voltage capacitor contains 3 lbs or more of dielectric fluid and which operates below 2,000 volts.	Yes*
PCB Hydraulic Machines		Includes die casting machines	Yes*[2]
PCB-Contaminated Electrical Equipment		Any electrical equipment (such as transformers, capacitors, and circuit breakers, including those in railroad locomotives and self-propelled cars) which contain ≥ 50 ppm and < 500 ppm PCBs in the dielectric fluid. In the case of dry electrical equipment, the electrical equipment is PCB-Contaminated if it has PCBs > 10 ug/100 cm^2 and < 100 ug/100 cm^2 as measured by a standard swipe test (40 CFR 761.123).	Yes
Other PCB Articles			--
	PCB Article (≥ 500 ppm PCBs)		Yes*
	PCB-Contaminated Article	Any article which contains ≥ 50 ppm and < 500 ppm PCBs in the dielectric fluid. In the case of dry electrical equipment, the electrical equipment is PCB-Contaminated if it has PCBs > 10 ug/100 cm^2 and < 100 ug/100 cm^2 as measured by a standard swipe test per 40 CFR 761.123.	Yes

* Requires disposal in Energy*Solutions*' Mixed Waste disposal embankment.
[1] Requires solvent flushing.
[2] Requires solvent flushing if PCB concentrations ≥ 1,000 ppm.

3.1.6.4 PCB Containers

A PCB Container is any package, can, bottle, bag, barrel, drum, tank, or other device that contains PCBs or PCB Articles and whose surfaces have been in direct contact with PCBs. PCB Containers must be emptied to the extent practical and not contain any free standing liquid. All PCB Containers received for disposal require a Uniform Hazardous Waste Manifest and removed from service dates. Waste containing PCBs in a liquid or solid phase is acceptable for VTD treatment (refer to Section 3.1.3.3).

PCB Container Category	Definition	Acceptable
≥ 500 ppm PCBs	The PCB concentration of material which was contained in the PCB Containers was ≥ 500 ppm	Yes*
< 500 ppm PCBs	The concentration of material which was contained in the PCB containers was < 500 ppm	Yes

* Requires disposal in Energy*Solutions*' Mixed Waste disposal embankment.

3.1.7 UCNI and Export Controlled Waste

Energy*Solutions* has been granted approval from the DOE to receive Unclassified Controlled Nuclear Information (UCNI) and Export Controlled radioactive waste. This type of waste primarily originates from the DOE gaseous diffusion enrichment facilities. DOE generators must contact Energy*Solutions* prior to shipping UCNI and Export Controlled radioactive waste.

3.1.8 Chelating Agents

Energy*Solutions* is authorized to dispose of waste containing up to 22 percent by weight chelating agents in the Mixed Waste disposal embankment. Waste disposed of in the LLRW disposal embankment must contain less than 0.1 percent by weight chelating agents. Generators may ship waste containing greater than 22 percent chelating agents to Energy*Solutions*' Treatment Facility once approved during the waste profiling process. Energy*Solutions* will treat waste containing greater than 22 percent chelating agents prior to disposal in order to comply with this requirement.

3.1.9 Asbestos and Beryllium

Energy*Solutions* is authorized to dispose of waste containing both friable and non-friable asbestos. The asbestos waste must be described in the Radioactive Waste Profile Record and packaged, marked, and labeled in accordance with applicable federal regulations. Friable asbestos must not be packaged in bulk containers unless approved in writing by Energy*Solutions*.

Asbestos waste that requires wetting to prevent dispersion must be inspected to minimize free liquids. However, unless the waste is to be solidified at the Treatment Facility, the free liquid may not exceed one percent of the waste volume. Absorbent material must be added to containers when free liquids are present. Waste streams containing greater than one percent free liquid by waste volume may be shipped to Energy*Solutions*' Treatment Facility for solidification prior to disposal. Contact Energy*Solutions* prior to shipping waste streams that contain free liquids.

Waste containing other potential inhalation hazards such as beryllium must be described in the Waste Profile and documented on the 5 Working-Day Advanced Shipment Notification form. A quantitative description of potential beryllium surface contamination and air monitoring measurements both before and after any fixatives or wrapping are applied should be included in the Waste Profile for beryllium contaminated waste. The description should also include information about the current management of the beryllium contaminated waste including specific work control procedures in handling and packaging the waste for shipment, details of the beryllium protection program as applicable, and air monitoring measurements, etc. Beryllium contaminated waste must be packaged in 55-gallon or smaller drums unless approved in writing by Energy*Solutions*.

3.1.10 Lab Packs

Lab packs are described as small containers of liquid with varying hazardous waste codes that are placed in a larger shipping or storage container. Energy*Solutions* is authorized to receive lab packs in which all of the contents are known and acceptable for treatment or disposal. Lab packs require a specific Waste Profile that must be approved by Energy*Solutions* prior to shipment. Generators must provide a description of unused chemicals within containers with the shipping paperwork.

3.2 ACCEPTABLE FORMS OF RADIOACTIVE WASTE

Energy*Solutions*' Radioactive Material License authorizes the receipt of radioactive waste in the form of liquids and solids. Solid radioactive waste must contain less than one percent free liquid by waste volume. Generators shipping solid waste must minimize free liquid to the maximum extent practicable. Conversely, liquid radioactive wastes contain greater than one percent free liquid by waste volume (e.g., sludge, wastewater, evaporator bottoms, etc.). Energy*Solutions* will determine if a waste contains free liquids by either visual inspection or by performing the Paint Filter Liquid Test (EPA SW-846 Method 9095). Liquid radioactive waste is solidified at Energy*Solutions*' Treatment Facility prior to disposal.

Solid waste includes, but is not limited to, the following forms of waste: soil, sludge, dry active waste, metal, concrete, wood, glass, resin, etc. For simplicity, these waste forms are categorized into either soil or debris waste streams due to the placement criteria specified in the license.

3.2.1 Soil or Soil-Like Wastes

Energy*Solutions* constructs the disposal embankment by achieving specified compaction criteria and minimizing void spaces in the disposal lift. Construction of the disposal embankment in this manner ensures long-term integrity of the disposal facility. Soil and soil-like waste material are placed in the disposal embankment and compacted in 12-inch soil lifts. The license requires these soil lifts to be compacted to greater than 90 percent of optimum density and at a moisture content not to exceed three percentage points above optimum moisture as determined by the Standard Proctor Method (ASTM D-698). Consequently, soil or soil-like waste must have soil-like properties and conform to the following specifications. Otherwise, the waste material will be considered debris and managed for disposal as described in Section 3.2.2.

Soil/Soil-Like Properties

- Greater than 70 percent by weight compactable material less than 3/4" particle size and 100 percent compactable material less than 4" particle size
- Maximum dry density greater than 70 pounds per cubic foot (dry weight basis)
- Moisture content of the soil or soil-like waste must not exceed three percentage points above optimum moisture upon receipt at Energy*Solutions*
- Maximum dry density and optimum moisture must be determined by Standard Proctor Method ASTM D-698

Energy*Solutions* may request a preshipment sample to perform an independent compaction test using Standard Proctor Method ASTM D-698. Generators must include their compaction test results as part of the waste profile submittal.

Shipments of soil or soil-like waste streams may contain some standard size debris in waste packages. The percentage of allowable debris in the waste stream must be listed in the waste profile. Soil or soil-like waste streams with moisture content exceeding three percentage points above optimum moisture are acceptable by Energy*Solutions* and require additional handling prior to disposal. Contact Energy*Solutions*' Customer Service representatives prior to shipping soil or soil-like waste streams with elevated moisture content.

3.2.2 Debris

Waste material not meeting the specified soil or soil-like properties is considered debris by Energy*Solutions*. Debris includes both decommissioning and routinely generated operational waste including, but not limited to, radiologically contaminated paper, piping, rocks, glass, metal, concrete, wood, bricks, resins, sludge, tailings, slag, residues, and personal protective equipment (PPE) that conforms to the debris size requirements.

3.2.2.1 Standard Size Debris

Debris is defined into two broad categories based on size. The first category is standard debris and includes materials that are less than 10 inches in at least one dimension and no longer than 12 feet in any dimension. Debris that does not meet this size criterion is categorized as oversize debris.

Standard size debris is uniformly distributed throughout the 12-inch soil lifts. Energy*Solutions* adds either native clay or radioactive soil to the debris. Each soil lift is limited to the amount of debris that may be placed with soil to achieve the required compaction criteria. Depending upon the conditions of the disposal agreement, some generators that have both soil and debris may be able to achieve cost savings by delivering these materials together such that the shipping package contains enough soil to mix with the debris to achieve compaction requirements. All debris must be placed in such a way to minimize void space in the soil lift.

3.2.2.2 Oversize Debris and Large Components

Waste material is considered oversize debris if the debris has at one dimension greater than 12 feet or does not have one dimension less than 10 inches. Since oversize debris cannot be compacted directly into the soil lifts, this material is placed in different areas of the disposal embankment where void spaces are minimized to the maximum extent practicable both in and around the debris.

Bulk oversize debris, such as a large component, is also disposed of using this alternative disposal process. Energy*Solutions* has received and disposed of several large components over 250 tons including steam generators, reactor heads, turbine components, and other large equipment as illustrated in Figure 3-2. Generators should identify these types of materials as part of the waste profiling process. This will allow Energy*Solutions* to evaluate the off-loading and placement of the large component prior to shipment.

Generally, single items over 20,000 pounds are considered large components and require special handling and engineering reviews prior to placement. The type of information required for large components includes drawings, photographs, weight, dimensions, description of enclosed voids, packaging configuration, rigging and loading plan, identification of lifting points, transportation mode, and radiological characterization and survey documentation. Void spaces within large components must be made accessible via a minimum of two access ports to allow grout in-fill during disposal operations at the Clive disposal facility. Access ports must be at least four inches in diameter unless approved in writing by Energy*Solutions*. Containers of oversize debris must exclude soil or soil-like waste due to placement criteria.

Energy*Solutions* may also elect to dispose of dispersible waste forms (e.g., filtercake, dusty material, etc.) or waste with elevated dose rates by not emptying the waste from the container. Although ion-exchange media (resin) meets the standard size debris criteria, resins are not emptied from the container but grouted to minimize void spaces. Consequently, resin waste streams must be shipped under a resin specific waste profile unless approved in writing by Energy*Solutions*. Void spaces in and around the containers are minimized to the maximum extent practicable.

Figure 3-2. Large Component Disposal

3.2.3 Gaseous Waste

Energy*Solutions* is authorized to receive gaseous waste in accordance with Utah Administrative Code R313-15-1008(2)(a)(viii). Gaseous waste must be packaged at an absolute pressure that does not exceed 1.5 atmospheres at a temperature of 20 degrees Celsius and the total activity of any container shall not exceed 100 Curies. This information must be identified in the Radioactive Waste Profile Record.

3.2.4 Waste Containing Free Liquids

Wastes containing free liquids greater than one percent by volume are considered liquid waste streams. Generators may use visual inspection of the waste or the Paint Filter Liquids Test to determine if the waste contains free liquids. The Radioactive Waste Profile Record must describe the physical, chemical, and radiological characteristics of the liquid waste. Energy*Solutions* received approval from the Utah DRC to receive radioactive liquid wastes that are aqueous based. Non-aqueous radioactive liquids require case-by-case approval from the Utah DRC.

Energy*Solutions* will perform a solidification study on a sample of the liquid waste prior to authorizing shipments. Liquid waste must be solidified and disposed at the Mixed Waste Facility. Energy*Solutions* has permitted liquid storage tanks to accommodate liquids delivered in tankers and other DOT approved bulk containers.

For generators with waste streams that may contain free liquids, the process by which the liquid will be minimized to less than one percent of the waste volume must be documented in the Radioactive Waste Profile Record. Approval of these waste streams would be considered authorized free liquids.

The presence of unauthorized free liquid within a package or shipment is a significant cause of non-compliance. Each incoming shipment will be tested for free liquids in accordance with Energy*Solutions*' Waste Characterization Plan using visual inspection of the waste or the Paint Filter Liquids Test.

If a solid waste shipment is found to contain unauthorized free liquids greater than one percent of the waste volume in any manifested container, Energy*Solutions* is required to promptly notify the generator and the Utah DRC. Energy*Solutions* may stop shipments of waste material until the cause of the problem is identified and corrected. The Waste Characterization Plan requires that the generator submit a quality control program that identifies the root cause of the problem and outlines corrective actions that will be taken to correct the problem and the quality control measures that will be implemented to prevent recurrence. Until this corrective action plan has been submitted, reviewed, and approved by Energy*Solutions*' Quality Assurance Manager, no further shipments may be permitted from the waste generator's site.

In order to control free liquid within the waste material, the use of absorbent materials is strongly recommended. Sufficient absorbent material to absorb twice the volume of the potential liquid should be used. Experience has shown that some soil matrices actually 'bleed' moisture out during transport due to vibration. If testing indicates that the waste material, as shipped, could exceed the optimum moisture content (as determined by the Standard Proctor Test) and that a risk of waste form separation exists while the shipment is en route, the precautionary addition of absorbents prior to shipment is strongly advised. To ensure that adequate absorbents are added, generators should also consider testing the moisture content of each shipment.

Although uncommon, in some cases it is possible for precipitation to enter the package resulting in free liquids. Detailed inspections should be completed before waste is placed in transit to ensure the package meets strong-tight criteria and that water cannot enter. Energy*Solutions* does not maintain a list of approved absorbents or manufacturers. If absorbents are added to the waste, the specific absorbent must be identified in the Radioactive Waste Profile Record (Section B.5).

3.3 PROHIBITED RADIOACTIVE AND MIXED WASTE

Condition 16 of the Radioactive Material License prohibits receipt of the following wastes:

- Sealed sources defined in UAC R313-12 as "radioactive material that is permanently bonded or fixed in a capsule or matrix designed to prevent release and dispersal of the radioactive material under the most severe conditions which are likely to be encountered in normal use and handling" (e.g., instrument calibration check sources, smoke detectors, nuclear density gauges, etc.).
- Radioactive waste which is classified as Class B, Class C, or Greater Than Class C waste.
- Solid waste containing unauthorized free liquids.
- Waste material that is readily capable of detonation, of explosive decomposition, reactive at normal pressure and temperature, or reactive with water or air.
- Waste materials that contain or are capable of generating quantities of toxic gases, vapors, or fumes harmful to persons transporting, handling, or disposing of the waste.
- Waste materials that are pyrophoric. Pyrophoric materials contained in wastes must be treated, prepared, and packaged to be nonflammable.
- Waste materials containing untreated biological, pathogenic, or infectious material including contaminated laboratory research animals. Generators desiring to ship this type of waste must document in the Radioactive Waste Profile Record the process used to treat the potential non-radiological hazard. Sharps including needles, scalpels, knives, syringes, pipettes, and similar items having a point or sharp edge or that are likely to break during transportation must not be packaged in bulk containers unless written approval is given by Energy*Solutions*. When these items are used in the medical industry or related research, they must be treated to remove the biohazard. Documentation of such treatment must be included in the Waste Profile.

The following Mixed Wastes are not acceptable for treatment or disposal at the Mixed Waste facility:

- Hazardous waste that is not also a radioactive waste
- Wastes that react violently or form explosive reactions with air or water
- Pyrophoric wastes and materials
- DOT Forbidden, Class 1.1, Class 1.2 and Class 1.3 explosives
- Shock sensitive wastes and materials
- Compressed gas cylinders, unless they meet the definition of empty containers
- Utah waste codes F999 and P999

SECTION 4

WASTE ACCEPTANCE PROCESS

4.1 WASTE PROFILING PROCESS

This section details Energy*Solutions*' waste characterization and profiling process. Profiling a waste stream involves collecting samples and obtaining analytical results for the parameters specified on Energy*Solutions*' Radioactive Waste Profile Record (Waste Profile). The Waste Profile serves the following functions: (1) enables Energy*Solutions* to evaluate wastes for acceptance, (2) maintains an operating record for the material during acceptance, storage, treatment, if applicable, and disposal of waste shipments, (3) provides a historical record of the waste project for each waste stream, and (4) ensures compliance with Energy*Solutions*' licenses and permits. The Waste Profile and related instructions can be downloaded from Energy*Solutions*' web site at www.energysolutions.com. An Energy*Solutions* Technical Services Representative is also available to assist in the waste profiling process.

The waste profiling process consists of the following steps as illustrated in Figure 4-1:

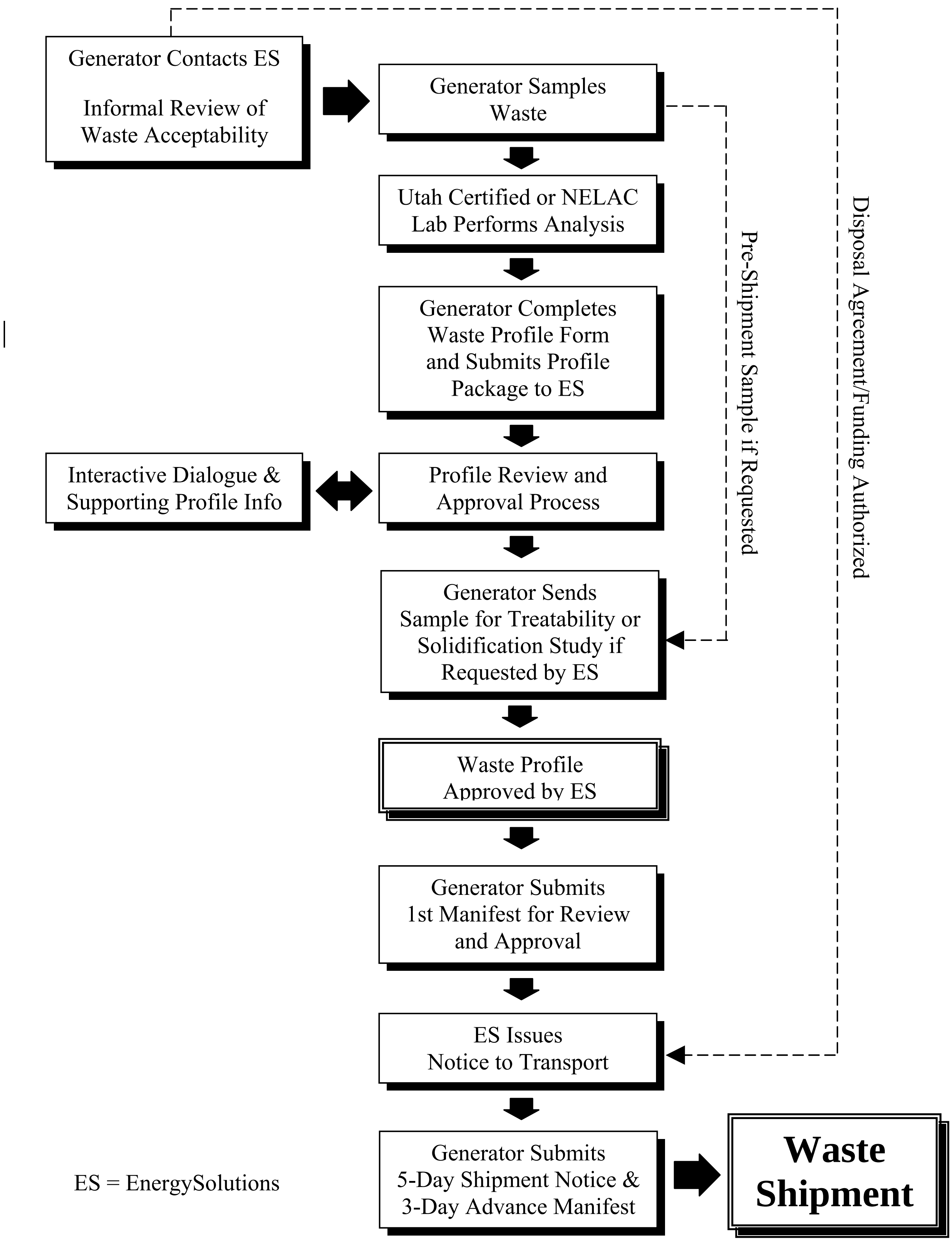
- Initial discussions
- Waste characterization
- Waste Profile Record completion and submittal
- Treatability and/or solidification study sample submitted, if requested
- Profile review and approval
- Notice to Transport

Initial discussions of the waste stream are critical in ensuring that the waste profiling process is accurate and efficient. Technical Services representatives are a resource to the generator in completing this process.

4.2 WASTE CHARACTERIZATION

Early in the process, the generator samples the waste stream where applicable and begins to accumulate the analytical data required in the waste profile record described below. It is critical that chemical analyses are performed by laboratories certified by either the State of Utah or the National Environmental Laboratory Accreditation Conference (NELAC). Generators may contact the Utah Department of Health at (801) 584-8501 or visit their website at http://health.utah.gov to obtain information on the Utah Laboratory certification requirements. Laboratories certified by NELAC are listed on the US EPA's website at www.epa.gov/nerlesd1/land-sci/nelac/accreditlabs.html. Technical Services representatives can also provide current laboratory certification information. Once the analytical support data is available, the generator completes the Waste Profile record as described in the following section.

Figure 4-1. Waste Acceptance Process



4.3 RADIOACTIVE WASTE PROFILE RECORD

The waste profile record is a document required by Energy*Solutions*' licenses and permits. It provides information in the following areas:

- Generator and waste stream information
- Physical properties and packaging
- Radiological information
- Chemical composition and hazard evaluation

Waste generators must complete a Radioactive Waste Profile Record for every waste stream shipped to Energy*Solutions*. To complete this form, the generator should use process knowledge along with analytical laboratory results. The form contains the following sections.

- Generator and Waste Stream Information
  These sections request generator contact information and general overview of the type of waste material, physical characteristics, transportation and package modes, identification of specific radionucildes, and the average and range of radionuclide concentrations.

- Chemical and Hazardous Waste Characteristics (LLRW or MW)
  The generator selects the applicable attachment for describing the chemical properties for either LLRW or Mixed Waste. These attachments request the chemical information to evaluate the waste relative to RCRA regulations. Only one of these attachments is required to be signed and submitted to Energy*Solutions* with the Waste Profile.

- SNM Exemption Certification
  This form requests the radiological information to evaluate waste containing SNM with respect to the SNM Exemption issued by the NRC and incorporated into Energy*Solutions*' license. Condition 3 of the SNM Exemption Certification form requests specific information to be included with the narrative of the Waste Profile.

- PCB Waste Certification
  This form requests information about the type of Polychlorinated Biphenyls (PCBs) waste included with the waste stream. PCB waste streams must be profiled separately from non-PCB waste streams. Energy*Solutions* uses this form and supporting information to evaluate PCB waste streams with respect to Energy*Solutions*' permits and TSCA regulations in 40 CFR 761.

4.3.1 Generator and Waste Stream Information

This section includes contact information for generators, including addresses and responsible parties. The contact information is required for the generator's representative as well as for the individual completing the Waste Profile. The generator must answer a series of questions designed to categorize the waste material that is profiled. The generator identifies the following:

- If the waste is hazardous, and whether it has been treated or requires treatment at Energy*Solutions*
- If the waste is Low-Level Radioactive Waste and subject to LLRW Compact Export approval
- If the waste contains Special Nuclear Materials, PCBs, or asbestos

4.3.2 Waste Physical Properties and Packaging

The physical and geotechnical properties of the waste include gradation of the material, density range, a full description of the physical composition and characteristics of the waste, moisture content, optimum moisture, and maximum dry density determined by the Standard Proctor Method (for soil or soil-like materials).

The purpose of the physical and geotechnical testing requirements is to demonstrate that the material can be managed at Energy*Solutions* under existing license/permit requirements and in accordance with Energy*Solutions*' waste disposal placement methods.

The gradation of the waste may be determined through analysis or waste process knowledge. After an assessment of the entire waste stream, the generator is expected to estimate the amount of material that would pass through the various screens indicated. This information is necessary to determine the method of waste placement.

In this section, the generator addresses questions regarding free liquids. If the waste contains free liquids, the Waste Profile requires a description including the quantity and nature (aqueous or non-aqueous) of the liquid. Solid waste profiled to contain free liquids must be minimized to the maximum extent practical but in no case shall the free liquid exceed one percent of the waste volume upon arrival and inspection at the Energy*Solutions* disposal site. Waste streams containing PCBs must not contain any free liquids unless shipped for VTD treatment.

The waste description is continued by addressing several items in a narrative description and history of the waste provided by the generator as an attachment, referred to as Attachment B.5. The narrative should include the following items as applicable:

- The process that generated the waste
- Waste material physical composition and characteristics
- Radiological and chemical characterization method
- Information requested on the SNM Exemption Certification form, if applicable
- The type and description of PCB waste, if applicable
- Basis for determining manifested radionuclide concentrations
- Description and amounts of absorbents, if applicable
- Basis of non-hazardous or hazardous waste determinations
- Treatment processes, if applicable
- Product information or Material Safety Data Sheets associated with the waste as applicable
- Information requested in other sections of the Waste Profile

4.3.3 Radiological Information

All waste streams must be analyzed to determine the radionuclide concentrations in the waste. The waste must be characterized via gamma spectroscopy, liquid scintillation, or other standard radiochemistry methods to determine the radionuclide concentrations in the waste. Indirect measurements such as dose-to-curie or use of scaling factors may also be used if the process has been validated with direct measurements. Radiological analysis does not need to be performed by a Utah-Certified laboratory. Non-gamma emitting radionuclides such as Fe-55 and Ni-63, may be scaled from the gamma spectral analysis obtained from testing the material if the waste generator has specific process knowledge of the material being profiled (10 CFR Part 61 analyses).

Please note that discrepancies between radiological information, particularly concentration ranges, and waste manifest documents could delay or prevent acceptance of a shipment. The Waste Profile must always be reviewed with the waste manifest documents prior to shipping waste to Energy*Solutions*. In the event that radiological, physical, or chemical properties of a profiled waste stream have changed, an update to the Waste Profile must be submitted and approved before such waste can be shipped to Energy*Solutions*.

Energy*Solutions* requires that generators evaluate the maximum dose rates and contamination levels anticipated in each waste stream. In the radiological section of Waste Profile, the generator indicates whether or not the maximum dose rate on accessible surfaces exceeds the ALARA Criteria as described in Section 2.3.1.

While Energy*Solutions* is permitted to receive Class A LLRW, certain radionuclides are subject to additional controls established by the Utah DRC. For example, Radium-226 is limited to 10,000 pCi/g. In addition, the Utah DRC regulates the following radionuclides under Condition 29E of Energy*Solutions*' Radioactive Materials License:

- Aluminum-26
- Berkelium-247
- Calcium-41
- Californium-250
- Chlorine-36
- Rhenium-187
- Terbium-157
- Terbium-158

Energy*Solutions* is required to provide a one-time notice for each generator shipping one of these radionuclides to the Class A disposal embankment. For waste shipped for disposal at the Mixed Waste disposal embankment, Energy*Solutions* must provide a one-time notification for each generator shipping waste containing Chlorine-36 and Berkelium-247. The generator includes the anticipated presence of these nuclides in the radiological information provided in the Waste Profile.

Finally, the generator lists the radionuclides present in the waste stream in conjunction with the expected maximum manifested concentration and the weighted average concentrations expected for each radionuclide. The generator is expected to manifest values for each shipment that are within the maximum values stated in this section of the Waste Profile. In the event that a generator needs to ship waste to Energy*Solutions* that exceeds the limits in the radiological information section of the Waste Profile, the generator may submit a revised Waste Profile to Energy*Solutions* for review and approval.

Any additional information including laboratory results for gamma spectroscopy or radiochemistry analysis must be attached to the Waste Profile. Radiological characterization methods and the basis for determining manifested radionuclide concentrations should be included in Attachment B.5 as described above.

4.3.4 Chemical Composition and Hazardous Waste Evaluation

In accordance with the response to the hazardous waste question posed in the generator and waste stream information section, the generator provides one of two attachments with the Waste Profile addressing the chemical composition of the waste.

For hazardous wastes, the generator provides a completed and signed copy of the Hazardous Waste Analysis Certification Attachment. The chemical and hazardous characteristics of the waste stream must be provided in extensive detail. The purposes of chemical testing are to (1) demonstrate that the waste meets specific waste acceptance chemical requirements; and (2) demonstrate that the waste is either non-hazardous, compliant with RCRA treatment standards, or will require treatment prior to disposal. In addition, analysis is required to qualify wastes that may contain other specific regulated constituents.

Energy*Solutions*' licenses and permits require the results of the following minimum analyses be provided with the Waste Profile:

Analysis	EPA SW-846 Method(s)
pH (liquids only)	Method 9045
PFLT (solid waste only)	Method 9095
Organics (Totals)	Method 8260 & 8270
Results from applicable concentration based treatment standards	

The results of these analyses are documented on the Hazardous Waste Analysis Certification Attachment and attached to the Waste Profile.

The Hazardous Waste Analysis Certification Attachment also includes waste codes applicable to the waste stream with corresponding treatment standards or technology codes and worst case concentrations. This information is critical in evaluating wastes for treatment at Energy*Solutions*.

Applicable Underlying Hazardous Constituents (as defined in 40 CFR 268.48) and other chemicals present are identified at the end of the attachment.

For non-hazardous waste streams, the generator provides a signed copy of the Low-Level Radioactive Waste Certification Attachment. Energy*Solutions*' licenses and permits require the results of the following analyses be provided with the Waste Profile:

Analysis	EPA SW-846 Method
pH (liquids only)	Method 9045
TCLP Metals	Method 6010/7470
TCLP Herbicides	Method 8151
TCLP Pesticides	Method 8081
TCLP Semi-volatiles	Method 8270
TCLP Volatiles	Method 8260

The individual chemical compounds required for these analyses are listed on the Low-Level Radioactive Waste Certification Attachment and correspond to the characteristic D-list constituents (D004 through D043) identified in 40 CFR 261.24 Table 1 as shown below.

40 CFR 261.24 Table 1

TABLE 1—MAXIMUM CONCENTRATION OF CONTAMINANTS FOR THE TOXICITY CHARACTERISTIC

EPA HW No.[1]	Contaminant	CAS No.[2]	Regulatory Level (mg/L)
D004	Arsenic	7440–38–2	5.0
D005	Barium	7440–39–3	100.0
D018	Benzene	71–43–2	0.5
D006	Cadmium	7440–43–9	1.0
D019	Carbon tetrachloride	56–23–5	0.5
D020	Chlordane	57–74–9	0.03
D021	Chlorobenzene	108–90–7	100.0
D022	Chloroform	67–66–3	6.0
D007	Chromium	7440–47–3	5.0
D023	o-Cresol	95–48–7	[4] 200.0
D024	m-Cresol	108–39–4	[4] 200.0
D025	p-Cresol	106–44–5	[4] 200.0
D026	Cresol	....	[4] 200.0
D016	2,4-D	94–75–7	10.0
D027	1,4-Dichlorobenzene	106–46–7	7.5
D028	1,2-Dichloroethane	107–06–2	0.5
D029	1,1-Dichloroethylene	75–35–4	0.7
D030	2,4-Dinitrotoluene	121–14–2	[3] 0.13
D012	Endrin	72–20–8	0.02
D031	Heptachlor (and its epoxide).	76–44–8	0.008
D032	Hexachlorobenzene	118–74–1	[3] 0.13
D033	Hexachlorobutadiene	87–68–3	0.5
D034	Hexachloroethane	67–72–1	3.0
D008	Lead	7439–92–1	5.0
D013	Lindane	58–89–9	0.4
D009	Mercury	7439–97–6	0.2
D014	Methoxychlor	72–43–5	10.0
D035	Methyl ethyl ketone	78–93–3	200.0
D036	Nitrobenzene	98–95–3	2.0
D037	Pentrachlorophenol	87–86–5	100.0
D038	Pyridine	110–86–1	[3] 5.0
D010	Selenium	7782–49–2	1.0
D011	Silver	7440–22–4	5.0
D039	Tetrachloroethylene	127–18–4	0.7
D015	Toxaphene	8001–35–2	0.5
D040	Trichloroethylene	79–01–6	0.5
D041	2,4,5-Trichlorophenol	95–95–4	400.0
D042	2,4,6-Trichlorophenol	88–06–2	2.0
D017	2,4,5-TP (Silvex)	93–72–1	1.0
D043	Vinyl chloride	75–01–4	0.2

[1] Hazardous waste number.
[2] Chemical abstracts service number.
[3] Quantitation limit is greater than the calculated regulatory level. The quantitation limit therefore becomes the regulatory level.
[4] If o-, m-, and p-Cresol concentrations cannot be differentiated, the total cresol (D026) concentration is used. The regulatory level of total cresol is 200 mg/l.

The attachment also includes a question as to whether or not the waste was at the point of generation of a hazardous waste, and a section to address former hazardous waste codes and additional chemical constituents.

As stated previously, the chemical analysis must be performed by a laboratory holding a NELAC or State of Utah certification. Data provided to the generator prior to any discussions of waste characterization with Energy*Solutions* may be acceptable for waste profiling purposes upon investigation of associated quality control sample data.

Energy*Solutions* may waive the chemical laboratory analyses if the material is not amenable to chemical sampling and analysis (e.g., debris items including metal pieces, concrete, plastic, etc.). Justification for waiving the chemical analyses must be provided in the narrative in Attachment B.5. Technical Service representatives can provide direction in cases where the waste meets such a description.

4.3.5 Special Nuclear Material Exemption Certification Form

Waste containing Special Nuclear Material (SNM) must comply with the SNM requirements for concentration, spatial distribution, chemical mixture, solubility and chemical composition of SNM isotopes as described in Section 3.1.5 of the BWF WAC. The SNM Exemption Certification form guides the generator through the supporting information that must accompany the Waste Profile and each shipment of waste containing SNM. In addition to answering the questions on the form, the generator includes descriptions in Attachment B.5 for the requirements listed in items 3(a) through 3(d) of the SNM form. A completed and signed copy of the SNM Exemption Certification form must accompany the shipping paperwork for waste shipments containing Special Nuclear Material.

4.3.6 PCB Waste Certification Form

Energy*Solutions*' Statue-Issued Part B Permit and Groundwater Quality Discharge Permit include the authorizations and requirements for Energy*Solutions* to receive PCB waste regulated for disposal under 40 CFR 761. The PCB waste types acceptable at Energy*Solutions* are listed in Section 3.1.6 of the BWF WAC. The generator must include a description of the type of PCB waste in the narrative of Attachment B.5. The PCB Waste Certification form does not need to accompany the waste shipment unless requested by Energy*Solutions* during the Waste Profile approval process.

4.4 TREATABILITY AND SOLIDIFICATION STUDY SAMPLES

For waste streams requiring treatment or solidification, Energy*Solutions* will request a preshipment sample to perform a treatability and/or solidification study during the waste profiling approval process. This allows Energy*Solutions* to develop the necessary treatment and solidification formula prior to receipt of the waste. Preshipment samples are not required for waste streams requiring treatment via macroencapsulation. Energy*Solutions* may request additional preshipment samples during the waste profiling process to evaluate the waste material prior to receipt.

Preshipment samples should represent the waste material destined for shipment to Energy*Solutions*. Representative sampling techniques appropriate to radiological and hazardous wastes should be employed in obtaining these samples. Treatability study samples should represent the "worst case" for a waste stream destined for treatment at Energy*Solutions*. The samples should contain the highest anticipated levels of chemical contaminants in the waste steam to ensure that Energy*Solutions* can develop a treatment formula that is adequate for the entire waste stream. Energy*Solutions* may be required to perform additional treatability studies if the waste shipments contain chemical constituents of concern at concentrations that are higher than the treatability study sample.

Preshipment samples may not be shipped to Energy*Solutions* without prior authorization. At a minimum, a preliminary Waste Profile will need to be created that describes the waste and its generation. This preliminary Waste Profile must include both chemical and radiological assessments and must be approved by Energy*Solutions* prior to shipment of the sample. When approved for shipment, Energy*Solutions* will provide a Preshipment Sample Authorization Record to the generator.

Samples should be packaged into one or more sealed containers in such a manner that the sample container will not break during normal shipping conditions. Generally, the volume of sample requested will be less than 5 gallons. Sample containers should be labeled with the waste stream number, date, and a sample ID number. Sample closure devices should also be sealed with a custody or anti-tamper seal to ensure sample integrity.

Preshipment samples sent to Energy*Solutions* must be properly classed, described, packaged, marked, labeled, and in condition for transport as required by the DOT Hazardous Materials Regulations (HMR) contained in 49 CFR Parts 171 through 180. The Preshipment Sample Authorization forms must be completed and attached to the outside of the shipping package. A Uniform LLRW Manifest (Forms 540/541) must also accompany the shipping paperwork. The manifest number for the shipping paperwork is the Waste Stream ID number (e.g., XXXX-YY). The samples must be sent to the following address:

Energy*Solutions*
Attention: Sample Control
US I-80, Exit 49
Tooele County
Clive, UT 84029 (84083 if using Fed Ex)
Phone: (435) 884-0155

Treatability studies normally require 30 to 45 days to complete. Please keep this in mind when planning the first shipment of waste. Rush treatability studies are possible; however, there are higher costs for this service. Please contact Energy*Solutions* if a rush treatability study is required to meet a disposal schedule.

4.5 WASTE PROFILE REVIEW AND APPROVAL

Energy*Solutions* will assist waste generators throughout the waste profiling process to ensure shipping and acceptance of the waste can be accomplished within the desired timeframe. In order to facilitate timely shipment and receipt of waste materials, Energy*Solutions* requests that the Waste Profile forms and analytical reports be provided as far in advance of the anticipated shipping date as possible. Upon receipt, Energy*Solutions* will complete a preliminary review of the waste profile information provided. Comments concerning the Waste Profile will usually be provided within two weeks of Energy*Solutions*' receipt of the profile information. If additional information is required for pre-acceptance, Energy*Solutions* will specify the information needed and communicate this to the generator. A comprehensive internal review is completed once all information has been submitted.

In order to assist each generator and accomplish the profile review and approval process as quickly as possible, Energy*Solutions* has developed a two-phase review process. During the first phase, an Energy*Solutions* Technical Services Representative will review and assess the Waste Profile, accompanying documentation, and analytical data for acceptability. If necessary, Energy*Solutions* will provide comments that delineate additional information needed for approval. This process typically takes one to two weeks. Once the additional information or revisions have been received by Energy*Solutions* and found to be satisfactory, phase 2 of the process begins.

The second phase involves and independent evaluation of the Waste Profile by Energy*Solutions*' Compliance and Operations representatives. Energy*Solutions* will notify the generator as soon as the review and approval process is completed.

At this point, the waste stream has been "pre-approved" for management at Energy*Solutions*, since the waste has been shown to be in compliance with all waste acceptance criteria. Energy*Solutions* will issue a Notice to Transport once the Waste Profile has been approved and a contractual disposal agreement or necessary funding is authorized for the waste stream.

4.6 NOTICE TO TRANSPORT

Energy*Solutions* will issue a Notice to Transport to the generator that authorizes subsequent waste shipments. The Notice to Transport is completed and issued once the Waste Profile is completed and approved by Energy*Solutions*. A Notice to Transport is also issued in the following situations:

- The Waste Profile is revised in such a way that additional evaluations are required (radiological, chemical, or physical properties change significantly)
- An annual update letter is received for Mixed Waste streams
- The approval to ship is restored after the Notice to Transport is revoked

In the event that the Notice to Transport is revoked, customers will not be able to schedule shipments until the approval to ship is restored and a new Notice to Transport is issued.

SECTION 5

SHIPMENT SCHEDULING AND MANIFESTING

5.1 GENERATOR SITE ACCESS PERMIT

Prior to the first shipment of waste material to Energy*Solutions*' disposal site, generators must receive a Generator Site Access Permit (GSAP) issued by the Utah DRC. Utah Administrative Code R313-26 establishes the terms for a Generator Site Access Permit Program that authorizes waste generators, waste processors, and waste collectors to deliver radioactive wastes to a disposal facility within Utah. Generators may apply for the GSAP on-line at the Utah DRC's website at www.radiationcontrol.utah.gov/DRC_prmt.htm.

The GSAP number must be listed in Block 5 of the Uniform LLRW Manifest Form 540 and correspond to the shipper's name and facility. Shippers must ensure the GSAP is renewed annually with the Utah DRC.

Shippers are subject to the provisions contained in the "Generator Site Access Permit Enforcement Policy" as amended, UAC R313-14, and UAC R313-19-100 for violations of state rules or requirements in the current land disposal facility operating license regarding radioactive waste packaging, transportation, labeling, notification, classification, marking, or manifesting requirements.

5.2 SHIPPING CHECKLIST

To assist generators with shipments to Energy*Solutions*, the "Shipping Checklist" shown below in Figure 5-1 provides general contact, scheduling, and manifesting information. Generators and shippers should use this checklist in conjunction with their shipping procedures to ensure compliance with Energy*Solutions*' waste acceptance process. Energy*Solutions*' Technical Service Representatives are available to assist generators and shippers during the shipment scheduling and transportation process.

5.3 5 WORKING-DAY ADVANCED SHIPMENT NOTIFICATION

Generators must schedule the shipment to arrive at the facility a minimum of five working days prior to the requested shipment arrival date. Energy*Solutions* strongly encourages generators to submit the 5 Working-Day Advanced Shipment Notification form prior to the shipment departing from the generator's site. A completed copy of the 5 Working-Day Advanced Shipment Notification form must be sent to the attention of Energy*Solutions* Scheduling Department to establish an arrival date for each shipment. This form may be downloaded from Energy*Solutions*' website at www.energysolutions.com. This form must be completed and either emailed to scheduling@energysolutions.com or faxed to the site at (435) 884-3549. Once this form has been received, the Scheduling Department will confirm the shipment's arrival date with the shipper. If all required information is not available at the time of submission, updates may be provided as the information becomes available. The Scheduling Department must be informed in the event that there are delays in the shipment scheduled arrival date.

Scheduling: Must be established at least 5 working days in advance of requested arrival date

- ☐ A "Notice to Transport" has been issued by Energy*Solutions* for the Waste Profile.
- ☐ **Submitted "5 Working Day Advanced Shipment Notification" form to request shipping schedule. Email form to scheduling@energysolutions.com or fax to (435) 884-3549.**
- ☐ Shipping schedule has been confirmed by Energy*Solutions*.
  Energy*Solutions*' Shipping & Receiving Scheduler: (435) 884-0155.

Advanced Manifesting: Must be submitted prior to releasing each shipment/conveyance

- ☐ Manifested information is consistent with the approved Waste Profile.
  Verify that all manifested radionuclides are listed in the approved Waste Profile and that manifested concentrations do not exceed the approved ranges.
- ☐ Verified consignee information on manifests (see below).
  Consignee: Energy*Solutions*, LLC, Clive Disposal Site, Interstate 80, Exit 49, Clive, UT 84029
  Contact: Shipping and Receiving
  Phone: (435) 884-0155
- ☐ Verified Shipment ID/Manifest Number (XXXX-YY-ZZZZ)
  XXXX is the generator number, YY is the waste stream number, and ZZZZ is the shipment number (starting with 0001 for the first shipment/conveyance and incrementing by one for each additional shipment/conveyance). If a Hazardous Waste Manifest is submitted, include the Shipment ID Number in Block 15.
- ☐ Verified valid Utah Site Access Permit number in Block 5 on Form 540. Generators must apply for the permit with the Utah Division of Radiation Control (DRC). The Shipper Name and Facility must be consistent with the Utah Site Access Permit number.
- ☐ Verified that Block 9 of Form 540 specifies Energy*Solutions*' "Treatment Facility" or "Bulk Waste Facility". Enter "Bulk Waste Facility" for LLRW, 11e.(2) Byproduct Material, and Mixed Waste shipped for direct disposal or enter "Treatment Facility" for waste streams requiring treatment by Energy*Solutions* prior to disposal.
- ☐ Submitted manifests to Energy*Solutions* **<u>at least three working days</u>** prior to the shipment arrival date. If possible, please export the manifests and send electronically via email to manifest@energysolutions.com. Otherwise, fax manifests to "Shipping and Receiving – Manifest" at (801) 413-5643. If applicable, include the LDR Notification/Certification forms, Hazardous Waste Manifest, and SNM Exemption Certification form.

Shipment Paperwork and Inspection

- ☐ The original shipping paperwork/manifests accompany each shipment (conveyance). If applicable, include the LDR Notification/Certification forms and Hazardous Waste Manifest for each shipment.
- ☐ If applicable, **a completed and signed copy of the SNM Exemption Certification form and DOE/NRC form 741** has been included with the shipping papers.
- ☐ If applicable, the Uniform Hazardous Waste Manifest lists all hazardous waste codes associated with the shipment.
- ☐ Containers have been inspected and comply with DOT packaging requirements. Waste must be packaged in a strong, tight container at a minimum.
- ☐ **Containers do not contain unauthorized free standing liquids.**
- ☐ If applicable, containers are labeled **"Class A Unstable" or "Class AU"**. Refer to Block 16 of NRC Form 541.

Figure 5-1. Shipping Checklist

Shipments containing radionuclides with total activities exceeding the limits listed below must be specified on the 5 Working-Day Shipment Notification form and approved prior to waste shipment.

- Californium-252 (in excess of 5.4 Ci)
- Co-60 (in excess of 8.1 Ci)
- Cs-137 (in excess of 27 Ci)
- Gd-153 (in excess of 270 Ci)
- Ir-192 (in excess of 22 Ci)
- Pm-147 (in excess of 11,000 Ci)
- Se-75 (in excess of 54 Ci)
- Tm-170 (in excess of 5,400 Ci)
- Yb-169 (in excess of 81 Ci)

5.4 SHIPPING PAPERWORK

Advance copies of the Uniform Low-Level Radioactive Waste Manifest (Forms 540/541, and 542 if applicable) are required to be sent to Energy*Solutions* **at least three working days** prior to the shipment arrival date. Shippers must submit the shipping paperwork electronically via email to **manifest@energysolutions.com** or fax to "Shipping and Receiving – Manifest" at (801) 413-5643. Energy*Solutions* encourages submittal of the Uniform LLRW Manifest electronically by exporting the manifest information to a specified file format as discussed below. The advance manifest must include the Uniform LLRW Manifest, and if applicable, LDR Notification/Certification forms, Uniform Hazardous Waste Manifest, and SNM Exemption Certification form.

Additional shipping paperwork may be required depending on the type of waste being shipped to Energy*Solutions*. Multiple waste streams on a single conveyance must include a unique set of shipping paperwork for each manifested shipment. The following paperwork may also need to accompany the shipping paperwork as applicable:

- SNM Exemption Certification form. This form must be completed, signed, and included with the shipping paperwork for shipments containing Special Nuclear Material.

- LDR Certification and/or Notification form must contain the information required in 40 CFR 268.7. Energy*Solutions* requires that this information be provided with each shipment of Mixed Waste or waste that has been treated to meet 40 CFR 268 treatment standards.

- Uniform Hazardous Waste Manifest must be included with the shipping paperwork for waste shipments of Mixed Waste. As applicable, Energy*Solutions* requests that shippers list the gross weight on the manifest.

5.4.1 Instructions for the Uniform LLRW Manifest Forms 540, 541, and 542

The NRC's guidance document "Instructions for Completing the NRC's Uniform Low-Level Radioactive Waste Manifest" (NUREG/BR-0204, Rev. 2, July 1998) should be used by shippers when preparing the shipping paperwork. Energy*Solutions* requires shippers to include information in both metric units and English units following the International Standard of Units (SI). Additionally, Energy*Solutions* has specific information that should also be included on the Uniform LLRW Manifest.

Form 540

- Block 5, "Shipper" must list the shipper's company name and facility that corresponds to the Utah Generator Site Access Permit (GSAP) number. Shippers shipping on behalf of the generator and using their GSAP number should list "(shipper's company name) on behalf of (generator's name)".

- Block 5, "Shipment Number" and "Shipment ID Number" may be used by the shipper for their own tracking purposes. In most cases, shippers use the "Manifest Number" in Block 8 as the "Shipment ID Number".

- Block 8, "Manifest Number" must list the Energy*Solutions* shipment number in the following format: (XXXX-YY-ZZZZ) where XXXX is the generator number, YY is the waste stream number, and ZZZZ is the shipment number (starting with 0001 for the first shipment and incrementing by one for each additional shipment).

- Block 9, "Consignee" must list Energy*Solutions*' disposal site address as shown below, contact name and telephone number. The address must specify Energy*Solutions*' "Treatment Facility" or "Bulk Waste Facility". List "Bulk Waste Facility" for LLRW, 11e.(2) Byproduct Material, and Mixed Waste shipped for direct disposal or list "Treatment Facility" for waste streams requiring treatment by Energy*Solutions* prior to disposal.

  Energy*Solutions*, LLC
  Clive Disposal Site – Bulk Waste Facility
  Interstate 80, Exit 49
  Clive, UT 84029

Form 541

- Block 6, "Container Description" specifically applies to the disposal container. For bulk shipments (e.g., gondola railcars, intermodals, etc.), list "11" for "Bulk, Unpackaged Waste" along with the bulk packaging descriptor if the bulk package does not contain other manifested packages inside. For example, a gondola railcar with a super-load wrapper would be listed as "11A" in Block 6.

- Blocks 7 and 8, "Volume" and "Waste and Container Weight" must list the gross volume and weight of the disposal container and contents. For bulk, unpackaged waste where the waste package will not be disposed (e.g., gondola railcar, intermodal, etc.), list the weight and volume of the waste.

- Block 15, "Radiological Description" must also include a column for the radionuclide concentration expressed in units of pCi/g.

- Block 16, "Waste Classification" must list "AU" for Class A Unstable LLRW. Waste packages must also be labeled either "Class A Unstable" or "Class AU". For NORM or 11e.(2) waste material, enter "N/A" since the waste classification requirements are not applicable.

Form 542

Form 542, "Manifest Index and Regional Compact Tabulation) is required for processors and collectors of LLRW who are shipping LLRW attributed to others for ultimate disposal at Energy*Solutions*. Energy*Solutions* requires that processors or collectors submitting the Form 542 do so electronically using the file transfer protocol described in Section 5.4.2 due to the size of the manifest.

5.4.2 Electronic Submittal of the Uniform LLRW Manifest

Energy*Solutions* developed a document titled "Electronic Submittal of the Uniform Low-Level Radioactive Waste Manifest" to assist generators with the electronic submittal of the Uniform Low-Level Radioactive Waste Manifest (Forms 540, 541 and 542). Generators are able to submit their manifests electronically in a comma-delimited file format to the Energy*Solutions* disposal facility for review and distribution. Upon arrival, manifests are imported directly into Energy*Solutions*' waste tracking system. Manifest information is checked against the information contained in the generators Waste Profile. Any discrepancy will be automatically flagged, allowing potential problems to be fixed well in advance of shipment arrival.

Electronic manifest submittal has numerous benefits for both the generator and Energy*Solutions* which include:

- Generators are able to e-mail their shipping manifests directly to the site, reducing the time and expense of express mailing or faxing copies to the disposal facility.
- The generator can use the electronic signature feature, eliminating the need for any advance hard copies to be sent to Energy*Solutions*.
- Energy*Solutions* personnel can print the required copies of the manifest, including electronic signature, and distribute for proper review.
- The import of manifest information directly to Energy*Solutions*' waste tracking system will eliminate manual data entry.
- Electronic submittal will significantly reduce the time it takes Energy*Solutions* personnel to process the advanced paperwork.

5.5 90-DAY SHIPPING FORECAST

The 90-Day Shipping Forecast is used by Energy*Solutions* to properly staff and ensure adequate resources are available to ensure efficient and timely management of waste shipments. Generators are strongly encouraged to provide Energy*Solutions* with a 90-Day Shipping Forecast for all upcoming shipments. Current shippers will receive a fax or email from Energy*Solutions* every month and are requested to return the shipping forecast to Energy*Solutions* within three working days of receipt. The forecast can also be emailed to the appropriate Client Service Manager.

SECTION 6

PACKAGING AND TRANSPORTATION

6.1 COMPLIANCE WITH TRANSPORTATION REGULATIONS

Each shipment of waste material sent to Energy*Solutions* for disposal must be properly classed, described, packaged, marked, labeled, and in condition for transport as required by the Department of Transportation (DOT) Hazardous Materials Regulations (HMR) contained in 49 CFR Parts 171 through 180. Shipments of radioactive waste that are exempt from DOT regulations must be shipped to Energy*Solutions*' disposal site in packages that prevent release of the waste during transit. Specifically, all waste packages must be secure to 1) prevent rain or snow from entering the manifested waste package and 2) prevent waste from being exposed to the environment at any time during transit. Shippers should review NRC IE Bulletin No. 79-19 for training requirements applicable to radioactive waste management.

Energy*Solutions* will inspect each shipment arriving at its disposal facility for compliance with the applicable licenses and/or permits including compliance with DOT HMR requirements. Energy*Solutions* will notify the generator of a non-compliant shipment and determine the best course of action to resolve the discrepancy in a safe, compliant, and timely manner.

6.2 WASTE PACKAGING GUIDELINES

Energy*Solutions* receives waste for disposal either in bulk or in non-bulk packages. The packaging used must be authorized for the specific material being shipped by the HMR. Each generator is responsible for ensuring that the packaging used meets the appropriate regulations. The shipper of waste material is responsible for the certification of the packaging as meeting the DOT requirements. The DOT and NRC have published a joint guidance document to assist shippers of LSA and SOC material. The title of this document is "Categorizing and Transporting Low Specific Activity Materials and Surface Contaminated Objects" (NUREG-1608 or RSPA Advisory Guidance 97-005). The document is available from either agency. The following minimum packaging requirements must be met for all packages received at Energy*Solutions*.

6.2.1 Bulk Packaging

Generators are able to minimize packaging and transportation costs by utilizing bulk packages that are intended for re-use. Energy*Solutions* receives various bulk packages illustrated in Figure 6-1 which include gondola railcars with either hard-top lids or super-load wrappers, intermodals, sealands, cargo containers, roll-offs, etc. Bulk packages are unloaded at Energy*Solutions* and then decontaminated, surveyed, and returned in accordance with the requested radiological release criteria specified in Section 6.5. Bulk packaging must conform to the following requirements:

- Bulk packaging must, at a minimum, meet the applicable requirements contained in 49 CFR 173.24, General Requirements for Packagings and Packages and in 49 CFR 173.410, General Design Requirements.
- Bulk packaging must be covered. The top must be completely enclosed with no opening along the sides or openings in the top.

- Bulk packaging (e.g., railcars, trucks, trailers, etc.) must also be tightly sealed to prevent waste from leaking out or water from leaking in to the package. Packages containing unauthorized free liquids will be considered non-compliant.
- Bulk packaging must be clean. It must not have any waste material, or other material that could be mistaken for waste material, on the outer surface. Energy*Solutions* will perform contamination surveys on suspect areas of the package to ensure compliance with DOT regulations.
- Bottom dump railcars and end-dump trucks are not permitted unless approved in writing by Energy*Solutions*.
- Bulk packaging in intermodals, sealands, cargo containers, roll-offs, etc. must have ISO connectors on the top corners as illustrated in Figure 6-1 to allow the containers to be lifted from the top unless approved in writing by Energy*Solutions*.
- Friable asbestos is prohibited in bulk packages unless approved in writing by Energy*Solutions*.
- Each bulk container, which requires marking, will be properly marked in accordance with 49 CFR 172 Subpart D.
- Bulk packaging may not contain a mixture of bulk, unpackaged waste and manifested packaged waste (e.g., an intermodal containing loose unpackaged soil with manifested disposal containers within the same intermodal).

6.2.2 Non-Bulk Packaging (Disposal Containers)

Energy*Solutions* receives non-bulk packages (disposal containers) including boxes, drums, super sacks, etc. The disposal container is generally disposed of with the waste contents and will not be returned to the generator. Energy*Solutions* recommends drums be palletized to reduce the amount of time required to offload drum shipments. Palletized drums are also safer to manage at the disposal site. Generators may be charged extra for shipments containing non-palletized drums. Drums on one pallet must be from the same waste stream unless approved in writing by Energy*Solutions*. Contact Energy*Solutions* to request approval to ship non-palletized drums prior to shipment. Non-Bulk packaging must conform to the following requirements:

- Non-Bulk packaging must, at a minimum, meet the applicable requirements contained in 49 CFR 173.24, General Requirements for Packagings and Packages and in 49 CFR 173.410, General Design Requirements.
- Containers must be properly sealed to prevent load movement from "pumping" dust-laden air out of the container.
- Containers must be clean. They must not have any waste material, or other material, which could be mistake for waste material, on the outer surface. Energy*Solutions* will perform contamination surveys on suspect areas of the package to ensure compliance with DOT regulations.
- Containers in a shipment must be properly loaded and blocked and braced securely to prevent shifting and damage during transport. The specific transport loading requirements contained in 49 CFR 174 for rail and 49 CFR 177 for highway should be examined as well as 49 CFR 393 Subpart I, Protection Against Shifting and Falling Cargo.
- Although preferred, containerized rail shipments are not required to be enclosed or covered.
- Do not have unnecessary container closures; e.g., welding of drum rings or box lids.
- Non-bulk packages will not be returned to the generator.
- Overpack containers only when necessary (e.g., to meet DOT requirements) for shipment.
- Energy*Solutions* prefers drums to be palletized to reduce the amount of time required to offload drum shipments. Palletized drums are also safer to manage at the disposal site. The pallets must

be strong enough to withstand collapse during transit. The drums should be securely banded to the pallet.

- Truck or railcar beds used to transport containers must be free of all loose material, waste or otherwise.
- Each container that is required to be labeled will be properly labeled in accordance with the requirements of 49 CFR 172 Subpart E and UAC R313-15-1008.

Each container that is required to be marked will be properly marked in accordance with the requirements of 49 CFR 172 Subpart D and/or 49 CFR 173.421 and Subpart 425.

Figure 6-1. Bulk Shipping Containers

6.3 HIGHWAY TRANSPORTATION

For highway shipments (Figure 6-2), Energy*Solutions* is located just three miles south of Interstate 80 at the Clive Exit (Exit 49). Highway shipments should arrive for receipt and acceptance between 7:00 AM to 12:00 PM MST, Monday through Friday only. Shipments that arrive after 12:00 PM may not be accepted until the next day unless special handling arrangements have been previously approved.

Figure 6-2. Truck Highway Shipments

Shipments are generally unloaded on a first-come, first-served basis. Non-compliant shipments may result in unexpected delays. Shipments may take up to four hours to be checked in, inspected, surveyed, evaluated, and unloaded. Consequently, drivers should be informed that there are no eating facilities within the vicinity of the site.

6.4 RAIL TRANSPORTATION

Rail shipments will be delivered to the Energy*Solutions*' rail siding by the Union Pacific railroad on a predetermined schedule (Figure 6-3). Once at Energy*Solutions*' siding, they will be moved into the disposal site by Energy*Solutions*' equipment.

Figure 6-3. Rail Shipments

Since the signed copies of the Uniformed Low-Level Radioactive Waste Manifest or Uniform Hazardous Waste Manifest forms do not travel with the railcars during transport, the original signed manifest must be mailed or electronically transferred to the Clive Disposal Facility. The documents must arrive at the Clive Disposal Facility a minimum of 3 working days prior to the receipt of the rail shipment.

6.5 RELEASE OF SHIPPING CONVEYANCES

The timeframe for the release of shipping conveyances (e.g., trucks, intermodal containers, railcars, etc.) is based on the specific contractual arrangements that have been established between each generator and Energy*Solutions*. Generators must request the type of radiological release prior to the shipment's arrival and must be allowed under the Terms and Conditions of the disposal agreement. The requested release types must be authorized by Energy*Solutions*' Business Development Department. Containers released to the Unrestricted Use criteria require significantly more time and expense due to the resources needed to meet these release criteria. Energy*Solutions* performs the following types of radiological releases as listed in the following table.

Energy*Solutions* Radiological Release Criteria

Release Type	Criteria	Reference
Unrestricted Use	Removable and fixed surface contamination levels are isotope specific. The most restrictive isotopic removable surface contamination levels are less than 20 dpm α/100 cm^2 and 200 dpm β-γ/100 cm^2. The most restrictive isotopic total surface contamination levels are less than 100 dpm α/100 cm^2 and 1,000 dpm β-γ/100 cm^2. The contamination levels apply to all internal and external surfaces. Contact Energy*Solutions*' Business Development Department to make contractual arrangements for this type of release.	US NRC Regulatory Guide 1.86, June 1974 (Consistent with Energy*Solutions*' RML Condition 27)
Return to Service	Removable surface contamination levels must be less than 220 dpm α/100 cm^2 and 2,200 dpm β-γ/100 cm^2. The radiation dose rate at each accessible surface must be less than 0.5 mrem/hr. The contamination levels apply to all internal and external surfaces of the transport vehicle.	49 CFR 173.443(c)
DOT Empty	Removable surface contamination levels on the outside of the package must be less than 220 dpm α/100 cm^2 and 2,200 dpm β-γ/100 cm^2. Removable surface contamination levels on the inside of the package must be less than 22,000 dpm α/100 cm^2 and 220,000 dpm β-γ/100 cm^2. The package must be emptied of contents to the extent practical.	49 CFR 173.428
Sole Use	Removable surface contamination levels on the outside of the transport vehicle must be less than 220 dpm α/100 cm^2 and 2,200 dpm β-γ/100 cm^2. The radiation dose rate on the internal surfaces must be less than 10 mrem/hr or 2 mrem/hr at one meter from the surface.	49 CFR 173.443(d)

APPENDIX A

CONTACT INFORMATION

<u>Energy*Solutions*</u>

Corporate Office Phone:	(801) 649-2000	Fax: (801) 537-7345
Technical Service Fax:	(801) 413-5664	
Shipment Scheduling Phone:	(435) 884-0155	Fax: (435) 884-3549 Email: scheduling@energysolutions.com
Shipping & Receiving Phone:	(435) 884-0155	Fax: (801) 413-5643 Email: manifest@energysolutions.com

Energy*Solutions* Website: www.energysolutions.com

<u>State of Utah</u>

Utah Dept of Environmental Quality:	www.deq.state.ut.us
Utah Division of Radiation Control (DRC) Email:	drcadmin@utah.gov
Utah Division of Radiation Control Website:	www.radiationcontrol.utah.gov
Utah DRC – Generator Site Access Permit:	(801) 536-0077
Utah DRC – Generator Site Access Permit:	www.radiationcontrol.utah.gov/DRC_prmt.htm
Utah DRC Rules:	www.radiationcontrol.utah.gov/rules.htm
Utah Division of Solid and Hazardous Waste:	www.hazardouswaste.utah.gov
Utah DSHW Rules:	www.hazardouswaste.utah.gov/rpc.htm
Utah Dept of Health – Lab Certification:	health.utah.gov/els/labimp/envlabcert.html
State-Issued Part B Permit:	www.hazardouswaste.utah.gov/HWBranch/CFFSection/EnvirocarePermit.htm

Appendix C-4:

Clean Harbors, Inc. – Deer Trail, Colorado

Clean Harbors Deer Trail NORM Waste Acceptance

Facility Permitting

Clean Harbors Deer Trail (CHDT) operates a treatment, storage and land disposal facility near Last Chance, Colorado. The Deer Trail facility operates under Colorado RCRA Permit CO-05-12-21-01, and Colorado Radioactive Materials License CO-1102. The permit and license allows for treatment, storage and landfill disposal of liquid and solid NORM wastes less than 2000 pCi/g total radionuclide activity. Additionally, our permits allow us to accept landfillable mixtures of RCRA and NORM wastes.

Waste Pre-Acceptance Process

To evaluate a NORM waste stream for facility acceptance, each Generator must submit a **Material Profile Sheet, Supplemental Radioactive Questionnaire and Laboratory Analysis.** Required lab analysis are listed below. CHDT evaluates the information to determine if the waste meets the acceptance criteria for land disposal at CHDT. After the waste is approved to come to CHDT, an **Application for Waste Impor**t must be made to the Rocky Mountain Low-Level Radioactive Waste Board (Compact) and an application fee must be sent with the application. (An import application is not required for wastes from the States of CO, NM and NV.) A sample Import Application is included. Import Application Requests are normally approved and processed within two weeks. If waste is generated from a one-time site or process, a new profile and analysis must be completed each time. If the waste is produced by an ongoing process from one site, the profile and import application can be approved such that only periodic analysis is needed for repeat waste shipments.

On-Site Waste Acceptance

Bulk waste shipments of radioactive material must be scheduled in advance. All shipments must be documented using a manifest. Once a shipment arrives at CHDT, it is weighed and the external dose rate of the vehicle is measured. The waste is analyzed using a portable gamma spectrum analyzer and the truck is surveyed for removable radioactive contamination. After testing is complete, the vehicle/container will either be dumped in the landfill or, if it requires solidification/treatment, will be dumped in the treatment area. After dumping, the inside and outside of the container will be surveyed for radioactive contamination. If necessary, the container will be decontaminated. CHDT's permit requires us not to release any container or vehicle above the allowed permit limits. Shippers of solid radioactive material are encouraged to line the beds of roll-off containers or dump trucks with plastic in order to prevent incurring the costs of vehicle washouts and decontamination fees.

Deer Trail Minimum Analytical Requirements

1. Total Uranium (mg/kg) by ICP; alternate Isotopic Uranium by Alpha Spec.
2. Total Thorium (mg/kg) by ICP; Alternate Isotopic Thorium by Alpha Spec.
3. Gamma spectrum analysis with Peak identification and Ra-226 quantitation pCi/g
4. Gross alpha (pCi/g)
5. Gross beta (pCi/g)
6. Pb-210 if applicable (pCi/g) (Natural Gas Processing Waste Only)

Deer Trail NORM Acceptance Limits

1. Must be Classified NORM or TENORM by CO Regulations
2. Must be less than 2000 pCi/g total activity
3. Must be less than 500mg/kg total Uranium and Thorium
4. Ra-226 must be less than 222pCi/g if only primary radionuclide present
5. Pb-210 must be less than 666pCi/g if only primary radionuclide present
6. Gamma dose rate must be less than 116 μRoentgens/hr at the surface of the container.

Other Requirements

1. Wastes containing free liquids must contain less than 500ppm VOC's (Volatile Organic Compounds)
2. Waste containing free liquids must have a flash point greater than 140F
3. Wastes containing greater than 500ppm reactive sulfides require special treatment.
4. RCRA/NORM wastes are acceptable but may require additional testing.

Clean Harbors Environmental Services
108555 East Highway 36, Deer Trail, CO 80105
Office: 970.386.2293

Transportation & Disposal

Deer Trail, Colorado Facility Facts

Colorado Radioactive Materials License Issued on December 21, 2005

The Deer Trail facility is a fully permitted Subtitle C landfill authorized to treat, store and dispose of a wide variety of hazardous and industrial wastes, including RCRA, TSCA (megarule) and debris for encapsulation.

As of December 21, 2005, Deer Trail is now licensed to dispose of Naturally Occurring Radioactive Material (**NORM**) and Technologically Enhanced Radioactive Material (**TENORM**) wastes. This license was issued by the State of Colorado, Department of Public Health and Environment. Deer Trail can accept NORM and TENORM wastes containing radionuclides (in the decay series of U-238, U-235 and Th-232) up to 2000 pCi/gram. The Rocky Mountain Low Level Radioactive Waste Compact has designated Deer Trail as the Low Level Waste Facility for Colorado, New Mexico and Nevada.

Deer Trail is located 75 miles east of Denver, CO. The facility can store, treat and dispose of wastes in bulk and containerized quantities. Deer Trail receives waste by truck and also by rail from a trans-loading point located in Sterling, Colorado.

Permits

- Colorado Radioactive Materials License Number Colo. 1101-01, CDPHE
- RCRA Part B Permit renewed 2005, No. CO-05-12-21-01, CDPHE
- EPA ID No COD991300484, USEPA
- Certificate of Designation, No. 147-82-C-CD, Adams County
- Colorado Wastewater Discharge Permit, No. CO-0042064, CDPHE
- Colorado Air Emissions No. 01AD0713

Facility Description & General Information

- Permit issued - 1987, first waste received - 1991
- 325 acres of permitted facility surrounded by 5760 acres of Clean Harbors owned buffer zone
- Rural location
- 2.5 million cubic yards of permitted cell space
- Sited on the impermeable Pierre Shale formation

Services Provided:

- Storage, final treatment and landfill disposal
- Stabilization treatment of toxic metal wastes
- Custom treatment of organic wastes
- Chemical reduction
- Solidification of liquid wastes
- Deactivation and neutralization
- Micro encapsulation
- Macro encapsulation
- Direct landfill

Typical Customers: Customers include, but are not limited to, remediation sites, chemical facilities, manufacturers, refineries, mines, plating facilities, and brokers.

Typical Waste Streams: Typical waste streams accepted include, but are not limited to, NORM and TENORM wastes, industrial metal bearing wastes, contaminated process wastewaters, refinery wastes, inorganic cleaning solutions, plating wastes, paint residues, debris from toxic or reactive chemical cleanups, off-spec commercial products.

Treatment, Storage and Disposal Capabilities

- Totally enclosed waste treatment building with dual emission control systems
- Drum Storage Building with capacity for 600 x 55-gallon drums or 33,000 gallons
- Bulk Container Storage Area A: 2000 cubic yards of bulk solids
- Bulk Container Storage Area B: 1000 cubic yards of bulk solids
- Wide range of permitted waste codes

CleanHarbors
ENVIRONMENTAL SERVICES®

Waste Disposal Services

NORM and TENORM Waste Management Fact Sheet

NORM and TENORM Waste Management

Clean Harbors provides disposal for Naturally Occurring Radioactive Material (NORM) and Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) wastes at our Deer Trail, Colorado and Buttonwillow, California facilities.

Deer Trail and Buttonwillow are fully permitted Subtitle C landfills authorized to accept NORM and TENORM wastes containing radionuclides (in the decay series of U-238, U-235 and Th-232) up to 2000 pCi/gram for Deer Trail and up to 1800 pCi/gram for Buttonwillow.

Typical sources of NORM and TENORM wastes include

- Oil and gas industry
- Geothermal energy production
- Coal combustion
- Mining of uranium and metals
- Phosphate production
- Municipal water treatment
- Abandoned mines and processing facilities
- General manufacturing

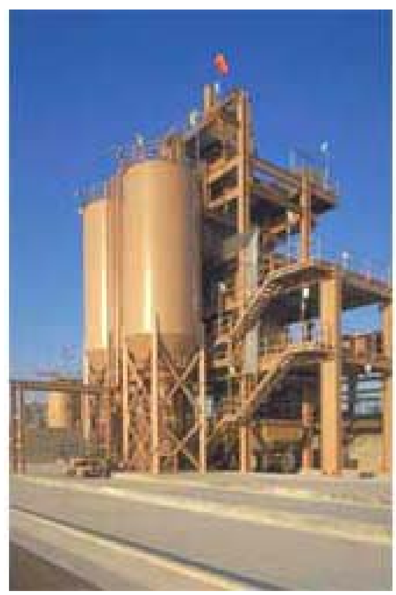
Deer Trail, Colorado Facility

The Rocky Mountain Low Level Radioactive Waste Compact has designated the Deer Trail facility as the low level waste facility for Colorado, New Mexico, and Nevada. The facility is located 75 miles east of Denver, Colorado, and can store, treat and dispose of wastes in bulk and containerized quantities. Deer Trail receives waste by truck and also by rail from a trans-loading point located in Sterling, Colorado.

The Deer Trail facility is also authorized to treat, store, and dispose of a wide variety of hazardous and industrial wastes including RCRA, TSCA (megarule), and debris for encapsulation.

Buttonwillow, California Facility

Located in central California, the Buttonwillow facility is also fully permitted to manage a large number of RCRA hazardous wastes, California hazardous waste, and non-hazardous waste for stabilization treatment, solidification, and landfill. It can handle waste in bulk (solids and liquids) and in containers.



This facility operates a permitted drum handling and storage area, which can store and/or transfer up to 1,500 drums. Permitted landfill capacity is in excess of 10 million cubic yards.

CleanHarbors
ENVIRONMENTAL SERVICES®

STATE OF COLORADO

Bill Owens, Governor
Dennis E. Ellis, Executive Director

Dedicated to protecting and improving the health and environment of the people of Colorado

4300 Cherry Creek Dr. S.
Denver, Colorado 80246-1530
Phone (303) 692-2000
TDD Line (303) 691-7700
Located in Glendale, Colorado

http://www.cdphe.state.co.us

Laboratory Services Division
8100 Lowry Blvd.
Denver, Colorado 80230-6928
(303) 692-3090

Colorado Department of Public Health and Environment

Fax

To:	Scott Zoller	**From:**	Jennifer Opila
Fax:	970-386-2262	**Pages:**	11 (includes cover sheet)
Phone:	970-386-2293	**Date:**	3/30/2009
Re:	License Amendment	**CC:**	

• **Comments:**

Scott,

Attached is the license amendment.

Please feel free to call me if you have any questions.

Thank you,

Jennifer T. Opila

Jennifer T. Opila
Radiation Management Unit
Hazardous Materials and Waste Management Division
Colorado Department of Public Health and Environment
(303) 692-3403

STATE OF COLORADO

Bill Ritter, Jr., Governor
James B. Martin, Executive Director

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8100 Lowry Blvd.
Denver, Colorado 80230-6928
(303) 692-3090

Colorado Department of Public Health and Environment

Clean Harbors Deer Trail, LLC
108555 East Hwy 36
Deer Trail, CO 80105

Attention: Scott Zoller, Radiation Safety Officer

Re: License Amendment
Colorado Radioactive Materials License Number Colo. 1102-01

Enclosed is Radioactive Materials License Number Colo. 1102-01, Amendment No. 6, which has been amended as requested in your letter dated March 18, 2009. Please review this document thoroughly.

This amendment was necessary because of a change to the definitions in the Colorado Rules and Regulations that caused radium contaminated debris to no longer fall under the definition of TENORM. It is now defined as a "new" type of byproduct material. Because the license restricted Clean Harbors to only NORM and TENORM, the amendment is necessary to retain Clean Harbors' ability to take radium contaminated debris and soil. This amendment does not expand the scope of the material that Clean Harbors is allowed to accept for disposal.

Please note that the mailing address, use location(s), maximum quantities of radioactive materials, and the radiation safety officer are specific conditions of your license. If you have questions about making changes to your licensed activities, please contact the Radiation Management Unit to discuss the requirements for an amendment of your license.

If you have any questions regarding this letter or your license please contact Jennifer Opila at 303-692-3403 or jennifer.opila@state.co.us. Additional questions or comments can be directed to me at 303-692-3423 or steve.tarlton@state.co.us.

Steve Tarlton, Unit Leader
Radiation Management Unit
Hazardous Materials and Waste Management Division

Enclosure: Colo. 1102-01, Amendment No. 6

State of Colorado
Department of Public Health and Environment

RADIOACTIVE MATERIALS LICENSE

Pursuant to the *Radiation Control Act* Title 25, Article 11, *Colorado Revised Statutes*, and the State of Colorado *Rules and Regulations Pertaining to Radiation Control* and in reliance on statements and representations heretofore made by the licensee designated below; a license is hereby issued authorizing such licensee to receive, possess, analyze, store, process and dispose the radioactive material(s) designated below; and to use such radioactive material(s) for the purpose(s) and at the place(s) designated below. This license is subject to all applicable rules, regulations, and orders now or hereafter in effect of the Colorado Department of Public Health and Environment (CDPHE) and to any conditions specified below.

1. Licensee: Clean Harbors Deer Trail, LLC
2. Address: 108555 East US Highway 36, Deer Trail, CO 80105-9611
3. License Number Colo. 1102-01, Amendment Number 06
4. Expiration date: December 31, 2010
5. Reference Number: Fee Category: 4.A

6. **Authorized Radioactive Material and Uses**

A. The licensee is authorized to receive, possess, analyze, store, process, and dispose of waste materials containing naturally occurring radioactive material (NORM), technologically enhanced naturally occurring radioactive material (TENORM), and radium contamination resulting from activities involving purposefully concentrated radium-226. The specific radionuclides are limited to K-40 and all of the radionuclides in the decay series for U-238, U-235 and Th-232. The summed activity of all radionuclides per gram contained in such waste materials shall not exceed 2000 pCi (74 Bq). Additionally, the Ra-226 activity per gram shall not exceed 400 pCi (14.8 Bq). The physical form of the material includes but is not limited to soils, sludges, process residues, resins, and filters that are compatible with the design and operational criteria required by the CHWA permit.

B. In addition to the limits established in items 6.A the total uranium and thorium content shall be less than 0.05% by weight (500 μg per gram) of the materials received for disposal.

C. In addition to the limits established in items 6.A and 6.B the licensee shall limit the total of all waste materials containing radioactive material to a total volume not to exceed 510,440 cubic yards. Of this amount, at least 16,000 cubic yards shall be set aside for radium processing wastes.

State of Colorado
Department of Public Health and Environment

RADIOACTIVE MATERIALS LICENSE

Conditions

7. The licensee shall comply with the provisions of the State of Colorado *Rules and Regulations Pertaining to Radiation Control*: Part 3, "Licensing of Radioactive Material"; Part 4, "Standards for Protection Against Radiation"; Part 10, "Notices, Instructions and Reports to Workers: Inspections"; Part 11, "Special Land Ownership Requirements"; Part 14, "Licensing Requirements for Land Disposal of Low Level Radioactive Wastes"; Part 15, "Colorado Low-Level Radioactive Waste Rate Regulations"; and Part 17, "Transportation of Radioactive Material."

8. Radioactive materials may be received, stored, handled, processed and disposed only at the Clean Harbors Deer Trail facility, 108555 East US Highway 36, Deer Trail, CO 80105-9611.

9. The licensee is prohibited from receiving low-level wastes, as defined by the Rocky Mountain Low Level Waste Compact Board, from outside the Compact Region without written authorization from the Rocky Mountain Low Level Waste Compact Board.

10. For the purposes of this license and as used in the application, regulated waste refers to any waste received, handled, processed or disposed of at the site containing radioactive material including: a) NORM/TENORM radionuclides in solid waste; b) NORM/TENORM radionuclides in material licensed by CDPHE; c) NORM/TENORM radionuclides mixed with Colorado Hazardous Waste Act (CHWA) hazardous wastes; d) radium processing wastes; and e) radium contamination resulting from activities involving purposely concentrated radium-226.

11. Pursuant to its authority over all radioactive materials at the facility, the Department may at any time impose additional requirements and/or license conditions regarding the receipt, processing, analysis, storage or disposal of these materials as may be necessary to ensure health and safety of workers, protection of the environment and compliance with any applicable rules, regulations and statutes.

12. Should the licensee become aware of radioactive materials that were not identified in any waste characterization or manifest that are present in waste materials received or buried at the site, the licensee shall maintain a record of these and shall provide immediate notification to the Department for any materials that are not specifically authorized on the license.

13. The designated Radiation Safety Officer (RSO) is Scott Zoller, CHP.

14. The designated Alternate Radiation Safety Officer (RSO) is Tracy A. Ikenberry, CHP.

15. The Radiation Safety Officer shall be on-site sufficient to ensure protection of workers and compliance with this license and the Rules and Regulations.

16. Radioactive material authorized in License Conditions 6.A. through 6.C. shall only be received, stored, handled, analyzed, processed or disposed by or under the supervision of John Kehoe, Michael Webb, Ismael Hernandez, Randall Musgrave, Daniel O'Brien, Leresa Wilson, Joseph Sanchez, or Terry Musgrave.

State of Colorado
Department of Public Health and Environment

RADIOACTIVE MATERIALS LICENSE

17. One or more authorized users identified in Condition 16 of this license shall be physically present at the facility at all times when radioactive materials are being received, stored, handled, analyzed, processed or disposed. The number of authorized users present on site at any one time shall be sufficient to ensure adequate supervision of all persons within the restricted area.

18. Temporary contract laborers and members of the public shall be escorted throughout the restricted area under the direct supervision and in the physical presence of an authorized user listed in License Condition 16. Temporary contract laborers shall sign in and out of the facility each day. The sign-in, sign-out logs for the facility shall be maintained in the Operating Record.

19. Contract laborers and consultants who have successfully completed the radiation safety training as described in the Radiation Protection Program may work throughout the restricted area without continuous direct supervision by Clean Harbors personnel.

20. The Radiation Safety Officer, Alternate Radiation Safety Officer, or persons specifically listed in License Condition 16 shall physically observe the day-to-day activities of contract laborers and consultants who work without constant supervision. The extent of these observations shall be sufficient to ensure that contract laborers and consultants are complying with established procedures and the requirements of this license.

21. Each person receiving an occupational dose at the facility is deemed to require monitoring pursuant to Section 4.18 of the Regulations.

22. The Radiation Safety Officer shall maintain training and dose monitoring records for each worker at the site who receives an occupational dose. These records shall show the initial hire date, the specific training received, the date training was successfully completed, the date when dose monitoring was initiated, the date when employment terminated, and a copy of the annual total dose assessment for each year the individual works at the site.

23. The licensee shall determine occupational doses on a quarterly basis, with the final determination being completed within 60 days from the end of each quarter.

24. The licensee shall determine occupational doses (total effective dose equivalent (TEDE), committed effective dose equivalent (CEDE), and deep dose equivalent (DDE)) within 90 days from the end of each calendar year.

State of Colorado
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25. The licensee shall not make any substantial modification to the facility, equipment, process, or procedures used in the receipt, storage, handling, processing or disposal of waste containing radioactive materials without first evaluating and documenting the impact of such changes to workers, the environment, and members of the public. The licensee shall obtain written authorization from the Department, including a license amendment, if deemed necessary by the Department prior implementing the proposed changes. The Radiation Safety Officer shall maintain documentation of all such evaluations for review by the Department.

26. Characterization and approval of regulated waste streams shall be performed in accordance with the Waste Acceptance SOP 15.W.01 dated April 19, 2006. All records of characterization and approval of regulated waste streams shall be maintained by the licensee for review by the department.

27. The licensee shall collect a random sample from 1 shipment out of every 20 shipments from each waste stream from each generator as described in the Waste Acceptance SOP 15.W.01 dated April 19, 2006. The random sample shall be sent to an off-site laboratory for analysis including: Gamma Spectrum, Gross Alpha Activity/g, Gross Beta Activity/g, Total Uranium Mass/g, Total Thorium Mass/g and Total Radium Activity/g. The results of this analysis shall be compared to the initial characterization data for the waste stream. If the results differ significantly from the profile, the RSO, general manager, compliance manager, or their designee shall contact the waste generator and attempt to resolve the discrepancy. If the results cannot be reconciled, the waste stream shall be deactivated until it can be resolved. All records from the random sampling program shall be maintained for review by the Department.

28. The licensee shall implement and maintain Department-approved controls for limiting the release of radon and radioactive particulates from all waste repositories and processing facilities.

29. The licensee shall conduct an air sampling program sufficient to demonstrate compliance with the public and occupational dose limits specified in Part 4 of the Regulations.

30. The licensee shall continue collecting monthly samples of groundwater, leachate and air for the purposes of establishing baseline environmental data for radionuclides until the Department approves an alternate sampling frequency.

31. Samples collected for the assessment of doses to members of the public, occupational doses, and samples collected for verification of characterization of wastes or environmental contamination levels shall be analyzed by radiochemistry laboratory that is appropriately licensed for the type of analysis being performed.

32. The licensee shall conduct sufficient radiation surveys on materials and equipment to ensure that contamination levels do not exceed Department-approved criteria prior to release to unrestricted areas or for unrestricted use. The results of each survey shall be recorded and maintained on file for review by the Department for three (3) years after the record is made in accordance with RH 4.42.

State of Colorado
Department of Public Health and Environment

RADIOACTIVE MATERIALS LICENSE

33. The licensee shall maintain all equipment and facilities, essential to operations governed by this license, in good working condition. This includes but is not limited to process equipment, process tanks, dust suppression equipment, air sampling equipment, water monitoring wells, radiation detection equipment, survey instruments, gates, fences, waste impoundments, security systems, safety equipment, and emergency systems and equipment.

34. The licensee's management and radiation safety officer shall take prompt and appropriate action to correct known deficiencies in the facility's procedures, processes, equipment, and site conditions. These deficiencies and the corrective actions shall be documented and records maintained for review by the Department for three (3) years.

35. The licensee shall document and implement a system of routine preventive maintenance so that safety equipment is checked for proper working order according to a regular schedule.

36. The license shall post individual areas of the facility and the entrances to each building or room that contains radioactive materials, with a conspicuous sign bearing the radiation symbol and the words, "Caution – Radioactive Materials".

37. The licensee shall maintain security measures to prevent unauthorized access to the site's facilities and radioactive materials.

38. Prior to closure of each landfill cell, the licensee shall submit an analysis of the adequacy of the cap design to the Department for approval. The cap design must provide reasonable assurance of control of radiological hazards to be effective for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years. Additionally, the cap design must be sufficient such that the release of Radon-222 does not exceed 20 pCi per square meter per second averaged over the surface area of the cell. This analysis shall include radon flux measurements and an analysis of the amount and concentration of radon producing materials disposed in the cell.

39. Upon closure of each landfill cell containing radioactive material, the licensee shall record with the Adams County clerk and recorder a deed annotation as required in Section 11.3.5.

40. Following the construction of a new landfill liner system or a landfill final cover system, the licensee shall provide the Department with "as-built" drawings of the landfill liner system or final cover system.

State of Colorado
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RADIOACTIVE MATERIALS LICENSE

41. The licensee shall provide the Department with an annual report by April 1 of each calendar year. That report shall contain the following items:

A. specification of each quantity of radioactive contaminants released to unrestricted areas in liquid and in airborne effluents;

B. the results of the environmental monitoring program;

C. a summary of licensee disposal unit radiation survey and maintenance activities;

D. a summary of activities and quantities of radionuclides disposed of;

E. any instances in which the observed site characteristics were significantly different from those described in the application for a license;

F. estimated doses to members of the public from the licensee's activities. This includes TEDE (total effective dose equivalent) and TODE (total organ dose equivalent) for both the nearest resident and the maximally exposed member of the public (if they are not the same person). The calculation of public doses shall be in accordance with Department approved methods, sampling frequencies, and dose modeling assumptions. Dose estimates shall be accompanied by appropriate supporting data including an electronic copy of the lab results, spreadsheets, computer model inputs, and modeling results/outputs;

G. a summary of Occupational Doses (total effective dose equivalent (TEDE), committed effective dose equivalent (CEDE), and deep dose equivalent (DDE));

H. a copy of the annual ALARA program audit;

I. a summary of anticipated activities for coming year;

J. an evaluation of the existing decommissioning warranty to ensure that the available funds are sufficient to account for inflation, current site conditions, and projected activities for the coming year; and

K. an evaluation of the existing decommissioning funding plan to ensure that the licensee will have sufficient funds for the licensee to complete site decommissioning activities.

State of Colorado
Department of Public Health and Environment

RADIOACTIVE MATERIALS LICENSE

License conditions 42 and 43 only apply to wastes under the jurisdiction of the Rocky Mountain Low-Level Radioactive Waste Board

42. Two (2) years after the facility has been licensed, the licensee shall petition the Board of Health of the State of Colorado to determine the rates using a historic test period of no less than twelve (12) continuous months, adjusted for known and certain future expenditures that will be incurred by the licensee which are reasonable and necessary for the operation of the facility.

43. The licensee shall provide rate review documentation to the Department pursuant to Sections 15.16, 15.17, 15.18 and 15.19.

    A. Semiannual reports shall be submitted by July 31st and January 31st of each year.

    B. Annual reports shall be submitted by April 1st of each year.

44. Records of waste disposal shall be maintained in accordance with Section 4.48.

45. The licensee's facility management and the radiation safety officer shall thoroughly review the content and requirements of this license. The licensee shall promptly notify the Department whenever it identifies an error in license authorizations or it has identified a specific license condition or technical requirement established in this license that is not achievable given the current state of technology or site conditions.

46. If statements in referenced documents conflict, the most recent document listed below shall prevail unless otherwise specified in this license.

47. The State of Colorado Rules and Regulations Pertaining to Radiation Control and the *Radiation Control Act* Title 25, Article 11, *Colorado Revised Statutes*, shall govern the licensee, unless the conditions of this license or the licensee's statements, representations, or procedures contained in applications or other documents submitted to the Department are more restrictive than the Regulations. Except as specifically provided otherwise by this license, the licensee shall possess and use radioactive material described in Item 6 of this license in accordance with statements, representations, and procedures contained in:

    A. the application and attachments received January 31, 2005; and

    B. the CHWA Subtitle C Permit dated December 2005; and

    C. financial assurance arrangements for decommissioning and long term care (Steadfast Insurance Policy Number ENC 5254333-02); and

    D. the decommissioning funding plan dated December 20, 2005; and

State of Colorado
Department of Public Health and Environment

RADIOACTIVE MATERIALS LICENSE

E. the Rocky Mountain Low-Level Radioactive Waste Board Designation as a Limited Regional Disposal Facility, as amended; and

F. the Radiation Protection Plan dated October 4, 2005; and

G. the Standard Operating Procedures as follows:

i. Standard Operating Procedure on Airborne Monitoring for Regulated Waste dated October 14, 2005;
ii. Standard Operating Procedure on Individual and Area Dosimetry dated October 4, 2005;
iii. Standard Operating Procedure 15.SUR.01 Routine Radiation Surveys Revision 1 dated April 16, 2007;
iv. Standard Operating Procedure on Personnel Surveys dated October 7, 2005;
v. Standard Operating Procedure on Equipment Surveys dated October 4, 2005;
vi. Standard Operating Procedure on Surveys Following Spills dated October 4, 2005;
vii. Standard Operating Procedure on Worker Radiation Protection Records dated October 4, 2005;
viii. Standard Operating Procedure on Use of the Gate Monitoring System dated October 4, 2005;
ix. Standard Operating Procedure on Gamma Spectra Analysis dated October 7, 2005;
x. Standard Operating Procedure on Treatment Operations dated October 14, 2005;
xi. Standard Operating Procedure on Regulated Waste Landfill Operations dated October 14, 2005;
xii. Standard Operating Procedure on Estimating Inhalation Doses dated June 23, 2005;
xiii. Standard Operating Procedure on Radiation Protection Training dated June 23, 2005;
xiv. Standard Operating Procedure 15.LAB.01 Use of the Alpha Beta Counter Revision 1 dated April 16, 2007;
xv. Standard Operating Procedure on Waste Tracking dated June 24, 2005;
xvi. Waste Acceptance SOP 15.WAC.01 Revision 2 dated April 19, 2006;
xvii. Groundwater Sampling Standard Operating Procedure 15.Env.2 dated September 1, 2006;
xviii. Standard Operating Procedure 15.OPS.03 Liquid Regulated Wastes Revision 1 dated April 16, 2007; and

H. the Decommissioning Plan dated December 21, 2005; and

I. the Environmental Covenant granted by the licensee to the Colorado Department of Public Health and Environment on January 5, 2006 and as may be amended from time to time; and

State of Colorado
Department of Public Health and Environment

RADIOACTIVE MATERIALS LICENSE

J. the correspondence and attachments dated April 7, 2005; May 2, 2005; May 24, 2005; July 7, 2005; July 26, 2005; July 28, 2005; August 10, 2005 (email); October 25, 2005; October 26, 2005; April 4, 2006; April 19, 2006; and October 10, 2006 (received by the Department on January 30, 2007); April 16, 2007, June 28, 2007; September 1, 2008; and March 18, 2009.

FOR THE COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT

By: 3/30/09 Date: [signature]

Waste Disposal Services

Truck-to-Rail Transloading Fact Sheet

Truck-to-Rail Transloading

Clean Harbors portable truck-to-rail transloading solution provides the most economical and safest method of overland transportation of bulk waste material. Our truck-to-rail transloading ramps offer you a significant advantage when managing the shipment of material from your project site to one of Clean Harbors rail served treatment and disposal facilities, including our incinerators and landfills. Even if your project location does not have rail on-site or the rail is at the opposite side of a property, you can still benefit from the economies of rail shipping by utilizing our truck-to-rail transloading solution.

- We provide a total solution
- Railroad approved & specifically designed
- Gain high throughput rates
- Minimal site requirements

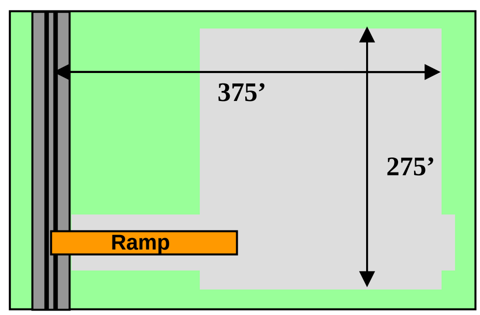
We Provide a Total Solution - Clean Harbors will set up and operate portable truck-to-rail ramps on your project site. We can also provide the trucks to move materials to the rail cars as well as manage the rail shipments to the end disposal facility.

Railroad Approved & Specifically Designed - These ramps are railroad approved and specifically designed for transloading activity involving transferring bulk loads of soils and small debris from dump trailers and roll-offs into 90-100 ton gondola rail cars.

Auto-leveling hoppers distribute the bulk wastes evenly throughout the length of the railcar. The ramps are configured for "back-on" use and can handle most any conventional dump trailer or the higher model roll-off frames. To maximize railcar payload, our ramp system is compatible for use with 53-foot, 90-100-ton gondola railcars.

Gain High Throughput Rates - When transloading operating conditions are optimal, approximately 92 tons (four trailer loads) can be transloaded per 1½ hours.

Minimal Site Requirements - We require a non-shared dedicated rail spur or siding. The transload ramp will be set-up at approximately the mid-point of the siding. The siding must have sufficient length to accommodate a full days/shifts production of railcars on both sides of the transload ramp. A minimum of 375 feet of perpendicular approach to the inside rail and approximately 275 feet of truck/trailer maneuvering area is necessary. Since our equipment is a back-on ramp, we do not require any additional area or accommodations on the opposite side of the rail.



Typical Site Layout – perpendicular approach to the rail supported by a load bearing improved surface, without overhead obstacles, shallow buried conveyances and/or highly irregular angles of approach.

Summary - Understanding and appreciating the complexities of remedial and project site activities and knowing the nuts and bolts of railroad service, Clean Harbors is able to provide a unique value-added service that makes transportation and disposal economical and as seamless and uncomplicated as ever.

CleanHarbors ENVIRONMENTAL SERVICES®

Appendix D

Evaluation of the Use of Apatite/Phosphate Treatment Technologies

Evaluation of the Use of Apatite/Phosphate Treatment Technologies

West Lake Landfill Operable Unit-1

Prepared for

The United States Environmental Protection Agency Region VII

Prepared on behalf of

The West Lake Landfill OU-1 Respondents

Prepared by

Engineering Management Support, Inc.
7220 West Jefferson Avenue, Suite 406
Lakewood, Colorado 80235

October 1, 2016

Table of Contents

List of Acronyms

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
EMSI	Engineering Management Support, Inc.
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
MDNR	Missouri Department of Natural Resources
MSW	Municipal solid waste
NRRB	National Remedy Review Board
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RIM	Radiologically-Impacted Material
ROD	Record of Decision
SFS	Supplemental Feasibility Study
TPD	Thorium phosphate diphosphate
UMTRCA	Uranium Mill Tailings Radiation Control Act

1. INTRODUCTION

This report presents an evaluation of the potential application of apatite and/or phosphate solutions for possible treatment of waste materials and/or groundwater for the remedial action for Operable Unit-1 (OU-1) of the West Lake Landfill Superfund Site (the Site). The evaluation presented in this report was prepared in accordance with the Revised Work Plan – Evaluation of the Use of Apatite/Phosphate Treatment Technologies (Work Plan) dated October 31, 2013 (EMSI, 2013) that was approved by the U.S. Environmental Protection Agency (EPA) on March 20, 2015.

1.1 Summary

An extensive review of the literature regarding the use of apatite and/or other phosphate-based materials for treatment of radionuclides and metals in water, soil, sediments, tailings and landfill leachate was performed. No literature or case studies were identified relative to use of apatite or phosphate-based materials for treatment of radium or thorium in soil or MSW.

No applications of apatite or phosphate-based treatment of any type were identified relative to MSW. Uncertainty exists as to whether apatite formation can be initiated synthetically under field conditions associated with MSW, including whether apatite solids or solutions can be delivered and homogeneously distributed within an overall heterogeneous matrix of MSW. DOE technical representatives with extensive experience with bench- and pilot-testing of apatite under various geochemical conditions have expressed concerns about unintended consequences such as a potential for increased mobility that could result from physical disturbance or modification of the geochemical conditions within the landfill from application of apatite based treatment technologies (Thompson and Wellman, 2012).

Applications of apatite/phosphate-based treatment of groundwater containing strontium, uranium, and some metals were identified. However, no known applications for treatment of radium or thorium in groundwater were identified.

Given the lack of demonstrated application of this technology for either radium or MSW, implementation uncertainties, and the potential for adverse effects, this technology is not considered appropriate for treatment of OU-1 soil/waste material. Therefore, it is recommended that this technology be eliminated from further consideration relative to treatment of OU-1 soil/waste. EPA has indicated that groundwater conditions will be addressed in a separate operable unit. Therefore, further evaluations of potential application of apatite/phosphate-based or other treatment technologies may be evaluated as part of the RI/FS for a groundwater OU.

1.2 Background

In an October 12, 2012 letter (EPA, 2012), EPA Region 7 indicated that the National Remedy Review Board (NRRB) recommended that more detailed evaluations of potential treatment technologies be conducted as part of a Supplement to the Supplemental Feasibility Study (SFS) (EMSI, 2011). EPA Region 7 requested in the letter that the OU-1 Respondents, among other things, evaluate potential applications of apatite and/or phosphate solutions for possible treatment of waste materials and/or groundwater at a level of detail comparable to that used to evaluate the treatment technologies previously analyzed in the SFS.

In its email approving the Revised Work Plan (EPA, 2015), EPA recommended that

> *"additional literature research be undertaken to identify all relevant literature pertaining to the reduction in mobility of Radiologically Impacted Material (RIM) in landfill environments of appropriate geochemical conditions (solubility and sorption). More specifically, the additional literature research should include various stabilization agents, for example, but not limited to (phosphates, carbonates, sulfates, sulfides) under current and projected subsurface geochemical conditions of pH and Eh at the West Lake landfill. The identified site conditions should dictate the best chemical treatment options based on waste, RIM and geochemical conditions to achieve minimum RIM component mobility.*

1.3 Apatite/Phosphate-Based Treatment

Apatite is an isomorphic mineral. More specifically, apatite is a group of crystalline phosphate mineral compounds that have different chemical compositions, but identical crystalline structures. Consequently, precipitation of apatite can result in incorporation of other elements into the mineral's crystalline structure. In an isomorphic mineral, certain ions or molecules will enter into the crystal-lattice of a mineral solid without causing any marked change in the crystal morphology or other physical properties of the mineral. For simplicity, this process reflects two ions having similar but not equal atomic radii and the same charge, with the smaller ion being preferentially concentrated in the early formed specimens of a crystallizing mineral series.

Application of apatite/phosphate-based treatment agents was considered as a possible in situ stabilization method. Stabilization refers to processes that involve chemical reactions that reduce the leachability of a waste (EPA, 2000). Stabilization is performed to chemically immobilize hazardous materials or to reduce their solubility through a chemical reaction (EPA, 2000).

Relative to the radionuclides at West Lake Landfill, apatite or other phosphate-based materials or solutions possibly could be added in situ to the solid waste materials containing the radionuclides to reduce potential leaching of the radionuclides. The apatite or other phosphate-based material would be added in sufficient quantities and under appropriate geochemical conditions necessary to promote apatite crystallization. Such crystallization may result in incorporation of Site-related radionuclides such as thorium, radium and uranium into the apatite crystals. Incorporation of radionuclides into the crystalline matrix would reduce the potential for leaching of such radionuclides. Alternatively, apatite or phosphate based solutions could be physically placed (*e.g.,* permeable reactive barrier) or injected into groundwater containing radionuclides with the goal of precipitating and thereby immobilizing radionuclides contained in groundwater.

Radium and thorium, and to a lesser extent uranium, are the major radionuclides of concern at the Site relative to potential leaching to groundwater. Thorium is known to be highly insoluble and uranium is relatively insoluble under reducing conditions such as those that occur at municipal solid waste (MSW) landfills. Neither of these radionuclides has been detected in groundwater at the Site at levels above background. Therefore, radium would be the key constituent for treatment using apatite materials.

1.4 Approach

Typically, the first step in the identification of potentially applicable remedial technologies is to evaluate general response actions that, based on site conditions and media of concern, could address the remedial action objectives (RAOs) at a site. The RAOs developed for OU-1 do not include direct treatment of the waste materials or treatment of groundwater. Consequently, potential remedial technologies related to these response actions were not evaluated in the FS (EMSI, 2006) or the SFS (EMSI, 2011). Therefore, as discussed in the Work Plan, for purposes of conducting an evaluation of potential apatite/phosphate-based treatment technologies, this initial step (evaluation of general response actions based on site conditions and media of concern) was omitted. Instead, to comply with EPA's direction, the evaluation was based on a hypothetical scenario where treatment of the waste/source materials and/or treatment of groundwater have been deemed appropriate response actions relative to the site conditions and media of concern. In the event that an apatite/phosphate-based treatment technology is determined to potentially be applicable to OU-1, it may be necessary to revisit the evaluation of general response actions and the identification of other potentially applicable remedial technologies.

Evaluation of the potential applicability of apatite or other phosphate-based treatment technologies for direct treatment of waste/source materials or for treatment of impacted groundwater was performed using the same approach used to evaluate other potential remedial technologies under a Feasibility Study level of effort. The first step was to identify potential apatite/phosphate-based treatment technologies and perform an initial screening of the technical implementability of such technologies relative to the waste and site conditions. The approach to evaluating the potential application of apatite/phosphate-based treatment technology was based on the following:

1. Review of available published literature; and
2. Discussions with DOE individuals with knowledge of the use and applicability of apatite injection technology.

If the initial screening of potential apatite/phosphate-based treatment technologies indicates that such technologies may potentially be applicable to the site and waste conditions in OU-1, these technologies are subjected to further evaluations, including potential effectiveness, implementability, and cost, in accordance with the procedures prescribed in EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988).

2. RESULTS OF INITIAL SCREENING

A search of available published technical literature was conducted as an initial screening of the technical implementability of apatite or other phosphate treatment technologies for the direct treatment of waste/source materials associated with West Lake Landfill OU-1 Areas 1 and 2 or for treatment of impacted groundwater. The results of the search are presented in Table 1. For each of the 72 references identified, Table 1 includes the name of the principal author; date of publication; the radioactive or other metal elements addressed; the nature of the media evaluated; and the scale of study conducted. A brief summary of the technical information/conclusions from each reference is also provided in Table 1.

Following is a summary of the radionuclide or metal elements addressed in the references:

Element(s)	Number of References
Radium	11
Thorium	3
Uranium	42
Other radionuclides	22
Metals (*e.g.*, lead, cadmium, zinc)	21

The types of liquid or solid media used in the various evaluations described in the literature include:

Media	Number of References
Water (groundwater, mine water, or synthetic water spiked with radionuclides and/or metals)	51
Soil	16
Sediments	9
Tailings	7
Landfill Leachate	1

The scale of the studies conducted in the literature is as follows:

Scale of Study	Number of References
Literature/Summary Review	18
Theoretical	4
Bench-scale	42

Pilot-scale	10
Full-scale	10

Application of apatite, other phosphate, or other treatment technologies to a source material composed of municipal solid waste such as the RIM present in OU-1 was not found in the literature. Also, a discussion with Department of Energy (DOE) personnel familiar with the use of apatite/phosphate-based treatment technologies at the Hanford Site indicated that because of the potential disruption in chemical equilibrium within the solid waste matrix, application of an apatite/phosphate media could result in an *increase* in the leaching potential of radionuclides instead of the reduction in leaching potential that would be intended by such an application.

3. APPLICATION OF APATITE TO SOLID MEDIA

The application of apatite or other treatment technologies to a material composed of municipal solid waste such as the RIM present in OU-1 was not found in the references reviewed. With respect to the 32 references where there was theoretical discussion of, or testing using, solid media (*i.e.*, soil, sediments, and tailings), a summary of the applications found in the literature that considered use of apatite or other technologies for removal from or immobilization of radionuclides or other metals within solid media is provided below.

- Several references (Bostick, undated; Conca and Wright, undated; Conca et al., 2000; CRC Press, 2000; Francis and Nancharaiah, 2014; Martinez et al., 2014; Raicevic et al., 2006; Shoesmith, 1984; Washington Department of Ecology, 2007; Wright and Conca, 2003; and Wright et al., 2004) were a literature or summary review or theoretical discussion of the potential applications of the use of apatite for removal of metals and radionuclides in groundwater and soil;

- Misra (2001) conducted bench-scale testing for removal of radium from soil using chemical washing followed by flotation;

- Arey et al. (1999) performed batch studies to assess the ability of hydroxyapatite to immobilize uranium in sediments;

- Burnett (1987) evaluated leaching of radium, uranium, radon, and polonium from phosphate mineral samples that contained radionuclides;

- Chen et al. (1997) conducted bench studies of sorption and desorption of lead, cadmium, and zinc from a contaminated soil reacted with apatite;

- Dacheux et al. (2000) performed bench studies of the behavior of thorium phosphate diphosphate (TPD) during acid leaching;

- Fyfe et al. (1981) showed in bench studies that collophanitic apatite removed uranium, thorium and barium from a synthetic solution and fixation of radium with potassium phosphate solutions using dry and wet tailings;

- Kanai (2003) conducted chemical leaching of uranium-series radionuclides in apatite-bearing sediments in bench-scale tests;

- Morrison and Spangler (1992) evaluated various industrial materials, including calcium phosphate, in bench tests for use as a chemical barrier for uranium and molybdenum under a uranium mill tailings repository in Monticello, UT;

- Murray et al. (1983) evaluated adsorption of radium, thorium, and uranium in mine water from tailings onto apatite in bench tests;

- Schumacher (1993) referenced bench mineralogical studies that showed much of the uranium in sediments from the Weldon Spring raffinate pits is associated with apatite;

- Wellman, Pierce, et al. (2008) conducted bench studies to optimize polyphosphate amendment within the Hanford 300 Area sediments vadose zone and capillary fringe to stabilize uranium; and

- Wellman et al. (2007) completed saturated and unsaturated column studies using sediment from the Hanford 300 Area N Process Pond and soluble sodium tripolyphosphate amendments to assess uranium removal.

None of these references involved pilot- or full-scale testing or mention of conditions similar to those requested by EPA in their approval of the Work Plan (*i.e, "…current and projected subsurface geochemical conditions of pH and Eh at the West Lake landfill.").* The materials employed in several of the studies might be considered for stabilization/immobilization of the soil component of the RIM present in OU-1, but the caution expressed by DOE personnel in use of apatite/phosphate-based treatment technologies with a solid waste matrix needs to be considered.

In addition to the above list, phosphate-based treatment has been used to stabilize lead-impacted soils (ITRC, 2010 and EPA, 1997). Chemical stabilization using phosphate for treatment of mining wastes has proven effective at reducing the mobility of divalent heavy metals both ex situ and in situ (ITRC, 2010). Ex situ treatment has been much more widely used than in situ and is usually used in conjunction with off-site disposal (ITRC, 2010). In situ phosphate treatment has been tested and proven effective but not widely implemented at stabilizing lead-contaminated soil in residential settings (ITRC, 2010).

4. APPLICATION OF APATITE TO GROUNDWATER

With respect to the potential application of apatite or other phosphate-based treatment technologies to groundwater, nine references provide information regarding full-scale operation of systems where apatite is employed to remove or sorb/sequester radionuclides and/or metals from groundwater or mining waters. Uranium and strontium-90 are the radionuclides being removed via these full-scale groundwater systems; there is no mention of radium and thorium, the predominant radionuclides associated with West Lake Landfill OU-1. The full-scale systems include:

- CETCO manufactures a permeable composite of geotextiles and apatite (Reactive Core Mat ™) that can be used as a subaqueous cap for sediments or for embankment seepage control to control leaching of certain metals;
- Conca and Wright (2006) describe a permeable reactive barrier (PRB) filled with Apatite II™ that removes zinc, lead, and cadmium from mine drainage in shallow alluvial groundwater in Idaho;
- A PRB with bone char apatite removes uranium from groundwater in Fry Canyon, UT (EPA, 2000). Fuller et al. (2003) conducted x-ray analysis of apatite samples from this PRB to determine the method of uranium sequestration within the PRB;
- A zeolite media PRB in groundwater at the DOE West Valley, NY site removes 77% of strontium-90 (DOE, 2013);
- DOE (2012) reported that apatite was injected into wells to expand a groundwater barrier in soil at the DOE Hanford facility, although the location and the nature of the contaminant(s) removed by the barrier were not specified in the reference; and
- The Washington Department of Ecology (2010 and undated), Heart of America NW (2010), and Vermeul et al. (2009) describe injection of apatite or apatite-forming minerals into the saturated and unsaturated zones of the Hanford N-100 Area plume along the shoreline of the Columbia River, forming a PRB that removes strontium-90.

Although no applications of removal of radium from groundwater were identified in the literature, at least two of the papers explicitly address sequestration of radium by apatite/phosphate in mine wastes based on the results of bench tests including:

> Fyfe W.S., Brown, J.R., Kronberg, E.I, and Murray, F., 1981, Immobilization of U-Th-Ra in Mine Wastes by Mineralization, Ontario Geological Survey Open-File Report 5366, Grant #28; and

Murray, F.H., Brown, J.R., Fyfe, W.S., and Kronberg, B.I., 1983, Immobilization of U-Th-Ra in Mine Wastes by Phosphate Mineralization. *Canadian Mineralogist*, Vol. 21, pp. 607-610.

It is also important to note that radium is an alkaline earth element. As such, it is in the same group as two other metals (strontium and barium). As an alkaline earth element, radium shares many geochemical properties with other elements of that group. It substitutes for/co-precipitates with strontium and barium in carbonates and sulfates, and it has a strong affinity for adsorption to various mineral surfaces because of its charge-to-ionic radius ratio. With regard to the alkaline earth elements, Kathren (1984) shows the cation exchange sequence for soils as follows:

$$Sr^{2+} < Ra^{2+} < Ca^{2+} < Mg^{2+}$$

There is no reason to expect that radium reacts unlike other alkaline earth elements in either surface-water or groundwater systems. Clearly, the two papers by Fyfe and others (1981) and Murray and others (1983) underscore the strong sorption affinity of radium for apatite-phosphate surfaces.

Removal of radionuclides from water is typically performed using ex situ techniques such as ion exchange or precipitation for radium removal, ion exchange for uranium removal, or air stripping/granular activated carbon for radon removal. EPA recently indicated that groundwater conditions at West Lake Landfill will be addressed in a separate operable unit (OU-3). Therefore, further evaluations of potential application of apatite/phosphate-based or other treatment technologies may be evaluated as part of the RI/FS for a groundwater OU.

5. CONCLUSIONS AND RECOMMENDATIONS

An extensive review of literature on the application and case studies of apatite/phosphate based technology, including applications for treatment of radionuclides, did not identify any known application of such technologies for immobilization of radium or radionuclide occurrences in a MSW matrix. Several theoretical/literature reviews and bench-scale study references relative to use of apatite/phosphate-based treatment for removal/immobilization of radionuclides and/or metals in solid media were identified; however, no studies were identified relative to immobilization of radium or relative to stabilization of radionuclides in MSW or under geochemical conditions similar to those present in an MSW landfill.

The effectiveness or potential effectiveness of in situ application of apatite/phosphate-based treatment technology for stabilization of radium or stabilization of radionuclides in MSW has not been demonstrated. Application of this technology also requires efficient delivery methods to control the effectiveness, implementability and cost of such an in situ treatment technique (EPA, 1993). The highly heterogeneous nature of the composition, chemistry and particle size of MSW would greatly affect the delivery of any injected liquid or mixing of any solid material. The variable organic content of MSW would also affect the binding ability and long-term stability of any stabilization/solidification technique. Therefore, large uncertainties exist with respect to the potential implementability of in situ stabilization using apatite/phosphate-based materials. In addition, questions have been raised regarding potential adverse effects of the application of such a technology to MSW, including a potential to increase the solubility of chemicals and/or radionuclides.

Given the lack of demonstrated application of this technology for either radium or MSW, implementation uncertainties and the potential for adverse effects, this technology is not considered appropriate for treatment of OU-1 soil/waste material. Therefore, it is recommended that this technology be eliminated from further consideration relative to treatment of OU-1 soil/waste. Since the results of this initial technical implementability screening indicate that apatite/phosphate-based treatment technologies are not applicable to the waste/source materials associated with OU-1, the further evaluations of the application of such technologies to MSW with respect to effectiveness, implementability, and cost prescribed in EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988) were not conducted.

Literature reports of several full-scale projects where apatite/phosphate-based treatment was used for removing/immobilization of uranium and strontium-90 in groundwater were identified. However, no case studies, testing or evaluations of such technologies for removal of radium or thorium from groundwater were identified. However, because it is an alkaline earth element, radium shares similar geochemical properties with other alkaline earth elements that are readily sequestered by various apatite-phosphate technologies. The absence of citations about radium sequestration from groundwater should be balanced by consideration of what is known about the geochemical properties of radium and other alkaline earth elements. EPA has indicated that groundwater conditions will be addressed in a separate operable unit. Therefore, further evaluations of potential application of apatite/phosphate-based or other treatment technologies may be evaluated as part of the RI/FS for a groundwater OU.

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Appendix E

Technical Memorandum: Evaluation of Potential "Hot Spot" Occurrences and Removal of Radiologically-Impacted Soil

Technical Memorandum:
Evaluation of Potential "Hot Spot" Occurrences and Removal
For Radiologically Impacted Soil
West Lake Landfill OU-1

INTRODUCTION

The West Lake Landfill Superfund Site consists of two Operable Units (OUs). OU-1 includes two areas, Areas 1 and 2, where radiologically impacted soil was mixed with municipal solid waste and construction debris. A Remedial Investigation report was previously completed for OU-1 (EMSI, 2000). A draft Feasibility Study (FS) for OU-1 was developed to identify and evaluate potential remedial alternatives for the radiological impacted soils present in Areas 1 and 2 of the West Lake Landfill (EMSI, 2000).

During the development of remedial alternatives in the FS, the Respondents considered the potential presence of "hot spots" and evaluated the potential need for consideration of hot spot removal as part of the remedial alternative evaluation for OU-1. For CERCLA municipal landfills such as the West Lake Landfill, EPA guidance indicates that "hot spots consist of highly toxic and/or highly mobile material and present a potential principal threat to human health and the environment." (EPA, 1993). EPA guidance further states that "Hot spots at CERCLA municipal landfills typically consist of liquids, buried drums or other highly mobile and toxic wastes that are present in a discreet area or portion of the landfill." As discussed further below, the FS concluded that there are no "hot spots" in the West Lake Landfill, and that implementation of hot spot removal as part of the remedial actions that may be undertaken for OU-1 is not warranted based on EPA guidance. Moreover, it is not practical and could potentially result in unacceptable risks to remediation workers. The additional risks involved in a hot spot removal significantly exceed the risks of leaving the waste in place as proposed in the FS.

The EPA Remedial Project Manager (RPM) requested at a June 14, 2000 meeting that the OU-1 Respondents prepare a separate technical memorandum addressing the evaluation of potential hot spots and possible removal of such hot spots. Specifically, at the June 14, 2000 meeting among EPA, a representative of the Missouri Department of Natural Resources (MDNR) and the Respondents, the EPA RPM requested the Respondents to submit a technical memorandum to evaluate potential "hot spot" removal of radiologically impacted soil present in Areas 1 and 2 of OU – 1. This memorandum responds to that request. A quantitative evaluation of the costs and risks associated with hot spot removal, however, requires that the Respondents proceed on the basis of an assumed volume of hot spot material. Because there are no "hot spots" at the West Lake Landfill, no basis exists to make such an assumption. Therefore, any such assumption would be arbitrary and the estimated costs would not be meaningful. Accordingly, the analysis that follows is primarily a qualitative analysis.

In evaluating the applicability of hot spot removal for OU-1, this memorandum summarizes the applicability to OU-1 of the use of the presumptive remedy of containment for municipal landfill sites; provides a discussion from EPA guidance regarding how "hot spots" should be addressed; includes a quantitative discussion of potential risks to workers and the public associated with excavation of filled material and removal of radionuclides within Areas 1 and 2 that are dispersed within soil material that is further dispersed throughout the overall, heterogeneous matrix of municipal refuse, construction and demolition debris and other, non-impacted soil materials; and concludes that hot spot removal for OU-1 at the West Lake Landfill is not appropriate based on EPA guidance documents.

APPLICATION OF THE PRESUMPTIVE REMEDY TO OU-1 AT THE WEST LAKE LANDFILL

Section 300.430(a)(iii)(B) of the NCP contains the expectation that engineering controls, such as containment, will be used for waste that poses a relatively low long-term threat or where treatment is impracticable (USEPA, 1990). The preamble to the NCP identifies municipal landfills as a type of site where treatment of the waste may be impracticable because of the size and heterogeneity of the contents (55 FR 8704). Waste in CERCLA landfills usually is present in large volumes and is a heterogeneous mixture of municipal waste frequently co-disposed with industrial and/or hazardous waste. Because treatment is usually impracticable, EPA generally considers containment to be the appropriate response action, or the "presumptive remedy" for the source areas of municipal landfill sites (USEPA, 1993).

Based upon EPA experiences at numerous CERCLA municipal landfill sites and as a result of the initiatives undertaken as part of the Superfund Accelerated Cleanup Model, EPA has initiated use of and developed presumptive remedies for specific types of sites, contaminants, or both, including CERCLA municipal landfill sites. Based upon its experience, EPA has identified the following components for consideration in applying the presumptive remedy approach for source area containment at CERCLA municipal landfills:

- Landfill cap;
- Source area ground-water control to contain plume;
- Leachate collection and treatment;
- Landfill gas collection and treatment, and/or
- Institutional controls to supplement engineering controls.

EPA's Remedial Project Manager (RPM) has previously indicated that the presumptive remedy for CERCLA municipal landfills should be considered in the development and evaluation of potential remedial alternatives for the West Lake Landfill. Occurrences of radionuclides within Areas 1 and 2 are dispersed within soil material that is further dispersed throughout the overall, heterogeneous matrix of municipal refuse, construction and demolition debris and other, non-impacted soil materials. Consequently, excavation of the radiologically impacted materials for possible ex situ treatment techniques or possible offsite disposal is impracticable.

Of the source containment options identified by EPA as part of the presumptive remedy approach, the landfill cap and institutional control actions are considered applicable to Areas 1 and 2. As there is no plume of groundwater contamination associated with Areas 1 and 2, source area ground-water control is not applicable to Areas 1 and 2. With the possible exception of the intermittent and highly localized seep in the southwestern portion of Area 2, no leachate discharge has been identified from Areas 1 and 2. Based on the results of the radon monitoring conducted during the RI, collection or control of radon gas is not considered necessary.

The West Lake Landfill site had been used for waste disposal and other industrial activities for approximately 50 years and will remain a waste disposal site forever regardless of any remedial actions that may be taken with respect to OU-1. As discussed in the FS, existing institutional controls will continue to be used to control current and future use of the entire West Lake Landfill and Areas 1 and 2 in particular. Institutional controls along with the existing landfill fencing are used to control and restrict access to Areas 1 and 2. The existing institutional controls consist of a deed restriction recorded in June 1997 against the entire landfill prohibiting residential use and groundwater use. An additional deed restriction was recorded in January 1998 restricting construction of buildings and underground utilities and pipes within Areas 1 and 2. These deed restrictions cannot be terminated without the written approval of the current owners, EPA, and MDNR. Also, as part of all alternatives in the FS except the No Action alternative, additional institutional controls in the form of additional deed restrictions would be implemented to prevent or control potential future uses of Areas 1 and 2 not currently expressly restricted. For example, construction of office buildings or other commercial or industrial structures could be performed in areas adjacent to Areas 1 and 2 in the future. As part of this type of development, there may be an expectation of using Areas 1 and 2 for ancillary uses such as landscaping, parking lots, or open storage. An additional deed restriction would be implemented to prevent use of Areas 1 and 2 for parking lots, employee recreation, open storage or other similar uses that may be ancillary to future commercial/industrial development of the landfill areas outside of Areas 1 and 2.

In addition, irrespective of the radiologically impacted soil present in Areas 1 and 2 of OU – 1, the entire West Lake Landfill Superfund Site is a landfill and will remain a landfill. The Missouri Solid Waste Rules (10 CSR 80) require owners of solid waste disposal areas, as part of closure of the solid waste disposal area to "Submit evidence to the department that a notice and covenant running with the land has been recorded with the recorder of deeds in the county where the sanitary landfill is located. The notice and covenant shall specify ….. that the use of the land in any manner which interferes with closure plans, and post-closure plans filed with the department, is prohibited."

EPA GUIDANCE ON "HOT SPOTS" RELATIVE TO RADIOLOGICALLY IMPACTED SOIL AT THE WEST LAKE LANDFILL

EPA's guidance for presumptive remedies at CERCLA municipal landfill sites also describes issues to be addressed related to the characterization and possible treatment of "hot spots". Hot spots consist of highly toxic and/or highly mobile material and present a potential principal threat to human health or the environment (EPA, 1993). EPA guidance (EPA, 1993) states that "The overriding question is whether the combination of the waste's physical and chemical characteristics and volume is such that the integrity of the new containment system will be threatened if the waste is left in place." Neither the physical nor chemical characteristics of the radiologically impacted materials in OU-1 will affect the integrity of a containment system (landfill cover). Consequently, the answer to the overriding question in determining whether hot spot removal is appropriate is that the integrity of the containment remedy presumed by EPA for CERCLA municipal landfill sites would not be threatened if the radiologically impacted soil is left in place. Hot spot removal is not considered appropriate for OU-1.

Excavation or treatment of hot spots is generally practicable where the waste type or mixture of wastes is in a discrete, accessible location of a landfill. EPA guidance provides that a hot spot should be large enough that its remediation would significantly reduce the risk posed by the overall site, but small enough that it is reasonable to consider removal or treatment.

EPA guidance identifies four questions to be addressed to determine whether characterization and/or treatment of hot spots are warranted. All four of these questions must be answered in the affirmative to support a decision to characterize and treat hot spots. These four questions are as follows:

- Does evidence exist to indicate the presence and approximate location of waste?
- Is the hot spot known to be principal threat waste?
- Is the waste in a discrete accessible part of the landfill?
- Is the hot spot known to be large enough that its remediation will reduce the threat posed by the overall site but small enough that it is reasonable to consider removal (e.g., 100,000 cubic yards or less)?

As to the first question, reliable historic information regarding the location of the radionuclide materials does not exist. Surveys and sampling conducted as part of the RI have identified the general locations of the occurrences of the radiologically impacted materials within Areas 1 and 2. Results of the RI investigations indicate that the radiologically impacted soil material is dispersed both laterally and vertically throughout the overall, heterogeneous matrix of municipal refuse, construction and demolition debris, and unimpacted soil cover material. Therefore, the exact location, boundaries and extent of the radiologically impacted materials cannot be precisely located and can only be approximately estimated. The answer to the first question is no.

Principal threat wastes addressed by the presumptive remedy guidance for which hot spot remediation is most likely to be appropriate include liquids, areas contaminated with high concentrations of toxic compounds, and highly mobile material. As defined in A Guide to Principal Threat and Low Level Threat Wastes (USEPA, 1991), principal threat wastes are "those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur." "Source material" is defined in the principal threat guidance as material that includes or contains hazardous substances, pollutants or contaminants that act as a reservoir for migration of contamination to groundwater, to surface water, to air, or act as a source for direct exposure. The guidance also states that no threshold level of toxicity/risk has been established to equate to a "principal threat", but that where toxicity and mobility of source material combine to pose a potential risk of 1×10^{-3} or greater, generally treatment alternatives should be considered.

Radiologically impacted materials at the West Lake Landfill occur in soil material, not liquids. The radionuclides are not present in a discrete area, unit, or zone of the landfill. Specifically the radiologically impacted soils are interspersed within the overall landfill matrix at depths ranging from the ground surface to over 20 feet below ground surface, making retrieval of the impacted materials impracticable. Similarly, the types of radionuclides, and the presence of the radionuclides in soil material, result in the radionuclide occurrences at the West Lake Landfill being generally immobile. Therefore, in accordance with the guidance, the radiologically impacted materials are not considered a source material or principal threat waste. The answer to the second question is no.

As the radionuclides are not located in a discrete area, the answer to the third question is no and hot spot removal is not appropriate. This conclusion is further supported by answering the "overriding question" of "whether the combination of the waste's physical and chemical characteristics and volume is such that the integrity of the new containment system will be threatened if the waste is left in place." (EPA, 1993) As discussed in the OU-1 Feasibility Study (EMSI, 2000), no significant risk to human health or the environment would occur if a containment remedy were implemented at the Site. There is no indication of widespread or even significant groundwater contamination from the radionuclides at the site and evaluations conducted as part of the RI report indicate that potential future migration is limited and should not significantly affect the underlying or downgradient groundwater quality. The only significant exposure pathways identified by the Baseline Risk Assessment (BRA) entailed gamma radiation from or direct contact with radiologically impacted soil. Both of these exposure pathways could be addressed through installation of a containment (landfill cover) system, supplemented with institutional controls. Radiologically impacted soil at the West Lake Site can easily and effectively be isolated through installation of a cover system. Neither the physical nor chemical characteristics of the radiologically impacted materials will affect the integrity of the landfill cover. Consequently, the answer to the overriding question in determining whether hot spot removal is appropriate is that the integrity of the containment remedy presumed by EPA for CERCLA municipal landfill sites would not be threatened if the radiologically impacted soil is left in place, and hot spot removal is not appropriate.

As to the fourth question, removal of the radionuclides would require excavation of approximately 130,000 cubic yards of refuse containing radiologically impacted soil plus an additional approximately 120,000 cubic yards of refuse present as overburden that is not expected to contain radiologically impacted soil. This combined volume of over approximately 250,000 cubic yards is substantially greater than the volume of 100,000 cubic yards or less that is considered by the guidance to be reasonable for removal. Therefore, excavation and offsite disposal of refuse containing radiologically impacted soil is not reasonable and not warranted.

As stated above, EPA guidance identifies four questions to be addressed to determine whether characterization and/or treatment of hot spots are warranted and all four of these questions must be answered in the affirmative to support a decision to characterize and treat hot spots. None of the four questions can be answered in the affirmative. Therefore, hot spot removal is not appropriate and not warranted. This conclusion is consistent with the evaluation of the overriding question of whether hot spot removal is necessary to protect the integrity of the containment remedy presumed by EPA for CERCLA municipal landfill sites.

THEORETICAL LIMITATIONS TO REMOVAL AND OFFSITE DISPOSAL OF RADIOLOGICALLY IMPACTED SOIL

As previously discussed, the radiologically impacted materials are present in soil material contained within the overall matrix of municipal refuse, construction and demolition debris and unimpacted soil, making retrieval of the impacted materials impracticable. Despite the conclusion that hot spot removal is not necessary, and to address EPA's request that hot spot removal scenarios be discussed, the following paragraphs present theoretical limitations to removal and off-site disposal of radiologically impacted soils. Excavation and offsite disposal of radiologically impacted soil would require either:

1. Excavation, loading, offsite transport via truck, offloading and transfer to railcars, and subsequent transport to an out-of-state facility for disposal of large volumes of municipal solid waste and debris that contains both radiologically impacted and non-impacted soil; or alternatively

2. Excavation of the solid waste and soil followed by screening or other physical separation of the radiologically impacted soil from the solid waste followed by loading, offsite transport via truck, off-loading and transfer to railcars, and

subsequent transport to an out-of-state facility for disposal of the soil fraction along with re-disposal onsite of the excavated refuse and debris.

If the first option were to be selected, a large volume, greater than the 100,000 cubic yard upper limit suggested in EPA's CERCLA Municipal Landfill guidance document as reasonable to consider for removal, would need to be excavated and sent for offsite disposal. This transportation would likely involve highway trucks travelling approximately 20 miles one-way or more on local roads and highways involving approximately 5,000 to 10,000 truck trips. The material would subsequently be transferred from the trucks to railcars at a truck/rail car transfer facility that would need to be built in the St. Louis area, and subsequent rail transport to an out-of-state disposal facility located in Utah, Texas, Washington or elsewhere. The rail distance to the Utah facility would be approximately 1,600 miles.

Under the second option, the radiologically impacted soil fraction would, to the maximum extent possible, initially be separated from the excavated refuse to reduce the total volume of material to be disposed offsite. Separation of the soil from the refuse and debris would be performed using a grizzly and/or vibrating screen. The act of screening would result in mixing of the more highly impacted soil with less impacted and unimpacted soil. After screening, the impacted soil would be loaded into trucks for transport to the rail transfer facility and subsequent rail transport to an out-of-state disposal facility as described above.

Removal of the highest levels of radionuclide occurrences from Area 2 would not eliminate the need for or reduce the scope of potential containment measures. It is unrealistic to assume that all of the radiologically impacted soil could be removed as portions of this soil occur at depths of 10 to 20 feet below ground surface. Consequently, there would still exist a need for implementation of a containment system. Furthermore, even if excavation of the refuse, debris and soil with attendant offsite disposal of impacted soil and refuse were to occur, it would not alleviate the need for installation of a cover system, as the site would still remain a municipal solid waste landfill. After completion of the excavation activities, the excavations would have to be filled and/or graded out, the surface of the landfill would have to be graded and contoured and a new cover system would have to be installed. Consequently, excavation of the radiologically impacted soil does not eliminate the need for or reduce the scope of installation of a new landfill cover system.

In contrast, containment measures, such as capping, can effectively address both the potential areas of higher levels of radionuclides as well as the overall extent of radionuclides in Areas 1 and 2 and the adjacent solid wastes.

POTENTIAL RISKS ASSOCIATED WITH REMOVAL OF RADIONUCLIDES

Excavation and offsite disposal of radiologically impacted soil pose potential risks to both remediation workers and other onsite workers as well as to the public at large.

Screening of the refuse to separate out the soil material would be a difficult, time- and labor-consuming and potentially hazardous activity. Screening of refuse material would necessitate use of personnel to remove plastic, wood and other material that would otherwise clog or foul the screens. In addition to the physical hazards associated with such activities (i.e., slip, trip and fall, crushing or laceration from contact with moving machinery, etc.) such workers would also be exposed to elevated levels of gamma radiation for which practical, effective protection could not be readily and/or effectively implemented.

Regardless of which two options for removal and offsite disposal of radiologically impacted soil might be considered, extensive amounts of earth and waste moving activity would be required with the attendant potential for accidents between equipment and/or between equipment and workers. Transport of wastes by such a large number of truck and railcar trips poses real and potentially severe potential for additional accidents or possibly deaths. Moving any material across the country increases the amount of traffic on public roads and railways.

It is estimated that approximately 130,000 cubic yards of material would have to be removed from the site if off-site disposal is implemented. Assuming 20 cubic yards per truckload, moving this volume of material would require approximately 6,500 trips by heavy trucks on public roads. If the distance to the railhead were 20 miles, then the total round trip distance by the hauling fleet on public roads would be about 260,000 miles. Data collected between 1988 and 1997 by the National Highway Traffic Safety Administration demonstrates that, on average, for every 1,168,310 miles a heavy truck travels on public roads, there is a chance of an accident involving injury or death (NHTSA, 1998). This implies that the risk of an injury or fatality from hauling materials to a railhead from the site is about 2×10^{-1}.

Using the same volume assumptions discussed above, it would require about 1,300 gondola railcar loads of material, or approximately 13 100-car trainloads. If the round trip rail distance to a disposal facility is about 3,200 miles, the total rail distance for off-site disposal is about 42,000 miles. Data collected by the Federal Railroad Administration shows that between 1994 and 1998, for every 42,720 miles traveled by rail, an accident involving an injury or death occurred (USDOT), 1999). This implies that the risk of injury or death for the rail transport portion of the alternative is approximately 1.0.

The combined transportation risk for this alternative is on the order of 1.0, indicating that there is a real risk of injuring or killing someone every time off-site disposal is selected as an option. This combined transportation risk is in contrast with the current no-action risk from the Baseline Risk Assessment (Auxier, 2000) of 4×10^{-5} to the groundskeeper. Future risks to a hypothetical storage yard worker, assuming no engineered controls were placed on the site were calculated to be 4×10^{-4}. Thus, the combined transportation risk of disposing the material offsite is between 2,500 and 25,000 times greater than the calculated risk associated with leaving the material in place under a no-action scenario. Implementation of a capping alternative would reduce the onsite risk and therefore further increase the difference in risks associated with offsite disposal compared to an onsite remedy.

Furthermore, due to the nature of the loading and transfer activities, it is expected that the truck and train transport would occur using covered loads; however, in the event of an accident, a real possibility exists that soil and refuse material could be exposed or possibly spilled on the roadways or rail lines.

The West Lake Landfill, as with all municipal landfills, also contains methane gas. Consequently, excavation of refuse at the landfill poses a potential risk for explosion hazard and creation of a landfill fire. In addition to potential physical and radiological hazards posed by excavation, regardless of the approach selected, removal of the impacted soil would require excavation of large volumes of the landfill and handling of large volumes of partially decomposed refuse with the attendant odor emissions. Although there are techniques that can be considered to reduce odor emissions, it unrealistic to assume that all of the odors that would emanate from decades-old refuse could be controlled. Consequently, it is highly likely that odor emissions would affect nearby properties and be a source of nuisance, discomfort and possibly even illness to adjacent receptors.

CONCLUSION

The overriding question posed by EPA guidance regarding potential hot spot removal is whether the combination of the waste's physical and chemical characteristics and volume is such that the integrity of the new containment system will be threatened if the waste is left in place. Neither the physical nor chemical characteristics of the radiologically impacted materials will affect the integrity of the landfill cover. Consequently, the answer to the overriding question in determining whether hot spot removal is appropriate is that the integrity of the containment remedy presumed by EPA for CERCLA municipal landfill sites would not be threatened if the radiologically impacted soil is left in place, and hot spot removal is not appropriate.

Further characterization, evaluation, and excavation/offsite disposal of potential "hot spots" within Areas 1 and 2 is not warranted. The radiologically impacted materials in Areas 1 and 2 are dispersed throughout the soil material contained within the overall matrix of municipal refuse, construction and demolition debris and unimpacted soil, cannot be classified as a "hot spot" as defined in EPA guidance, and are not known to be a principal threat waste as defined by EPA. The chemical and physical characteristics of the impacted material will not adversely affect the cap called for by the presumptive remedy. Furthermore, based on the evaluation of the four factors identified by EPA, implementation of "hot spot" removal as part of the remedial actions that may be undertaken for OU-1 at the West Lake Landfill is not considered practical. In addition, as discussed above, excavation and subsequent screening of the refuse containing the soils with the elevated levels of radionuclides could potentially:

1. Expose remediation workers to physical hazards, gamma exposure and other unacceptable risks which, in the case of gamma exposure, could not easily or possibly effectively be mitigated with standard protective equipment;

2. Expose remediation workers, other onsite employees, offsite workers, and possible other nearby receptors to nuisance or noxious odor emissions; and

3. Expose remediation workers, onsite employees and the public to increased risks associated with potential accidents and possible spills associated with transportation by truck and rail of the excavated material to a distant offsite facility.

Consequently, excavation and offsite disposal of "hot spot" material is not considered practical, effective, beneficial or safe for Operable Unit 1 at the West Lake Landfill. Furthermore, excavation and offsite disposal of the radiologically impacted soil is inconsistent with EPA's established approach for CERCLA Municipal Landfill Sites, published EPA guidance and the National Contingency Plan.

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ATTACHMENTS

Attachment A: Presumptive Remedy for CERCLA Municipal Landfill Sites, EPA 540-F-93-035, OERR Directive No. 9355.0-49FS, September 1993.

Attachment B: A Guide to Principal Threat and Low Level Threat Wastes, Office of Emergency and Remedial Response, Superfund Publication 9380.3-06FS, November, 1991.

Attachment A:
Presumptive Remedy for CERCLA Municipal Landfill Sites

United States Environmental Protection Agency

Office of Solid Waste and Emergency Response

Directive No. 9355.0-49FS
EPA 540-F-93-035
PB 93-963339
September 1993

EPA

Presumptive Remedy for CERCLA Municipal Landfill Sites

Office of Emergency and Remedial Response
Hazardous Site Control Division 5203G

Quick Reference Fact Sheet

Since Superfund's inception in 1980, the remedial and removal programs have found that certain categories of sites have similar characteristics, such as types of contaminants present, types of disposal practices, or how environmental media are affected. Based on information acquired from evaluating and cleaning up these sites, the Superfund program is undertaking an initiative to develop presumptive remedies to accelerate future cleanups at these types of sites. The presumptive remedy approach is one tool of acceleration within the **Superfund Accelerated Cleanup Model (SACM).**

Presumptive remedies are preferred technologies for common categories of sites, based on historical patterns of remedy selection and EPA's scientific and engineering evaluation of performance data on technology implementation. The objective of the presumptive remedies initiative is to use the program's past experience to streamline site investigation and speed up selection of cleanup actions. Over time presumptive remedies are expected to ensure consistency in remedy selection and reduce the cost and time required to clean up similar types of sites. Presumptive remedies are expected to be used at all appropriate sites except under unusual site-specific circumstances.

This directive establishes **containment** as the presumptive remedy for CERCLA municipal landfills. The framework for the presumptive remedy for these sites is presented in a streamlining manual entitled *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites,* February 1991 (OSWER Directive 9355. 3-11). This directive highlights and emphasizes the importance of certain streamlining principles related to the scoping (planning) stages of the remedial investigation/feasibility study (RI/FS) that were identified in the manual. The directive also provides clarification of and additional guidance in the following areas: (1) the level of detail appropriate for risk assessment of source areas at municipal landfills and (2) the characterization of hot spots.

BACKGROUND

Superfund has conducted pilot projects at four municipal landfill sites[1] on the National Priorities List (NPL) to evaluate the effectiveness of the manual *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites* (hereafter referred to as "the manual") as a streamlining tool and as the framework for the municipal landfill presumptive remedy. Consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (or NCP), EPA's expectation was that containment technologies generally would be appropriate for municipal landfill waste because the volume and heterogeneity of the waste generally make treatment impracticable. The results of the pilots support this expectation and demonstrate that the manual is an effective tool for streamlining the RI/FS process for municipal landfills.

Since the manual's development, the expectation to contain wastes at municipal landfills has evolved into a presumptive remedy for these sites.[2] Implementation of the streamlining principles outlined in the manual at the four pilot sites helped to highlight issues requiring further clarification, such as the degree to which risk assessments can be streamlined for source areas and the characterization and remediation of hot spots. The pilots also demonstrated the value of focusing streamlining efforts at the scoping stage, recognizing that the biggest savings in time and money can be realized if streamlining is incorporated at the beginning of the RI/FS process. Accordingly, this directive addresses those issues identified during the pilots and highlights streamlining opportunities to be considered during the scoping component of the RI/FS.

[1] Municipal landfill sites typically contain a combination of principally municipal and to a lesser extent hazardous wastes.

[2] See EPA Publication 9203.1-021, SACM Bulletins, *Presumptive Remedies for Municipal Landfill Sites,* April 1992, Vol. 1, No. 1, and February 1993, Vol. 2, No. 1, and SACM Bulletin *Presumptive Remedies,* August 1992, Vol. 1, No. 3.

Finally, while the primary focus of the municipal landfill manual is on streamlining the RI/FS, Superfund's goal under SACM is to accelerate the entire cleanup process. Other guidance issued under the municipal landfill presumptive remedy initiative identifies design data that may be collected during the RI/FS to streamline the overall response process for these sites (see Publication No. 9355.3-18FS, *Presumptive Remedies: CERCLA Landfill Caps Data Collection Guide*, to be published in October 1993).

CONTAINMENT AS A PRESUMPTIVE REMEDY

Section 300.430(a)(iii)(B) of the NCP contains the expectation that engineering controls, such as containment, will be used for waste that poses a relatively low long-term threat where treatment is impracticable. The preamble to the NCP identifies municipal landfills as a type of site where treatment of the waste may be impracticable because of the size and heterogeneity of the contents (55 FR 8704). Waste in CERCLA landfills usually is present in large volumes and is a heterogeneous mixture of municipal waste frequently co-disposed with industrial and/or hazardous waste. Because treatment usually is impracticable, EPA generally considers containment to be the appropriate response action, or the "presumptive remedy," for the source areas of municipal landfill sites.

The presumptive remedy for CERCLA municipal landfill sites relates primarily to containment of the landfill mass and collection and/or treatment of landfill gas. In addition, measures to control landfill leachate, affected ground water at the perimeter of the landfill, and/or upgradient ground-water that is causing saturation of the landfill mass may be implemented as part of the presumptive remedy.

The presumptive remedy does not address exposure pathways outside the source area (landfill), nor does it include the long-term ground-water response action. Additional RI/FS activities, including a risk assessment, will need to be performed, as appropriate, to address those exposure pathways outside the source area. It is expected that RI/FS activities addressing exposure pathways outside the source generally will reconducted concurrently with the streamlined RI/FS for the landfill source presumptive remedy. A response action for exposure pathways outside the source (if any) may be selected together with the presumptive remedy (thereby developing a comprehensive site response) or as an operable unit separate from the presumptive remedy.

Highlight 1 identifies the components of the presumptive remedy. Response actions selected for individual sites will include only those components that are necessary, based on site-specific conditions.

Highlight 1: Components of the Presumptive Remedy: Source Containment

- Landfill cap;
- Source area ground-water control to contain plume;
- Leachate collection and treatment;
- Landfill gas collection and treatment; and/or
- Institutional controls to supplement engineering controls.

The EPA (or State) site manager will make the initial decision of whether a particular municipal landfill site is suitable for the presumptive remedy or whether a more comprehensive RI/FS is required. Generally, this determination will depend on whether the site is suitable for a streamlined risk evaluation, as described on page 4. The community, state, and potentially responsible parties (PRPs) should be notified that a presumptive remedy is being considered for the site before work on the RI/FS work plan is initiated. The notification may take the form of a fact sheet, a notice in a local newspaper, and/or a public meeting.

Use of the presumptive remedy eliminates the need for the initial identification and screening of alternatives during the feasibility study (FS). Section 300.430(e)(1) of the NCP states that, "... the lead agency shall include an alternatives screening step, <u>when needed</u>, (emphasis added) to select a reasonable number of alternatives for detailed analysis."

EPA conducted an analysis of potentially available technologies for municipal landfills and found that certain technologies are routinely and appropriately screened out on the basis of effectiveness, feasibility, or cost (NCP Section 300.430(e)(7)). (See Appendix A to this directive and "Feasibility Study Analysis for CERCLA Municipal Landfills," September 1993 available at EPA Headquarters and Regional Offices.) Based on this analysis, the universe of alternatives that will be analyzed in detail may be limited to the components of the containment remedy identified in Highlight 1, unless site-specific conditions dictate otherwise or alternatives are considered that were not addressed in the FS analysis. The FS analysis document, together with this directive, must be included in the administrative record for each municipal landfill presumptive remedy site to support elimination of the initial identification and screening of site-specific alternatives. Further detailed and comprehensive supporting materials (e.g., FS reports included in analysis, technical reports) can be provided by Headquarters, as needed.

While the universe of alternatives to address the landfill source will be limited to those component identified in Highlight 1, potential alternatives that may exist for each component or combinations of components may be evaluated in the detailed analysis. For example, one component of the presumptive remedy is source area ground-water control. If appropriate, this component may be accomplished in a number of ways, including pump and treat, slurry walls, etc. These potential alternatives may then be combined with other components of the presumptive remedy to develop a range of containment alternatives suitable for site-specific conditions. Response alternatives must then be evaluated in detail against the nine criteria identified in Section 300.430(e)(9) of the NCP. The detailed analysis will identify site-specific ARARs and develop costs on the basis of the particular size and volume of the landfill.

EARLY ACTION AT MUNICIPAL LANDFILLS

EPA has identifies the presumptive remedy site categories as good candidates for early action under SACM. At municipal landfills, the upfront knowledge that the source area will be contained may facilitate such early actions as installation of a landfill cap or a ground-water containment system. Depending on the circumstances, early actions may be accomplished using either removal authority (e.g., non-time-critical removal actions) or remedial authority. In some cases, it may be appropriate for an Engineering Evaluation/Cost Analysis to replace part or all of the RI/FS if the source control component will be a non-time-critical removal action. Some factors may affect whether a specific response action would be better accomplished as a removal or remedial action including the size of the action, the associated state cost share, and/or the scope of O&M. A discussion of these factors is contained in *Early Action and Long-term Action Under SACM- Interim Guidance* Publication No. 9203.1-05I, December 1992.

SCOPING A STREAMLINED RI/FS UNDER THE PRESUMPTIVE REMEDY FRAMEWORK

The goal of an RI/FS is to provide the information necessary to: (1) adequately characterize the site; (2) define site dynamics; (3) define risks; and (4) develop the response action. As discussed in the following sections, the process for achieving each of these goals can be streamlined for CERCLA municipal landfill sites because of the upfront presumption that landfill contents will be contained. The strategy for streamlining each of these areas should be developed early (i.e., during the scoping phase of the RI/FS).

1. Characterizing the Site

The use of existing data is especially important in conducting a streamlined RI/FS for municipal landfills. Characterization of a landfill's contents is not necessary or appropriate for selecting a response action for these sites except in limited cases; rather, existing data are used to determine whether the containment presumption is appropriate. Subsequent sampling efforts should focus on characterizing areas where contaminant migration is suspected, such as leachate discharge areas or areas where surface water runoff has caused erosion. It is important to note that the decision to characterize hot spots should also be based on existing information, such as reliable anecdotal information, documentation, and/or physical evidence (see page 6).

In those limited cases where no information is available for a site, it may not be advisable to initiate use of the presumptive remedy until some data are collected. For example, if there is extensive migration of contaminants from a site located in an area with several sources, it will be necessary to have some information about the landfill source in order to make an association between on-site and off-site contamination.

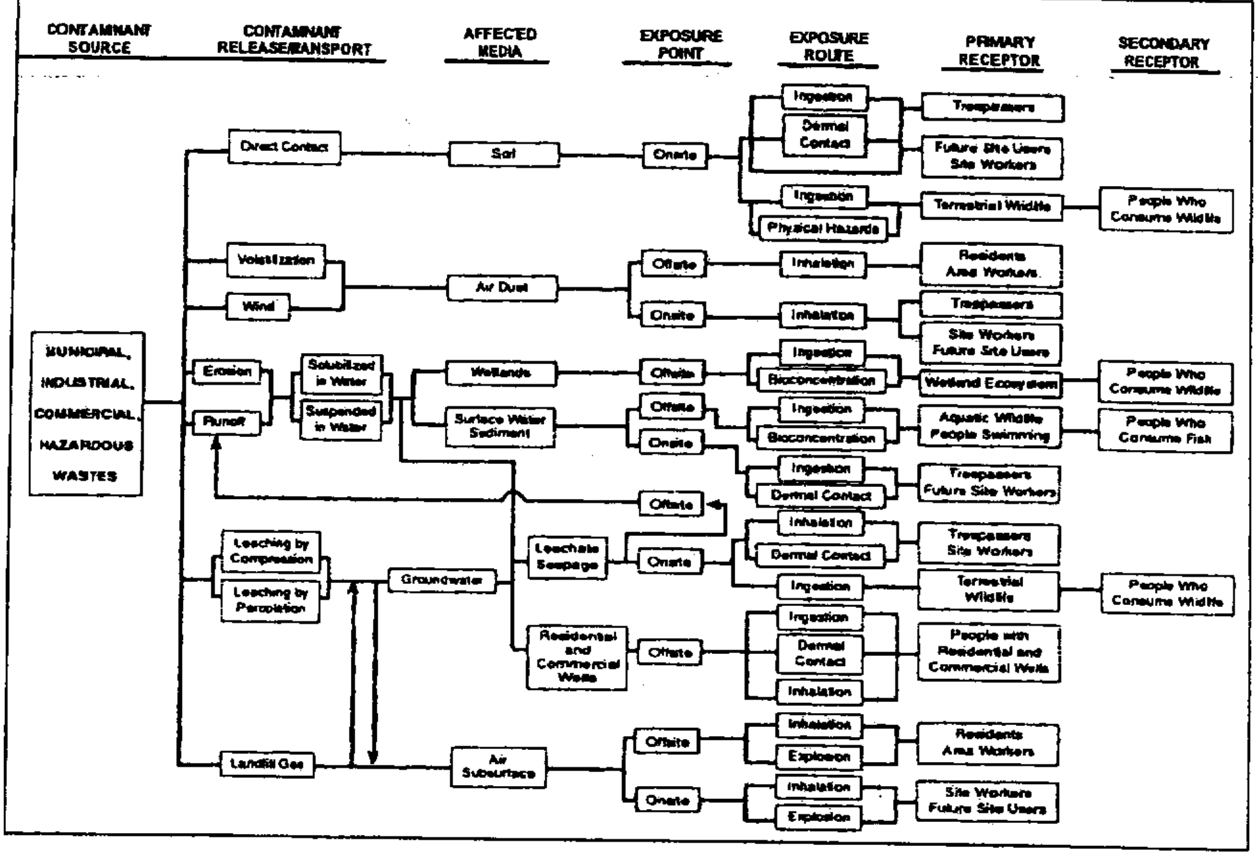
Sources of information of particular interest during scoping include records of previous ownership, state files, closure plans, etc., which may help to determine types and sources of hazardous materials present. In addition, a site visit is appropriate for several reasons, including the verification of existing data, the identification of existing site remediation systems, and to visually characterize wastes (e.g., leachate seeps). Specific information to be collected is provided in Sections 2.1 through 2.4 of the municipal landfill manual.

2. Defining Site Dynamics

The collected data are used to develop a conceptual site model, which is the key component of a streamlined RI/FS. The conceptual site model is an effective tool for defining the site dynamics, streamlining the risk evaluation, and developing the response action. Highlight 2 presents a generic conceptual site model for municipal landfill. The model is developed before any RI field activities are conducted, and its purpose is to aid in understanding and describing the site and to present hypotheses regarding:

- The suspected sources and types of contaminants present;
- Contaminant release and transport mechanisms;

Highlight 2: Generic Conceptual Site Model



- Rate of contaminant release and transport (where possible);
- Affected media;
- Known and potential routes of migration; and
- Known and potential human and environmental receptors.

After the data are evaluated and a site visit is completed, the contaminant release and transport mechanisms relevant to the site should be determined. The key element in developing the conceptual site model is to identify those aspects of the model that require more information to make a decision about response measures. Because containment of the landfill's contents is the presumed response action, the conceptual site model will be of most use in identifying areas beyond the landfill source itself that will require further study, thereby focusing site characterization away from the source area and on areas of potential contaminant migration (e.g., ground water or contaminated sediments).

3. Defining Risks

The municipal landfill manual states that a streamlined or limited baseline risk assessment will be sufficient to initiate response action on the most obvious problems at a municipal landfill (e.g., ground water, leachate, landfill contents, and landfill gas). One method for establishing risk using a streamlined approach is to compare contaminant concentration levels (if available) to standards that are potential chemical-specific applicable or relevant and appropriate requirements (ARARs) for the action. The manual states that where established standards for one or more contaminants in a given medium are clearly exceeded, remedial action generally is warranted[3]

It is important to note, however, that based on site-specific conditions, an active response is not required if ground-water contaminant concentrations exceed chemical-specific standards but the site risk is within the Agency's acceptable risk range (10^{-4} to 10^{-6}). For example, if it is determined that the release of

[3]See also OSWER Directive 9355.0-30, *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions*, April 22, 1991, which states that if MCLs or non-zero MCLGs are exceeded, [a response] action generally is warranted.

contaminants from a particular landfill is declining, and concentrations of one or more ground-water contaminants are at or barely exceed chemical-specific standards, the Agency may decide not to implement an active response. Such a decision might be based on the understanding that the landfill is no longer acting as a source of ground-water contamination, and that the landfill does not present an unacceptable risk from any other exposure pathway.

A site generally will not be eligible for a streamlined risk evaluation if ground-water contaminant concentrations do not clearly exceed chemical-specific standards or the Agency's accepted level of risk, or other conditions do not exist that provide a clear justification for action (e.g., direct contact with landfill contents resulting from unstable slopes). Under these circumstances, a quantitative risk assessment that addresses all exposure pathways will be necessary to determine whether action is needed.

Ultimately, it is necessary to demonstrate that the final remedy addresses all pathways and contaminants of concern, not just those that triggered the remedial action. As described in the following sections, the conceptual site model is an effective tool for identifying those pathways and illustrating that they have been addressed by the containment remedy.

Streamlined Risk Evaluation Of The Landfill Source

Experience from the presumptive remedy pilots supports the usefulness of a streamlined risk evaluation to initiate an early response action under certain circumstances. As a matter of policy, <u>for the source area</u> of municipal landfills, a quantitative risk assessment that considers all chemicals, their potential additive effects, etc., is not necessary to establish a basis for action if ground-water data are available to demonstrate that contaminants clearly exceed established standards or if other conditions exist that provide a clear justification for action.

A quantitative risk assessment also is not necessary to evaluate whether the containment remedy addresses all pathways and contaminants of concern associated with the source. Rather, all potential exposure pathways can be identified <u>using the conceptual site model and compared to the pathways addressed by the containment presumptive remedy.</u> Highlight 3 illustrates that the containment remedy addresses all exposure pathways associated with the source at municipal landfill sites.

Finally, a quantitative risk assessment is not required to determine clean-up levels because the type of cap will be determined by closure ARARs, and ground water that is extracted as a component of the presumptive remedy will be required to meet discharge limits, or other standards for its disposal. Calculation of cleanup levels for ground-water contamination that has migrated away from the source will not be accomplished under the presumptive remedy, since such contamination will require a conventional investigation and a risk assessment.

Highlight 3: Source Contaminant Exposure Pathways Addressed by Presumptive Remedy

1. Direct contact with soil and/or debris prevented by landfill cap;
2. Exposure to contaminated ground water within the landfill area prevented by ground-water control;
3. Exposure to contaminated leachate prevented by leachate collection and treatment; and
4. Exposure to landfill gas addressed by gas collection and treatment, as appropriate.

Streamlining the risk assessment of the source area eliminates the need for sampling and analysis to support the calculation of current or potential future risk associated with direct contact. It is important to note that because the continued effectiveness of the containment remedy depends on the integrity of the containment system, it is likely that institutional controls will be necessary to restrict future activities at a CERCLA municipal landfill after construction of the cap and associated systems. EPA has thus determined that it is not appropriate or necessary to estimate the risk associated with future residential use of the landfill source, as such use would be incompatible with the need to maintain the integrity of the containment system. (Long-term waste management areas, such as municipal landfills, may be appropriate, however, for recreational or other limited uses on a site-specific basis.) The availability and efficacy of institutional controls should be evaluated in the FS. Decision documents should include measures such as institutional controls to ensure the continued integrity of such containment systems whenever possible.

Areas of Contaminant Migration

Almost every municipal landfill site has some characteristic that may require additional study, such as leachate discharge to a wetland or significant surface water run-off caused by drainage problems. These migration pathways, as well as ground-water contamination that has migrated away from the source, generally will require characterization and a more comprehensive risk assessment to determine whether action is warranted beyond the source area and, if so, the type of action that is appropriate.

While future residential use of the landfill source area itself is not considered appropriate, the land adjacent to landfills is frequently used for residential purposes. Therefore, based on site-specific circumstances, it may be appropriate to consider future residential use for ground water and other exposure pathways when assessing risk from areas of contaminant migration.

4. Developing the Response Action

As a first step in developing containment alternatives, response action objectives should be developed on the basis of the pathways identified for action in the conceptual site model. Typically, the primary response action objectives for municipal landfill sites include:

<u>Presumptive Remedy</u>

- Preventing direct contact with landfill contents;
- Minimizing infiltration and resulting contaminant leaching to ground water;
- Controlling surface water runoff and erosion;
- Collecting and treating contaminated ground water and leachate to contain the contaminant plume and prevent further migration from source area; and
- Controlling and treating landfill gas.

<u>Non-Presumptive Remedy</u>

- Remediating ground water;
- Remediating contaminated surface water and sediments; and
- Remediating contaminated wetland areas.

As discussed in Section 3, "Defining Risks," the containment presumptive remedy accomplishes all but the last three of these objectives by addressing all pathways associated with the source. Therefore, the focus of the RI/FS can be shifted to characterizing the media addressed in the last three objectives (contaminated ground water, surface water and sediments, and wetland areas) and on collecting data to support design of the containment remedy.

Treatment of Hot Spots

The decision to characterize and/or treat hot spots is a site-specific judgement that should be based on the consideration of a standard set of factors. Highlight 4 lists questions that should be answered before making the decision to characterize and/or treat hot spots. The overriding question is whether the combination of the waste's physical and chemical characteristics and volume is such that the integrity of the new containment system will be threatened if the waste is left in place. This question should be answered on the basis of what is <u>known</u> about a site (e.g., from operating records or other reliable information). An answer in the affirmative to all of the questions listed in Highlight 4 would indicate that it is likely that the integrity of the containment system would be threatened, or that excavation and treatment of hot spots would be practicable, and that a significant reduction in risk at the site would occur as a result of treating hot spots. EPA expects that few CERCLA municipal landfills will fall into this category; rather, based on the Agency's experience, the majority of sites are expected to be suitable for containment only, based on the heterogeneity of the waste, the lack of reliable information concerning disposal history, and the problems associated with excavating through refuse.

The volume of industrial and/or hazardous waste co-disposed with municipal waste at CERCLA municipal landfills varies from site to site, as does the amount of information available concerning disposal history. It is impossible to fully characterize, excavate, and/or treat the source area of municipal landfills, so uncertainty about the landfill contents is expected. Uncertainty by itself does not call into question the containment approach. However, containment remedies must be designed to take into account the possibility that hot spots are present in addition to those that have been identified and characterized. The presumptive remedy must be relied upon to contain landfill contents and prevent migration of contaminants. This is accomplished by a combination of measures, such as a landfill cap combined with a leachate collection system. Monitoring will further ensure the continued effectiveness of the remedy.

The following examples illustrate site-specific decision making and show how these factors affect the decision whether to characterize and/or treat hot spots.

Examples of Site-Specific Decision Making Concerning Hot Spot Characterization/ Treatment

<u>Site A</u>

There is anecdotal information that approximately 200 drums of hazardous waste were disposed of at this 70-acre former municipal landfill, but their location and contents are unknown. The remedy includes a landfill cap and ground-water and landfill gas treatment.

A search for and characterization of hot spots is not supported at Site A based on the questions listed in

Highlight 4: Characterization of Hot Spots

If all of the following questions can be answered in the affirmative, it is likely that characterization and/or treatment of hot spots is warranted:

1. Does evidence exist to indicate the presence and approximate location of waste?
2. Is the hot spot known to be principal threat waste?*
3. Is the waste in a discrete, accessible part of the landfill?
4. Is the hot spot known to be large enough that its remediation will reduce the threat posed by the overall site but small enough that it is reasonable to consider removal (e.g., 100,000 cubic yards or less)?

*See *A Guide to Principal Threat and Low Level Threat Wastes*, November 1991, Superfund Publication No. 9380.3-06FS.

Highlight 4: (1) no reliable information exists to indicate the location of the waste; (2) the determination of whether the waste is principal threat waste cannot be made since the physical/chemical characteristics of the wastes are unknown; (3) since the location of the waste is unknown, the determination of whether the waste is in a discrete accessible location cannot be made; (4) in this case, the presence of 200 drums in a 70-acre landfill is not considered to significantly affect the threat posed by the overall site. Rather, the containment system will include measures to ensure its continued effectiveness (e.g., monitoring and/or leachate collection) given the uncertainty associated with the landfill contents and suspected drums.

__Site B__

Approximately 35,000 drums, many containing hazardous wastes, were disposed of in two drum disposal units at this privately owned 80-acre inactive landfill, which was licensed to receive general refuse. The site is divided into two operable units. The remedy for Operable Unit 1 (OU 1) is incineration of drummed wastes in the two drum disposal units. The remedy for OU2 consists of treatment of contaminated ground water and leachate and containment of treatment residuals (from OU 1) and remaining landfill contents, including passive gas collection and flaring.

Treatment of landfill contents is supported at Site B because all of the questions in Highlight 4 can be answered in the affirmative: (1) existing evidence from previous investigations and sampling conducted by the state (prior to the RI) indicated the presence and approximate location of wastes; (2) the wastes were considered principal threat wastes because they were liquids and (based on sampling) were believed to contain contaminants of concern; (3) the waste is located in discrete accessible parts of the landfill; and (4) the waste volume is large enough that its remediaton will significantly reduce the threat posed by the overall site.

CLOSURE REQUIREMENTS

Subtitle D

In the absence of Federal Subtitle D closure regulations, State Subtitle D closure requirements generally have governed CERCLA response actions at municipal landfills as applicable or relevant and appropriate requirements (ARARs). New Federal Subtitle D closure and post-closure care regulations will be in effect on October 9, 1993 (56 FR 50978 and 40 CFR 258)[1] State closure requirements that are ARARs and that are more stringent than the Federal requirements must be attained or waived

The new Federal regulations contain requirements related to construction and maintenance of the final cover, and leachate collection, ground-water monitoring, and gas monitoring systems. The __final cover__ regulations will be __applicable__ requirements for landfills that received household waste after October 9, 1991. EPA expects that the final cover requirements will be applicable to few, if any, CERCLA municipal landfills, since the receipt of household wastes ceased at most CERCLA landfills before October 1991. Rather, the substantive requirements of the new Subtitle D regulations generally will be considered __relevant and appropriate__ requirements for CERCLA response actions that occur after the effective date.

Subtitle C

RCRA Subtitle C closure requirements may be applicable or relevant and appropriate in certain circumstances. RCRA Subtitle C is __applicable__ if the landfill received waste that is a listed or characteristic waste under RCRA, __and:__

1. The waste was disposed of after November 19, 1980 (effective date of RCRA), or

[1] An extension of the effective date has been proposed but not finalized at this time.

2. The new response action constitutes disposal under RCRA (i.e., disposal back into the original landfill).[7]

The decision about whether a Subtitle C closure requirement is <u>relevant and appropriate</u> is based on a variety of factors, including the nature of the waste and its hazardous properties, the date on which it was disposed, and the nature of the requirement itself. For more information on RCRA Subtitle C closure requirements, see *RCRA ARARs: Focus on Closure Requirements* Directive No. 9234.2-04FS, October 1989.

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[7]Note that disposal of only small quantity hazardous waste and household hazardous waste does not make Subtitle C applicable.

Notice:

The policies set out in this document are intended solely as guidance to the U.S. Environmental Protection Agency (EPA) personnel; they are not final EPA actions and do not constitute rulemaking. These policies are not intended, nor can they be relied upon, to create any rights enforceable by any party in litigation with the United States. EPA officials may decide to follow the guidance provided in this document, or to act at variance with the guidance, based on an analysis of specific site circumstances. EPA also reserves the right to change the guidance at any time without public notice.

APPENDIX A
TECHNICAL BASIS FOR PRESUMPTIVE REMEDIES

This Appendix summaizes the analysis that EPA conducted of feasibilty study (FS) and Record of Decision (ROD) data from CERCLA municipal landfill sites which led to the establishment of containment as the presumptive remedy for these sites. The objectve of the study was to idenffy those technologies that are consistently included in the remedies selected, those that are consistently screened out, and to identify the basis for their elimination. Results of this analysis support the decision to eliminate the initial technology identification and screening steps on a site-specific basis for this site type. The technical review found that certain technologies are appropriately screened out based on effectiveness, implementability, or excessive costs.

The methodology for this analysis entailed reviewing the technology identification and screening components of the remedy selection process for a representative sample of municipal landfill sites. The number of times each technology was either screened out or selected in each remedy was compiled. A detailed discussion of the methodology used is provided below.

METHODOLOGY

<u>Identification of Sites for Feasibility Study Analysis</u>

Of the 230 municipal landfill sites on the NPL, 149 sites have had a remedy selected for at least one operable unit. Of the 149 sites, 30 were selected for this study on a random basis, or slightly greater than 20 percent. The sites range in size from 8.5 acres to over 200 acres and are located primarily in Regions 1,2,3, and 5. This geographical distribution approximates the distribution of municipal landfills on the NPL.

<u>Technology Secrning and Remedial Alternative Analysis</u>

The FS analysis involved a review of the technology identification and screening phase, including any pre-screening steps, followed by a review of the detailed analysis and comparative analysis phases. Information derived from each review was documented on site-specific data collection forms, which are available for evaluation as part of the Administrative Record for this presumptive remedy directive. The review focused on the landfill source contamination only; ground-water technologies and alternatives were not included in the analysis.

For the screening phase, the full range of technologies considered was listed on the data collection forms, along with the key reasons given for eliminating technologies from further consideration. These reasons were categorized according to the screening criteria: cost, effectiveness, or implementability. The frequency with which specific reasons were given for eliminating a technology from further consideration was then tallied and compiled into a screening phase summary table.

For the detailed analysis and comparative analysis, information on the relative performance of each technology/alternative with respect to the seven NCP criteria was documented on the site-specific data collection forms. The advantages and disadvantages associated with each clean-up option were highlighted. In some cases, a technology was combined with one or more technologies into one or more alternatives. The disadvantages of a technology/alternative were then compiled into a detailed analysis/comparative analysis summary table, under the assumption that these disadvantages contributed to non-selection. All summary tables are available for review as part of the Administrative Record.

APPENDIX A
TECHNICAL BASIS FOR PRESUMPTIVE REMEDIES (continued)

RESULTS

The information from the technology screening and remedial alternative analyses is provided in Table 1. It demonstrates that containment (the presumptive remedy), was chosen as a component of the selected remedy at all thirty of the sites analyzed. No other technologies or treatments were consistently selected as a remedy or retained for consideration in a remedial alternative. However, at eight of the thirty sites, there were circumstances where technologies were included in the selected remedy to address a site-specific concern, such as principal threat wastes. These technologies are included in the column entitled "Tech. Not Primary Component of Alternative"[1] in Table 1 and include incineration at two sites, waste removal and off-site disposal at two sites, soil vapor extraction at two sites, and bioreclamation at one site.

Leachate collection and gas collection systems were also tracked as part of the detailed analysis and comparison of remedial alternatives. These types of systems generally were not considered as remediation technologies during the screening phases. At fifteen sites, leachate collection was selected as part of the overall containment remedy. At seventeen sites, gas collection systems were selected as part of the overall containment remedy.

This analysis supports the decision to eliminate the initial technology identification and screening step for municipal landfill sites. On a site-specific basis, consideration of remediation technologies may be retained as needed.

[1] This column title is used for record-keeping purposes only and is not meant to imply that these treatment technologies are not considered important components of the selected remedies.

TABLE 1• SUMMARY OF SCREENING AND DETAILED ANALYSIS FOR LANDFILLS[1]

Technology[2]	# FSs Where Technology Considered	# FSs Tech. Passed Screening	# FSs Tech. Screened Out	Tech. Not Primary Component of Alternative	# FSs Where Criterion Contributed To Screening Out [3]: Cost	# FSs Where Criterion Contributed To Screening Out [3]: Effectiveness	# FSs Where Criterion Contributed To Screening Out [3]: Implement	# RODs Tech. Selected	# RODs Tech. Not Selected	#RODs Where Criterion Contributed to Non-Selection: Protect	ARARs	TMV Through Treatment	Long-term Effect.	Short-term Effect.	Cost	Implem.	State Concerns [4]	Community Concerns [4]
Multi-layer Cap	28	25	3	0	2	2	0	18	7	1	0	0	1	3	5	3	---	---
Clay Cap	16	8	8	0	1	8	0	4	4	2	2	1	2	1	0	1	---	---
Asphalt Cap	17	0	17	0	2	14	5	0	0	0	0	0	0	0	0	0	---	---
Concrete Cap	17	0	17	0	3	14	5	0	0	0	0	0	0	0	0	0	---	---
Soil Cover	16	7	5	4	0	5	1	5	2	1	0	0	0	0	0	0	---	---
Synthetic Cap	13	3	10	0	0	10	1	2	1	1	1	1	1	1	1	1	---	---
Chemical Seal	5	0	5	0	0	4	0	0	0	0	0	0	0	0	0	0	---	---
Slurry Wall	22	5	14	3	2	8	6	2	3	3	2	2	1	2	0	2	---	---
Grout Curtain	18	0	18	0	3	15	9	0	0	0	0	0	0	0	0	0	---	---
Sheet Piling	17	1	16	0	0	13	5	0	1	0	0	0	0	0	0	0	---	---
Grout Injection	8	0	8	0	0	8	2	0	0	0	0	0	0	0	0	0	---	---
Block Displacement	5	0	5	0	0	3	3	0	0	0	0	0	0	0	0	0	---	---
Bottom Sealing	5	0	5	0	0	3	4	0	0	0	0	0	0	0	0	0	---	---

TABLE 1• SUMMARY OF SCREENING AND DETAILED ANALYSIS FOR LANDFILLS[1]

TECHNOLOGY[2]	# FSs Where Technology Considered	# FSs Tech. Passed Screening	# FSs Tech. Screened Out	Tech. Not Primary Component of Alternative	# FSs Where Criterion Contributed To Screening Out[3]: Cost	Effectiveness	Implement	# RODs Tech. Selected	# RODs Tech. Not Selected	#RODs Where Criterion Contributed to Non-Selection: Protect	ARARs	TMV Through Treatment	Long-term Effect.	Short-term Effect.	Cost	Implem.	State Concerns[4]	Community Concerns[4]
Vibrating Beam	5	0	5	0	0	3	3	0	0	0	0	0	0	0	0	0	---	---
Liners	2	0	2	0	0	1	2	0	0	0	0	0	0	0	0	0	---	---
Offsite Nonhazardous Landfill	3	0	3	0	0	0	3	0	0	0	0	0	0	0	0	0	---	---
Offsite RCRA Landfill	17	0	13	4	8	3	12	0	0	0	0	0	0	0	0	0	---	---
Offsite Landfill (unspecified)	9	1	8	0	5	3	5	1	0	0	0	0	0	0	0	0	---	---
Onsite Nonhazardous Landfill	2	0	2	0	1	1	1	0	0	0	0	0	0	0	0	0	---	---
Onsite RCRA Landfill	14	1	11	2	3	2	10	0	1	0	0	0	0	0	0	1	---	---
Onsite Landfill (unspecified)	7	0	6	1	3	3	6	0	0	0	0	0	0	0	0	0	---	---
Bioremediation (unspecified)	13	0	13	0	0	13	1	0	0	0	0	0	0	0	0	0	---	---
Bioremediation Ex-situ	10	0	10	0	0	7	7	0	0	0	0	0	0	0	0	0	---	---
Bioremediation In-situ	15	1	14	0	1	13	7	1	0	0	0	0	0	0	0	0	---	---
Dechlorinization/ APEG	6	0	5	1	1	4	2	0	0	0	0	0	0	0	0	0	---	---
Oxidation/ Reduction	12	0	12	0	1	8	5	0	0	0	0	0	0	0	0	0	---	---

TABLE 1• SUMMARY OF SCREENING AND DETAILED ANALYSIS FOR LANDFILLS[1]

TECHNOLOGY[2]	# FSs Where Technology Considered	# FSs Tech. Passed Screening	# FSs Tech. Screened Out	Tech. Not Primary Component of Alternative	# FSs Where Criterion Contributed To Screening Out[3]: Cost	Effectiveness	Implement	# RODs Tech. Selected	# RODs Tech. Not Selected	#RODs Where Criterion Contributed to Non-Selection: Protect	ARARs	TMV Through Treatment	Long-term Effect.	Short-term Effect.	Cost	Implem.	State Concerns[4]	Community Concerns[4]
Neutralization	4	0	3	1	0	2	1	0	0	0	0	0	0	0	0	0	---	---
Thermal Destruction (unspecified)	6	0	6	0	0	3	4	0	0	0	0	0	0	0	0	0	---	---
Offsite Incineration (unspecified)	19	2	14	3	9	5	10	1	1	0	0	0	0	1	1	0	---	---
Onsite Incineration (unspecified)	12	0	8	3	5	5	6	0	1	0	0	0	0	1	1	1	---	---
Fluidized Bed	9	0	9	0	5	6	4	0	0	0	0	0	0	0	0	0	---	---
Infrared	8	0	7	1	6	3	3	0	0	0	0	0	0	0	0	0	---	---
Pyrolysis	5	2	3	1	2	2	1	0	1	0	1	0	0	1	1	1	---	---
Multiple Hearth	4	0	4	0	2	2	1	0	0	0	0	0	0	0	0	0	---	---
Rotary Kiln	10	0	9	1	6	5	4	0	0	0	0	0	0	0	0	0	---	---
Vitrification	21	0	21	0	8	15	11	0	0	0	0	0	0	0	0	0	---	---
Low Temperature Thermal Desorp/ Stripping	13	1	11	1	2	9	3	0	1	0	0	0	0	0	1	0	---	---
In-situ Steam Stripping	5	0	5	0	1	4	2	0	0	0	0	0	0	0	0	0	---	---
Soil Flushing	16	2	14	0	2	9	10	0	0	0	0	0	0	0	0	0	---	---

TABLE 1• SUMMARY OF SCREENING AND DETAILED ANALYSIS FOR LANDFILLS[1]

TECHNOLOGY[2]	# FSs Where Technology Considered	# FSs Tech. Passed Screening	# FSs Tech. Screened Out	Tech. Not Primary Component of Alternative	# FSs Where Criterion Contributed To Screening Out[3]: Cost	Effectiveness	Implement	# RODs Tech. Selected	# RODs Tech. Not Selected	#RODs Where Criterion Contributed to Non-Selection: Protect	ARARs	TMV Through Treatment	Long-term Effect.	Short-term Effect.	Cost	Implem.	State Concerns[4]	Community Concerns[4]
Soil Washing	12	2	9	1	1	8	6	0	0	0	0	0	0	0	0	0	---	---
Soil Vapor Extraction (SVE)	14	1	11	2	2	9	5	1	0	0	0	0	0	0	0	0	---	---
Fixation	7	1	5	1	0	4	2	2	0	0	0	0	0	0	0	0	---	---
Stabilization/ Solidification	20	0	19	2	1	13	6	0	0	0	0	0	0	0	0	0	---	---
Aeration	7	0	7	0	0	5	3	0	0	0	0	0	0	0	0	0	---	---

[1] The study was conducted on 30 RODs and their corresponding FSs.
[2] This does not include the no-action or institutional control only alternatives. No RODs selected either of these as remedies.
[3] FSs and RODs may contain more than one criterion for screening or non-selection of technology. Also, some FSs did not fully explain the criteria for screening out a technology. Thus, the totals for screening and non-selection criteria are not equal to the number of FSs and RODs considered.
[4] Information on State and community concerns was not included in this analysis because FSs do not contain this information and RODs generally only reference supporting documentation (i.e., State concurrence letter and responsiveness summary).

Attachment B:
A Guide to Principal Threat and Low Level Threat Wastes

United States Environmental Protection Agency
Office of Solid Waste and Emergency Response
Superfund Publication: 9380.3-06FS
November 1991

EPA

A Guide to Principal Threat and Low Level Threat Wastes

Office of Emergency and Remedial Response
Hazardous Site Control Division OS-220W

Quick Reference Fact Sheet

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) promulgated on March 8, 1990 states that EPA expects to use "treatment to address the principal threats posed by a site, wherever practicable" and "engineering controls, such as containment, for waste that poses a relatively low long-term threat." (40 CFR Section 300.430(a)(1)(iii).) These expectations, derived from the mandates of CERCLA §121 and based on previous Superfund experience, were developed as guidelines to communicate the types of remedies that the EPA generally anticipates to find appropriate for specific types of wastes. Although remedy selection decisions are ultimately site-specific determinations based on an analysis of remedial alternatives using the nine evaluation criteria, these expectations help to streamline and focus the remedial investigation/feasibility study (RI/FS) on appropriate waste management options. **This guide explains considerations that should be taken into account in categorizing waste for which treatment or containment generally will be suitable and provides definitions, examples, and ROD documentation requirements related to waste that constitute a principal or low level threat.** EPA makes this categorization of waste as principal or low level threat waste after deciding whether to take remedial action at a site. The "Interim Final Guidance on Preparing Superfund Decision Documents," (EPA/624/1-87/90, October 1990) and "A Guide to Developing Superfund Records of Decision" (Publication 9335.3-02FS-1, May 1990) provide additional information on ROD documentation.

NCP Expectations

EPA established general expectations in the NCP (40 CFR 300.430(a)(1)(iii)) to inform the public of the types of remedies that EPA has found to be appropriate for certain types of waste in the past and anticipates selecting in the future. These expectations (see Highlight 1) provide a means of sharing collected experience to guide the development of cleanup options. They reflect EPA's belief that certain source materials are addressed best through treatment because of technical limitations to the long-term reliability of containment technologies, or the serious consequences of exposure should a release occur. Conversely, these expectations also reflect the fact that other source materials can be safely contained and that treatment for all waste will not be appropriate or necessary to ensure protection of human health and the environment, nor cost effective.

Identifying Principal and Low Level Threat Wastes

The concept of principal threat waste and low level threat waste as developed by EPA in the NCP is to be applied on a site-specific basis when characterizing source material. "Source material" is defined as material that includes or contains hazardous substances, pollutants or contaminants that act as a reservoir for migration of contamination to ground water, to surface water, to air, or acts as a source for direct exposure.

HIGHLIGHT 1: NCP Expectations Involving Principal and Low Level Threat Wastes

EPA expects to:

1. Use treatment to address the principal threats posed by a site, wherever practicable.
2. Use engineering controls, such as containment, for wastes that pose a relatively low long-term threat or where treatment is impracticable.
3. Use a combination of methods, as appropriate, to achieve protection of human health and the environment. In appropriate site situations, treatment of principal threats posed by a site, with priority placed on treating waste that is liquid, highly toxic or highly mobile, will be combined with engineering controls (such as containment) and institutional controls, as appropriate, for treatment residuals and untreated waste.
4. Use institutional controls such as water use and deed restrictions to supplement engineering controls as appropriate for short- and long-term management to prevent or limit exposure to hazardous substances.

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Contaminated ground water generally is not considered to be a source material although non-aqueous phase liquids (NAPLs) may be viewed as source materials. The NCP establishes a different expectation for remediating contaminated ground water (i.e., to return usable ground waters to their beneficial uses in a time frame that is reasonable given the particular circumstances of the site). Examples of source and non-source materials are provided in Highlight 2.

> **HIGHLIGHT 2: Examples of Source and Non-Source Materials**
>
> **Source Materials**
>
> - Drummed wastes
> - Contaminated soil and debris
> - "Pools" of dense non-aqueous phase liquids (NAPLs) submerged beneath ground water or in fractured bedrock
> - NAPLs floating on ground water
> - Contaminated sediments and sludges
>
> **Non-Source Materials**
>
> - Ground water
> - Surface water
> - Residuals resulting from treatment of site materials

Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. They include liquids and other highly mobile materials (e.g., solvents) or materials having high concentrations of toxic compounds. No "threshold level" of toxicity/risk has been established to equate to "principal threat." However, where toxicity and mobility of source material combine to pose a potential risk of 10^{-3} or greater, generally treatment alternatives should be evaluated.

Low level threat wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of release. They include source materials that exhibit low toxicity, low mobility in the environment, or are near health-based levels.

Determinations as to whether a source material is a principal or low level threat waste should be based on the inherent toxicity as well as a consideration of the physical state of the material (e.g., liquid), the potential mobility of the wastes in the particular environmental setting, and the lability and degradation products of the material. However, this concept of principal and low level threat waste should not necessarily be equated with the risks posed by site contaminants via various exposure pathways. Although the characterization of some material as principal or low level threats takes into account toxicity (and is thus related to degree of risk posed assuming exposure occurs), characterizing a waste as a principal threat does not mean that the waste poses the primary risk at the site. For example, buried drums leaking solvents into ground water would be considered a principal threat waste, yet the primary risk at the site (assuming little or no direct contact threat) could be ingestion of contaminated ground water, which as discussed above is not considered to be a source material, and thus would not be categorized as a principal threat.

The identification of principal and low level threats is made on a site-specific basis. In some situations site wastes will not be readily classifiable as either a principal or low level threat waste, and thus no general expectations on how best to manage these source materials of moderate toxicity and mobility will necessarily apply. [NOTE: In these situations wastes do not have to be characterized as either one or the other. The principal threat/low level threat waste concept and the NCP expectations were established to help streamline and focus the remedy selection process, not as a mandatory waste classification requirement.]

> **HIGHLIGHT 3: Examples of Principal and Low Level Threat Wastes**
>
> Wastes that generally will be considered to constitute principal threats include, but are not limited to:
>
> - Liquids - waste contained in drums, lagoons or tanks, free product (NAPLs) floating on or under ground water (generally excluding ground water) containing contaminants of concern.
> - Mobile source material - surface soil or subsurface soil containing high concentrations of contaminants of concern that are (or potentially are) mobile due to wind entrainment, volatilization (e.g., VOCs), surface runoff, or sub-surface transport.
> - Highly-toxic source material - buried drummed non-liquid wastes, buried tanks containing non-liquid wastes, or soils containing significant concentrations of highly toxic materials.
>
> Waste that generally will be considered to constitute low level threat wastes include, but are not limited to:
>
> - Non-mobile contaminated source material of low to moderate toxicity - Surface soil containing contaminants of concern that generally are relatively immobile in air or ground water (i.e., non-liquid, low volatility, low leachability contaminants such as high molecular weight compounds) in the specific environmental setting.
> - Low toxicity source material - soil and subsurface soil concentrations not greatly above reference dose levels or that present an excess cancer risk near the acceptable risk range.

Examples of principal and low level threat wastes are provided in Highlight 3.

Risk Management Decisions fo. Principal and Low Level Threat Wastes

The categorization of source material as a principal threat or low level threat waste, and the expectations regarding the use of treatment and containment technologies follows the fundamental decision as to whether any remedial action is required at a site. These determinations, and the application of the expectations, serve as general guidelines and do not dictate the selection of a particular remedial alternative. For example, EPA's experience has demonstrated that highly mobile wastes (e.g., liquids) are difficult to reliably contain and thus generally need to be treated. As such, EPA expects alternatives developed to address highly mobile material to focus on treatment options rather that containment approaches.

However, as stated in the preamble to the NCP (55 FR at 8703, March 8, 1990), there may be situations where wastes identified as constituting a principal threat may be contained rather than treated due to difficulties in treating the wastes. Specific situations that may limit the use of treatment include:

- Treatment technologies are not technically feasible or are not available within a reasonable time frame;
- The extraordinary volume of materials or complexity of the site make implementation of treatment technologies impracticable;
- Implementation of a treatment-based remedy would result in greater overall risk to human health and the environment due to risks posed to workers or the surrounding community during implementation; or.
- Severe effects across environmental media resulting from implementation would occur.

Conversely, there may be situations where treatment will be selected for both principal threat wastes and low level threat wastes. For example, once a decision has been made to treat some wastes (e.g., in an onsite incinerator) economies of scale may make it cost effective to treat all materials including low level threat wastes to alleviate or minimize the need for engineering/institutional controls.

While these expectations may guide the development of appropriate alternatives, the fact that a remedy is consistent with the expectations does not constitute sufficient grounds for the selection of that remedial alternative. The selection of an appropriate waste management strategy is determined solely through the remedy selection process outlined in the NCP (i.e., all remedy selection decisions are site-specific and must be based on a comparative analysis of the alternatives using the nine criteria in accordance with the NCP). Independent of the expectations, selected remedies must be protective, ARAR-compliant, cost-effective, and use permanent solutions or treatment to the maximum extent practicable. Once the final remedy is selected, consistency with the NCP expectations should be discussed as part of the documented rationale for the decision.

ROD Documentation

Declaration

The "Description of the Selected Remedy" section should note whether the remedy is addressing any source materials that constitute "principal" or "low level" threat wastes, or both.

The "Statutory Determinations" section should discuss how the selected remedy satisfies the statutory preference stated in CERCLA §121 to select remedial actions "in which treatment which permanently and significantly reduces the volume, toxicity or mobility of the hazardous substances, pollutants, and contaminants is a principal element." In evaluating this statutory preference, the site manager needs to decide whether treatment selected in the ROD constitutes treatment as a major component of the remedy for that site. Remedies which involve treatment of principal threat wastes likely will satisfy the statutory preference for treatment as a principal element, although this will not necessarily be true in all cases (e.g., when principal threat wastes that are treated represent only a small fraction of the wastes managed through containment). Ground water treatment remedies also may satisfy the statutory preference, even though contaminated ground water is not considered a principal threat waste and even though principal threat source material may not be treated.

Decision Summary

The "Decision Summary" of the ROD should identify those source materials that have been identified as principal threat and/or low level threat wastes, and the basis for these designations. These designations should be provided in the "Summary of Site Characteristics" section as part of the discussion focusing on these source materials that pose or potentially pose a risk to human health and the environment. In addition, the "Description of Alternatives" and the "Selection of Remedy" sections should briefly note how principal and/or low level threat wastes that may have been identified are being managed.

The "Statutory Determinations" section of the ROD should include a discussion of how the statutory preference for treatment as a principal element is satisfied or explain why it is not satisfied, stating reasons in terms of the nine evaluation criteria.

NOTICE: The policies set out in this memorandum are intended solely as guidance. They are not intended, nor can they be relied upon, to create any rights enforceable by any party in litigation with the United States. EPA officials may decide to follow the guidance provided in this memorandum, or to act at variance with the guidance, based on an analysis of specific site circumstances. The Agency also reserves the right to change this guidance at any time without public notice.

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APPENDIX F

Cover Thickness Calculations

COVER THICKNESS CALCULATIONS

For the

Final Feasibility Study

Radiological-Impacted Material
Excavation Alternatives Analysis
West Lake Landfill Operable Unit-1

Prepared for
The United States Environmental Protection Agency Region VII

Prepared on behalf of
The West Lake Landfill OU-1 Respondents

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December 2016

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1 REQUIREMENTS DETERMINING COVER THICKNESS

This appendix reviews the basis for the cover design proposed for the three remedial alternatives that leave RIM in place and assesses the theoretical ability of those cover designs to attenuate radon emissions and gamma radiation. The five proposed alternatives listed in the Final Feasibility Study (FFS) are:

- **No Action Alternative –** Required by the National Contingency Plan (NCP) and RI/FS guidance to provide a baseline against which all of the other remedial alternatives are evaluated.
- **The 2008 Record of Decision (ROD)-Selected Remedy**: This remedy would require grading parts of Operable Unit 1 (OU-1) before leaving all radiological-impacted material (RIM) in place. In this remedy, OU-1 would be covered by an engineered cover.
- **Partial Excavation 1,000 pCi/g Alternative**: This remedial alternative would leave residual RIM containing less than 1,000 pCi/g of radium-226 + radium-228 or 1,000 pCi/g of thorium-232 + thorium-230 beneath an engineered cover.
- **Partial Excavation 52.9 pCi/g Alternative**: This remedial alternative would excavate all soil/waste containing combined radium (radium-226 plus radium-228) or combined thorium (thorium-230 plus thorium-232) with activity levels greater than 52.9 pCi/g down to a total depth of 16 feet beneath the 2005 topographic surface.
- **Full Excavation with Off-site Disposal Alternative**: This remedy involves the excavation of all soil containing more than 7.9 pCi/g of radium-226 + radium-228 or 7.9 pCi/g of thorium-232 + thorium-230 and installing an engineered cover over the remaining soil (the "complete rad removal" alternative).

Three of the remedial alternatives evaluated in this FFS involve leaving at least some of the RIM identified at OU-1 in place, and covering OU-1 with an enhanced cover that takes into consideration the presence of radionuclides.

The cover thicknesses of all four remedial alternatives are governed, in part, by the Missouri Department of Natural Resources (MDNR) Solid Waste Regulations and the Uranium Mill Tailings Radiation Control Act (UMTRCA). In particular, the final cover system designs should:

1. Consider the requirements of Missouri's 10 Code of State Regulations (CSR) 80-3.010, to the extent that such additional requirements do not compromise or diminish the performance of appropriate components of the UMTRCA regulations; and,
2. Provide assurance that the design will limit radon emissions consistent with the standards set forth in 40 Code of Federal Regulations (CFR) Part 192 – "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," as required by UMTRCA.

The “complete rad removal” remedial alternative involves the complete removal of the RIM from OU-1, eliminating the need for a radiological performance evaluation of its final configuration (Item 2, above).

The analysis described in this appendix first identifies the minimum thickness required to satisfy the MDNR Solid Waste regulations applicable to all remedial alternatives. The resulting MDNR cover and RIM configurations are then evaluated to determine if they will meet the UMTRCA design requirements.

1.1 MDNR DESIGN REQUIREMENTS FOR LANDFILL COVERS

The MDNR Solid Waste regulation 10 CSR 80-3.010(17)(C)(4)(A) is an applicable or relevant and appropriate requirement which mandates that the final cover of existing sanitary landfills without composite liners to include at least two feet (2’) of compacted clay with a coefficient of permeability of 1×10^{-05} centimeters per second) cm/s or less, and be overlaid by at least one foot (1’) of soil capable of sustaining vegetative growth.

Areas 1 and 2 are pre-existing landfills that do not have composite liners. The MDNR has requested the inclusion of a bio-intrusion layer be incorporated in any remedial alternative leaving residual RIM. To accommodate this request, a bio-intrusion layer of rock has been incorporated into the remedy designs of any alternative where RIM is left in place. This rock layer is included in the table of MDNR-based design criteria and discussed in more detail in the following section.

1.2 UMTRCA REQUIREMENTS

Standards for UMTRCA remedial cell performance have been established by the U.S. Environmental Protection Agency (EPA) in 40 CFR Part 192, Subpart A - Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites and Subpart B - Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites (collectively, the UMTRCA standards). These standards require that final cover designs limit exposures to radiation and radioactive materials, provide long-term stability, and require minimal maintenance to assure performance standards are met in the future. Control measures would be designed to be effective for up to 1,000 years (to the extent reasonably achievable) and, in any case, for at least 200 years.

The control measures must provide reasonable assurance that releases of radon-222 from residual radioactive material to the atmosphere will not exceed an average release rate of 20 picocuries per square meter per second ($pCi/m^2/s$) averaged over the entire disposal site and over a one-year period or increase the average concentration of radon-222 in air by more than 0.5 picoCuries per liter (pCi/L).

2 DESCRIPTION OF COVER DESIGNS EVALUATED

2.1 GEOMETRY OF COVER AND RIM USED IN SIMULATIONS

The physical dimensions of the cover layers effect both radon flux and gamma emissions from the ground surface. The thickness of the component layers that will make up the proposed final cover systems are listed in Table 1.

2.2 RADIOACTIVE SOURCE LAYER

The minimum cover thicknesses required to meet the UMTRCA standards (as stated above) is directly related to the concentrations of the radionuclides present within the RIM. Radioactive decay of some radionuclides and the subsequent in-growth of others is expected to change the concentrations of the radionuclides within the RIM during the evaluation period. This change must be quantitatively estimated in order to determine the cover thickness required during the period of maximum radioactivity. In particular, the concentration of radium-226 must be estimated before radon emanation or gamma shielding calculations can be made. Table 2 presents the concentrations of thorium-230 and radium-226 in Areas 1 and 2 at one year and 1,000 years after construction of a particular remedial alternative.

3 COVER PERFORMANCE EVALUATION

The updated Baseline Risk Assessment (BRA) (Auxier 2016), which represents the no action alternative, identified direct exposure to gamma radiation as the only viable exposure pathway from OU-1 producing hypothetical risks to receptors that exceed the risk range used by EPA at Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites. The ability of the different covers to reduce the amount of gamma radiation passing through them is therefore of interest when evaluating the long-term effectiveness of each assessed remedial alternative.

The updated BRA determined that modeled current and future radon exposures from OU-1 are not expected to result in risks to hypothetical receptors that exceed the CERCLA risk range. However, the effectiveness of each remedial alternative's cover in reducing radon flux levels has been estimated in this appendix to demonstrate compliance with the UMTRCA standard in Section 1.2.

3.1 PERFORMANCE COMPARED TO EXPOSURE RATE CONSTRAINTS

Exposure rates are influenced by time, distance and shielding. The values used to represent each of these parameters and the reasons for their selection are presented below:

Time: The exposure time used to estimate the exposure rates from OU-1 after construction of a given remedial alternative was 52.7 h/y (8.5 h/d x 6.2 d/y). This is the same exposure time used in the updated BRA (Auxier 2016) to describe the portion of time the reasonably maximally exposed (RME) individual, a grounds keeper, who spends time maintaining the surface of OU-1 each year.

Distance: Exposure rates are typically assessed at one meter above the ground's surface, and the exposure rates evaluated in this evaluation were all calculated at this height. This reflects the observation that the majority of the body's blood forming and filtering organs (marrow, liver and spleen) are typically located near this height in adult humans.

Shielding: In this case, shielding will be afforded by engineered covers placed over any residual RIM remaining within OU-1. The amount of shielding will depend on the thickness of those covers. The total thicknesses of the different covers are presented in Table 1. An aggregate density of 1.6 grams per cubic centimeter was used for all covers.

The exposure rates for the cover design evaluated were calculated using a computer program called MicroShield® produced by Grove Engineering. These calculations were performed as part of the human health risk assessment presented in Appendix H to the FFS. The exposure rates from that evaluation are reproduced in Table 3.

3.2 COVER PERFORMANCE COMPARED TO RADON-222 FLUX CONSTRAINTS

While some radon-222 gas (radon) produced by radioactive decay of radium-226 in soil are typically released to the atmosphere, recent radon flux measurements in OU-1 indicate radon fluxes from OU-1 currently meet UMTRCA standards. These fluxes can be further reduced by placing a cover over the radium-bearing materials. Such a cover will slow the escape of free radon, allowing its rapid decay rate[1] to deplete the amount of activity that reaches the surface. The percent reduction in radon emissions achieved by each remedial alternative's cover was calculated using the approach described in NUREG/CR-3533[2]. This handbook (NUREG/CR-3533) offers a set of one-dimensional, steady-state radon diffusion calculations to determine radon concentrations and fluxes in a multi-layer system. These equations form the basis of the computer program RAECOM (Radiation Attenuation Effectiveness and Cover Optimization with Moisture effects). A copy of this program has been modified to run as a web-based calculator.[3] The RAECOM web-based calculator requires user input that describes the physical and radiological characteristics of the source and overlying cover layers. Specific types of information required include:

- radon emanation coefficient of material in the source layer,
- porosity and moisture content of materials in the source and each layer of the cover (see Table 4), and
- thicknesses of the source layer and the overlying cover layers (see Table 1).

Site-specific values for many of these variables were not available when the 2011 Supplemental Feasibility Study (SFS) (EMSI 2011) was prepared. The calculations have been updated in this appendix using recently available data and field observations.

---

1 The half-life of radon-222 is 3.8 days (Kocher 1981). Only half of the produced radon-222 remains after 3.8 days. After 7.6 days, a quarter of the original radon-222 remains. Delaying its emergence by 30 days reduces the radon to just 0.4% of its original concentration.

2 "Radon Attenuation Handbook for Uranium-Mill Tailings Cover Design, NUREG/CR-3533." Battelle Pacific Northwest Labs., Richland, WA. April 1984.

3 The RAECOM web calculator used in this evaluation is hosted at http://www.wise-uranium.org/ctc.html.

3.2.1 Determination of Site-Specific Radon Emanation Coefficient

Most of the radon-222 produced by radium-226 in a particle of soil remains captured within that particle. A small fraction of the produced radon escapes into the void space surrounding the particle, and this radon emanation fraction is called the radon emanation coefficient in this evaluation. A site-specific value for this fraction was not determined in 2011, but it was assumed to be similar to uranium mill tailings based on its origin and processing history.

After submittal of the 2011 SFS, EPA Region 7 commissioned the Southwest Research Institute to perform radon emanation tests on six soil samples collected at the West Lake Landfill Site in Bridgeton, Missouri. In April 2016, Tetra Tech, Inc. submitted an analytical report produced by Southwest Research Institute and a Level IV Data Validation Report to EPA Region 7 containing radon emanation results from the six samples (Tetra Tech 2016). These six samples were exposed to a variety of thermal conditions where samples were heated to different temperatures for various durations and then subjected to radon-222 emanation tests. After careful homogenization, sample aliquots of approximately 50 grams were analyzed via gamma spectrometry (Tetra Tech 2016).

Radon emanation results from the six samples in the Southwest Research Institute and accompanying laboratory report are presented in Table 5, along with their associated statistics. Column headers in Table 5 include the thermal test conditions evaluated. The radon emanation results in the "None, As Received" column of Table 5 were selected to determine a representative radon emanation coefficient because the samples were not heated prior to analyses and therefore most closely resembled the "in-situ" condition of RIM in OU-1. The arithmetic mean of the emanation coefficients reported for the six unheated samples in the "None, As Received" column is 0.18, which is slightly less than the value of 0.2 used in the 2011 SFS. It is comparable to emanation coefficients reported in other studies (Sakoda, et al. 2011). The RAECOM default value for emanation fraction of 0.2 was used on all cover layers.

3.2.2 Porosity and Moisture Content of Soil

The values for soil porosity and percent moisture used to represent the source layer and various components of the cover layers required by the evaluated remedial alternatives are presented in Table 4. These are consistent with those used in the cover evaluations presented in the 2011 SFS, with one exception. The porosity of the source layer was reduced from the original value of 0.671 to 0.4 to reflect observations made in the field regarding the effect that more than 30 years of decomposition and settling has had on the municipal solid waste in the landfill.

3.2.3 Cover Thicknesses over RIM in Areas 1 and 2

The cover for the three remedial alternatives that leave some residual RIM in OU-1 is made up of three layers: soil, clay, and rock; while the cover in the "complete rad removal" alternative is thinner and composed only of soil and clay. Table 1 lists the dimensions of these covers and their component layers.

3.2.4 Reduction in Radon Fluxes as Calculated Using NUREG/CR-3533 (RAECOM)

The radon attenuation characteristics of the cover design described in the previous subsection was evaluated for the RIM in Areas 1 and 2 using a source layer concentration of 1 pCi/g. Using 1 pCi/g will provide a unit value that can be used to test the effectiveness of the cover. The percent reduction of radon flux can then be applied to existing measured radon flux values. The percent reduction of radon flux is listed as the last line of the output file. For these simulations, the average thickness of the RIM layer of 1.3 meters (m) in Area 1 and 2.2 m in Area 2 were taken from Section 6.4 of the RI Addendum (EMSI 2016).

The outputs from these simulations are reproduced in Figure 1 and Figure 2. In these figures, the case name and case-specific input values are listed at the top of each output file and the results of the calculations for the different layers follow the input values.

3.3 MEASURED RADON FLUXES FROM THE BARE SURFACE OF OU-1

In June 2016, radon flux was measured at 124 locations within OU-1, including 35 positions within Area 1 and 76 positions within Area 2.[4] Section 4.13.2.3 of the Remedial Investigation Addendum (RI) (EMSI 2016) contains a description of the collection of the 2016 radon measurements and Section 7.1.1.1 of the RI for a full discussion of the results. Table 6 contains summary statistics for the analytical results, in units of activity flux ($pCi/m^2/s$), as reported by a Multi-Agency Radiological Laboratory Analytical Protocol (MARLAP) compliant analytical lab (Eberline Services). Radon was detected in 68 of the 124 samples collected in 2016. Fluxes ranged from 0 to 1.5 $pCi/m^2/s$, with an arithmetic mean value of approximately 0.06 $pCi/m^2/s$, which is far below the UMTRCA standard of 20 $pCi/m^2/s$.

[4] Thirteen additional, duplicate samples were collected for QA purposes, bringing the total to 124 locations.

3.4 CALCULATION OF RADON FLUXES THROUGH THE COVER AFTER 1,000 YEARS

The maximum theoretical radon fluxes in the first 1,000 years were estimated by dividing the 95% UCL radon fluxes for Areas 1 and 2 (Q), in pCi/m^2/s by the concentrations of radium-226 in Area 1 and 2 soils (C). These ratios of flux per unit of activity were then used to estimate the radon emission from an uncovered source layer in the future assuming radium ingrowth had occurred:

$$Q_{Rn222,1000y,uncovered}\left(\frac{pCi}{m^2 \cdot s}\right) = C_{Ra226,1000y}\left(\frac{pCi}{g}\right) \times \frac{Q_{Rn222,current}\left(\frac{pCi}{m^2 \cdot s}\right)}{C_{Ra226,current}\left(\frac{pCi}{g}\right)}$$

The reduction of radon flux produced by the cover was then calculated using the estimated radon flux in the future and the percent reduction in radon flux as calculated using RAECOM as described in Section 3.2.4:

$$Q_{Rn222,1000y,covered}\left(\frac{pCi}{m^2 \cdot s}\right) = Q_{Rn222,1000y,uncovered}\left(\frac{pCi}{m^2 \cdot s}\right) \times \left(1 - \frac{\%Reduction}{100\%}\right)$$

The results of these calculations are summarized in Table 3. The results indicate that the cover for the three proposed remedial alternatives that leave RIM in place is sufficient to meet the 20 pCi/m^2/s radon flux UMTRCA standard for the RIM in OU-1.

3.5 SUMMARY

The cover proposed as part of the remedial alternatives where RIM is left in place and assessed in this Appendix meet the design requirements of 10 CSR 80-3.010(17)(C)(4)(A). In addition, the cover's ability to attenuate radon flux from any residual RIM left by a particular remedial alternative meets the performance requirements of 40 CFR 192 (UMTRCA).

4 REFERENCES

10 CSR Part 80	Title 10 Code of State Regulations Division 80 – "Solid Waste Management," State of Missouri, Department of Natural Resources, 2001.
40 CFR Part 192	Title 40 Code of Federal Regulations Part 192 – "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," 2016.
Auxier 2016	"Updated Baseline Risk Assessment," prepared for West Lake OU-1 Respondents Group, prepared by Auxier & Associates, Inc., October 2016.
EMSI 2011	"Supplemental Feasibility Study, Radiological-Impacted Material, Excavation Alternatives Analysis, West Lake Landfill Operable Unit-1," prepared for The United States Environmental Protection Agency Region VII, prepared on behalf of The West Lake Landfill OU-1 Respondents, Prepared by Engineering Management Support, Inc.
EMSI 2016	"Remedial Investigation Addendum, West Lake Landfill Operable Unit 1," prepared for West Lake OU-1 Respondents Group, prepared by Engineering Management Support, Inc., July 2016.
EPA 1994	U.S. Environmental Protection Agency, EPA/600/R-94/168a. Schroeder, P. R., Dozier, T.S., Zappi, P. A., McEnroe, B. M., Sjostrom, J. W., and Peyton, R. L. "The Hydrologic Evaluation of Landfill Performance (HELP) Model: Engineering Documentation for Version 3," September 1994, U.S. EPA Office of Research and Development, Washington, DC.
EPA 2003	U.S. Environmental Protection Agency, EPA-456/R-03-007. Alexander, Amy, "Example Moisture Mass Balance Calculations for Bioreactor Landfills," December 2003, U.S. EPA Office of Air Quality Planning and Standards, Research Triangle Park, NC.
Kocher 1981	David C. Kocher, "Radioactive Decay Data Tables, A Handbook for Application to Radiation Dosimetry and Radiological Assessments." Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, TN, 1981.

NUREG/CR-3533 "Radon Attenuation Handbook for Uranium-Mill Tailings Cover Design, NUREG/CR-3533," Battelle Pacific Northwest Labs, Richland, WA. April 1984.

Sakoda, et al. 2011 A. Sakoda, Y. Ishimori, K. Yamaoka, "A Comprehensive Review of Radon Emanation Measurements for Mineral, Rock, Soil, Mill Tailing and Fly Ash," Applied Radiation and Isotopes, 69 (2011), pp. 1422–1435.

Tetra Tech 2016 "Radon Emanation Coefficient Study, West Lake Landfill Site, Bridgeton, Missouri," EPA Region 7, START 4, Contract No. EP-S7-13-06, Task Order No. 0007, Submitted as attachment to a July 13, 2016 letter from Robert Monnig and Ted Faile to Bradley Vann (EPA).

Table 1 Design Cover Thickness

Remedial Alternative	Rock Layer (m)	Clay Cap (m)	Top Soil (m)	Total Thickness (m)
ROD-Selected Remedy	0.6	0.6	0.3	1.5
Residual RIM < 1,000 pCi/g	0.6	0.6	0.3	1.5
Residual RIM < 52.9 pCi/g	0.6	0.6	0.3	1.5
Residual RIM < 7.9 pCi/g [a]		0.6	0.3	0.9

[a] UMTRCA compliance not assessed for cover configuration proposed for the "complete rad removal" alternative.

Table 2 One Year and 1,000 Year Inventories for Thorium-230 and Radium-226 for the Remedial Alternatives Leaving Residual RIM

Remedial Alternative / Location	Th-230 Conc. in First Year (pCi/g) [a]	Ra-226 Conc. in First Year (pCi/g) [a]	Th-230 Conc. at 1,000 y (pCi/g) [b]	Ra-226 Conc. at 1,000 y pCi/g [c]
ROD-Selected Remedy				
Area 1	1,464	247	1,451	672
Area 2	4,732	395	4,690	1,910
Residual RIM < 1,000 pCi/g				
Area 1	1000	167	991	459
Area 2	1000	83.5	991	404
Residual RIM < 52.9 pCi/g				
Area 1	52.9	8.93	52	24
Area 2	52.9	4.42	52	21

[a] First year concentrations in Areas 1 and 2 are the 95% UCL on the arithmetic mean values listed as "All Depths" in Tables 18 and 19 in the updated BRA (Auxier 2016).

[b] Slight reduction (<1%) due to radioactive decay. Th-230 at 1,000y = Initial_Th-230(pCi/g) x EXP[-Lambda_Th(0.000009002/y) x Time(1000y)]

[c] Ra-226 at 1,000y = {Initial_Ra-226(pCi/g) x EXP[-Lambda_Ra(0.0004327/y) x Time(1000y)]} + {[Lambda_Ra(0.0004327/y) x Initial_Th-230(pCi/g)] / [Lambda_Ra(0.0004327/y) - Lambda_Th(0.000009002/y)]} x {EXP[-Lambda_Th(0.000009002/y) x Time(1000y)] - EXP[-Lambda_Ra(0.0004327/y) x Time(1000y)])}

[d] Radium-226 assumed to remain in equilibrium with thorium-232 to simplify analysis and Ra-226 at 1,000y was assumed to equal the Th-230(pCi/g) at 1000y.

Table 3 Summary of Cover Effectiveness in Reducing Radon Flux and Gamma Emissions

Remedial Alternative Area	Ra-226 (pCi/g)	Uncovered Radon Flux ($pCi/m^2/s$) [b]	Radon Flux Reduction by Cover (%)	Radon Flux ($pCi/m^2/s$)	Exposure Rate (mrem/h)
No Action (Baseline Conditions) - Current					
Area 1	247	0.08	no cover	< 1	
Area 2	395	0.19	no cover	< 1	
ROD-Selected Remedy at 1,000 y					
Area 1	672	0.21	99.72 [a]	< 1	< 1 [c]
Area 2	1,910	0.90	99.72 [a]	< 1	< 1 [c]
Removal of RIM > 1,000 pCi/g at 1,000 y					
Area 1	459	0.15	99.72 [a]	< 1	< 1 [c]
Area 2	404	0.19	99.72 [a]	< 1	< 1 [c]
Removal of RIM > 52.9 pCi/g at 1,000 y					
Area 1	24	0.0076	99.72 [a]	< 1	< 1 [c]
Area 2	21	0.0099	99.72 [a]	< 1	< 1 [c]

[a] See Section 3.4.

[b] Field data collected by Auxier & Associates, Inc., June 2016.

[c] Appendix H.

Table 4 Moisture and Porosity of RIM/Cover Materials Used in Cover Optimization Calculations

Parameter	Value	Units	Reference
Municipal solid waste porosity	0.4	none	RI Fate and Transport Analysis (Groundwater Fate and Transport, Appendix I of EMSI 2016)
Municipal solid waste moisture content	25	%	EPA-456/R-03-007[1], pg 6
Rock layer porosity	0.397	none	EPA/600/R-94/168a[2], Table 4, HELP soil texture class 21
Rock layer moisture content	0.8	%	EPA/600/R-94/168a, Table 4, HELP soil texture class 21, Soil Solid Density = 2.7, at wilting point
Clay layer porosity	0.427	none	EPA/600/R-94/168a, Table 4, HELP soil texture class 16
Clay layer moisture content	23.7	%	EPA/600/R-94/168a, Table 4, HELP soil texture class 16, Soil Solid Density = 2.7, at saturation
Top soil porosity	0.419	none	EPA/600/R-94/168a, Table 4, HELP soil texture class 22
Top soil moisture content	11.5	%	EPA/600/R-94/168a, Table 4, HELP soil texture class 22, Soil Solid Density = 2.7, at wilting point

1 EPA-456/R-03-007. Alexander, Amy, “Example Moisture Mass Balance Calculations for Bioreactor Landfills” December 2003, U.S. EPA Office of Air Quality Planning and Standards, Research Triangle Park, NC.

2 EPA/600/R-94/168a. Schroeder, P. R., Dozier, T.S., Zappi, P. A., McEnroe, B. M., Sjostrom, J. W., and Peyton, R. L. "The Hydrologic Evaluation of Landfill Performance (HELP) Model: Engineering Documentation for Version 3," September 1994, U.S. EPA Office of Research and Development, Washington, DC.

Table 5 Radon Emanation Fractions from OU-1 Soils from Southwest Research Institute

	Test Condition								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Customer Sample ID	**None, As Received**	**105° for 16 hours As Found**	**250° for 16 hours As Found**	**250° for 48 hours As Found**	**250° for 48 hours As Received**	**250° for 48 hours 10% Moisture**	**No Drying m = Saturated**	**60° until moisture ≤ 2%**	**60° until moisture ≤ 10 %**
WL-234CT	0.136	0.0547	0.0435	0.0287	0.0907	0.0894	0.126	0.0235	0.107
1D7-84-85	0.14	0.0514	0.0411	0.0366	0.0898	0.134	0.134	0.0712	0.0541
A1-AC-1	0.128	0.0383	0.0452	0.033	0.131	0.12	0.118	0.0716	0.0989
A1-AC-3	0.14	0.0525	0.0459	0.0435	0.164	0.139	0.161	0.0654	0.143
A2-S1	0.0664	0.0519	0.0306	0.044	0.141	0.139	0.146	0.0628	0.121
A2-AC-21	0.473	0.228	0.124	0.13	0.376	0.336	0.358	0.149	0.391
1D7-84-85 (DUP) [a]	0.138		0.042		0.171			0.0623	
A2-S1 (DUP)		0.0517		0.0499		0.0619	0.141		
Stats, Excluding Dups									
number	6	6	6	6	6	6	6	6	6
min	0.07	0.04	0.03	0.03	0.09	0.09	0.12	0.02	0.05
max	0.47	0.23	0.12	0.13	0.38	0.34	0.36	0.15	0.39
median	0.14	0.05	0.04	0.04	0.14	0.14	0.14	0.07	0.11
average	**0.18**	0.08	0.06	0.05	0.17	0.16	0.17	0.07	0.15
standard deviation	0.15	0.07	0.03	0.04	0.11	0.09	0.09	0.04	0.12
geometric mean	0.15 [a]	0.06	0.05	0.05	0.14	0.15	0.16	0.06	0.13

[a] Duplicates presented for completeness.

[b] Agrees with values reported for tailings as reported by Sakoda, et al. 2011.

Table 6 Summary of Radon Flux Measurements Collected in June 2016 on OU-1

Stat	Area 1	Area 2	OU-1	Units
Detection Frequency	26 / 35	37 / 76	63 / 111	measurements
Range Reported Values	-0.006 to 0.198	-0.032 to 1.506	-0.032 to 1.506	$pCi/m^2/s$
Arith mean	0.064	0.064	0.064	$pCi/m^2/s$
StDev	0.049	0.172	0.145	$pCi/m^2/s$
Arith mean + 2 StDev	0.16	0.41	0.35	$pCi/m^2/s$
95% UCL [a]	**0.08**	**0.19**	**0.15**	**$pCi/m^2/s$**

[a] Calculated using ProUCL as described in the updated BRA (Auxier2016)

```
Area 1 All Alternatives Leaving RIM in Place
----------------  Input Parameters  ----------------

 Number of Layers:  4
 Radon Flux into Layer 1:  0 pCi/m2s
 Surface Radon Concentration:  0 pCi/L

 Layer 1 exceeds saturation:
      Moisture changed from 25 to 24.44 dry wt_%
 Bare Source Flux (Jo) from Layer 1:  0.016 pCi/m2s
 Specific Bare Source Flux from Layer 1:  0.016 pCi/m2s per pCi_Ra-226/g

Layer Thickness  Ra-226   Emanat  Porosity  Moisture  Diff Coeff
 No.     [m]     [pCi/g]  Fract            [dry wt_%]  [m2/s]
  1    1.3       1        0.18     0.4       24.44     1.407E-9
  2    0.6       0        0.2      0.397     0.8       4.038E-6
  3    0.6       0        0.2      0.427     23.7      46.58E-9
  4    0.3       0        0.2      0.419     11.5      1.496E-6


--------  Results of Radon Diffusion Calculation  --------

Layer  Thickness   Exit Flux  Exit Conc.     MIC
 No.      [m]      [pCi/m2s]   [pCi/L]
  1     1.3         0.016       8.384E0     0.267
  2     0.6         0.001       27.45E0     0.976
  3     0.6         0.000       11.61E-3    0.365
  4     0.3         0.000       0E0         0.681

Total cover radon retention: 99.72%
```

Figure 1 RAECOM Calculator Output File: Remedial Alternatives Leaving RIM in Area 1

Note: Box around radon retention added.

```
Area 2 All Alternatives Leaving RIM in Place
----------------  Input Parameters  ----------------

 Number of Layers:  4
 Radon Flux into Layer 1:  0 pCi/m2s
 Surface Radon Concentration:  0 pCi/L

 Layer 1 exceeds saturation:
      Moisture changed from 25 to 24.44 dry wt_%
 Bare Source Flux (Jo) from Layer 1:  0.016 pCi/m2s
 Specific Bare Source Flux from Layer 1:  0.016 pCi/m2s per pCi_Ra-226/g

Layer Thickness  Ra-226   Emanat  Porosity  Moisture  Diff Coeff
 No.     [m]     [pCi/g]  Fract            [dry wt_%]  [m2/s]
  1    2.2       1        0.18     0.4       24.44     1.407E-9
  2    0.6       0        0.2      0.397     0.8       4.038E-6
  3    0.6       0        0.2      0.427     23.7      46.58E-9
  4    0.3       0        0.2      0.419     11.5      1.496E-6


--------  Results of Radon Diffusion Calculation  --------

Layer  Thickness   Exit Flux  Exit Conc.     MIC
 No.      [m]      [pCi/m2s]   [pCi/L]
  1     2.2         0.016       8.384E0     0.267
  2     0.6         0.001       27.45E0     0.976
  3     0.6         0.000       11.61E-3    0.365
  4     0.3         0.000       0E0         0.681

Total cover radon retention: 99.72%
```

Figure 2 RAECOM Calculator Output File: Remedial Alternatives Leaving RIM in Area 2

Note: Box around cover exit flux added for clarity.

APPENDIX G

Conceptual Bases for Costs of Occupational and Environmental Monitoring Associated with Each Remedial Alternative

West Lake Landfill OU-1
Supplemental Feasibility Study

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December 2016

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List of Acronyms

DOT	U.S. Department of Transportation
dpm	atomic disintegrations per minute
EMSI	Engineering Management Support, Inc.
FFS	Final Feasibility Study
ft	feet
LAACC	Large Area Activated Charcoal Canisters
LEL	lower explosive limit
MCL	Maximum Contaminant Level
MDNR	Missouri Department of Natural Resources
m^2	square meter
µCi/mL	microCuries per milliliter
NCP	National Contingency Plan
NESHAPs	National Emission Standards for Hazardous Air Pollutants
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PPE	Personal Protective Equipment
QA	quality assurance
QC	quality control
RIM	radiologically-impacted materials
ROD	Record of Decision
SWMP	Solid Waste Management Program
SVOC	semi-volatile organic compound
TOC	total organic carbon
µg	microgram
UMTRCA	Uranium Mill Tailings Radiation Control Act
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

1 INTRODUCTION

The West Lake Landfill OU-1 Superfund Site (the Site) is a former solid waste landfill that consists of various contiguous and discrete areas historically used for disposal of municipal solid wastes and construction and demolition debris. During past operations at the Site, radiologically-impacted materials (RIM) were placed in two areas (now known as Area 1 and Area 2). The Site also includes the Buffer Zone/Crossroads property. No occupied structures are currently located on Areas 1 and 2.

Land use surrounding the Site is primarily commercial and industrial. A small population of individuals works in the area primarily during the daytime. A few occupied buildings are currently located on the Site, and the Spanish Village residential subdivision is located less than a mile to the south of Area 1 (Figure 1-1).

EPA determined that additional work is necessary to accomplish the objectives of the Remedial Investigation/Feasibility Study (RI/FS) for the OU-1 of the West Lake Landfill. Specifically, Region 7's Statement of Work (SOW) for the RI Addendum and Final Feasibility Study (FFS) identifies the following five alternatives:

> **No Action Alternative–** Required by the National Contingency Plan (NCP) and RI/FS guidance to provide a baseline against which all of the other alternatives are evaluated[1]. This alternative is considered the baseline condition, and theoretical risks associated with this alternative are discussed in detail in the updated Baseline Risk Assessment (BRA) (Auxier 2016);
>
> **Partial Excavation 1,000 pCi/g Alternative –** Excavation of all soil/waste containing combined radium (radium-226 plus radium-228) or combined thorium (thorium-230 plus thorium-232) with activity levels greater than 1,000 pCi/g[2];
>
> **Partial Excavation 52.9 pCi/g Alternative–** Excavation of all soil/waste containing combined radium (radium-226 plus radium-228) or combined thorium (thorium 230 plus thorium-232) with activity levels greater than 52.9 pCi/g down to a total depth of 16 feet beneath the 2005 topographic surface;

---

[1] The SOW identifies an alternative no. 3 "Leaving all RIM in place on-site." Subsequent discussions with EPA indicated that this alternative was the No Action Alternative.

[2] In all cases evaluated in the baseline, thorium-230 and radium-226 (plus decay products) accounted for more than 95% of the risk to the target receptors. Other radionuclides are co-located with radium-226 and thorium-230 and are projected to produce risks to the future groundskeeper of $< 10^{-7}$. Remediation of the thorium-230 and radium-226, by themselves, would reduce the total risks from RIM to below 10^{-4}. Any remediation of radium-226 and thorium-226 would also lower the negligible risks from these ancillary radionuclides still further.

Full Excavation with Off-site Disposal Alternative – Excavation of all soil/waste containing combined radium (radium-226 plus radium-228) or combined thorium (thorium-230 plus thorium-232) with activity levels greater than 7.9 pCi/g (the "complete rad removal" alternative); and

2008 ROD-Selected Remedy – A containment remedy that consists of regrading and installation of a new landfill cover and other remedial components for Area 1 and 2, as well as the consolidation of any radiologically-impacted soil that may remain on the former Ford property (now known as the Buffer Zone and Crossroad Lot 2A2) into the containment areas in Area 1 and 2 prior to placement of additional fill and construction of the new landfill cover.

Each of these alternatives would include monitoring activities that would be performed both during and after construction. This Appendix G was prepared only for purposes of developing cost estimates for the FFS. Therefore, the exact scope and detailed plans of this monitoring would be developed as part of the alternative design effort, but a generic, preliminary description of the scope of potential monitoring activities is necessary to assess the anticipated effectiveness of a monitoring system, as well as to provide the bases for estimated monitoring costs. Actual monitoring networks, locations, analytical parameters, specific instrumentation, and sampling frequencies would be determined during remedial design (RD) of the EPA-selected alternative.

Monitoring activities associated with the four remedial alternatives were divided into three groups for this evaluation: pre-construction baseline monitoring, monitoring activities with a limited duration that would be performed during construction (short-term monitoring), and longer duration monitoring activities performed after alternative construction is complete (long-term monitoring). These three groups of monitoring activities are discussed separately in this evaluation.

The remainder of this Appendix provides a description of the monitoring systems proposed for each alternative. Section 2 contains a description of the pre-construction baseline environmental monitoring program. Section 3 provides a description of short-term monitoring during construction. Section 4 presents a description of the long-term monitoring systems. Section 5 provides a summary of monitoring activities and systems for each alternative.

2 PRE-CONSTRUCTION BASELINE AIR MONITORING

An integrated system of 13 air monitoring stations has been installed at the Site in accordance with EPA guidance. Air monitoring activities began in May 2015 and continue to date. The purpose of the air monitoring program is to provide baseline data regarding air quality prior to implementation of remedial actions. Ultimately, baseline data will be compared to future data obtained during implementation of remedial actions to assess whether such actions contribute to any release of radionuclides or volatile organic compound (VOCs). Twelve of these stations are located around the perimeters of Areas 1 and 2, with two located close to the nearest onsite buildings (the landfill office and the transfer station building). The thirteenth station is located in the southwest corner of the Site, the farthest distance onsite from Areas 1 and 2. These 13 locations were selected to ensure that the monitoring network encompassed Areas 1 and 2, including the Site entrance road and the road through the center of the Site (see Figure 2-1).

An on-site meteorological station (the "met station") measures and logs temperature, barometric pressure, relative humidity, wind speed and direction. The station is located adjacent to the landfill office building (13570 St. Charles Rock Road). Details regarding both the configuration and installation of the air monitoring stations and met station can be found in the RI Addendum and EPA-approved Air Monitoring, Sampling, and QA/QC Plan (EMSI 2016 and A&A 2014).

The monitoring network shown in Figure 2-1 provides coverage around Areas 1 and 2 under all wind direction conditions. The air monitoring and sampling locations near the center of the Site are arranged in a broad line oriented approximately southeast to northwest and parallel to the predominant wind directions. Additional stations are located transverse to this orientation, parallel to the less dominant southwest and northeast wind directions. Stations A1-A6 and A9 bound the perimeter of Area 2. Stations A5, A7, A8, A10 and 11 bound Area 1. Station 12 is located at the southern boundary of the North Quarry pit area. Station A13 is at the southern boundary of the South Quarry pit area, and is located upwind of Areas 1 and 2 (A&A 2014).

Table 2-1 lists the types and quantities of environmental monitoring equipment for the different monitoring stations depicted in Figure 2-1. The table also lists the COPCs measured by the equipment housed at each station.

The sampling and sensor equipment in each monitoring station enclosure operates continuously. The equipment in these stations consists of a high volume air sampler for airborne particulates, a continuous radon monitor (alpha track etch), and an environmental radiation detector called a thermoluminescent dosimeter (TLD). Alpha track etch monitors provide a cumulative measure of radon gas present and allow determination of average radon levels for the sampling period. TLDs measure ambient gamma radiation levels.

Particulates gathered on air sample filters are collected every four weeks (28 days) and analyzed for alpha and beta emitters. Radiation dosimeters and alpha track etch detectors are exchanged and sent for analysis every calendar quarter.

Five of the monitoring stations house continuous passive samplers to monitor for VOCs. VOC monitoring is performed using the Radiello RAD130 chemical adsorbing cartridge diffusion samplers that are left in place for a period of 14 days. The Radiello RAD130 cartridges consist of a stainless steel net cylinder with 100 mesh grid openings and a 5.8 mm diameter, packed with approximately 530 milligrams of activated charcoal. VOCs are trapped by adsorption and recovered by carbon disulfide displacement.

A summary of the types of measurements and frequency is shown in Table 2-2. A summary of the results can be found in the air monitoring quarterly reports (A&A 2015-2016).

3 SHORT-TERM MONITORING

Short-term monitoring activities that would be performed during construction of the alternatives were divided into two categories for this evaluation: (1) health-based monitoring and (2) remediation control monitoring. Data quality objectives are different for each category of short-term monitoring activity. Health-based monitoring activities would be designed to evaluate potential human exposures during construction of a given alternative. Remediation control monitoring would be designed to guide the construction contractor during excavation of the RIM, to ensure that equipment and materials remain free of residual radioactive materials, to characterize excavated material prior to transport and disposal, and to perform final status surveys. Both of these categories of monitoring and survey activities would be limited to the period of construction and are therefore called "short-term monitoring" in this evaluation. Health-based monitoring activities will mirror the EPA-approved monitoring activities performed during Phase I investigations. Plans for these activities will be developed during remedial design and will include procedures for data validation, recordkeeping and QA/QC.

In addition to the short-term monitoring program descriptions, this section also includes a discussion regarding the utility of providing an onsite radiological analytical laboratory for the partial or full excavation alternatives.

3.1 Short-Term Health-Based Monitoring

Potential emissions that might affect the health of workers or the public would be monitored using a combination of fixed and mobile monitors. After potential emissions, exposures, and receptors associated with construction of each alternative were identified, the type and number of fixed and mobile monitors were estimated for each alternative.

Among all four of the remedial alternatives, RIM would be encountered in the same locations in Areas 1 and 2 and similar general construction techniques would be used (See Appendix B). Similar emissions and types of exposure pathways would be produced during construction of all four remedial alternatives. Therefore, the same types of emissions and exposures would be measured by the short-term monitoring programs for all four remedial alternatives. The major difference in monitoring among the four remedial alternatives would be relative differences in the alternative construction duration and resulting magnitude of emissions and exposures that might be generated during implementation of the different alternatives. For example, workers would be required to be in close proximity to the RIM at some point during excavation and/or grading operations for each alternative. While the potential exposure pathways would be the same for each alternative, the amount of time spent near the RIM and the degree to which the RIM would be disturbed would vary. For the ROD-selected remedy, the amount of time spent near the RIM and the degree to which the RIM would be disturbed would be minimal. The amount of time spent near the RIM and the degree to which the RIM would be disturbed would be significant for the two "partial excavation" alternatives. The "complete rad removal" alternative would result in the highest disturbance and amount of time spent near the RIM (See Appendix H).

An evaluation of populations in the area concluded that during construction, each of the four remedial alternatives had the potential to impact similar groups and types of receptors. One group of potential receptors common to all alternatives is remediation workers. Remediation workers could potentially encounter RIM directly or indirectly as part of their duties and would be subject to the project medical monitoring and health and safety programs. A second group of potential receptors common to all alternatives is members of the public (i.e., workers in nearby businesses, Site visitors, and off-property residents) (see Appendix H).

Table 3-1 contains a list of potential exposure pathways and receptors considered for the remedial alternatives. These short-term exposures and associated monitoring efforts are grouped by the program under which they would likely be monitored - either the Occupational Health and Safety Program or the Environmental Monitoring Program. The list of receptors and the types and nature of potential exposures discussed in this Appendix is based on current knowledge of the Site and may change in response to additional information collected during remedial design or construction (see Appendix H).

3.1.1 Health-Based Monitoring During Construction of ROD-Selected Remedy

During construction of the ROD-selected remedy, it is anticipated that most of the RIM would remain covered throughout the construction phase. A smaller volume of radiologically-impacted soil is anticipated to be relocated from the Buffer Zone/Crossroad Property to Area 2. Additionally, some RIM located near the surface of Areas 1 and 2 might be disturbed during cut-and-fill activities associated with regrading of Areas 1 and 2 to achieve final surface slopes. Direct contact with exposed RIM would be expected to be limited to remediation workers in a few areas.

Remediation workers might walk over or operate equipment on the RIM during construction of the ROD-selected remedy, but most of the RIM would remain covered so repeated contact during construction is expected to be limited. Some remediation workers performing activities close to the RIM may encounter elevated radiation levels. Radiation survey technicians and other health and safety personnel would be expected to spend the most time near the RIM and therefore have the greatest risk for exposure. Because only a minimal volume of RIM is anticipated to be disturbed, it was assumed that minimal, if any, measureable airborne exposure levels would be experienced during construction of the ROD-selected remedy (See Appendix H).

It is possible that non-remediation workers would be present in buildings near the Site during construction of the ROD-selected remedy. The nearest residential community is located about 1,000 meters to the south of the portion of the Site where RIM in Areas 1 and 2 might be exposed. It is assumed that these two groups of potential receptors (i.e., non-remediation workers and offsite residents) would not be exposed to radiation directly from the RIM, but might be subject to airborne exposure. Airborne radiological and chemical constituent exposures to these receptors, if any, would be expected to be transient and small. Use of dust control measures at the Site and the distance between the potential receptors and the Site reduces the potential for dust generation and exposure to dust, thereby lessening risk of ingestion or inhalation by on-site or off-property receptors. Specific detailed plans for minimizing fugitive dust during alternative implementation will be generated during remedial design.

Due to operational procedures and engineering controls, any ponding of surface water from precipitation would be expected to be localized and limited in size during construction of this alternative. Any surface water contacting exposed RIM during construction would be collected, sampled, and treated or discharged. Workers handling collected surface water would be required to wear personal protective equipment (PPE) and use appropriate tools and techniques to minimize exposures and risks.

3.1.1.1 Occupational Health and Safety Monitoring

Because exposures to remediation workers are assumed to be much greater than exposures to other individuals, these workers would be subject to more rigorous monitoring than other potential receptors (e.g., continuous monitoring of environmental conditions and dosimetry). If monitoring can demonstrate that risks to remediation workers from radiological and other hazardous constituents are within acceptable levels, then it is safe to assume that risks to less-exposed receptors would also be within acceptable levels.

Airborne emissions from construction activities would be monitored on a daily basis as part of the Occupational Health and Safety Program and in accordance with the existing Radiation Safety Plan for Invasive Subsurface Activities in place at the Site (Auxier 2013). Portable air samplers would be set up in the area of construction and moved as necessary to provide representative samples of air in the breathing zone of workers. These samples would be collected at the end of each work day and checked for total alpha and total beta radiation. In some cases, continuous radon monitors may be included to monitor occupational radon exposures.

Radiation exposure rates in work areas would be periodically monitored with hand-held instrumentation. Any cumulative radiation exposures would be tracked using personal dosimetry badges or electronic dosimeters.

The anticipated types of health and safety monitors (as well as proposed and projected quantities) are presented in Table 3-2. This table also lists the current constituents of potential concern with the understanding that the list may change if new information becomes available during remedy design.

3.1.1.2 Air Monitoring

An integrated system of 13 air monitoring stations (as described in Section 2) has been established around the perimeters of Areas 1 and 2, and near the closest occupied building onsite (Figure 2-1). Air samples collected in the stations would be analyzed for particulates and gases that may be emitted during cut and fill operations, grading for the final cover, and movement of any RIM from the Buffer Zone/Crossroad Property onto Area 2.

The types and quantities of equipment in each weatherproof monitoring station enclosure are listed in Table 2-1. The types of measurements and frequency of collection are summarized in Table 2-2. The table also lists the current constituents of potential concern, with the understanding that this list may change if new information becomes available during remedy design.

These air monitoring stations would be maintained by the onsite radiological protection group (health physics personnel). Buried or overhead electrical power service has already been established at all air monitoring station locations.

3.1.2 Health-Based Monitoring During the "Partial Excavation to 1,000 pCi/g", "Partial Excavation to 52.9 pCi/g", and "Complete Rad Removal" Alternatives

These alternatives would involve partial or complete removal of the RIM in Areas 1 and 2. In all cases, overburden would be excavated and stockpiled onsite, and RIM in Areas 1 and 2 would be excavated and transported to a permitted off-site disposal facility. A smaller volume of RIM would also be excavated from the Buffer Zone/Crossroad Property (Figure 1-1), consolidated with the RIM from Areas 1 and 2, and then transported and disposed at the off-site facility. It is anticipated that only a portion of the RIM would be uncovered at any one time, and the remaining RIM would be covered until it was scheduled to be excavated.

In the analysis of the three excavation alternatives, it was assumed that individuals working near the RIM for a protracted period of time would encounter elevated radiation levels. During construction, remediation workers could walk over RIM or operate equipment on RIM. Other remediation workers would be close to the RIM while surveying. If RIM were to be transported via truck to a truck-to-intermodal trans-loading facility, remediation workers sealing the RIM-filled intermodal containers on the semi-trailers would be close to the RIM during the sealing activity. Dust control measures, along with routine contamination control surveys and air monitoring, would be implemented to keep exposures to airborne radioactive material as low as reasonably achievable.

Of all the potential receptors evaluated, radiation survey technicians and other health and safety personnel are assumed to encounter the highest risk from radioactive and chemical exposures because they would spend the most time near the RIM and would therefore receive the highest potential doses. Highway semi-truck drivers who would routinely haul RIM could potentially accrue a small but measureable dose, as they are assumed to spend a part of their workday near the RIM when loaded semi-trailers are hauled to the truck-to-rail trans-loading facility. Exposures to the public from covered trucks hauling RIM are expected to be transitory and therefore minimal.

Due to operational procedures and engineering controls, any ponding of surface water from precipitation is expected to be localized and limited in size during construction of these alternatives. Any surface water contacting exposed RIM during construction would be collected, sampled, and treated or discharged. Workers handling collected surface water would be required to wear PPE and use appropriate tools and techniques to minimize exposures and risks.

3.1.2.1 Occupational Health and Safety Monitoring

Because exposures to remediation workers are assumed to be expected to be much greater than exposures to other individuals, these workers would be subject to more rigorous monitoring than other potential receptors (e.g., continuous monitoring of environmental conditions and dosimetry). If monitoring can demonstrate that risks to remediation workers from radiological and other hazardous constituents are within acceptable levels, then it is safe to assume that risks to less exposed receptors would also be within safe levels.

Airborne emissions from construction activities would be monitored on a daily basis as part of the Occupational Health and Safety Program. Portable air samplers would be set up in the area of construction and moved as necessary to provide representative samples of air in the breathing zone of workers. These samples would be collected at the end of each work day and checked for total alpha and total beta radiation. In some cases continuous radon monitors may be included to monitor occupational radon exposures.

Ambient radiation levels would be monitored in real time with hand-held instrumentation. Any cumulative radiation exposures would be tracked using personal dosimetry badges or electronic dosimeters.

It would be likely that some surface water from precipitation would be collected, sampled, and treated or discharged during remediation. Workers handling this water would be required to wear PPE and use appropriate tools and techniques to minimize exposures and risks.

The anticipated types of health and safety monitors (as well as proposed and projected quantities) are presented in Table 3-2. This table also lists the current constituents of potential concern, with the understanding that the list may change if new information becomes available during remedy design.

3.1.2.2 Air Monitoring

Similar to the ROD-selected remedy, for the “partial excavation to 1,000 pCi/g”, “partial excavation to 52.9 pCi/g”, and “complete rad removal” alternatives, the integrated system of air monitoring stations will continue to operate during construction. See Section 2 and 3.1.1.2 for a complete description.

3.2 Short-Term Remediation Monitoring

Short-term remediation control monitoring would include remediation control surveys to guide cut and fill operations, guide overburden and RIM excavation activities, verify that cover thickness would be sufficient under the ROD-selected remedy, and verify that RIM from the Buffer Zone/Crossroad Property and from Areas 1 and 2 had been removed both during and after RIM excavation. Remediation control monitoring would also include waste characterization surveys and sampling.

3.2.1 Remediation Control Monitoring During Construction of the ROD-Selected Remedy

Disturbance of RIM during construction of the ROD-selected remedy would be minimal. Some RIM might be moved during cut and fill operations that would be necessary for regrading of the surfaces of Areas 1 and 2. Other deposits of RIM may be inadvertently uncovered during grading in preparation for placement of the cover over Areas 1 and 2. Other than the RIM that would be relocated from the Buffer Zone/Crossroad Property onto Area 2 or Area 1, no RIM would be excavated and relocated or disposed off-site.

3.2.1.1 Remediation Control Surveys

Four types of radiological surveys would be conducted to guide the minor cut and fill operations in Areas 1 and 2, to guide the excavation and relocation of RIM from the Buffer Zone/Crossroad Property onto other parts of OU-1 (Area 1 or Area 2), and to confirm that final cover placement over Areas 1 and 2 would meet design criteria:

- Surveys conducted to identify and delineate any exposed RIM at the Buffer Zone/Crossroad Property;
- Quality Control (QC) walkover surveys of areas after final cover grading operations have ceased, but before the cover would be released for final status survey;
- Final Status Surveys for each covered (capped) area; and
- Final Status Surveys for areas on the Site adjacent to the final-covered Areas 1 and 2.

Following is a description of each of the remediation control survey types:

<u>Surveys conducted to locate and delineate any exposed RIM at the Buffer Zone/Crossroad Property.</u> These surveys would be conducted to locate areas where RIM is exposed or close to the surface at the Buffer Zone/Crossroad Property. Due to the complexity of surveying in unconsolidated material, the care that survey technicians would need to exhibit during the survey, and the need to communicate potentially complex instructions to the excavator operator, this process would reduce the excavator

efficiency. In order to calculate estimated survey costs, a 50 percent reduction in excavation production was assumed.

Samples of RIM and surrounding materials would be collected during any activity where RIM would be exposed or moved. These samples would require rapid analysis by field or on-site or off-site laboratory equipment to support decisions by the survey technicians to continue or cease handling materials on the current working face.

QC walkover surveys conducted after final cover grading and capping in an area has ceased. This type of survey would involve a systematic walkover survey of the final cover areas of Areas 1 and 2 after construction has ended. The intent of this type of survey is to provide reasonable assurance that recently disturbed or capped areas have a high likelihood of passing a final survey.[3] These surveys would follow MARSSIM guidance and established procedures. This survey would be conducted with hand-held gamma survey equipment. Soil samples would likely be collected if areas of higher gamma activity were identified during the scan. Any areas where soil concentrations above the remediation goals are identified would be marked and referred to engineering construction management personnel for potential RIM relocation or covering. These areas would then be resurveyed. This process would repeated until the entire covered area of Areas 1 and 2 meets the surface soil concentration criteria and cover design requirements. This level of effort would likely require two or three survey technicians equipped with hand held survey meters and soil sampling equipment. The survey team should be able to complete a survey of 1,000 square meters (m^2) in 4 to 8 man-hours. Some of these survey and sampling activities could potentially be conducted as areas of the final cover are being completed and prior to the entire cover surface being completed.

3.2.1.2 Final Status Surveys

Final Status Surveys for each covered area. These surveys, which are required to demonstrate compliance with cleanup standards and ARARs will be performed in order to confirm that the covered areas in Areas 1 and 2 meet the release criteria.[4] The exact method used to perform the Final Status Survey will be submitted for approval by EPA and other stakeholders (as applicable) prior to remedy construction. For example, on other sites impacted with similar radionuclides, walkover surveys have been conducted using a 2” x 2” sodium iodide detector coupled to a meter and a GeoPositioning System (GPS). The surveys were conducted by walking across the site in a systematic pattern at a rate of one meter per second with the detector held as close to the ground as practical.

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[3] During the remedy design and planning phase, remediation goals will be established. While the proposed remediation goals would include area and depth averaging criteria, the intent of this post-excavation QC survey would be to remediate to a “not-to-exceed” number. The averaging criteria would be used during the subsequent final status survey, but they would not be considered during this phase of the remediation.

[4] These numerical criteria will be established and implemented during the during the remedy design phase.

The results of these surveys were plotted on site maps or aerial photos and examined for anomalies. If no anomalies were identified, a reference grid was staked out on the remediated area and samples were taken at regular intervals as specified in the Final Status Survey Plan. Note that if the preceding QC walkover survey did not identify locations of elevated radioactivity in an area during the first pass over the area, that QC walkover survey was used to satisfy the walkover requirement of the Final Status Survey. The same approach would be proposed in the Final Status Survey Plan for the excavation remedial alternatives.

For planning purposes, the level of effort for this Final Status Survey would likely require three or four survey technicians as well as a health physics supervisor. For purposes of estimating costs in this FFS, it is assumed that the survey team would complete a survey of 1,000 m^2 in 4 to 8 man-hours, and 10 samples every 1,000 m^2 would be collected for laboratory analysis. Samples would be subject to gamma spectroscopy analysis and alpha spectroscopy analysis for isotopic thorium and isotopic uranium. A final survey report for both Areas 1 and 2 would be prepared and submitted for approval to EPA. When accepted, these surveys will serve as the baseline gamma surveys for these areas.

Final Status Surveys for areas on the Site adjacent to the final-covered Areas 1 and 2. A final survey of the surface of the property would also be required for areas traversed by vehicles containing RIM and where overburden was stored. These surveys would be identical to the final status surveys conducted for covered/capped areas. For purposes of estimating costs in this FFS, it is assumed that the survey team would complete a survey of 1,000 m^2 in 4 to 8 man-hours, and 10 samples every 1,000 m^2 would be collected for laboratory analysis. When accepted by EPA, these surveys will serve as the baseline gamma survey for these areas.

3.2.1.3 Waste Characterization Surveys and Sampling

Since disturbance of RIM in Areas 1 and 2 during construction of the ROD-selected remedy would be minimal and no areas of RIM in Areas 1 and 2 would be targeted for excavation and disposal, no formal waste characterization sampling would be necessary. A small volume of soil containing RIM would be relocated from the Buffer Zone/Crossroad Property onto Area 1 or Area 2. Waste characterization of this soil would involve collection and analysis of samples for radiological parameters at a frequency to be determined during remedial design.

3.2.2 Remediation Control Monitoring during Partial Excavation to 1,000 pCi/g", "Partial Excavation to 52.9 pCi/g", and "Complete Rad Removal" Alternatives

Disturbance of RIM during the alternatives that involve excavation activities would be significant. Remediation control monitoring would be crucial in assuring (1) that excavated overburden debris from Areas 1 and 2 would not contain any RIM, and (2) that all RIM has been removed from Areas 1 and 2 as well as from the Buffer Zone/Crossroad Property. Remediation control monitoring would be used to selectively excavate RIM while leaving non-impacted materials behind.

3.2.2.1 Remediation Control Surveys

Seven types of radiological surveys would be conducted to guide excavation of RIM in Areas 1 and 2 and from the Buffer Zone/Crossroad Property under the excavation remedial alternatives:

- Surveys of overburden known or suspected to be above an area of RIM;
- Surveys conducted to identify and delineate any exposed RIM;
- Surveys conducted to guide selective excavation of RIM;
- Surveys conducted on trucks leaving the Site;
- QC walkover surveys of an excavated area after excavation has ceased but before the area would be released for Final Status Survey;
- Final Status Surveys for each completed excavation of a RIM area; and
- Final Status Surveys for the unexcavated areas involved with the movement and handling the RIM, overburden storage locations, and Subtitle D capped areas over Areas 1 and 2.

Following is a description of each of the remediation control survey types:

<u>Surveys conducted to support removal of overburden from above the RIM</u>. This type of survey would be designed to assure that RIM would not be intermingled with the uncontaminated debris overburden being excavated. The survey would be conducted on the uncontaminated waste as it was moved by the excavator. The level of effort would likely require one full-time survey technician with each excavator.

<u>Surveys conducted to locate and delineate any exposed RIM.</u> These surveys would be conducted to locate areas where RIM is exposed or close to the surface. These surveys would likely require two or three full-time survey technicians with survey instruments to accompany each excavator. Due to the complexity of surveying in unconsolidated material, the care that survey technicians would need to exhibit during the survey, and the need to communicate potentially complex instructions to the excavator operator, this process would reduce the excavator efficiency. In order to estimate survey costs, a 50 percent reduction in excavation production was assumed.

Samples of RIM and surrounding materials would be collected during any activity where RIM would be exposed or moved. These samples would require rapid analysis by field or on-site or off-site laboratory equipment to support decisions by the survey technicians to continue or cease handling materials on the current working face.

<u>Surveys conducted to guide selective excavation of RIM.</u> The purpose of these real-time surveys would be to guide the excavator operators to deposits of RIM. These surveys

would likely require two or three full-time survey technicians with survey instruments to accompany each excavator. Due to the complexity of surveying in unconsolidated material, the care that survey technicians would need to exhibit during the survey and the need to communicate potentially complex instructions to the excavator operator, this process would reduce the efficiency of excavation. In order to calculate estimated survey costs, a 50 percent reduction in excavation production was assumed.

Samples of RIM and surrounding materials would be collected during any excavation involving RIM or overburden. These samples would require rapid analysis by laboratory equipment to support decisions by the survey technicians to continue or cease excavation on the current working face.

Surveys conducted on trucks leaving the Site. These surveys would be conducted on the tires of the highway trucks prior to the trucks leaving the Site. If radiological material were to be identified as a result of the survey, the truck would be directed to a decontamination pad where the radiological material would be removed and the truck resurveyed.

QC walkover surveys of an excavated area after excavation has ceased but before the area was released for Final Status Survey. This type of survey would involve a systematic walkover survey of the entire excavated area after excavation has ceased but before the excavator is released from the area. The intent of this type of post-excavation survey is to provide reasonable assurance that the recently excavated area has a high likelihood of passing a Final Status Survey.[5] QC walkover surveys would be conducted with hand-held gamma survey equipment. Soil samples would likely be collected if areas of higher gamma activity were identified during the scan. If any areas where soil concentrations above the remediation goals are identified, these areas would be subject to focused excavation and resurveyed until the entire area meets the soil concentration criteria established for each alternative. Extensive QC surveying and sampling is anticipated, and it is expected that this QC sampling would be supplemented by some boring or excavation to provide reasonable assurance that another layer of RIM does not exist below the newly exposed uncontaminated surface. A small excavator or backhoe (with an operator) might be necessary to assist the survey technicians. The level of effort would likely require two or three survey technicians equipped with hand-held survey meters and soil sampling equipment. After RIM excavation is completed in a particular area, it is estimated that the survey team would be able to complete a QC walkover survey of a 1,000 m^2 area in 4 to 8 man-hours. Some of the survey and sampling work would be on-going as excavation was being completed.

[5] During the remedy design and planning phase, remediation goals will be established. While the proposed remediation goals would include area and depth averaging criteria, the intent of this post-excavation survey would be to remediate to a "not-to-exceed" number. The averaging criteria would be used during the subsequent final status survey, but they would not be considered during this phase of the remediation.

3.2.2.2 Final Status Surveys

Final Status Surveys for completed RIM excavation areas. These surveys are conducted to confirm that the excavated area meets the release criteria. The exact method used to perform the Final Status Survey will be submitted for approval prior to remedy construction. Walkover surveys will be conducted using a 2” x 2” sodium iodide detector coupled to a meter and a GeoPositioning System (GPS), or equivalent. The surveys would be conducted by walking across the Site in a systematic pattern at a rate of one meter per second with the detector held as close to the ground as practical. The results of these surveys will be plotted on Site maps or aerial photos and examined for anomalies. If no anomalies are identified, a reference grid will be laid out on the remediated area and samples will be taken at regular intervals as specified in an approved Final Status Survey Plan. Note that if areas of elevated radioactivity are not identified during the first pass of the preceding QC survey, that QC walkover survey will be used to satisfy the area survey component of the Final Status Survey. The same successful approach would be proposed in the Final Status Survey Plan for these alternatives.

The level of effort for this Final Status Survey would likely require three or four survey technicians, as well as a health physics supervisor. For purposes of estimating costs in this FFS, it is assumed that the survey team would complete a survey of 1,000 m^2 in 4 to 8 man-hours, and 10 samples every 1,000 m^2 would be collected for laboratory analysis. A final survey report for each RIM excavation area would be prepared and submitted for approval to EPA. When accepted, these surveys will serve as the baseline gamma surveys for the excavated areas.

Final Status Surveys for the unexcavated areas involved with the movement and handling the RIM and overburden storage locations. Final Status Surveys would be conducted of the surface of the property traversed by vehicles containing RIM (i.e., the areas between where trucks would be loaded and the transfer station) and the area between any RIM excavations and the overburden staging area and the surface of the property where overburden would be stored. These surveys would be identical to the Final Status Surveys conducted for excavated areas.

For purposes of estimating costs in this FFS, it is assumed that the survey team would complete a survey of 1,000 m^2 in 4 to 8 man-hours and 10 samples every 1,000 m^2 would be collected for laboratory analysis. When accepted by EPA, these surveys will serve as the baseline gamma survey for the completed remedy in these locations.

3.2.2.3 Waste Characterization Sampling and Analyses

Off-site disposal facilities require that incoming waste meet certain acceptance criteria. Prior to being transported off-site, waste would be sampled as determined by the disposal facility waste acceptance criteria, and analyzed by the on-site laboratory to determine that the material meets the waste acceptance criteria of the receiving facility.

3.3 Utility of an On-site Laboratory during Construction of the "Partial Excavation to 1,000 pCi/g", "Partial Excavation to 52.9 pCi/g", and "Complete Rad Removal" Alternatives

A large number of air and soil samples would be generated by the Occupational Health and Safety and air monitoring programs discussed previously in this section for the partial and full excavation alternatives. The estimated cost for analysis of these samples in an off-site commercial analytical laboratory would be substantial. To significantly decrease the turnaround time on key samples, as well as to reduce project costs, estimated costs associated with siting and operating/maintaining an on-site laboratory containing a low-background alpha-beta counter and gamma and alpha spectroscopy systems are included in the cost estimates presented in Appendix K of the FFS for the excavation alternatives.

Significantly fewer samples for radiological parameter analysis would be generated during implementation of the ROD-selected remedy because only a minor amount of RIM, if any, would be disturbed during cut/fill activities associated with regrading the surfaces of Areas 1 and 2 prior to cap placement. Therefore, use of an on-site laboratory was not considered in the cost estimates for the ROD-selected remedy.[6]

3.3.1 Radiological Analysis of Air Samples

As discussed above, the proposed air monitoring systems would be designed to capture information regarding potential emissions during alternative implementation activities. A large number of air samples requiring radiological analysis would be generated over the duration of construction. Due to the volume of samples expected, an on-site laboratory would be proposed to reduce response times and overall analytical costs.

Any radioanalytical equipment used on-site would be required to have the capability to reliably measure radionuclide concentrations in air that were at or below health-based standards. A very conservative detection goal for air samples was set in this analysis to evaluate the feasibility of an on-site laboratory and to estimate the total counter time required to perform the analyses.

The required radionuclide detection limit for on-site radioanalytical equipment was calculated by assuming that thorium-230 would be the only alpha emitter in the sampled air. Thorium-230 was chosen because it has the most restrictive allowable limit for air (and therefore would provide the most conservative, or protective, results), and it produces Radium-226, whose daughters are the most radiotoxic radionuclides at the Site. The assumption that thorium-230 is the only alpha emitter is very health-protective,

[6] The cost estimates provided in Appendix I for the ROD-Selected remedy do assume the on-site use of a low-background counter during the cut/fill and surface regrading activities.

because some of the alpha emissions in air would actually be produced by less-radiotoxic radionuclides.

In 10 CFR Part 20 Appendix B, Annual Limits on Intake (ALI) and Derived Air Concentration of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage, the NRC limits the acceptable airborne concentration of thorium-230 in areas accessible to the public to 2×10^{-14} microCuries per milliliter (µCi/mL). Assuming all alpha emissions in air were from thorium-230 (a gross overestimation), the detection limit for this equipment would be set at the NRC limit of 2×10^{-14} µCi/mL, after correcting for interferences from radon daughters.

For the purpose of estimating operation costs for an on-site laboratory, it assumed that each air sample would require two separate 15 minute analyses on a state-of-the-art low-background counter.[7] Approximately 30 samples per day could be counted (including sample loading, unloading and counter maintenance) with one gas proportional counter. Based on this evaluation, one gas proportional counter was assumed to be included in an on-site laboratory in the cost estimates for each of the partial and full excavation alternatives in Appendix K of the FFS. This assumption may be revised after preparation of the Construction Sampling and Analysis Plan during remedial design to include two counters to provide redundancy and excess capacity for smear and occupational health and safety samples.

3.3.2 Non-radiological Analysis of Particulate Air Samples

For the purpose of estimating costs, it was assumed that two air sample filters per week would be submitted for chemical analysis. The number of samples per week may increase depending on the nature of the activities being conducted.

Chemical analyses of air samples would not be considered for an on-site laboratory because of the significant cost of analytical equipment and QA/QC requirements for a laboratory conducting chemical analyses. The detection limits for the analytical methods used would allow direct comparison to the air quality objectives established for the project during alternative design.

3.3.3 Radiological Analysis of Soil and Waste Samples

Because of the anticipated significant number of soil and RIM waste samples that would require analysis for the excavation alternatives, it is anticipated that on-site gamma spectroscopy and alpha spectroscopy systems would be installed. As compared to shipping samples to an off-site commercial laboratory for analytical services, use of an on-site system would afford a rapid turnaround time between sample collection and

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[7] This would allow interferences from radon daughter build-up on the filters to be estimated and removed from the final gross alpha measurement used to determine compliance with the 2×10^{-14} µCi/mL thorium-230 limit in air.

analytical reporting, thereby allowing excavation decisions to be made quickly (thus reducing both standby time for construction equipment and the overall alternative implementation schedule). A secondary consideration is the reduction in the analytical cost per sample that would be provided by on-site gamma spectroscopy and alpha spectroscopy systems.

3.3.4 Non-radiological Analysis of Soil and Waste Samples

After the nondestructive radiological analysis of an individual soil or waste sample is completed, and depending on the characteristics of the sample (e.g., chemical toxicity, matrix interference, etc.), it may be sent to an off-site commercial analytical laboratory for analysis of organic and/or inorganic parameters. The laboratory manager would likely make this determination.

4 POST-CONSTRUCTION MONITORING

Post-construction radiological monitoring would be conducted to confirm that the remedial action has been completed as designed and to provide initial post-construction values that could be compared to long-term monitoring results.

4.1 Post-Construction Monitoring Following Construction of the ROD-Selected Remedy, the "Partial Excavation to 1,000 pCi/g", and "Partial Excavation to 52.9 pCi/g" Alternatives

Post-construction monitoring performed following completion of construction of the ROD-selected remedy and the two partial excavation alternatives would be used to assess whether any radon gas is emanating from or around the cover over Areas 1 and 2. Monitoring activities would include:

- Measurement of radon flux emanating from the cover over Areas 1 and 2; and
- Measurement of radon in subsurface landfill gas.

4.1.1 Radon Flux Measurement

A one-time radon flux monitoring campaign would be performed after the final cover is completed over Areas 1 and 2. The purpose of this monitoring is to assess surface emissions of radon from the final cover over Areas 1 and 2 in order to demonstrate compliance with the radon flux emission standard established under 40 CFR § 192.02(b).

Radon flux would be measured using the Large Area Activated Charcoal Canisters (LAACC) method presented in Method 115, Appendix B, 40 CFR Part 61. The protocols used for the LAACC radon flux measurement program and calculations are contained in the USEPA report "Radon Flux Measurements on Gardinier and Royster Phosphogypsum Piles near Tampa and Mulberry, Florida" (USEPA, 1986).

For purposes of costing, it was assumed that approximately 50 LAACC samplers would be placed on the surface of Areas 1 and 2. The LAACC samplers would be distributed to provide coverage similar to the spacing in the 2016 sampling event. This proposed measurement campaign may vary depending upon the alternative chosen.

4.1.2 Sub-surface Landfill Gas Monitoring

A landfill gas monitoring program would be developed and implemented as part of the long-term monitoring program. The need for and scope of the landfill gas monitoring program, including the exact number and locations of gas monitoring points and measurement frequency, would be determined in the remedial design documents for the selected alternative for OU-1. Final landfill gas monitoring well locations and spacing would be based on geologic conditions and proximity to property boundaries and adjacent features. Gas monitoring wells would be designed and constructed in accordance with the MDNR Solid Waste Management Program (SWMP) fact sheet *Design and Construction of Landfill Gas Monitoring Wells* (MDNR, 2007). This guidance indicates that monitoring locations be spaced 100 to 500 feet apart, depending on the ground permeability and the number of nearby features that could be potentially damaged from landfill gas.

For purposes of this FFS, it is assumed that 2-inch diameter "Code Wells" (see MDNR, 2007) would be installed to a depth of approximately 10 feet for the subsurface gas monitoring program. The inner casing of each well would be sealed with a bushing and a sampling port consisting of a shutoff valve and hose barb fitting. For purposes of preparing cost estimates for the ROD-selected remedy and the two partial excavation alternatives, it is assumed that approximately 16 monitoring wells would be installed along the boundary of Area 1 and approximately 15 wells along the boundary of Area 2 (Figure 4-1). A more frequent spacing was assumed for the wells around Area 1 because of the proximity of Area 1 to the Site entrance road and St. Charles Rock Road. Because of the lack of significant features near the boundaries of Area 2, a greater spacing was assumed for the Area 2 gas monitoring wells.

For the post-construction radiological monitoring program, only radon gas would be monitored in the gas wells. Landfill gas (i.e., lower explosive limit [LEL] for methane) would be monitored as part of the Long-Term Monitoring Program (see discussion in Section 5). Gas samples would be collected from each well and the radon content of the gas would be measured using a radon gas monitor and detector (e.g., Pylon Instrument Manufacturing Model AB-5R monitor and Pylon Model 300A detector).

4.2 Post-Construction Monitoring Following Construction of the "Complete Rad Removal" Alternative

Since all RIM will have been removed under this alternative as confirmed by the Final Status Surveys discussed in Section 3.2.2.2, the only monitoring that would be conducted under the full excavation remedial alternative would be measurement of radon gas in landfill gas wells installed along the boundaries of Areas 1 and 2. For purposes of preparing cost estimates for this "complete rad removal" alternative, it is assumed that the same locations and type and number of gas monitoring wells as those assumed for the ROD-selected remedy (Figure 4-1) would be monitored. Gas samples would be collected from each well and the radon content of the gas would be measured using a radon gas monitor and detector.

4.3 Gamma Radiation

As discussed in Sections 3.2.1.2, and 3.2.2.2, the Final Status Surveys will serve as the post-construction survey of gamma radiation after remedy construction is complete.

5 LONG-TERM MONITORING

Long-term monitoring of landfill gas, groundwater, and surface water, as well as annual post-construction Site inspections, would be conducted after the selected remedial alternative is constructed to verify that the constructed remedy is performing as designed. Long-term air monitoring would not be necessary, as after construction of the engineered cap, the potential for windborne transport of RIM containing gases and dust would be eliminated. Detailed plans would be generated during remedy design.

This section provides a conceptual overview of the types of systems and equipment that would be used to monitor potential exposure and emissions after remedy construction is complete. For purposes of preparing a monitoring plan for the FFS, it is assumed that the level of potential exposure is low for the four remedial alternatives under consideration and that the constructed remedy has reduced potential exposures to the point that they would be indistinguishable from background levels using current technology. A detailed long-term monitoring plan would be developed as part of the remedial design for the selected alternative.

5.1 Long-term Monitoring Following Construction of the ROD-Selected Remedy, the "Partial Excavation to 1,000 pCi/g", and "Partial Excavation to 52.9 pCi/g" Alternatives

5.1.1 Long-term Landfill Gas Monitoring

Landfill gas would be monitored following construction of the cover over Areas 1 and 2 as part of the Long-Term Monitoring Program for the ROD-selected remedy and the two partial excavation alternatives using the approximately 31 subsurface gas monitoring wells discussed in Section 4.1.2. Gas samples would be analyzed for methane (as a percentage of total air volume or as a percentage of LEL) and percent volume of oxygen using a multi-gas detector (e.g., Industrial Scientific iBrid™ MX6). The radon content of each gas sample would also be measured using a radon gas monitor and detector. In addition, the barometric pressure at the time of gas sample collection would be recorded.

In accordance with the MDNR Solid Waste Management Program technical bulletin *Sampling of Landfill Gas Monitoring Wells* (MDNR, 2006), landfill gas monitoring would be conducted quarterly during the months of February, May, August, and November. Depending on weather conditions, consideration would also be given to sampling at those times when landfill gas would be most likely to migrate (i.e., when barometric pressure is low and soils are saturated, when snow cover is just beginning to melt, and/or when the ground is frozen or ice covered).

5.1.2 Long-term Groundwater Monitoring

One of the primary objectives of the ROD-selected remedy and the two partial excavation alternatives is to protect groundwater from any ongoing or future impacts from Areas 1 and 2. The landfill cover over Areas 1 and 2 would be designed and constructed to shed water and minimize the potential for precipitation to infiltrate waste materials. Therefore, the cover is expected to further reduce the potential for migration of contaminants from Areas 1 and 2 to the shallow groundwater underlying the Site.

A long-term groundwater monitoring program would be established to demonstrate that the ROD-selected remedy or the two partial excavation alternatives perform as required over the post-closure period. Also, as requested in the EPA Office of Superfund Remediation and Technology Innovation (OSRTI) memorandum of May 21, 2009 to EPA Region 7, the groundwater monitoring program would be designed so that it can be determined whether contaminants from the Site have migrated across the waste management unit boundary in concentrations that exceed drinking water Maximum Contaminant Levels (MCLs). Statistical evaluation of groundwater data would be used to assess groundwater quality and identify long-term trends.

The exact scope and requirements for the long-term groundwater monitoring component of the selected alternative would be set forth in the remedial design documents. Any design and implementation of a long-term groundwater monitoring program would be expected to meet the substantive requirements of the UMTRCA groundwater protection and monitoring requirements and the MDNR post-closure regulations for closed solid waste landfills.

A conceptual groundwater monitoring plan for the ROD-selected remedy and the two partial excavation alternatives was developed as part of the FFS (EMSI, 2016). For purposes of estimating monitoring costs for this FFS, the point of compliance for groundwater monitoring is assumed to consist of those portions of the boundaries of Areas 1 and 2 that would be coincident with the boundary of the West Lake Landfill. Specifically, this would include the northeastern boundary of Area 1 and the northeastern, northern, northwestern and western boundaries of Area 2. The point of compliance used for this evaluation does not include the other boundaries of Areas 1 and 2, as these boundaries would be located internal to and within the overall boundary of the Site and therefore would be adjacent to areas containing other landfill wastes, making compliance monitoring along these boundaries impractical.

In this FFS evaluation it was assumed for purposes of monitoring the point of compliance that 24 groundwater monitoring wells would monitored. The specific wells to be monitored would be determined during remedial design. It is anticipated that the wells to be monitored would consist of a combination of existing well clusters (Figure 5-1) and new wells that would be constructed (the costs for 12 new groundwater monitoring wells were included in the capital cost estimates for the ROD-selected and excavation alternatives). The wells would be sampled twice per year for the first five years to characterize baseline conditions and annually thereafter.

Groundwater samples would be analyzed for gross alpha and beta, uranium and radium isotopes, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), trace metals, mercury, total organic carbon (TOC), major anions and cations, phosphorus, and ammonia as required by the UMTRCA groundwater protection standards and the MDNR regulations. During the sample collection process, water level elevations and field parameters (e.g., pH, specific conductance, turbidity, temperature, and redox potential) would be recorded. Also, as requested in the EPA OSRTI memorandum of May 21, 2009 to EPA Region 7, broader water quality parameter indicators (e.g., alkalinity, carbonates, and sulfates/sulfides) would analyzed in the collected samples. Both filtered and unfiltered samples would be collected in the field and analyzed in the laboratory.

As with any alternative, the exact number and locations of the wells to be monitored, the parameters for which they would be monitored, and the frequency at which they would be monitored would be determined as part of the remedial design activities. In addition, EPA had determined that an additional operable unit (OU-3) will be created and investigations to address groundwater may affect cost estimates. The description of the wells to be monitored, analyte list, and monitoring frequency presented above is intended solely to provide a basis for developing an estimated cost for long-term groundwater monitoring following construction of the ROD-selected remedy or the either of the partial excavation alternatives.

5.1.3 Annual Post Construction Site Inspections

Every year the surface of the cover constructed over Areas 1 and 2 would be inspected to assess whether any significant changes have occurred.

Annual long-term monitoring results would be validated and compiled along with air monitoring results from previous years in a database and archived in a secure, accessible location. Monitoring results would be made available to the regulatory agency team conducting the Comprehensive Five-Year Reviews of the alternative (OSWER Directive 9355.7-03B-P). The frequency and extent of post-construction site inspections would be subject to reassessment as a result of each Five-Year Review. Estimated costs for compiling, reporting, and maintaining monitoring results are included in the long-term monitoring costs provided in Appendix K of the FFS for the ROD-selected remedy and the two partial excavation alternatives.

5.2 Long-term Monitoring Following Construction of the "Complete Rad Removal" Alternative

5.2.1 Long-term Landfill Gas Monitoring

Under the "complete rad removal" alternative, all RIM will have been removed from Areas 1 and 2. Therefore, samples from subsurface gas wells installed around Areas 1 and 2 would only be analyzed for methane and percent volume of oxygen. It is assumed for purposes of this FFS that the same number of subsurface gas monitoring wells would be installed and monitored as those for the other alternatives discussed in Section 5.1 (Figure 3-1).

5.2.2 Long-term Groundwater Monitoring

Although under the “complete rad removal” alternative, RIM will have been removed from the Site, it is assumed for purposes of this FFS that the same number of groundwater monitoring wells discussed in Section 5.1.2 would be monitored. Further, it is assumed that the frequency of monitoring and parameters analyzed would also be the same as those described previously for the other alternatives in Section 5.1.2.

5.2.3 Annual Post Construction Site Inspections

Every year, the surface of the Subtitle D cover constructed over Areas 1 and 2 after the RIM has been removed would be inspected to assess whether any significant changes have occurred.

Annual long-term monitoring results would be compiled along with environmental monitoring results from previous years and archived in a secure, accessible location. Long-term monitoring results would be made available to the regulatory agency team conducting the Five-Year Reviews of this alternative. The estimated costs for compiling, reporting, and maintaining monitoring results are included in the long-term monitoring costs provided in Appendix I of the FFS for the “complete rad removal” alternative.

6 SUMMARY OF MONITORING FOR EACH ALTERNATIVE

A summary table listing the types of monitoring assumed for the purpose of generating estimated costs is provided in Table 6-1. Specific types of monitors and the number of monitor types would likely change to some degree during remedy design and construction.

7 REFERENCES

Engineering Management Support, Inc. (EMSI), 2016, Final Feasibility Study, West Lake Landfill Operable Unit 1, August.

Missouri Department of Natural Resources (MDNR), 2006, Solid Waste Management Program (SWMP) Technical Bulletin *Sampling of Landfill Gas Monitoring Wells*, June.

MDNR, 2007, SWMP Fact Sheet *Design and Construction of Landfill Gas Monitoring Wells*, January.

United States Environmental Protection Agency (USEPA), 1986, "Radon Flux Measurements on Gardinier and Royster Phosphogypsum Piles Near Tampa and Mulberry, Florida", EPA 520/5-85-029, January.

Engineering Management Support, Inc. (EMSI), 2016, *Remedial Investigation Addendum, West Lake Landfill Operable Unit 1*, July

Auxier and Associates, 2014, *Air Monitoring Sampling, and QA/QC Plan, West Lake Superfund Site Operable Unit 1*, October.

Auxier and Associates, 2013, *Radiation Safety Plan for Invasive Subsurface Activities West Lake Superfund Site Operable Unit 1*, October.

Auxier and Associates, 2015-2016, *West Lake Landfill Perimeter Air Monitoring Quarterly Reports, West Lake Superfund Site Operable Unit 1*.

Auxier and Associates, 2016, *Appendix H Evaluation of Potential Risks Associated with the Proposed Remedial Alternatives*, December.

Tables

Table 2-1 List of Samplers for Perimeter Air Monitoring

Perimeter Monitor Inventory per Location	Sampling Mode and Collection Frequency	Contaminants Measured
List of samplers at A01, A05, A07, A08, A11		
Metered air pump with dual chamber sampler for particulate fiber filter	Continuous / Every 28 days	Total alpha and beta activity
Alpha Track Etch Detector for radon gas	Continuous / Quarterly	Radon-222 and radon daughters
Radiello RAD130 Canister	Continuous / Every 14 days	Volatile Organic Compounds[1]
Radiation dosimeter (TLD)	Continuous / Quarterly	Gamma radiation levels
List of samplers at remaining on-site and perimeter locations (x8)		
Metered air pump with filter to collect particulates	Continuous / Monthly	Total alpha and beta activity
Alpha Track Etch Detector for radon gas	Continuous / Quarterly	Radon-222 and radon daughters
Radiation dosimeter (TLD)	Continuous / Quarterly	Gamma radiation levels
Meteorological monitoring station		
High resolution wind sensor	Continuous	Wind speed and direction

[1] The Radiello 130 media are analyzed for the list of analytes included in Appendix F of the Plan. This list was provided by the laboratory and reflects common analytes for which sampling rates have been calculated for the Radiello 130 media.

Table 2-2 Field Sampling Summary

Analytical Parameter	Level of Sensitivity	Matrix	Sample Frequency	Container Type	Annual Subtotal Target Field Samples	Field QC Extras			Total Annual Field Samples
						Trip Blank	Filter Blanks	Field Duplicates	
Gross Alpha/Beta	1 dpm/ sample	Air Filter	13 x Continuous Air Samplers /Monthly	Glassine Envelope	156	NA	12	12	180
Radon	0.5 pCi/l	Track Etch Detector	13 x Continuous Samplers /Quarter	Track Etch Detector	56	NA	NA	NA	56
Gamma Dose	1 mrem	TLD	13 x Stations/ Quarter	TLD	56	*1 (Jan 2016)	NA	NA	56
VOC	See Plan Appendix B for MDL and RL	Radiello Canister	5 Continuous Every 14 Days	Radiello Canister	130	*1 (8/15/15)	NA	1 Every 14 Days	156

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Table 3-1 Short-term Health-based Monitoring Responsibilities

Potential Exposure Source	Postulated Transport Mechanism	Receptors Evaluated	Constituents of Potential Concern	Controlling Program
Exposed RIM	Suspension of particulates and transport as windborne dust	Remediation workers like survey techs, operators, waste handlers, and truck drivers	Metals, radioactive particles	Occupational Health & Safety Program
		Workers in adjacent businesses, off-property residents	Metals, radioactive particles	Environmental Monitoring Program
	Emission of gas followed by windborne transport	Remediation workers like survey techs, operators, waste handlers, and truck drivers	Methane, radon, hydrogen sulfide, etc.	Occup. Health & Safety Program
		Workers in adjacent businesses, off-property residents	Methane, radon, hydrogen sulfide, etc.	Environmental Monitoring Program
	Irradiation due to proximal exposure	Remediation workers like survey techs, operators, waste handlers, and truck drivers	Predominately radium-226	Occup. Health & Safety Program
		Workers in adjacent businesses, off-property residents	Receptors not located next to RIM, pathway not considered further	N/A
	Direct contact with exposed RIM	Remediation workers like survey techs, operators, waste handlers, and truck drivers	None. Workers required to wear appropriate PPE	Occup. Health & Safety Program monitors PPE during operations
		Workers in adjacent businesses, off-property residents	Receptors not located next to RIM, pathway not considered further	N/A
Excavated RIM (Only for Full and Partial Excavation Alternatives)	Loose RIM on trucks leaving restricted areas	Remediation workers like survey techs, operators, waste handlers, and truck drivers	Predominately isotopes of uranium, thorium, and radium.	Occup. Health & Safety Program monitors equipment release and safe work practices
		Workers in adjacent businesses, off-property residents	Trucks would be surveyed and decontaminated if necessary before leaving contaminated areas, pathway not considered further	N/A
	Radiation from exposed RIM in trucks	Remediation workers like survey techs, operators, waste handlers, and truck drivers	Predominately radium-226	Occup. Health & Safety Program monitors PPE during operations
		Receptors near roads	Exposure durations very limited, partial shielding by truck, dosimeters on drivers will provide upper-bound exposure.	Occup. Health & Safety Program monitors worker dosimetry

Table 3-2 Projected Occupational Health and Safety Monitoring During Construction

Monitoring Location	Sampler Type	Number of Monitors	Parameters of Concern
On-site in areas of exposed RIM	Air pumps with air filters	1 per work area	Total alpha and total beta, total mass of particulates
	Portable monitors for volatile and explosive gases	1 per work area	Methane, misc. volatile organics
	Portable monitors for radon-222 gases	1 per work area	Radon-222
	Radiation dosimeters	1 per worker	Personal gamma radiation doses accrued over time
	Hand held radiation detection instruments	2 per work area	Exposure rates
	Hand held radiation detection instruments, smears	1 per work area	Total and removable surface contamination (rad)
	Hand held radiation gamma detectors	1 per work area	Excavation surveys

Table 6-1 Types of Monitoring Included in Cost Estimates for Each Alternative

Site Status and Monitoring Program		Monitor Type	Rod-Selected Remedy	Partial or Full Excavation Alternatives
During Construction	Short-term Environmental Monitoring	Static perimeter monitoring stations	12	12
		Static background monitoring stations	1	1
	Short-Term Occupational Health and Safety Monitoring	Area air samplers	1 per exposed area	
		Portable gas monitor	1 per exposed area	
		Portable radon gas monitor	1 per exposed area	
		Personal air samplers	1 per exposed area	
		Hand-held radiation detection instruments	2 per area	
		Smears	As needed	
		Radiation dosimeter	1 per worker	
Baseline	Radon Attenuation	One-time radon flux measurement	50	50
		Sub-surface gas monitoring	38	38
Post-Construction	Long-term Environmental Monitoring	Groundwater sampling wells	16	16
		Surface water sampling locations	2	2
		Sub-surface gas monitoring	38	38

Figures

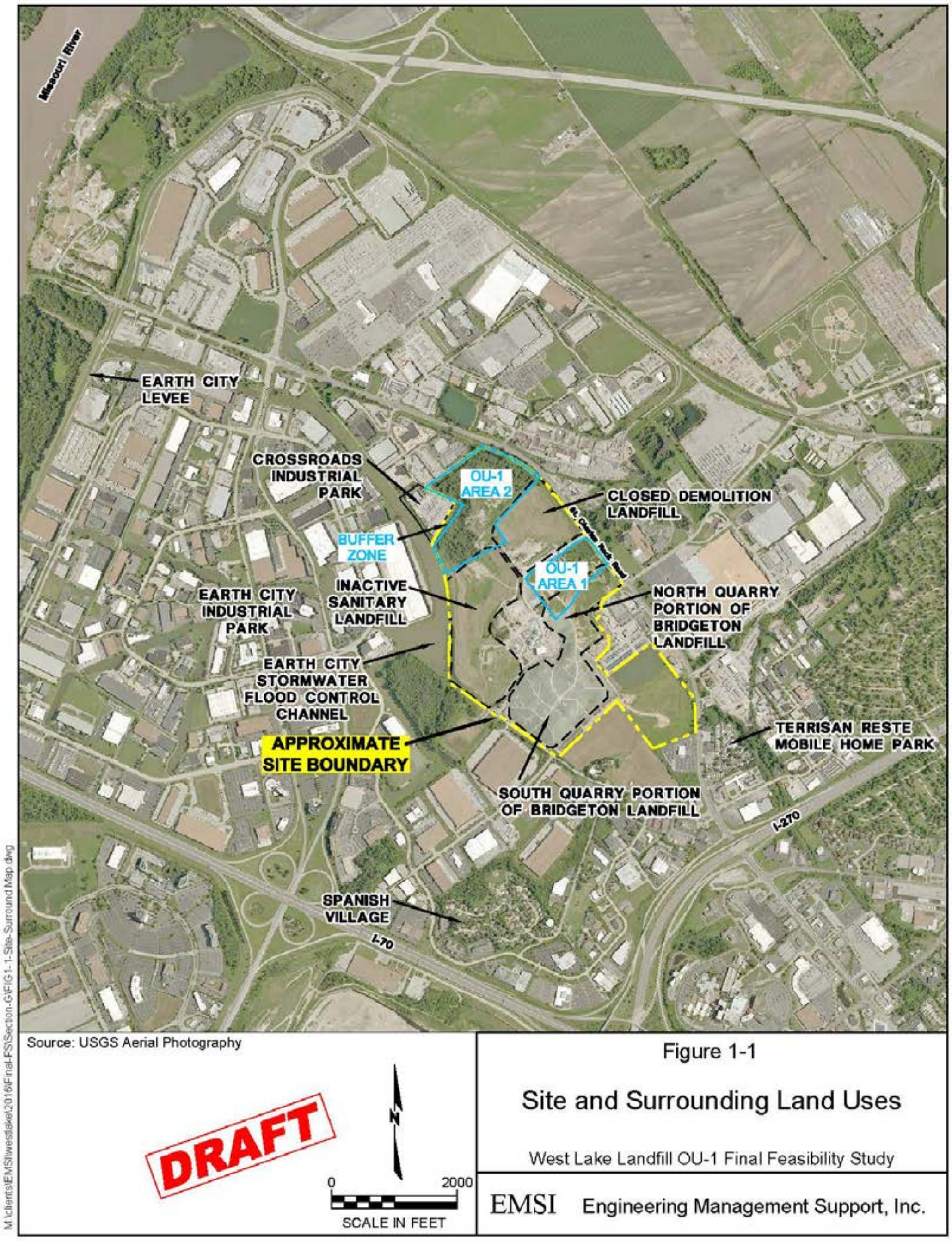

Figure 1-1 Site and Surrounding Areas

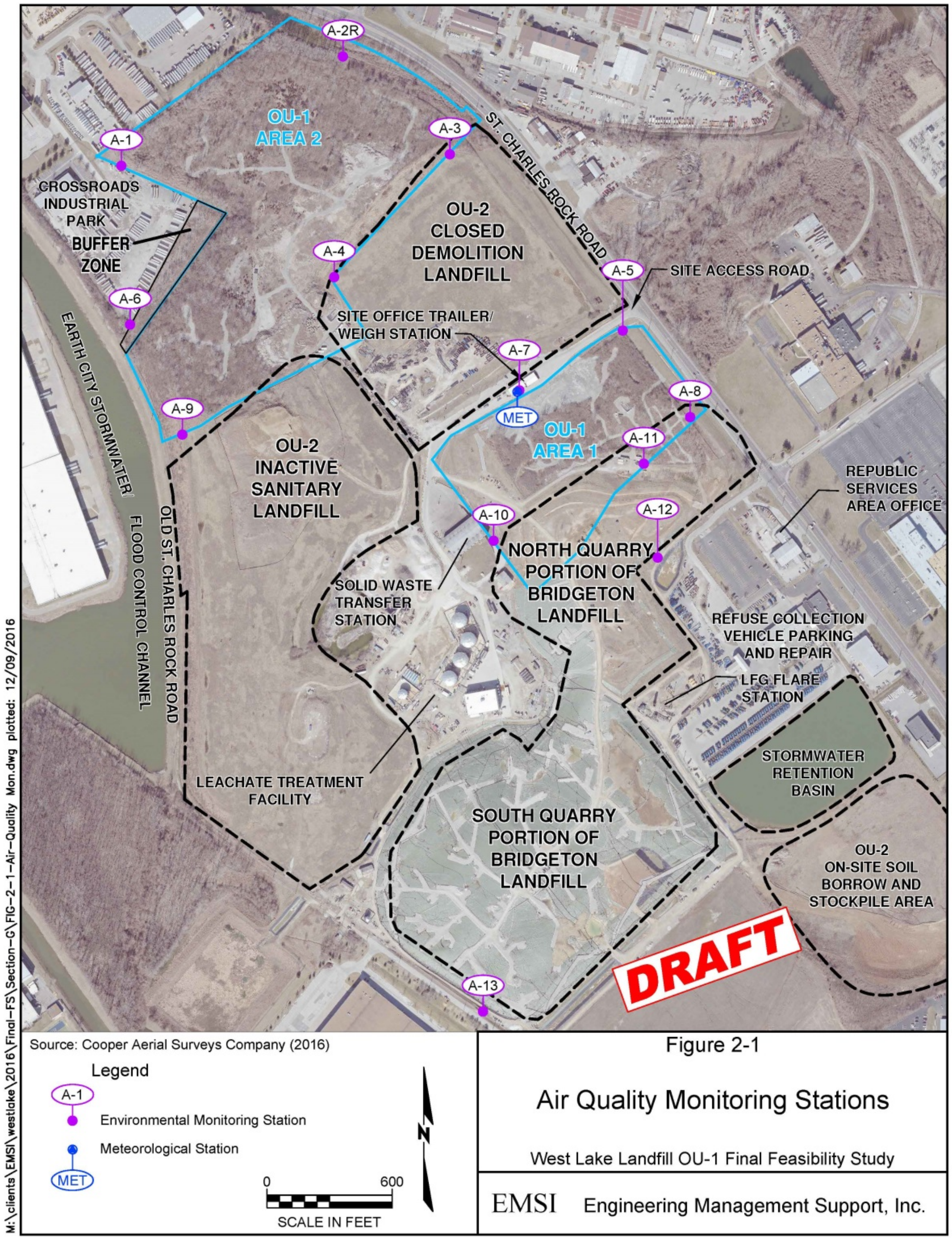

Figure 2-1 Air Quality Monitoring Stations

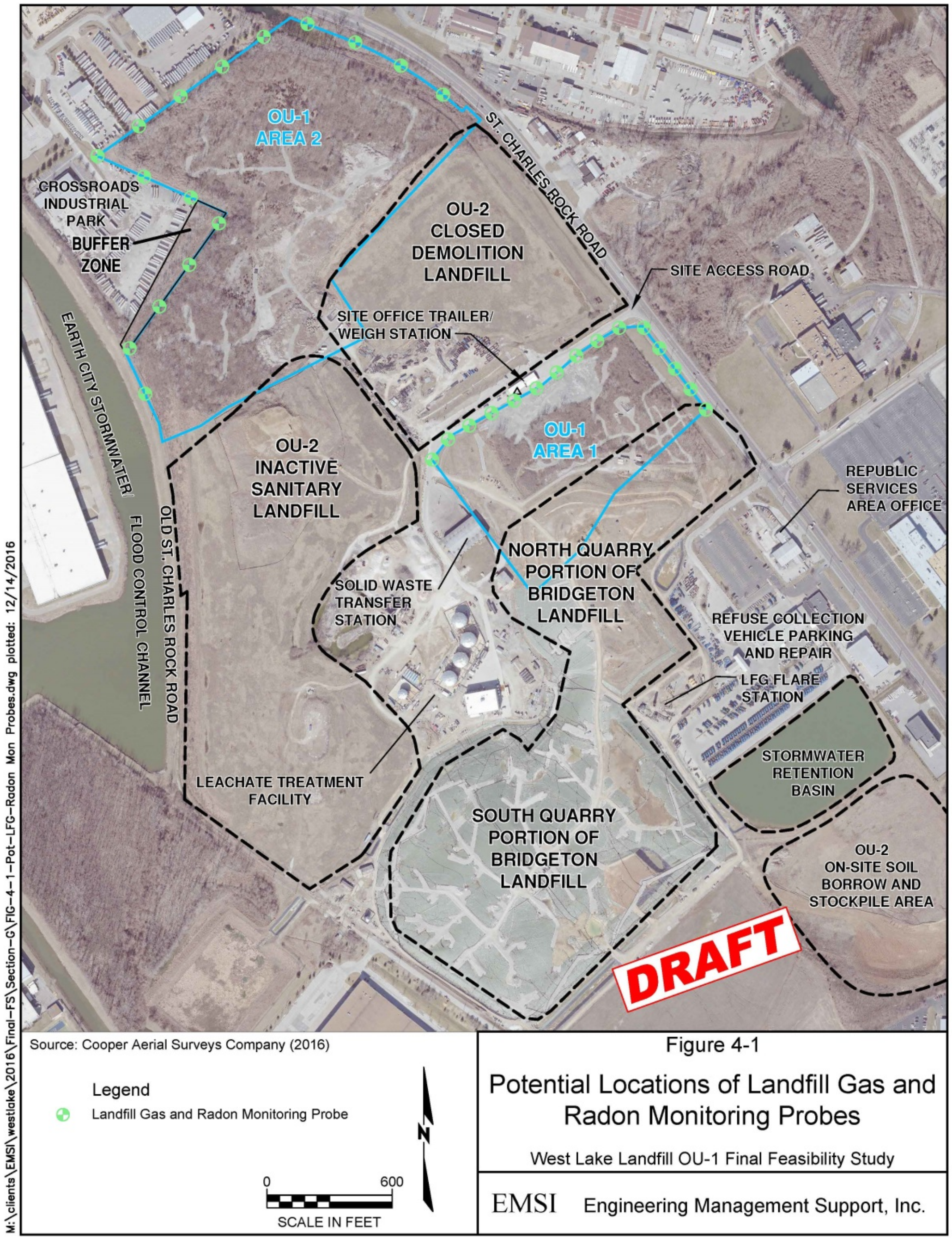

Figure 4-1 Potential Locations of Landfill Gas and Radon Monitoring Probes

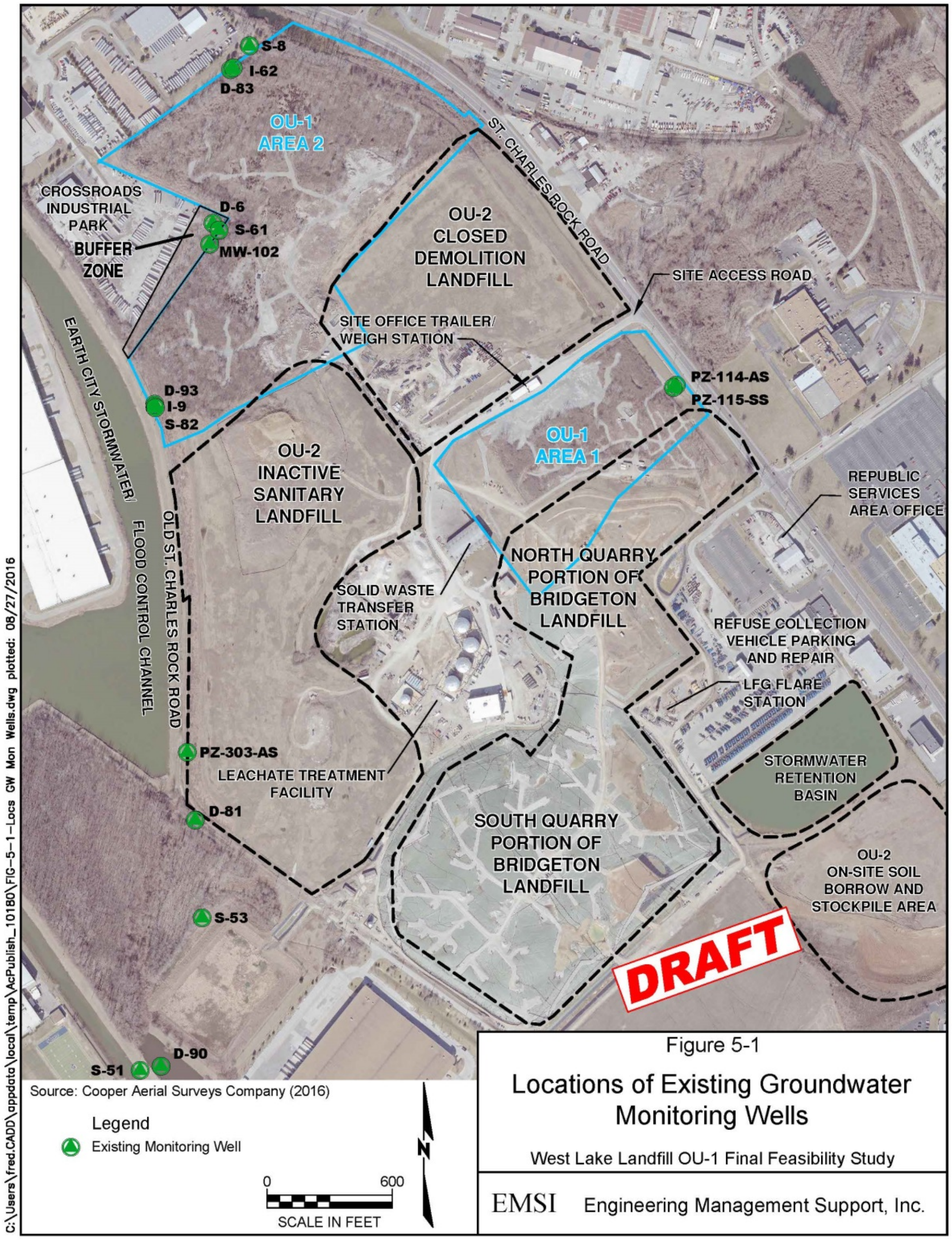

Figure 5-1 Locations of Existing Groundwater Monitoring Wells

APPENDIX H

Evaluation of Potential Risks Associated with the Proposed Remedial Alternatives

Evaluation of Potential Risks Associated with the Proposed Remedial Alternatives

FOR THE

Final Feasibility Study

West Lake Landfill Operable Unit-1

Prepared for

The United States Environmental Protection Agency Region 7

Prepared on behalf of

The West Lake Landfill OU-1 Respondents

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EXECUTIVE SUMMARY

Auxier & Associates, Inc. (Auxier) has prepared this Evaluation of Potential Risks Associated with the Proposed Remedial Alternatives (the Remedial Risk Assessment) to support the Final Feasibility Study (FFS) for OU-1 of the West Lake Landfill Superfund Site (the Site) in Bridgeton, Missouri. The purpose of the Remedial Risk Assessment is to calculate a conservative assessment of the potential short-term and long-term risks associated with each remedial alternative. The results of the Remedial Risk Assessment show that the overall risks of the ROD-selected remedy are less than any other remedial alternative. In fact, the short-term and long-term risks from the ROD-selected remedy are the only set of risks that are less than the upper bound of EPA's acceptable risk range. The risks for the off-property resident for all remedial alternatives are less than 10^{-07}, well below EPA's acceptable risk range for CERCLA sites.

ES1. Methods

The risk evaluations in this Remedial Risk Assessment build on the updated Baseline Risk Assessment (Auxier 2016) (BRA) for OU-1, which modeled hypothetical current and future risks to potential receptors at and near the Site, conservatively assuming that no corrective action would occur in OU-1 (i.e., assuming implementation of the No Action alternative). This Remedial Risk Assessment models hypothetical current and future risks to potential receptors at and near the Site for each of the remedial alternatives proposed by EPA in its December 9, 2015 RI/FS Statement of Work:

- 2008 ROD-selected remedy, which involves installing an enhanced cover over Areas 1 and 2 of OU-1, among other remedial components;
- Excavation and off-site disposal of all soil/waste containing combined radium or combined thorium with activity levels greater than 52.9 picoCuries per gram (pCi/g) down to a total depth of 16 feet beneath the 2005 topographic surface;
- Excavation and off-site disposal of all soil/waste containing combined radium or combined thorium with activity levels greater than 1,000 pCi/g;
- Excavation and off-site disposal of all soil/waste containing combined radium or combined thorium with activity levels greater than 7.9 pCi/g.

Potential risks associated with each of these remedial alternatives were modeled by conducting a human health risk assessment (HHRA) in accordance with CERCLA regulations and guidance. The HHRA characterizes potential risks posed by radioactive or chemical constituents to hypothetical humans assumed to live or work at or near the Site. It consists of the following steps:

- *Identification of constituents of potential concern (COPCs):* OU-1 of the West Lake Landfill contains both radiological and chemical (non-radiological) constituents of potential concern (COPCs). The concentrations and toxicity of these constituents were identified and used in the updated BRA to focus the risk assessment on the chemicals and radionuclides most likely to produce risks above the 10^{-06} cancer risk point of departure. These risk-driving constituents were defined as COPCs and are used in this Remedial Risk Assessment to evaluate the effectiveness of each remedial alternative to reduce risks.

- *Exposure assessment:* This step calculates the ways in which humans may be exposed to the constituents in OU-1. For example, humans may be exposed to OU-1 constituents by breathing, touching, or consuming contaminated air, water, or soil. These exposure routes are referred to in the BRA as "pathways," and pathway exposure assessments take into account how long, how often, and how many ways in which certain types of people may be exposed. The types of people who are hypothetically assumed to be exposed are defined by their physical characteristics and behaviors and are called "receptors" in this Remedial Risk Assessment. Potential exposure pathways were qualitatively evaluated in this Remedial Risk Assessment for each remedial alternative in order to identify receptors with the greatest potential for exposure. The receptor with greatest exposure potential is called the "reasonably maximally exposed" individual (RME individual).

- *Toxicity assessment:* This step evaluates the potential health effects that exposure to constituents found in OU-1 may cause. It includes an assessment of the increased risk of cancer, as well as non-carcinogenic effects. The chemicals and radionuclides selected for evaluation are the same as those listed as COPCs in the updated BRA.

- *Risk characterization:* This final step combines the results of the first three steps to identify the largest sources of risk that may be posed by COPCs in OU-1 and determine whether these risks exceed the acceptable risk range of 10^{-06} to 10^{-04} required by EPA under CERCLA.

ES2. Modeling Risks

Among other risks, this Remedial Risk Assessment evaluates what are called "cancer risks." It is well established that humans are exposed to a wide variety of carcinogens on a daily basis (for example, secondhand smoke, cosmic and solar radiation from the sun, and air pollution, among others). Therefore, the risks described in this Remedial Risk Assessment are expressed numerically as the incremental increase to lifetime risk of cancer due to a human's exposure to a particular constituent under a certain prescribed scenario. Stated another way, an incremental cancer risk of 10^{-06} is equivalent to a 0.0001% increase in the chance that a particular person may get cancer as a result of the assumed exposure scenario. The EPA has previously determined that exposures resulting in an incremental cancer risk of no more than one instance in ten thousand – that is, 10^{-04}, or a 0.01% chance increase – to the hypothetical receptor are acceptable for purposes of CERCLA risk assessment. Because risk is calculated as a probability, a finding of risk associated with a particular constituent does not necessarily mean that a person will actually develop cancer as a result of exposure to that constituent.

The purpose of this Remedial Risk Assessment is to undertake an evaluation of the potential short-term and long-term risks associated with each remedial alternative. Short-term risks are risks that are associated with the process of implementing a particular remedial alternative. Long-term risks are risks that remain after the remedial work is complete. This evaluation is designed to be conservative in that it is intended to *overstate* potential risk. In order to accomplish this, risks are evaluated based upon a hypothetical RME individual – that is, the person who is assumed to have the greatest exposure to COPCs at the Site with respect to the remedial alternatives. In this Remedial Risk Assessment, the RME individual for short-term risk associated with all remedial alternatives is the radiation control technician working on remedial alternative implementation. The RME individual for the long-term risk associated with all remedial alternatives is a grounds keeper working on the OU-1 areas.

ES3. Results

This Remedial Risk Assessment concludes that:

- The calculated short-term risks associated with implementation of the ROD-selected remedy are substantially lower than the potential short-term risks associated with the remedial alternatives (the full excavation and both partial remedial alternatives) in all risk categories evaluated.
- The calculated short-term risks to the RME individual (the radiation control technician) during implementation of the ROD-selected remedy are within EPA's generally acceptable risk range at CERCLA sites. The risks associated with the other remedial alternatives are up to an order of magnitude greater than EPA's generally accepted risk range at CERCLA sites.
- The calculated short-term risks to the off-property resident for all remedial alternatives are less than 10^{-07}.
- Construction and industrial accident forecasts for all remedial alternatives were higher than the construction and industrial accident forecasts for the ROD-selected remedy.
- The estimated short-term radiation dose to the RME individual for the ROD-selected remedy is also the lowest of all the remedial alternatives.
- All calculated long-term risks are well below EPA's maximum acceptable risk of 10^{-04}, and are in fact below 10^{-08}. The predicted radiation doses to the RME individual (the landfill grounds keeper) for all remedial alternatives are also well below the occupational exposure limit of 5,000 millirem per year (mrem/yr).
- The short-term risks from the ROD-selected remedy are the only set of risks that are less than the upper bound of EPA's acceptable risk range.

Table ES-1 Compilation of Calculated Short-term and Long-term Hazards and Risks

	Category of Hazard or Risk	Partial Excavation to 1,000 pCi/g Alternative	Partial Excavation to 52.9 pCi/g Alternative	Full Excavation with Off-Site Disposal Alternative	ROD-Selected Remedy
Short-term	Projected Incidence of Transportation Accidents [a]	1.66E+01	1.06E+01	3.49E+01	6.14E-01
	Projected Incidence of Industrial Accidents [b]	1.17E+01	8.47E+00	1.78E+01	2.76E+00
	Carcinogenic Risk to Reasonably Maximally-Exposed RadCon Tech during Construction [c]	2.38E-03	1.18E-03	2.19E-03	9.23E-05
	Hazard Index for Reasonably Maximally-Exposed RadCon Tech during Construction [c]	1.22E+00	1.22E+00	1.22E+00	1.22E+00
	Carcinogenic Risk to Reasonably Maximally-Exposed Off-property Resident during Construction [c]	5.26E-08	4.17E-08	5.17E-08	3.37E-08
	Hazard Index for Reasonably Maximally-Exposed Off-property Resident during Construction [c]	4.12E-04	4.12E-04	4.12E-04	4.12E-04
	Dose (TEDE) to Qualified Radiation Remediation Worker (mrem/y) [d]	8.67E+02	7.20E+02	4.05E+02	1.87E+02
Long-term	Carcinogenic Risk to Reasonably Maximally-Exposed Individual after Construction [e]	3.63E-10	1.90E-11	1.48E-09	1.01E-09
	Dose (TEDE) to Reasonably Maximally-Exposed Individual after Construction (mrem/y) [d]	2.89E-04	1.51E-05	1.71E-04	4.23E-04

[a] Dependent on mileage on public roads.
[b] Dependent on man-hours worked.
[c] Dependent on man-hours worked while RIM exposed and will vary depending on length of project. Note systemic effects from lead were evaluated separately from other non-carcinogens; no unacceptable risks were predicted for lead.
[d] Annual dose limited by concentration and 1 year reporting period.
[e] Highest risks are in year 1,000 at Area 1.

1 INTRODUCTION

Operable Unit 1 (OU-1) of the West Lake Landfill (the "Site") is currently the subject of a Remedial Investigation /Feasibility Study (RI/FS) pursuant to the Comprehensive Environmental Response, Compensation & Liability Act (CERCLA or "Superfund Act"). As part of the RI/FS process, numerous reports presenting Site investigation data and evaluations have been submitted to the United States Environmental Protection Agency (EPA) Region 7. This Appendix contains evaluations of potential human health risks associated with the remedial alternatives proposed by EPA and thus is a companion document to the Final Feasibility Study (FFS), which was prepared to fulfill EPA's December 9, 2015 Statement of Work (SOW). Consistent with the SOW, the FFS evaluates the following five potential remedial alternatives:

No Action Alternative – Required by the National Contingency Plan (NCP) and RI/FS guidance to provide a baseline against which all of the other remedial alternatives are evaluated[1]. This alternative is considered the baseline condition, and modeled risks associated with this alternative are discussed in detail in the updated Baseline Risk Assessment (BRA) (Auxier 2016);

Partial Excavation 1,000 pCi/g Alternative – Excavation and off-site disposal of all soil/waste containing combined radium (radium-226 plus radium-228) or combined thorium (thorium-230 plus thorium-232) with activity levels greater than 1,000 picoCuries per gram (pCi/g)[2];

Partial Excavation 52.9 pCi/g Alternative– Excavation and off-site disposal of all soil/waste containing combined radium (radium-226 plus radium-228) or combined thorium (thorium-230 plus thorium-232) with activity levels greater than 52.9 pCi/g down to a total depth of 16 feet beneath the 2005 topographic surface;

Full Excavation with Off-site Disposal Alternative– Excavation and off-site disposal of all soil/waste containing combined radium (radium-226 plus radium-228) or combined thorium (thorium-230 plus thorium-232) with activity levels greater than 7.9 pCi/g (the "complete rad removal" alternative); and

2008 ROD-Selected Remedy – This alternative is the remedy selected pursuant to EPA's 2008 Record of Decision (ROD) for the Site. It is a containment remedy consisting of regrading and installation of a new landfill cover and other remedial components for the Site, including consolidation of any radiologically-impacted soil that may remain on the former Ford property (now known as the Buffer Zone and Crossroad Lot 2A2) into the containment areas in Area 1 and 2 prior to placement of additional fill and construction of the new landfill cover.

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[1] The SOW identifies an alternative no. 3: "Leaving all RIM in place on-site." Subsequent discussions with EPA indicated that this alternative was the No Action Alternative.

[2] In all cases evaluated in the baseline, thorium-230 and radium-226 (plus decay products) accounted for more than 95% of the risk to the target receptors. Other radionuclides are co-located with radium-226 and thorium-230 and are projected to produce risks to the future groundskeeper of $< 10^{-7}$. Remediation of the thorium-230 and radium-226, by themselves, would reduce the total risks from RIM to below 10^{-4}. Any remediation of radium -226 and thorium-226 would also lower the negligible risks from these ancillary radionuclides still further.

The FFS comparatively evaluates these remedial alternatives based on nine criteria set forth in the National Contingency Plan (NCP): (i) overall protection of human health and the environment; (ii) compliance with Applicable or Relevant and Appropriate Requirements (ARARs); (iii) long-term effectiveness; (iv) reduction of toxicity, mobility, or volume; (v) short-term effectiveness; (vi) implementability; (vii) cost; (viii) state acceptance; and (ix) community acceptance. In support of evaluating protectiveness of human health and the environment, this Appendix contains evaluations of potential short-term and long-term risks associated with soil and air for each remedial alternative and the methods used to identify and quantify those risks. Note that groundwater risks are not evaluated herein because (i) under current and anticipated future conditions, there are no known completed exposure pathways and (ii) groundwater at the Site is being evaluated as a separate operable unit (OU-3).

This Appendix has been prepared consistent with guidance provided in Risk Assessment Guidance for Superfund (RAGS) Volume 1 Human Health Evaluation Manual(EPA 1989). This Appendix also contains information on projected remedial alternative-specific industrial hazards, such as construction and traffic accidents, for the four remedial alternatives.

1.1 OBJECTIVES

The specific objectives of this evaluation are:

- Estimate the magnitude of potential short-term health risks associated with activities involved with implementation of each remedial alternative; and
- Estimate the magnitude of potential long-term health risks that may be posed by the Site after implementation of each remedial alternative is complete.

For the purposes of this evaluation, "short-term" is defined as the period during which a given remedial alternative is being implemented and "long-term" is defined as the post-remediation period (whether 1 year or 1,000 years later). Risks were grouped into the following categories for this report:

- Short-term risks to human health from short-duration exposures to radio-carcinogenic, chemical-carcinogenic, and systemic (non-carcinogenic) constituents;
- Short-term risks of injury or fatalities from industrial and construction accidents, which are collectively referred to herein as "industrial hazards";
- Short-term occupational doses to radiation workers; and
- Long-term risks to human health from exposures to radio-carcinogenic constituents of potential concern (COPCs).

Potential short-term and long-term human health risks for each of the four remedial alternatives are evaluated in this Appendix. The modeled risks associated with the No Action alternative are detailed in the updated BRA (Auxier 2016).

1.2 INCORPORATION OF UPDATED INFORMATION

In conjunction with the RI Addendum and FFS, Auxier & Associates, Inc. completed an update to the BRA that was previously prepared in 2000 for OU-1 of the West Lake Landfill (Auxier 2000). The updated BRA builds upon the information, evaluations and data collected prior to and as part of the RI (EMSI 2000), the FS (EMSI 2006), the ROD (EPA 2008a), the

Supplemental Feasibility Study (SFS) (EMSI 2011), and the RI Addendum (EMSI 2016). The BRA was updated to reflect the latest physical changes (installation of the non-combustible cover over radiologically-impacted material (RIM) on the surface of the Site) to Areas 1 and 2 and the latest efforts to characterize the nature and extent of the RIM. The BRA used EPA methodology to model hypothetical current and future risks to a variety of potential receptors, conservatively assuming that no corrective action would occur in Area 1, Area 2, and/or the Buffer Zone.

The risk evaluations in this FFS build on the updated BRA (Auxier 2016) for OU-1 of the West Lake Landfill. Updated information regarding toxicity, dose conversion factors, and toxicity values gathered from EPA's Integrated Risk Information System (IRIS) database and risk assessment websites were incorporated in the updated BRA and in this evaluation.

1.3 ORGANIZATION OF APPENDIX

An introduction to the human health risk assessment methods and general risk assessment information that applies to both short-term and long-term COPC risks is presented in Section 2. Short-term risk methods common to all remedial alternatives are presented in Section 3. Short-term assessments for the individual alternatives are presented in Sections 4 through 7. Sections 8 through 12 present the long-term risks calculated for each of the four alternatives. A summary of the findings presented in this Appendix are presented in Section 13. References are listed in Section 14.

2 COPC HUMAN HEALTH RISK ASSESSMENT METHODOLOGY

2.1 INTRODUCTION

Modeled theoretical risk estimates from potential exposure to COPCs in environmental media for the four remedial alternatives are evaluated in this Appendix. The theoretical risks associated with the No Action Alternative are detailed in the updated BRA (Auxier 2016). The subsections that follow present the methods used herein to evaluate potential radiocarcinogenic, chemical-carcinogenic, and systemic (non-carcinogenic) risks associated with each of the four remedial alternatives.

2.2 RISK ASSESSMENT PARAMETERS

Short-term and long-term risks from exposure to radiological and chemical constituents are evaluated using standard EPA methodology for conducting human health risk assessments (HHRAs), which includes the following four components: selection of COPCs, exposure assessment, toxicity assessment, and risk characterization. Elements of these components that are common to all alternatives under short-term and long-term scenarios are discussed below; elements specific to a timeframe or an alternative are described in greater detail, as appropriate, in Sections 3 through 12.

2.2.1 **Identification of Constituents of Potential Concern**

OU-1 of the West Lake Landfill contains both radiological and chemical (non-radiological) COPCs. The concentrations and toxicity of these constituents were identified and used in the updated BRA to focus the risk assessment on the chemicals and radionuclides most likely to produce risks above the 10^{-06} cancer risk point of departure. These risk-driving constituents were defined as COPCs and are used to evaluate the effectiveness of each remedial alternative to reduce risks. The COPCs identified in Table 2-1 and Table 2-2 are applicable to short-term and long-term risks; however, note that under future scenarios, exposure pathways for non-radiological COPCs are assumed to be incomplete due to cap/cover installation.

2.2.1.1 Radionuclides of Potential Concern

The updated BRA identified as constituents of interest the radionuclides associated with the naturally occurring uranium-238, uranium-235, and thorium-232 decay series. Soil samples from various sampling events in and around OU-1 were compiled into one data set. A series of screening evaluations were performed on these data to focus attention on those detected analytes that are (1) believed to be associated with RIM at the Site, and (2) may be important contributors to human health risk. Table 2-1 presents the radionuclides that were evaluated in the updated BRA risk characterization process. Calculated BRA risks for many of the radionuclide COPCs did not exceed the 10^{-06} cancer risk point of departure; however, in consideration of the potential for in-growth and therefore changing activity levels, all radionuclide COPCs from the updated BRA were retained for evaluation herein.

Table 2-1 Radionuclide COPCs in Soil at the West Lake Landfill

	Frequency Screen			Background Screen		
Analyte	**Detection Frequency**	**Detection Rate**	**Maximum Screening Concentration**	**Background Concentration [a]**	**Background Comparison**	**Screen Results**
Radionuclides	**(hits/analyses)**	**(< 5% ?)**	**(pCi/g)**	**(pCi/g)**	**(< 2 x BKG)**	
Uranium Series						
Uranium-238	300/308	No	1823	1.33	No	Pass
Thorium-234	109/326	No	1166	1.18	No	Pass
Uranium-234	298/308	No	1711	1.47	No	Pass
Thorium-230	305/326	No	57300	1.51	No	Pass
Radium-226	261/326	No	4926	1.06	No	Pass
Lead-214	289/326	No	4578	1.01	No	Pass
Bismuth-214	237/326	No	3690	0.72	No	Pass
Lead-210	158/326	No	1370	2.08	No	Pass
Actinium Series						
Uranium-235	267/308	No	774	0.33	No	Pass
Protactinium-231	55/326	No	2030	2.19	No	Pass
Actinium-227	160/308	No	1320	0.45	No	Pass
Thorium Series						
Thorium-232	292/308	No	515	0.90	No	Pass
Radium-228	184/326	No	31.8	1.12	No	Pass
Actinium-228	147/326	No	31.8	ND	No	Pass
Thorium-228	176/308	No	16.9	0.68	No	Pass
Radium-224	47/326	No	6580	1.93	No	Pass
Lead-212	262/326	No	800	1.29	No	Pass
Thallium-208	221/326	No	23.5	0.44	No	Pass

[a] Background values are based on four site samples taken by McLaren/Hart in 1995. Analytical suites differed between sample groups and a background screen was only performed on analytes where background values were reported.

2.2.1.2 Chemicals of Potential Concern

The updated BRA included a series of screening tests on the chemicals that were reported at the Site. Table 2-2 presents the concentrations used in the screening evaluation and the results; a “pass” flag in the screening results column indicates that the chemical was identified as a COPC for further evaluation in the BRA risk characterization.

Table 2-2 Summary of Chemical Toxicity Screen in All Soil at the West Lake Landfill

		Frequency Screen			Nutrient Screen		Toxicity Screen [b]					
Analyte	CAS Number	Detection Frequency	Detection Rate	Maximum Screening Concentration [a]	Nutrient Screening Value	Essential Nutrient?	Ingestion Screening Value	Dermal Screening Value	Inhalation Screening Value	Target Screening Value	Toxicity Comparison	Screen Results
Inorganic Chemicals		(hits/analyses)	(< 5% ?)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(< Criterion)	
Antimony	7440-36-0	63/131	No	54		No	47			47	No	Pass
Arsenic	7440-38-2	112/134	No	610		No	3.6	17	3900	3	No	Pass
Chromium, Total	18540-29-9	130/134	No	890		No	6.5		200	6.3	No	Pass
Cobalt	7440-48-4	99/100	No	2700	7.82	No	35		1900	35	No	Pass
Lead	7439-92-1	132/134	No	13000		No				800	No	Pass
Mercury	7439-97-6	92/134	No	12		No			4.6	4.6	No	Pass
Nickel	7440-02-0	134/134	No	3600		No	2300		54000	2200	No	Pass
Vanadium	7440-62-2	79/100	No	1800		No	590		60000	580	No	Pass
Uranium	7440-61-1	300/308	No	5457		No	350		24000	NA	No	Pass
Pesticides/Polychlorinated Biphenyls (PCBs)												
Aroclor 1242	53469-21-9	5/44	No	2.60		No	1.6	2.8	13	0.95	No	Pass
Aroclor 1254	11097-69-1	4/44	No	1.6		No	1.6	2.8	18	0.97	No	Pass
Volatile Organic Compounds												
1,4-Dichlorobenzene	106-46-7	10/36	No	2100		No	610		12	11	No	Pass
Chlorobenzene	108-90-7	8/37	No	180		No	2300		140	130	No	Pass

[a] Screening concentrations are maximum detected concentrations. Note that sample WL-208-U was an anomalous sample where the drillers went through a paint can. This sample is not thought to be representative of the entire landfill, therefore the sample was removed for the purposes of this screening table.

[b] Unless otherwise noted, screening values are from EPA Regional Risk-Based Screening Levels (EPA 2016a)

2.2.2 Exposure Assessment

The purpose of an exposure assessment is to estimate the nature and magnitude of exposures from a site under current and plausible future conditions. An exposure assessment consists of the following steps:

- Characterization of the exposure setting during remedy implementation (i.e., the short-term);
- Quantification of exposure point concentrations;
- Identification of receptors with potentially complete exposure pathways and selection of representative receptors for use in the FFS comparative analysis; and
- Quantification of receptor-specific intake/exposure.

Components of the exposure assessment that are specific to an alternative are discussed in Section 4 through Section 7 in the short-term, and Section 9 through Section 12, in the long-term. The subsections that follow present those components that are broadly applicable to the COPC risk characterization.

2.2.3 Exposure Point Concentrations in Soil

2.2.3.1 Short-term

The calculated risks published in the updated BRA indicate that radio-carcinogenic risks to receptors associated with Area 2 were consistently higher than risks to the same receptors in Area 1. Therefore, this assessment uses the radionuclide concentrations associated with Area 2 to provide a conservative estimate of the risk to hypothetical receptors (i.e., receptors in other areas will be exposed to lower concentrations of the constituents producing the greatest human health effects).

The 95% upper confidence limit on the mean (UCL) for all radionuclide COPCs were calculated from sample results using methods described in the updated BRA. Subsequently, the average concentrations of Ra-226 and Th-230 based on the volume of soil excavated for each remedial alternative were calculated using the methods described in Appendix L. The exposure point concentration for other radionuclide COPCs were estimated by establishing the ratio of the average and 95% UCL for Ra-226 and Th-230 (average concentration / 95% UCL). Those two ratios were averaged and then multiplied by the 95% UCL to scale the other radionuclide COPCs and establish their exposure point concentrations.

A smaller number of samples were tested for chemical analytes rather than for radionuclides. As a result, all chemical sample results from OU-1 were combined into one data set. The 95% UCL was calculated from this data set and used as representative chemical exposure point concentrations. This approach is reasonable due to the limited number of chemical samples and because not all chemical analytes were found in one area. The identified chemical analytes are associated with general landfill materials; therefore, this assessment conservatively assumes that the identified chemical analytes could be detected in either Area 1 or Area 2, even if they were not detected in one of the areas.

Because the remaining and excavated soil volumes for each of the remedial alternatives will result in differing soil concentrations in the short-term, Sections 4 through 7 will present each remedial alternative's specific exposure point concentrations.

2.2.3.2 Long-term

In the long-term (post-construction), the identification of remedial alternative-specific remediation criteria will result in remedial alternative-specific exposure point concentrations (EPCs). Only constituents that produce indirect exposures that would emanate through the cap need to be considered, as there is no means of direct contact with RIM under any of the four remedial alternatives in the long term. The chemical COPCs were screened out of the long-term assessment because the landfill cap contemplated under all four remedial alternatives will prevent direct contact with these COPCs, and their lack of volatility prevents their emission in gaseous form. Representative concentrations for each COPC will be presented in each of the remedial alternative-specific long-term risk sections.

2.2.4 **Exposure Point Concentrations in Air**

2.2.4.1 Short-term

Occurrences of RIM within Areas 1 and 2 are dispersed within landfilled material that is further dispersed throughout portions of the overall, heterogeneous matrix of municipal refuse, construction and demolition debris, and soil materials. As such, material that will be disturbed during remedial alternative implementation is not just soil. Rather, the material likely consists of a mixture of paper, rags, plastic, bottles and cans, lumber and pipe, old food and refuse, with some soil mixed into the matrix. It is likely that the trash/debris will have a much lower resuspension rate than soil undergoing similar processes.

Thus there are two competing considerations when modeling air concentrations at OU-1: construction activities would be expected to raise dust levels, but given the nature of the materials being handled, substantial dust would not be expected. In addition, dust suppression measures, partial excavation of areas, and a properly managed health and safety monitoring program will further reduce dust emissions within the working areas. For this evaluation, it was conservatively assumed that the material was "true" soil and would be dispersed and transported as such.

The air transport model AERMOD-View^{TM} v 9.1 was used to simulate aerial transport of respirable particulate matter (PM 2.5) and radon. AERMOD-View^{TM} v 9.1 is a commercially available application which features a user-friendly interface on the EPA-approved air dispersion modeling code known as AERMOD (EPA 2004), version 15181 (EPA 2015). Radon flux values were measured on OU-1 after the non-combustible cover was installed in 2016. Since radon is a gas it is minimally impacted by the non-combustible cover. Those measured radon flux values were then modelled using AERMOD to obtain the projected radon concentrations at the specific receptor sites. Since radon exposure is from all of OU-1, the maximum concentration does not change based on the remedial alternative chosen. Table 2-3 presents the projected radon concentrations at both an on-property and off-property receptor location; these locations were selected based on the results presented in the updated BRA (Auxier 2016). The particulate concentrations, however, vary with the volume of soil excavated and therefore are specific to each remedial alternative. The specific concentrations will be presented in each short-term risk section.

Table 2-3 Projected Radon Concentrations at Selected Locations

Analyte	Off-Property, Southeast (722898 E 4293620 N)	On-Site, Area 2 (721720 E 4294785 N)
Flight distance(m)	1090	440
Flight time(min) [a]	4.40	1.80
Current		
Rn-222 (pCi/m^3)	2.3 E-2	2.2 E+0
Po-218 (pCi/m^3)	1.5 E-2	7.1 E-1
Pb-214(pCi/m^3)	9.3 E-4	1.7 E-2
Bi-214 + 1 dtr (pCi/m^3)	5.0 E-5	3.6 E-4

[a] Average flight time to a location is estimated as a quotient of the location's distance from the center of the domain and 4.1 m/s, the average annual wind speed (Dist(m)/Speed(m/s/60s/min).

2.2.4.2 Long-term

Each remedial alternative includes a landfill cover as a remedial component, thereby eliminating the potential for fugitive dust emissions from any remaining RIM. Therefore, for the long-term AERMOD was used to simulate aerial transport of only radon from Area 1 and 2. Representative radon concentrations for each remedial alternative will be presented in each of the remedial alternative-specific long-term risk sections.

2.2.5 **Potential Receptors**

In the short-term, the activities expected to occur during construction of each of the remedial alternatives were examined to identify potential receptors. Most of the tasks and activities are common to all four remedial alternatives. Other activities would be limited to the specific remedial alternatives. Each short-term remedial alternative-specific evaluation in Sections 4 through 7 contains a list of hypothetical receptors considered for that particular risk assessment. As detailed in Section 3, the On-Property RadCon Tech Worker and Off-Property Resident were selected as representative receptors for the short-term evaluation.

The long-term post-construction receptor chosen for evaluation was the hypothetical grounds keeper, who was the reasonably maximally exposed (RME) individual, as determined in the updated BRA.

2.2.6 **Exposure Pathways**

Exposure pathways are discussed in length in Section 3.1.3 of the updated BRA. The six plausible exposure pathways are: inhalation of fugitive dust, inhalation of radon, direct radiation from soil, direct radiation from submersion in air, incidental soil ingestion, and dermal contact. In the short term, RIM will be disturbed by grading or excavation during construction of each of the four remedial alternatives. In the long term, the presence of the cover and/or the extent of RIM removal will affect the plausible exposure pathways.

There are currently no private wells used to provide domestic or community (potable) water supplies within a 2-mile radius of the West Lake Landfill. The Landfill and surrounding areas are projected to continue to receive potable water from the municipal supply system for the foreseeable future. Due to the limited potential for leaching of the principal constituents , the deed restrictions that prohibit use of wells for drinking water at the Site, and the lack of potable groundwater wells, direct exposure to groundwater at the West Lake Landfill and surrounding areas represents an incomplete exposure pathway and was not considered for quantitative evaluation.

2.2.7 Toxicity Assessment

The chemicals and radionuclides selected for evaluation are the same as those listed as COPCs in the updated BRA. The toxicity values used in the updated BRA were also used herein for both short-term and long-term risk evaluations. Further discussion regarding the carcinogenic and systemic effects of the COPCs can be found in the updated BRA.

2.2.7.1 Blood Lead Levels of Workers During Construction

EPA's Adult Lead Methodology (2003, 2007, 2009a, and 2009b) and the EPA Adult Lead Methodology (ALM) spreadsheet[3] were used to calculate blood levels for the RadCon Tech providing health physics services in the field during construction. This receptor could potentially have years of regular direct contact with OU-1 soils while they are exposed during construction. The potential exposures for other occupational receptors will be more limited due to (1) lack of direct access to RIM, (2) exposure to more limited quantities of RIM, or (3) shorter and/or intermittent exposure to RIM.

The EPA methodology recommends using the average concentration of lead in soil to calculate blood lead levels in adults (EPA 2007). The average current concentrations for Area 1 and Area 2 surface soil, as presented in Section 2.6 of the updated BRA, are 85.5 mg/kg and 555 mg/kg, respectively. These average current concentrations were used to calculate blood lead levels in two hypothetical adult populations. The calculated blood levels in those two populations effectively describe the upper and lower ranges of the measured blood levels in U.S. women aged 17-45, monitored as part of the NHANES III study.[4]

Using the average surface soil lead concentrations and an exposure duration of 225 days yields adult blood lead levels of 1.1 µg/dL to 1.8 µg/dL for the RadCon Tech exposed to Area 1 and Area 2 soil, respectively, as presented in Table 2-4. EPA guidance is pending on the potential impacts of low blood lead level concentrations on public health, but these calculated levels are less than the EPA's 5-10 µg/dL levels discussed as potential benchmarks in EPA's OSWER Directive 9200.2-82 (EPA 2009a). The ALM also predicts an unlikely probability that blood lead levels in a fetus will exceed these acceptable benchmark levels; EPA has set a goal that there should be no more than a 5% chance that a child will have a blood lead level above 10 µg/dL. Results of the blood lead modeling are evaluated based on comparisons to these benchmarks.

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[3] From https://www.epa.gov/sites/production/files/2015-09/alm_2009.xls (Aug 25, 2016).

[4] For more information about these two test populations and the default parameters used in the calculation, see EPA 2002, CDC 2005a, CDC 2005b, and CDC 2005c.

It should be noted that proper use of standard personal protective equipment such as gloves, the use of heavy equipment for most jobs requiring direct handing of RIM, and active dust suppression measures all would likely result in actual soil ingestion rates that are less than those used in the calculations. Any reduction of soil ingestion rates would, in turn, reduce calculated blood lead levels, suggesting that the calculated blood lead levels published here overestimate what can be expected during remedial alternative construction.

It should be noted that proper use of standard personal protective equipment such as gloves, the use of heavy equipment for most jobs requiring direct handing of RIM, and active dust suppression measures all would likely result in actual soil ingestion rates that are less than those used in the calculations. Any reduction of soil ingestion rates would, in turn, reduce calculated blood lead levels, suggesting that the calculated blood lead levels published here overestimate what can be expected during remedial alternative construction.

Table 2-4 Projected Blood Levels in Workers Exposed to Current Concentrations of Lead in Surface Soil

Variable	Description of Variable	Units	Area 1		Area 2	
			EPA 2009 [a]	EPA 2002 [b]	EPA 2009 [a]	EPA 2002 [b]
PbS	Soil lead concentration	mg/kg	86	86	555	555
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	unitless	0.9	0.9	0.9	0.9
BKSF	Biokinetic Slope Factor	µg•d/dL•µg	0.4	0.4	0.4	0.4
GSD_i	Geometric standard deviation PbB	unitless	1.8	2.1	1.8	2.1
PbB_0	Baseline PbB	µg/dL	1.0	1.5	1.0	1.5
IR_{S+D}	Ingestion rate, soil + indoor dust	g/d	0.050	0.050	0.050	0.050
$AF_{S, D}$	Absorption fraction (soil and dust)	unitless	0.12	0.12	0.12	0.12
$EF_{S, D}$	Exposure frequency (soil and dust)	d/y	225	225	225	225
$AT_{S, D}$	Averaging time (soil and dust)	d/y	365	365	365	365
PbB_{adult}	**PbB of adult worker, geomean**	**µg/dL**	**1.1**	**1.6**	**1.8**	**2.3**
$PbB_{fetal, 0.95}$	95th %tile PbB among worker's fetuses	µg/dL	2.7	5.0	4.3	7.1
PbB_t	Target PbB benchmark	µg/dL	**10.0**	**10.0**	**10.0**	**10.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB > PbB_t, assuming lognormal distribution**	**%**	**0.00%**	**0.5%**	**0.10%**	**1.7%**

Note: Portions of table extracted from: https://www.epa.gov/sites/production/files/2015-09/alm_2009.xls (Aug 25, 2016).

[a] More homogeneous, GSD_i and PbB_o from NHANES 1999-2004. Recommended by EPA 2009.

[b] Reflects an earlier evaluation of a more homogeneous population, GSD_i and PbB_o from NHANES III (Phases 1&2)

2.2.8 **Exposure Setting and Risk Characterization Methods**

Potential exposure media, receptors, and exposure points are typically identified in an HHRA based on site conditions, including current and future land use. In the short-term, general land use at and surrounding West Lake Landfill is expected to remain unchanged – the Site will continue operating within an industrial setting. As such, many of the receptors identified in the updated BRA are also relevant to the evaluation of short-term COPC exposure risks (e.g., nearby workers, off-property residents). Several additional receptors are expected be present at OU-1 during remedial alternative implementation – some of which are expected to be in close proximity to RIM. Therefore, in the short term, the anticipated activities are the key aspect of the exposure setting considered in this evaluation.

The construction phase of all remedial alternatives considered in this study is expected to produce direct exposure to RIM and chemical COPCs, and all but one ("complete rad removal") will leave some RIM in place at the West Lake Landfill. The post-construction surface of OU-1 for all the remedial alternatives will be covered by a RCRA Subtitle D solid waste landfill cover designed to comply with structural and performance standards associated with the closure and post-closure requirement of the Missouri solid waste regulations. Under the ROD-selected remedy and the two remedial alternatives that leave concentrations of RIM above 7.9 pCi/g, the solid waste landfill cover would also include a rock/concrete rubble bio-intrusion/marker layer pursuant to Uranium Mill Tailings Radiation Control Act (UMTRCA) requirements.

Potential human health effects resulting from exposure to COPCs are estimated using methods established by the EPA. These methods are published in a series of guidance documents including the Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (EPA 1989a) (RAGS) and integrated into web-based calculators hosted by the Oak Ridge National Laboratory (ORNL) and EPA.[5]

Other tools used in the COPC risk assessment process include AERMOD, which was used to estimate the air concentration of COPCs at receptor locations, MicroShield, which was used to calculate the Total Effective Dose Equivalent (TEDE), and EPA's Adult Lead Model (short-term only). These are described in more detail in the following subsections.

2.2.8.1 EPAs PRG and RSL Calculators to Assess Risks

Radio-and chemo-carcinogenic risks involving contact with surface and subsurface soils (inhalation, ingestion, direct radiation, and submersion) and from inhalation (fugitive dust, radon and radon daughters) were calculated using the EPA's web-based preliminary remediation goal (PRG) calculator[6] or the Regional Screening Level (RSL) calculator[7]. These calculators provide PRGs for radionuclides or RSLs for chemicals for each exposure route. Using a target risk (TR) of 10^{-06} and the EPA web calculator's default or site-specific parameters for a particular type of worker or resident, the "unit PRG (or RSL)" or the PRG associated with 1 pCi/g (or mg/kg or $\mu g/m^3$) can be determined. This method results in an effective and efficient means of calculating

[5] https://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search and https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-may-2016

[6] http://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search

[7] http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/

the risk associated with any concentration of a COPC. The risk is calculated by dividing 10^{-06} by the unit PRG (or RSL), and then multiplying by the concentration (soil or air depending on the application) of the COPC. For example, the default unit PRG for outdoor worker exposures for radium-226 and its short-lived daughters in soil from all exposure routes is 2.33 x 10^{-02} pCi/g. The incremental risk associated with each additional pCi/g of radium-226 is 4.292 x 10^{-05} (10^{-06} / 2.33 x 10^{-02}). This ratio can be multiplied by the applicable concentration to determine the risk associated with exposure to the COPC.

In the FFS, risks to specific workers from soil and air are evaluated using the method illustrated above. However, assessment of carcinogenic risks to individual types of workers identified during the scheduling and manpower evaluation stages of this study may require job-specific changes in parameters used to calculate the unit PRG, such as exposure time and duration. Therefore, a combination of site- and receptor-specific parameters and default values from the EPA calculators were used during risk calculation. Changes in these parameters and their justifications are presented as part of the risk evaluation in each remedial alternative specific section. Because the relationship between risk and exposure is linear, the risk results will change linearly with changes in either exposure times or durations. For example, if the calculated risk from 45,000 hours[8] of exposure to soil containing 1 pCi/g of radium-226 is 4.0 x 10^{-05}, then exposure to the same soil for only one hour will be 1/45,000th of that risk or 8.9 x 10^{-10} per pCi/g per hour and a 1,000 hour exposure would yield a calculated risk of 8.9 x 10^{-07}.

2.2.8.2 MicroShield

Dose rates to the short-term and long-term occupationally exposed individuals, in units of millirem/year (mrem/y), were calculated using MicroShield® software. MicroShield® is a comprehensive photon/gamma ray shielding and dose assessment program that is widely used for designing shields, estimating source strength from radiation measurements, minimizing exposure to people, and teaching shielding principles.

The TEDE was calculated by multiplying the time spent exposed to RIM in a year by the dose rate in mrem/y as calculated by MicroShield (given the soil concentration of COPCs and a cover thickness where applicable). To provide a preliminary evaluation of potential risk, these dose rates were compared to the default occupational exposure limit of 5,000 mrem/y.

2.2.8.3 AERMOD

Air exposure point concentrations at selected receptor exposure points were estimated using AERMOD. AERMOD is an EPA-approved, steady-state Gaussian dispersion model. BREEZE AERMOD is an enhanced version of AERMOD that provides modelers with the tools and functionality required to perform air quality analyses to address both permitting, regulatory, and nuisance issues as well as to perform academic research.

Radio-carcinogenic risk from radon and radon daughters was calculated by dividing 10^{-06} by the "Air" unit PRG and then multiplying by the estimated air concentration as modeled using AERMOD (given the soil concentration of COPCs and a cover thickness where applicable).

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[8] http://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search. EPA's outdoor worker receptor assumes the worker is present for 8 hours a day, 225 days/year for 25 years, or 25 years x 225 days/year x 8 hour/day = 45,000 hours of exposure.

2.2.8.4 EPAs RSL Calculator to Assess Hazard Indices

The effects associated with exposures to non-carcinogenic chemicals are evaluated differently from the approach used to evaluate carcinogens. Intakes are compared to a reference quantity that represents a safe level of exposure. The ratio of a receptors intake over the reference quantity is termed the Hazard Quotient (HQ) for that chemical in a given exposure scenario. If the HQ exceeds 1, there may a risk of potential health effects. In the case where a receptor receives simultaneous exposures to several chemicals, a Hazard Index (HI) is calculated as the sum of the HQ. Table 2-2 presents the non-carcinogenic COPCs that were considered in this FFS and in this evaluation.

2.3 SHORT-TERM RISK ASSESSMENTS FOR PROPOSED REMEDIAL ALTERNATIVE

Short-term risks were grouped into two major categories in this report: risks to human health from exposures to RIM and COPCs present in OU-1; and, risks of injury or fatalities from industrial and construction accidents in conjunction with implementation of the remedial alternatives. These risks are evaluated for both on- and off-property individuals. Human health risks include carcinogenic and non-carcinogenic effects from exposure to any RIM and COPCs that might be uncovered, excavated, transported or handled while on the Site or during transportation from the Site. The risks from construction, material handling, and transportation accidents have been grouped together under “industrial hazards”. Specifics risks for each remedial alternative are found in Sections 3 through 7.

2.4 LONG-TERM RISK ASSESSMENTS FOR PROPOSED REMEDIAL ALTERNATIVE

Long-term human health risk assessments for each of the four remedial alternatives are also presented. These risks are presented in Sections 8 through 12. Each of the remedial alternative-specific risk assessments identify the source and inventory of RIM constituents, lists exposure pathways, identifies the RME individual(s) and presents remedial alternative-specific details about the methods and data used to assess potential risks at year 1 after construction and over the next 1,000 years after implementation of a remedial alternative.

3 SHORT-TERM RISK EXPOSURE ASSESSMENT

This section presents the short-term exposure assessment, which consists of the following steps:

- Characterization of the exposure setting during remedy implementation (i.e., the short-term);
- Quantification of exposure point concentrations;
- Identification of receptors with potentially complete exposure pathways and selection of representative receptors for use in the FFS comparative analysis; and
- Quantification of receptor-specific intake/exposure.

This exposure assessment supports the evaluation of short-term COPC exposure risks. Information presented in this section, unless otherwise noted, is applicable to each "action" alternative (i.e., the two partial excavation remedial alternatives, the full excavation remedial alternative, and the ROD-selected remedy).

3.1 CHARACTERIZATION OF EXPOSURE SETTING

Potential exposure media, receptors, and exposure points are typically identified in an HHRA based on site conditions, including current and future land use. In the short-term, general land use at and surrounding West Lake Landfill is expected to remain unchanged – the Site will continue operating within an industrial setting. As such, many of the receptors identified in the BRA are also relevant to the evaluation of short-term COPC exposure risks (e.g., nearby workers, off-property residents). Several additional receptors are expected be present at OU-1 during remedy implementation, some of whom will be in close proximity to RIM. Therefore, in the short term, the anticipated activities are the key aspect of the exposure setting considered in this evaluation.

Activities anticipated in conjunction with the remedial alternatives may include:

- move contaminated materials from the Buffer Zone onto Area 2;
- excavate RIM from Areas 1 and 2 (not applicable to the ROD-selected remedy);
- move excavated material around OU-1(not applicable to the ROD-selected remedy);
- ship excavated RIM to an off-site location(not applicable to the ROD-selected remedy);
- ship cover materials into OU-1;
- grade the landfill surface; and
- construct a multilayer, vegetated cover over Areas 1 and 2.

3.2 EXPOSURE POINT CONCENTRATIONS

The short-term exposure point concentrations for both soil and air were introduced in Sections 2.2.3.1 and 2.2.4.1, respectively. Remedial alternative-specific exposure point concentrations are presented in Sections 4 through 7.

3.3 POTENTIAL RECEPTORS

The activities expected to occur during construction of each of the remedial alternatives were examined to identify potential receptors. Some of the tasks and activities are common to all four remedial alternatives. Other activities would be limited to specific remedial alternatives. Potential receptors identified include:

- **<u>Radiation Survey/Radiation Control Technicians (RadCon Techs)</u>** – One or more RadCon Techs were assumed to be involved in identifying areas of soil containing RIM, directing the excavation and movement of RIM on the Site, and surveying the equipment that has to move into and out of the exclusion zones set up around work areas. These receptors will spend most of their work day standing on or next to areas containing RIM. They will likely be exposed to higher concentrations of RIM for longer periods of time than any other potential receptor identified.

- **<u>Heavy Equipment Operator</u>** – One or more heavy equipment operators were assumed to be involved in excavating the RIM, loading this material into trucks, spreading any fill or cover materials placed on the excavated areas, and regrading the surface of OU-1. These workers are assumed to be riding above the surface of the RIM in an enclosed cab with portions of the vehicle, thereby shielding them from the underlying RIM.

- **<u>Truck to Rail Transfer Facility Operators</u>** – One or more qualified radiation workers may be involved with material handling operations at a waste transfer facility. Activities might include operating heavy equipment, inspecting trucks and railcars, spill cleanup, waste sampling, and general housekeeping. These workers would be partially shielded by the sides of the trucks and the railcars and would often be working at some distance from the RIM. Note: this receptor is potentially relevant to the partial and full excavation remedial alternatives, but not the ROD-selected remedy.

- **<u>Truck Drivers</u>** – One or more truck drivers were assumed to be involved with hauling any RIM from OU-1 to a transfer station. This driver is also assumed to haul fill material and cover material into OU-1 during construction of a cover. The driver would remain seated in his truck during the majority of his work shift. Note: receptors hauling RIM off-site are potentially relevant to the partial and full excavation remedial alternatives, but not the ROD-selected remedy.

- **<u>Laborers</u>** – One or more qualified radiation workers may perform manual labor within the OU-1 as part of the remediation. Activities could range from carrying equipment to cleaning equipment. It is expected that the exposure times required to perform these activities will be shorter that the exposure times of the RadCon Techs.

- **<u>Engineers/Management</u>** – This group of receptors include qualified radiation workers who direct operations and respond to atypical occurrences but typically spend limited time in close proximity to exposed RIM.

- **<u>Nearby Workers</u>** – Businesses located near the Site employ workers who may be exposed to transient plumes of dust transported from the Site by wind. The average exposure concentrations in air (if any) would be lower than those encountered by RadCon Techs because exposures to a given receptor will only occur during times when the wind blows in their direction. Further, when the wind does blow in the direction of the workers, near ground turbulence will mix the particulates into a larger volume of air, lowering their concentrations.

- **<u>Off-Property Residents</u>** – One or more off-property residents may be exposed to fugitive dust and/or gases during the construction of the remedial alternative.

- **Highway Users** – If RIM is shipped on public roads, the trucks containing the RIM would pass near members of the public on those same roads. The RIM on the trucks would be placed in strong-tight packaging, and any radiation from the RIM would be partially shielded by the body of the truck. Trucks will be inspected for loose contamination before being allowed to leave the Site. In the event of an accident, any spillage would be removed from the road as part of incident response. Any routine or accidental exposures would be transitory and receptors would be separated from the truck carrying the RIM by at least two to three meters. Note: this receptor is potentially relevant to the partial and full excavation remedial alternatives, but not the ROD-selected remedy.

- **Transients/Visitors** – Individuals may visit the Site to service or repair equipment, deliver items or inspect operations. Exposures to these individuals are expected to be transitory. Note: if visitors are present on a more frequent basis, *e.g.*, such as a local delivery driver, risks calculated for laborers would be applicable to these receptors.

- **Rail Users** – If RIM is shipped by rail, the trains containing the RIM could pass near members of the public adjacent to the rail line. The RIM in the railcars would be contained in super sacks, and any radiation from the RIM would be partially shielded by the body of the railcar. Any exposures would be transitory and receptors would be separated from the train carrying the RIM by at least three to five meters. Note: this receptor is potentially relevant to the partial and full excavation remedial alternatives, but not the ROD-selected remedy.

- **Rail Workers** – One or more rail workers were assumed to be involved with hauling any RIM from the Site to the disposal site. These workers would be shielded from the RIM in the railcars by at least one diesel engine and separated from the RIM by many meters of distance. Note: this receptor is potentially relevant to the partial and full excavation remedial alternatives, but not the ROD-selected remedy.

Potential exposure pathways for each of these receptors were qualitatively evaluated to identify receptors with the greatest potential for exposure that were relevant to each of the action remedial alternatives. Consistent with the conclusions of the updated BRA (Auxier 2016), the RME individual is anticipated to be an on-property receptor. This reflects the dominance of the gamma exposure pathway in the risk assessment calculations. Off-property receptors would not be exposed to direct gamma from the soil and the primary pathway for those receptors would be potential inhalation of airborne emissions from the Site. Based on these considerations, the On-Property RadCon Tech Worker and Off-Property Resident were selected for quantitative evaluation herein. These potential and selected receptors are listed in Table 3-1.

Table 3-1 Potential Short-Term Receptors Identified During Remedial Alternative Implementation

Receptors Identified	[a] Scenario Applicability (P/F/R)	Exposure Route: Inhalation of Fugitive Dust	Inhalation of Radon	Direct Radiation from Soil	Direct Radiation from Submersion in Air	Incidental Soil Ingestion	Dermal Contact	Selected for Quantitative Evaluation?
RadCon Techs	**P/F/R**	●	●	●	●	●	●	**Yes**
Heavy Equipment Operators	**P/F/R**	{O}	{O}	{O}	{O}	{O}	{O}	No
Truck to Rail Transfer Facility Operators	**P/F**	{O}	{O}	{O}	{O}	{O}	{O}	No
Truck Drivers	**P/F/R**	{O}	{O}	{O}	{O}			No
Laborers	**P/F/R**	{O}	{O}	{O}	{O}			No
Engineers/Management	**P/F/R**	{O}	{O}	{O}	{O}			No
Nearby Workers	**P/F/R**	{O}	{O}	{O}	{O}			No
Off-Property Residents	**P/F/R**	●	●		●			**Yes**
Highway Users	**P/F**			{S}				No
Transients/Visitors	**P/F/R**	{O}	{O}					No
Rail Users	**P/F**			{O}	{O}			No
Rail Workers	**P/F**			{O}	{O}			No

[a] An exposure scenario was considered if it included a source, a means of moving constituents of concern to a location of interest, and a receptor at that location. All receptor scenarios listed in the table are applicable to the partial ("P") and full ("F") excavation alternatives; however, only a subset are applicable to the ROD-selected ("R") remedy.

●	Exposure route selected for detailed analysis
(shaded box)	A shaded box indicates that the receptor/exposure route combination was not selected for quantitative analysis.
{O}	Not quantified because other receptors identified for this scenario have higher intake rates and longer exposure times.
{S}	Scoping level analysis of possible spillage of RIM performed using MicroShield indicates doses < 1 mrem/y. Source evaluated was 1 mm thick soil containing 338 pCi Ra-226/g (Area 2 conc.) spread across one 100 ft. long lane (16 ft. wide). Dose point 3 feet over road through 2 mm iron (car floor).

3.4 EXPOSURE PATHWAYS

The following potentially complete exposure pathways were identified for the selected representative receptors:

- **On-Property RadCon Tech Workers** – These on-property workers are potentially exposed to COPCs via inhalation of fugitive dust, inhalation of radon gas, direct radiation from soil, direct radiation from submersion in air, incidental ingestion of soil, and dermal contact with soil.
- **Off-Property Residents** – These receptors are potentially exposed to COPCs via inhalation of fugitive dust, inhalation of radon, and direct radiation from submersion in air.

The details of these exposures (e.g., exposure time and duration) are remedial alternative-specific and are addressed in the short-term evaluations for each remedial alternative presented in Sections 4 through 7.

4 SHORT-TERM RISKS FOR THE "PARTIAL EXCAVATION TO 1,000 PCI/G" ALTERNATIVE

4.1 ALTERNATIVE DESCRIPTION

In this remedial alternative, RIM with activity levels above 1,000 pCi/g will be excavated and shipped to an approved out-of-state disposal facility. This remedial alternative is intended to protect human health by removing the RIM above the established criterion and placing an engineered cap over all of OU-1. This cap design provides a physical barrier that isolates the remaining RIM from surface receptors.

This risk analysis identifies and evaluates the major short-term hazards and exposures from the construction and transportation activities during excavation, capping, and restoration of Areas 1 and 2 that would occur during construction of the "partial excavation to 1,000 pCi/g" alternative. It also evaluates the human health risks from exposure to chemicals and radionuclides that may occur during remedial alternative construction.

4.2 QUANTIFICATION OF SHORT-TERM COPC EXPOSURE RISKS

As discussed in Section 2, a human health assessment considers the following components: COPC selection, exposure assessment (exposure point concentrations, potential receptors, and exposure pathways), toxicity assessment, and risk characterization. This section combines the first three components to characterize risks to both on-property and off-property receptors from exposure to COPCs. The following sections combine information from Section 3 with remedial alternative-specific information and present the calculations specific to the "partial excavation to 1,000 pCi/g" alternative.

4.2.1 Exposure Point Concentrations in Soil

The exposure point concentration is the concentration of a contaminant in an exposure medium that may be contacted by a real or hypothetical receptor. As previously discussed in Section 2.2.1.1, the average concentration of radionuclides in the total volume of excavated materials was calculated and used for radionuclide exposure point concentrations. Radionuclide concentrations in Area 2 were selected to evaluate human health effects because the radionuclide concentrations with the greatest impact on health (Ra-226 and Th-230) are in Area 2.

Chemical exposure point concentrations were calculated from combined OU-1data as described in Section 2.2.1.2. Table 4-1presents the representative concentrations of radionuclides and chemicals in soil used in this short-term risk assessment.

Table 4-1 Short-term Soil Exposure Point Concentrations for the "Partial Excavation to 1,000 pCi/g" Alternative

Analyte	Soil Exposure Point Concentrations	Units
Radionuclides [a]		
Uranium Series		
Uranium-238 + 3 dtrs	47.33	pCi/g
Uranium-234	49.6	pCi/g
Thorium-230	694.09	pCi/g
Radium-226 + 8 dtrs	241.2	pCi/g
Lead-210 + 2 dtrs	52.63	pCi/g
Actinium Series		
Uranium-235 + 1 dtr	2.42	pCi/g
Protactinium-231	68.91	pCi/g
Actinium-227 + 9 dtrs	46.57	pCi/g
Thorium Series		
Thorium-232 + 10 dtrs	8.33	pCi/g
Inorganic Chemicals [b]		
Antimony (metallic)	5.97	mg/kg
Arsenic, Inorganic	40.18	mg/kg
Chromium, total) [c]	64.87	mg/kg
Cobalt	349.00	mg/kg
Lead and Compounds	785.80	mg/kg
Mercury [c]	0.70	mg/kg
Nickel Soluble Salts	432.40	mg/kg
Uranium (Soluble Salts)	156.00 [d]	mg/kg
Vanadium and Compounds	158.00	mg/kg
Pesticides/PCBs [b]		
Aroclor 1242	0.43	mg/kg
Aroclor 1254	0.40	mg/kg
Volatile Organic Compounds (VOCs) [b]		
Dichlorobenzene, 1,4-	312.79	mg/kg
Chlorobenzene	26.45	mg/kg

[a] Based on average concentration of excavated material in Area 2 only..
[b] Based on 95% UCLs of sample results for all OU-1 soils combined.
[c] The names listed reflect the lab chemical designation. There are no RSL values within the EPA calculator for these laboratory chemical names. As such, risk is calculated using the RSL values within the EPA calculator for related chemicals (i.e., chromium (VI) for chromium, total, and mercury (elemental) for mercury.
[d] Of the isotopes of natural uranium, uranium-238 accounts for more than 99 percent of the mass of uranium. The 95% UCL mass concentration of uranium-238 for all OU-1 soils of 52.3 pCi/g was divided by the specific activity of 0.336 pCi/µg, resulting in a mass concentration of 156 mg of uranium (soluble salts) per kg of soil (mg/kg).

4.2.2 **Exposure Point Concentrations in Air**

As previously discussed in Section 2.2.8.3, AERMOD was used to simulate aerial transport of both fugitive dust and radon. Radon concentrations in the short-term are derived from measured values, are the same values as presented in the updated BRA, and are presented in Table 2-3. Particulate air concentrations for selected locations are dependent on soil concentrations and are presented in Table 4-2 below.

Table 4-2 Short-term Air Exposure Point Concentrations for the "Partial Excavation to 1,000 pCi/g" Alternative

Analyte	Off-Property, Southeast (722898 E 4293620 N)	On-site, Area 2 (721720 E 4294785 N)
Uranium Series (pCi/m^3)		
Uranium-238 + D	2.84E-07	3.45E-04
Uranium-234	2.97E-07	3.62E-04
Thorium-230	4.16E-06	5.06E-03
Radium-226 + D	1.45E-06	1.76E-03
Lead-210 + D	3.16E-07	3.84E-04
Actinium Series (pCi/m^3)		
Uranium-235 + 1 D	1.45E-08	1.76E-05
Protactinium-231 + D	4.13E-07	5.02E-04
Actinium-227 + D	2.79E-07	3.40E-04
Thorium-232 Series (pCi/m^3)		
Thorium-232 + 10 D	5.32E-14	7.87E-08
Inorganic Chemicals (µg/m^3)		
Antimony	3.57E-08	4.34E-05
Arsenic	2.41E-07	2.93E-04
Chromium (as IV)	3.89E-07	4.73E-04
Cobalt	2.09E-06	2.54E-03
Lead	4.71E-06	5.73E-03
Mercury	4.19E-09	5.10E-06
Nickel	2.59E-06	3.15E-03
Uranium	9.33E-07	1.13E-03
Vanadium	9.45E-07	1.15E-03
Pesticides/PCBs (µg/m^3)		
Aroclor-1242	2.60E-09	3.16E-06
Aroclor-1254	2.45E-09	2.98E-06
VOCs (µg/m^3)		
1,4-Dichlorobenzene	1.88E-06	2.28E-03
Chlorobenzene	1.59E-07	1.93E-04

4.2.3 Exposure Pathways

During remedial alternative construction, the RIM and chemicals will be disturbed by excavation and loading into open-topped trucks for on-property transport. The receptors identified in Section 3.3 could be exposed to this material by inhalation of fugitive dust, inhalation of radon, incidental ingestion of soil, direct exposure to radiation from soil, direct exposure to radiation and chemicals from submersion in air, or dermal contact, depending on the receptor and their locations.

4.2.4 Quantification of Human Health COPC Exposure Risks

4.2.4.1 Calculation of Carcinogenic Risk to Selected Receptors

Calculations of carcinogenic risks to potential receptors were based on the relationships between risk and concentration produced by Site-specific scenario descriptions input into EPA's PRG and RSL calculators. The major differences between the default parameter values used by EPA to calculate health effects to default receptors and the values used to describe Site-specific receptors at this Site are the times the receptors are assumed to spend exposed to RIM. For example, EPA's PRG calculations for an outdoor worker assume the workers spends 5,625 days on the Site[9] during a 25 year period, and scheduling information suggests the worker will be exposed to RIM for 8 hours a day over a 1,468 day period[10] during the excavation of the RIM from the three areas where RIM has been identified (Areas 1 and 2 and the Buffer Zone).

The work is scheduled to be performed over 6.5 years, and the period of exposure was allocated equally between the 6.5 years. The RadCon Tech was assumed to be exposed for 225 days a year over the duration of the construction. The off-property resident may also be exposed for a longer period while the RIM is exposed but no work is ongoing (nights, weekends, etc.). Therefore, the default EPA annual exposure frequency of 350 days a year was used.

Table 4-3 and Table 4-5 provide the input parameters for EPA's Soil and Air PRG and RSL Calculators for outdoor workers and off-property residents. Table 4-4 and Table 4-6 provide the results of the calculations using these parameters.

Table 4-3 Input for EPA's Soil and Air PRG and RSL Calculators, RadCon Tech, "Partial Excavation to 1,000 pCi/g" Alternative

Variable	Radionuclide PRG Calculator Value	Chemical RSL Calculator Value
Slab size for ACF (area correction factor) m^2	2000	NA
t_{ow} (time – outdoor worker) yr	6.5	NA
ED_{ow} (exposure duration – outdoor worker) yr	6.5	6.5
ET_{ow} (exposure time – outdoor worker) hr/day	8	8
EF_{ow} (exposure frequency - outdoor worker) day/yr	225	225

Note: Other parameters were left at their default values.

[9] Total days = Exposure Duration 25 (y/lifetime) x 225 (d/y) = 5,625 (d/lifetime)

[10] Derived from project schedule provided by Feezor Engineering, Inc., dated September 27, 2016.

Table 4-4 Calculated Risks to the Hypothetical RadCon Tech During "Partial Excavation to 1,000 pCi/g" Alternative

COC	Incidental Soil Ingestion	Direct Radiation from Soil	Dermal	Inhalation of Dust	Inhalation of Radon [a]	Direct Radiation, Submersion in Air	All Routes
Uranium Series							
Uranium-238 + 2 dtrs	3.88E-07	6.45E-06	NA	2.40E-07	NA	5.87E-14	7.08E-06
Uranium-234	3.70E-07	1.68E-08	NA	2.94E-07	NA	2.48E-16	6.81E-07
Thorium-230	7.85E-06	7.54E-07	NA	5.06E-06	NA	9.07E-15	1.37E-05
Radium-226 + 8 dtrs	1.55E-05	2.28E-03	NA	1.80E-06	NA	1.82E-11	2.29E-03
Actinium Series							
Uranium-235 + 1 dtr	1.76E-08	1.37E-06	NA	1.29E-08	NA	1.57E-14	1.40E-06
Protactinium-231 + 10 dtrs	2.80E-06	1.04E-05	NA	3.24E-06	NA	6.55E-13	1.65E-05
Thorium Series							
Thorium-232 + 10 dtrs	9.50E-07	3.88E-05	NA	5.31E-10	NA	4.01E-16	3.97E-05
Radon-222 Series in Air [b]							
Rn-222	NA	NA	NA	NA	1.60E-07	3.90E-12	1.60E-07
Po-218	NA	NA	NA	NA	-	2.56E-17	2.56E-17
Pb-214	NA	NA	NA	NA	1.16E-08	1.35E-11	1.16E-08
Bi-214 + 1 dtr	NA	NA	NA	NA	1.71E-10	1.69E-12	1.72E-10
						Total Radiocarcinogenic Risk	**2.37E-03**
Inorganic Chemicals							
Antimony (metallic)	-	NA	-	-	NA	NA	0.00E+00
Arsenic, Inorganic	2.59E-06	NA	5.47E-07	2.40E-08	NA	NA	3.16E-06
Chromium(VI)	2.32E-06	NA	-	7.58E-07	NA	NA	3.07E-06
Cobalt	-	NA	-	4.37E-07	NA	NA	4.37E-07
Lead and Compounds	-	NA	-	-	NA	NA	0.00E+00
Mercury (elemental)	-	NA	-	-	NA	NA	0.00E+00
Nickel Oxide	-	NA	-	1.56E-08	NA	NA	1.56E-08
Uranium (Soluble Salts)	-	NA	-	-	NA	NA	0.00E+00
Vanadium and compounds	-	NA	-	-	NA	NA	0.00E+00
Pesticides/PCBs							
Aroclor 1242	6.20E-08	NA	3.67E-08	3.45E-11	NA	NA	9.88E-08
Aroclor 1254	5.86E-08	NA	3.47E-08	3.25E-11	NA	NA	9.33E-08
Volatile Organic Compounds							
Dichlorobenzene, 1,4-	1.21E-07	NA	-	4.79E-10	NA	NA	1.21E-07
Chlorobenzene	-	NA	-	-	NA	NA	0.00E+00
						Total Chemocarcinogenic Risk	**7.00E-06**
						Total Carcinogenic Risk	**2.38E-03**

NA - Not applicable

"-" indicates no PRG or RSL.

[a] Using inhalation slope factor for naked radon-222 as derived in footnote of Table 26 of Auxier 2016.

[b] Radon source term includes emissions from all OU-1 areas.

Table 4-5 Input for EPA's Air PRG and RSL Calculators, Off-Property Resident, "Partial Excavation to 1,000 pCi/g" Alternative

Variable	Radionuclide PRG Calculator Value	Chemical RSL Calculator Value
TR (target cancer risk) unitless	0.000001	0.000001
THQ (target hazard quotient) unitless	NA	1
EF_{res} (exposure frequency) day/yr	350	350
ET_{res} (exposure time - resident) hr	24	24
$ED_{res\text{-}a}$ (exposure duration, carcinogenic – resident adult) yr	6.5	6.5
LT (lifetime - resident) year	NA	70
t_{res} (time - resident) yr	6.5	NA

Note: Other parameters were left at their default values.

Table 4-6 Calculated Risks to the Off-Property Resident During "Partial Excavation to 1,000 pCi/g" Alternative

COC	Inhalation of Dust	Inhalation of Radon [a]	Direct Radiation, Submersion in Air	All Routes
Uranium Series				
Uranium-238 + 2 dtrs	3.06E-10	NA	2.25E-16	3.06E-10
Uranium-234	3.76E-10	NA	9.50E-19	3.76E-10
Thorium-230	6.45E-09	NA	3.50E-17	6.45E-09
Radium-226 + 8 dtrs	2.30E-09	NA	6.99E-14	2.30E-09
Actinium Series				
Uranium-235 + 1 dtr	1.65E-11	NA	6.06E-17	1.65E-11
Protactinium-231 + 10 dtrs	4.15E-09	NA	2.51E-15	4.15E-09
Thorium Series				
Thorium-232 + 10 dtrs	5.58E-16	NA	1.26E-21	5.58E-16
Radon-222 Series in Air [b]				
Rn-222	NA	3.22E-09	2.35E-13	3.22E-09
Po-218	NA	-	3.59E-18	3.59E-18
Pb-214	NA	1.70E-09	5.94E-12	1.70E-09
Bi-214 + 1 dtr	NA	7.07E-11	2.09E-12	7.28E-11
			Total Radiocarcinogenic Risk	**1.86E-08**
Inorganic Chemicals				
Antimony (metallic)	-	NA	NA	0.00E+00
Arsenic, Inorganic	9.23E-11	NA	NA	9.23E-11
Chromium(VI)	3.21E-08	NA	NA	3.21E-08
Cobalt	1.67E-09	NA	NA	1.67E-09
Lead and Compounds	-	NA	NA	0.00E+00
Mercury (elemental)	-	NA	NA	0.00E+00
Nickel Oxide	6.00E-11	NA	NA	6.00E-11
Uranium (Soluble Salts)	-	NA	NA	0.00E+00
Vanadium and compounds	-	NA	NA	0.00E+00
Pesticides/PCBs				
Aroclor 1242	1.32E-13	NA	NA	1.32E-13
Aroclor 1254	1.25E-13	NA	NA	1.25E-13
Volatile Organic Compounds				
Dichlorobenzene, 1,4-	1.84E-12	NA	NA	1.84E-12
Chlorobenzene	-	NA	NA	0.00E+00
			Total Chemocarcinogenic Risk	**3.40E-08**
			Total Carcinogenic Risk	**5.26E-08**

NA - Not applicable
"-" indicates no PRG or RSL.
[a] Using inhalation slope factor for naked radon-222 as derived in footnote of Table 26 of Auxier 2016.
[b] Radon source term includes emissions from all OU-1 areas.

The calculated lifetime risk to the hypothetical RadCon Tech on Area 2 is 2.38 x 10^{-03}. The risks to a hypothetical receptor living at the location identified in the updated BRA as "Off-Property, Southeast"[11] were calculated as 5.26 x 10^{-08}.

[11] The updated BRA (Auxier 2016) identified the "Off-Property, Southeast" receptor as the RME receptor of the two residents assessed.

4.2.4.2 Calculation of Non-Carcinogenic Effects to Selected Receptors

Site-specific parameters listed in Table 4-3 and Table 4-5 were used in the EPA RSL calculator to calculate the hazard quotients to the RadCon Tech and off-property resident, respectively. The results for the hypothetical RadCon Tech are presented in Table 4-7. Table 4-8 presents the hazard quotients calculated for the off-property resident.

Table 4-7 Hazard Index Calculated for the Hypothetical RadCon Tech During "Partial Excavation to 1,000 pCi/g" Alternative

COC	Outdoor Worker HQ = 1, Ingestion	Outdoor Worker HQ = 1, Direct Radiation from Soil	Outdoor Worker HQ = 1, Dermal	Outdoor Worker HQ = 1, Inhalation of Dust	Outdoor Worker HQ = 1, Inhalation of Radon	Outdoor Worker HQ = 1, Submersion in Air	Calculated HQ to Outdoor Worker, All Pathways
Inorganic Chemicals							
Antimony (metallic)	1.15E-02	NA	-	-	NA	NA	1.15E-02
Arsenic, Inorganic	6.19E-02	NA	1.31E-02	4.01E-03	NA	NA	7.90E-02
Chromium(VI)	1.67E-02	NA	-	9.71E-04	NA	NA	1.76E-02
Cobalt	8.96E-01	NA	-	8.70E-02	NA	NA	9.83E-01
Lead and Compounds	-	NA	-	-	NA	NA	0.00E+00
Mercury (elemental)	-	NA	-	3.49E-06	NA	NA	3.49E-06
Nickel Oxide	1.66E-02	NA	-	7.20E-03	NA	NA	2.38E-02
Uranium (Soluble Salts)	4.00E-02	NA	-	5.82E-03	NA	NA	4.58E-02
Vanadium and compounds	2.41E-02	NA	-	2.36E-03	NA	NA	2.65E-02
Pesticides/PCBs							
Aroclor 1242	-	NA	-	-	NA	NA	0.00E+00
Aroclor 1254	1.57E-02	NA	9.35E-03	-	NA	NA	2.51E-02
Volatile Organic Compounds							
Dichlorobenzene, 1,4-	3.44E-03	NA	-	5.86E-07	NA	NA	3.45E-03
Chlorobenzene	1.02E-03	NA	-	7.94E-07	NA	NA	1.02E-03
						Total Hazard Index (HI)	**1.22E+00**

NA - Not applicable
"-" indicates no PRG or RSL.

Table 4-8 Hazard Index Calculated for the Off-Property Resident During "Partial Excavation to 1,000 pCi/g" Alternative

COC	Resident RSL, HQ = 1, Inhalation of Dust	Resident RSL, HQ = 1, Inhalation of Radon	Resident RSL, HQ = 1, Inhalation of Radon	Calculated HQ to Resident, All Pathways
Inorganic Chemicals				
Antimony (metallic)	-	NA	NA	0.00E+00
Arsenic, Inorganic	1.54E-05	NA	NA	1.54E-05
Chromium(VI)	3.74E-06	NA	NA	3.74E-06
Cobalt	3.34E-04	NA	NA	3.34E-04
Lead and Compounds	-	NA	NA	0.00E+00
Mercury (elemental)	1.34E-08	NA	NA	1.34E-08
Nickel Oxide	2.76E-05	NA	NA	2.76E-05
Uranium (Soluble Salts)	2.24E-05	NA	NA	2.24E-05
Vanadium and compounds	9.08E-06	NA	NA	9.08E-06
Pesticides/PCBs				
Aroclor 1242	-	NA	NA	0.00E+00
Aroclor 1254	-	NA	NA	0.00E+00
Volatile Organic Compounds				
Dichlorobenzene, 1,4-	2.25E-09	NA	NA	2.25E-09
Chlorobenzene	3.04E-09	NA	NA	3.04E-09
			Total Hazard Index (HI)	**4.12E-04**

NA - Not applicable
"-" indicates no PRG or RSL.

The calculated HI for the hypothetical RadCon Tech located on Area 2 is 1.22. The HI for a receptor living at the location identified in the updated BRA as "Off-Property, Southeast" was calculated as 4.12×10^{-04}. The EPA has previously determined that an HI of greater than one (1) for a particular COPC may represent a potential health risk.

4.3 QUANTIFICATION OF INDUSTRIAL INCIDENT RISK

There is a risk of occupational and traffic accidents during earthmoving or transportation of materials on public roads. Generally, the risk of occurrence is time dependent, increasing as the duration of the activity lengthens. The severity of the accident depends, in part, on the activity itself.

In order to assess the likelihood and severity of possible accidents, Occupational Safety and Health Administration (OSHA) and National Highway Traffic Safety Administration (NHTSA) statistics for workers in different occupations and transportation records were used in conjunction with manpower and resource projections from remedial alternative construction schedules to calculate the risks for accidents.

4.3.1 **Transportation Hazards**

Table 4-9 lists statistics on the rate that traffic accidents involving heavy trucks occurred in 2012 (NHTSA 2014). The projection for heavy truck use on public roads during construction of the "partial excavation to 1,000 pCi/g" alternative is 3,290,000 miles. Multiplying this mileage by the injury and fatality rates in Table 4-9 yields the transportation incident forecast presented Table 4-10.

Table 4-9 Accident Incident Rate for Trucks on Public Roads

Incident	Published rate [a]	Per mile rate [b]
Injury Crashes	2.90E+01	2.90E-07
Fatal Crashes	1.42E+00	1.42E-08

[a] Rate per 100 million miles (NHTSA 2014).
[b] Derived from rate (incidents/100,000,000 mile)

Table 4-10 Traffic Injury and Fatality Forecast for the "Partial Excavation to 1,000 pCi/g" Alternative

Parameter	Value
Total miles for all hauling on public roads [a]	3.29E+06
Injury risk for the project	9.54E-01
Fatality risk for the project	4.67E-02
Forecast of accidents involving injuries or fatalities	**1.00E+00**

[a] Estimate provided by Feezor Engineering, Inc., September 27, 2016, "Total Delivery Miles (Totals)"

Hazards from transporting the RIM by rail from the local railhead to the off-site destination can be similarly assessed (Table 4-11 and Table 4-12).

Table 4-11 Accident Incident Rate for Railroads

Incident	Published Per Mile Rate [a]
Injury Rate	1.20E-05
Fatality Rate	1.04E-06

[a] Rate per mile (FRAOSA 2016).

Table 4-12 Railroad Injury and Fatality Forecast for the "Partial Excavation to 1,000 pCi/g" Alternative

Parameter	Value
Rail mile [a]	1.20E+06
Injury risk for the project	1.44E+01
Fatality risk for the project	1.24E+00
Forecast of rail accidents involving injuries or fatalities	**1.56E+01**

[a] Rail distance calculated as 374 trains x 3,200 miles round trip

The projected number of on-site and off-site transportation accidents involving injury or death during construction of the "partial excavation to 1,000 pCi/g" alternative of 16.6 is related primarily to the number of trucks hauling materials onto the Site and transporting the RIM via rail to an off-site disposal facility. It should be noted that this projection includes injuries and deaths of people other than the truck occupants. In 2012, 3% of the injuries and 10% of the fatalities from traffic accidents on public roads were to people not riding in the truck involved in the incident (NHTSA 2014).

4.3.2 Industrial Hazards

As in the previous assessment, the workers involved with remedial alternative construction have been divided into two groups: general construction and driver/operators. The Bureau of Labor Statistics (BLS) maintains historical information on the rate that accidents occur in the U.S. These statistics are available grouped by job description, and Table 4-13 and Table 4-14 list accident statistics for general construction and off-road drivers, respectively.

Table 4-13 Accident Rate for General Construction and Support Workers

Parameter	Value
Injury accident rate per 100 full-time workers [a]	2.90E+00
Accident rate per man-hour worked	1.45E-05
Accident rate per man-day worked	1.16E-04
Number of general construction + support man-days worked [b]	7.38E+04
Number of Accidents Forecast	**8.56E+00**

[a] Bureau of Labor Statistics News Release, October 29, 2014 "Employer-Reported Workplace Injuries and Illnesses – 2014" for Heavy and civil engineering construction (237). (BLS 2015)
[b] Estimate provided by Feezor Engineering, Inc., September 27, 2016, "Crew Man-Days Overall"

Table 4-14 Occupational Accident Rate for Truck Drivers

Parameter	Value
Injury accident rate per 100 full-time workers [a]	4.40E+00
Accident rate per hour worked	2.20E-05
Hours spent driving [b]	1.19E+05
Other transportation activities (hrs) [c]	2.38E+04
Total transportation man-hours worked	1.43E+05
Number of Accidents Forecast [d]	**3.15E+00**

[a] Bureau of Labor Statistics News Release, October 29, 2014 "Employer-Reported Workplace Injuries and Illnesses – 2014" for Heavy and civil engineering construction (484). (BLS 2015)

[b] Estimate provided by Feezor Engineering, Inc., September 27, 2016, "Crew Man-Days On-site Haul Trucks" x 8 h/d

[c] Hours assumed - Driving hours x 0.2.

[d] Accident Rate per hour x Total Transportation Man-hours

Table 4-13 and Table 4-14 also list the remedial alternative construction time in either man-days or man-hours that can be grouped into each of those broad labor categories. Multiplying the total time by the appropriate accident rate will yield an accident forecast for this group's activities during this project. The number of accidents forecast for the general construction and off-road drivers are presented in bold on the last line of Table 4-13 and Table 4-14, respectively. Summing the number of accidents forecast for both labor groups yields the total accident projection for the project.

For example, it is estimated that it will require 73,800 man-days of general construction and support labor to construct the "partial excavation to 1,000 pCi/g" alternative. Multiplying this duration by the injury and fatality rate of 1.16×10^{-04} accidents per man-day in Table 4-13 yields the construction incident forecast of 8.56 accidents. Adding this to the project risk of non-traffic accidents for truck drivers in Table 4-14 yields a total accident projection for general construction and off-road activities of 11.71.

4.4 QUANTIFICATION OF OCCUPATIONAL EXTERNAL RADIATION EXPOSURE

Remedial workers were assumed to be classified as radiation workers in this assessment. As such, the RadCon Tech is expected to be the RME individual in the short-term. Unit doses factors to those workers were calculated using MicroShield 9.02. The current exposure point concentrations from Table 4-1 were multiplied by the unit dose rate to calculate the average dose rate for the worker. Multiplying the average of these dose rates and the total projected time spent exposed to RIM yields the estimated annual TEDE to RadCon Techs on the project (Table 4-15).

Table 4-15 Radiation Dose to RadCon Tech

	Area 2
Days per Project	1468
Average TEDE on surface (mrem/hour)	4.81E-01
Hours spent exposed to RIM (per year)	1.80E+03 [b]
TEDE for Reasonably Maximally-Exposed Individual (mrem/y)	**8.67E+02**

[a] Calculated by MicroShield.
[b] 1,468 worker exposure days / 6.5 year project duration= 225 days/year x 8 hours/day = 1,800 hours/year

The calculated average exposure rate to the hypothetical RadCon Tech would be approximately 0.481 mrem/hr. If the RadCon Tech spent 1,800 hours per year working on the RIM, the TEDE would be 867 mrem/y. To put this in perspective, according to 10 CFR § 20.1201, a radiation worker has an occupational exposure limit of 5,000 mrem/y, assuming no administrative limits are imposed for the Site (NRC 1991).

4.5 SUMMARY

The short-term human health risks and hazard projections are summarized in Table 4-16.

Table 4-16 Summary of Short-Term Hazards and Risks Associated with "Partial Excavation to 1,000 pCi/g" Alternative

Category of Hazard or Risk	Value
Projected Incidence of Transportation Accidents	1.66E+01
Projected Incidence of Industrial Accidents	1.17E+01
Carcinogenic Risk to RadCon Tech	2.38E-03
Carcinogenic Risk to Off-Property Resident	5.26E-08
HI to RadCon Tech	1.22E+00
HI to Off-Property Resident	4.12E-04
TEDE to Reasonably Maximally-Exposed Individual	8.67E+02

It is projected that 16.6 individuals could be injured or killed on public roads during implementation of the "partial excavation to 1,000 pCi/g" alternative, and 11.7 injuries or deaths are projected to be related to industrial activities. There is also a 4.7% chance of a fatal transportation accident and a 95% chance that a person will be injured as a result of a transportation accident.

Carcinogenic risks from exposure to COPCs, including RIM, encountered during construction are expected to be no greater than the risk calculated for the RadCon Tech. The lifetime risk to the RadCon Tech for the "partial excavation to 1,000 pCi/g" alternative was calculated to be 2.38 x 10^{-03}. This calculated risk exceeds EPA's acceptable risk range of 10^{-06} to 10^{-04}. The most important single contributor to this risk is the gamma radiation from RIM on and near the surface of the contamination area. Note that the carcinogenic risk to the off-property resident is less than 10^{-06}.

5 SHORT-TERM RISKS FOR THE "PARTIAL EXCAVATION TO 52.9 PCI/G" ALTERNATIVE

5.1 ALTERNATIVE DESCRIPTION

In this remedial alternative, RIM with activity levels above 52.9 pCi/g would be excavated and shipped to an approved out-of-state disposal facility. This remedial alternative is intended to protect human health by removing the RIM above the established criterion and placing an engineered cap over all of OU-1. This cap will provide a physical barrier that isolates the remaining RIM from surface receptors.

This risk analysis identifies and evaluates the major short-term hazards and exposures from the construction and transportation activities during excavation, capping, and restoration of Areas 1 and 2 that would occur during construction of the "partial excavation to 52.9 pCi/g" alternative. It also evaluates the human health risks from exposure to chemicals and radionuclides that may occur during remedial alternative construction.

5.2 QUANTIFICATION OF SHORT-TERM COPC EXPOSURE RISKS

As discussed in Section 2, a human health assessment considers the following components: COPC selection, exposure assessment (exposure point concentrations, potential receptors, and exposure pathways), toxicity assessment, and risk characterization. This section combines the first three components to characterize risks to both on-property and off-property receptors from exposure to COPCs. The following subsections combine information from Section 3 with remedial alternative-specific information and present the calculations specific to the "partial excavation to 52.9 pCi/g" alternative.

5.2.1 Exposure Point Concentrations in Soil

The exposure point concentration is the concentration of a contaminant in an exposure medium that may be contacted by a real or hypothetical receptor. As previously discussed in Section 2.2.1.1, the average concentration of radionuclides in the total volume of excavated materials was calculated and used for radionuclide exposure point concentrations. Radionuclide concentrations in Area 2 were selected to evaluate human health effects because the radionuclide concentrations with the greatest impact on health (Ra-226 and Th-230) are in Area 2.

Chemical exposure point concentrations were calculated from combined OU-1data as described in Section 2.2.1.2. Table 5-1presents the representative concentrations of radionuclides and chemicals in soil used in this short-term risk assessment.

Table 5-1 Short-Term Soil Exposure Point Concentrations for the "Partial Excavation to 52.9 pCi/g" Alternative

Analyte	Soil Exposure Point Concentrations	Units
Radionuclides [a]		
Uranium Series		
Uranium-238 + 3 dtrs	43.21	pCi/g
Uranium-234	45.28	pCi/g
Thorium-230	529.37	pCi/g
Radium-226 + 8 dtrs	228.90	pCi/g
Lead-210 + 2 dtrs	48.05	pCi/g
Actinium Series		
Uranium-235 + 1 dtr	2.21	pCi/g
Protactinium-231	62.91	pCi/g
Actinium-227 + 9 dtrs	42.52	pCi/g
Thorium Series		
Thorium-232 + 10 dtrs	7.60	pCi/g
Inorganic Chemicals [b]		
Antimony (metallic)	5.97	mg/kg
Arsenic, Inorganic	40.18	mg/kg
Chromium, total	64.87	mg/kg
Cobalt	349.00	mg/kg
Lead and Compounds	785.80	mg/kg
Mercury	0.70	mg/kg
Nickel Soluble Salts	432.40	mg/kg
Uranium (Soluble Salts)	156.00 [c]	mg/kg
Vanadium and Compounds	158.00	mg/kg
Pesticides/PCBs [b]		
Aroclor 1242	0.43	mg/kg
Aroclor 1254	0.40	mg/kg
Volatile Organic Compounds [b]		
Dichlorobenzene, 1,4-	312.79	mg/kg
Chlorobenzene	26.45	mg/kg

[a] Based on average concentration of excavated material in Area 2 only..
[b] Based on 95% UCLs of sample results for all OU-1 soils combined.
[c] The names listed reflect the lab chemical designation. There are no RSL values within the EPA calculator for these laboratory chemical names. As such, risk is calculated using the RSL values within the EPA calculator for related chemicals (i.e., chromium (VI) for chromium, total, and mercury (elemental) for mercury.
[d] Of the isotopes of natural uranium, uranium-238 accounts for more than 99 percent of the mass of uranium. The 95% UCL mass concentration of uranium-238 for all OU-1 soils of 52.3 pCi/g was divided by the specific activity of 0.336 pCi/µg, resulting in a mass concentration of 156 mg of uranium (soluble salts) per kg of soil (mg/kg).

5.2.2 Exposure Point Concentrations in Air

As previously discussed in Section 2.2.8.3, AERMOD was used to simulate aerial transport of both fugitive dust and radon. Radon concentrations in the short-term are the same values as presented in the updated BRA, and are presented in Table 2-3. Particulate air concentrations for selected locations are dependent on soil concentrations and are presented in Table 5-2 below.

Table 5-2 Short-Term Air Exposure Point Concentrations for the "Partial Excavation to 52.9 pCi/g" Alternative

Analyte	Off-Property, Southeast (722898 E 4293620 N)	On-site, Area 2 (721720 E 4294785 N)
Uranium Series (pCi/m^3)		
Uranium-238 + D	2.59E-07	3.15E-04
Uranium-234	2.71E-07	3.30E-04
Thorium-230	3.17E-06	3.86E-03
Radium-226 + D	1.37E-06	1.67E-03
Lead-210 + D	2.88E-07	3.50E-04
Actinium Series (pCi/m^3)		
Uranium-235 + 1 D	1.32E-08	1.61E-05
Protactinium-231 + D	3.77E-07	4.59E-04
Actinium-227 + D	2.55E-07	3.10E-04
Thorium-232 Series (pCi/m^3)		
Thorium-232 + 10 D	4.86E-14	7.19E-08
Inorganic Chemicals (µg/m^3)		
Antimony	3.57E-08	4.34E-05
Arsenic	2.41E-07	2.93E-04
Chromium (as IV)	3.89E-07	4.73E-04
Cobalt	2.09E-06	2.54E-03
Lead	4.71E-06	5.73E-03
Mercury	4.19E-09	5.10E-06
Nickel	2.59E-06	3.15E-03
Uranium	9.33E-07	1.13E-03
Vanadium	9.45E-07	1.15E-03
Pesticides/PCBs (µg/m^3)		
Aroclor-1242	2.60E-09	3.16E-06
Aroclor-1254	2.45E-09	2.98E-06
VOCs (µg/m^3)		
1,4-Dichlorobenzene	1.88E-06	2.28E-03
Chlorobenzene	1.59E-07	1.93E-04

5.2.3 Exposure Pathways

During remedial alternative construction, the RIM and chemicals will be disturbed by excavation and loading into open-topped trucks for on-property transport. The receptors identified in Section 3.3 could be exposed to this material by inhalation of fugitive dust, inhalation of radon, incidental ingestion of soil, direct exposure to radiation from soil, direct exposure to radiation and chemicals from submersion in air, or dermal contact, depending on the receptor and their locations.

5.2.4 Quantification of Human Health COPC Exposure Risks

5.2.4.1 Calculation of Carcinogenic Risk to Selected Receptors

Calculations of carcinogenic risks to potential receptors were based on the relationships between risk and concentration produced by Site-specific scenario descriptions input into EPA's PRG and RSL calculators. The major difference between the default parameter values used by EPA to calculate health effects to default receptors and the values used to describe Site-specific receptors at this Site is the amount of time the receptors are assumed to spend exposed to RIM. For example, EPA's PRG calculations for an outdoor worker assume the workers spends 5,625 days on the site[12] during a 25-year period, and scheduling information suggests the worker will be exposed to RIM for 8 hours a day over a 762 day period[13] during the excavation of the RIM from the three areas where RIM has been identified (Areas 1 and 2 and the Buffer Zone).

The work is scheduled to be performed over 3.4 years, and the period of exposure was allocated equally between the 3.4 years. The timeframe is a shorter duration because of the depth limitation written into the remedial alternative design. The RadCon Tech was assumed to be exposed for 225 days a year over the duration of the construction. The off-property resident may also be exposed for a longer period while the RIM is exposed but no work is ongoing (nights, weekends, etc.). Therefore, the default EPA annual exposure frequency of 350 days a year was used.

Table 5-3 and Table 5-5 provide the input parameters for EPA's Soil and Air PRG and RSL Calculators for outdoor workers and off-property residents. Table 5-4 and Table 5-6 provide the results of the calculations using these parameters.

Table 5-3 Input for EPA's Soil and Air PRG and RSL Calculators, RadCon Tech, "Partial Excavation to 52.9 pCi/g" Alternative

Variable	Radionuclide PRG Calculator Value	Chemical RSL Calculator Value
Slab size for ACF (area correction factor) m^2	2000	NA
t_{ow} (time – outdoor worker) yr	3.4	NA
ED_{ow} (exposure duration – outdoor worker) yr	3.4	3.4
ET_{ow} (exposure time – outdoor worker) hr/day	8	8
EF_{ow} (exposure frequency - outdoor worker) day/yr	225	225

Note: Other parameters were left at their default values.

[12] Total days = Exposure Duration 25 (y/lifetime) x 225 (d/y) = 5,625 (d/lifetime)

[13] Derived from project schedule provided by Feezor Engineering, Inc., dated September 27, 2016.

Table 5-4 Calculated Risks to the Hypothetical RadCon Tech During "Partial Excavation to 52.9 pCi/g" Alternative

COC	Incidental Soil Ingestion	Direct Radiation from Soil	Dermal	Inhalation of Dust	Inhalation of Radon [a]	Direct Radiation, Submersion in Air	All Routes
Uranium Series							
Uranium-238 + 2 dtrs	1.86E-07	3.09E-06	NA	1.14E-07	NA	2.81E-14	3.39E-06
Uranium-234	1.77E-07	8.01E-09	NA	1.40E-07	NA	1.18E-16	3.25E-07
Thorium-230	3.13E-06	3.01E-07	NA	2.01E-06	NA	3.61E-15	5.44E-06
Radium-226 + 8 dtrs	8.09E-06	1.13E-03	NA	8.84E-07	NA	9.02E-12	1.14E-03
Actinium Series							
Uranium-235 + 1 dtr	8.42E-09	6.56E-07	NA	6.16E-09	NA	7.55E-15	6.71E-07
Protactinium-231 + 10 dtrs	1.37E-06	5.18E-06	NA	1.55E-06	NA	3.13E-13	8.10E-06
Thorium Series							
Thorium-232 + 10 dtrs	4.61E-07	1.86E-05	NA	2.54E-10	NA	1.91E-16	1.90E-05
Radon-222 Series in Air [b]							
Rn-222	NA	NA	NA	NA	1.00E-07	2.45E-12	1.00E-07
Po-218	NA	NA	NA	NA	-	1.96E-17	1.96E-17
Pb-214	NA	NA	NA	NA	1.05E-08	1.23E-11	1.05E-08
Bi-214 + 1 dtr	NA	NA	NA	NA	1.72E-10	1.70E-12	1.74E-10
						Total Radiocarcinogenic Risk	**1.18E-03**
Inorganic Chemicals							
Antimony (metallic)	-	NA	-	-	NA	NA	0.00E+00
Arsenic, Inorganic	1.35E-06	NA	2.87E-07	1.26E-08	NA	NA	1.65E-06
Chromium(VI)	1.21E-06	NA	-	3.97E-07	NA	NA	1.61E-06
Cobalt	-	NA	-	2.29E-07	NA	NA	2.29E-07
Lead and Compounds	-	NA	-	-	NA	NA	0.00E+00
Mercury (elemental)	-	NA	-	-	NA	NA	0.00E+00
Nickel Oxide	-	NA	-	8.19E-09	NA	NA	8.19E-09
Uranium (Soluble Salts)	-	NA	-	-	NA	NA	0.00E+00
Vanadium and compounds	-	NA	-	-	NA	NA	0.00E+00
Pesticides/PCBs							
Aroclor 1242	3.23E-08	NA	1.93E-08	1.81E-11	NA	NA	5.16E-08
Aroclor 1254	3.06E-08	NA	1.82E-08	1.71E-11	NA	NA	4.88E-08
Volatile Organic Compounds							
Dichlorobenzene, 1,4-	6.32E-08	NA	-	2.50E-10	NA	NA	6.34E-08
Chlorobenzene	-	NA	-	-	NA	NA	0.00E+00
						Total Chemocarcinogenic Risk	**3.67E-06**
						Total Carcinogenic Risk	**1.18E-03**

NA - Not applicable
"-" indicates no PRG or RSL.
[a] Using inhalation slope factor for naked radon-222 as derived in footnote of Table 26 of Auxier 2016.
[b] Radon source term includes emissions from all OU-1 areas.

Table 5-5 Input for EPA's Air PRG and RSL Calculators, Off-Property Resident, "Partial Excavation to 52.9 pCi/g" Alternative

Variable	Radionuclide PRG Calculator Value	Chemical RSL Calculator Value
TR (target cancer risk) unitless	0.000001	0.000001
THQ (target hazard quotient) unitless	NA	1
EF_{res} (exposure frequency) day/yr	350	350
ET_{res} (exposure time - resident) hr	24	24
ED_{res-a} (exposure duration, carcinogenic – resident adult) yr	3.4	3
LT (lifetime - resident) year	NA	70
t_{res} (time - resident) yr	3.4	NA

Note: Other parameters were left at their default values.

Table 5-6 Calculated Risks to the Off-Property Resident During "Partial Excavation to 52.9 pCi/g" Alternative

COC	Inhalation of Dust	Inhalation of Radon [a]	Direct Radiation, Submersion in Air	All Routes
Uranium Series				
Uranium-238 + 2 dtrs	1.46E-10	NA	1.07E-16	1.46E-10
Uranium-234	1.80E-10	NA	4.54E-19	1.80E-10
Thorium-230	2.58E-09	NA	1.39E-17	2.58E-09
Radium-226 + 8 dtrs	1.13E-09	NA	3.47E-14	1.13E-09
Actinium Series				
Uranium-235 + 1 dtr	7.87E-12	NA	2.89E-17	7.87E-12
Protactinium-231 + 10 dtrs	1.98E-09	NA	1.20E-15	1.98E-09
Thorium Series				
Thorium-232 + 10 dtrs	2.67E-16	NA	6.04E-22	2.67E-16
Radon-222 Series in Air [b]				
Rn-222	NA	1.69E-09	1.23E-13	1.69E-09
Po-218	NA	-	1.88E-18	1.88E-18
Pb-214	NA	8.88E-10	3.10E-12	8.91E-10
Bi-214 + 1 dtr	NA	3.68E-11	1.09E-12	3.79E-11
			Total Radiocarcinogenic Risk	**8.64E-09**
Inorganic Chemicals				
Antimony (metallic)	-	NA	NA	0.00E+00
Arsenic, Inorganic	4.83E-11	NA	NA	4.83E-11
Chromium(VI)	3.21E-08	NA	NA	3.21E-08
Cobalt	8.74E-10	NA	NA	8.74E-10
Lead and Compounds	-	NA	NA	0.00E+00
Mercury (elemental)	-	NA	NA	0.00E+00
Nickel Oxide	3.14E-11	NA	NA	3.14E-11
Uranium (Soluble Salts)	-	NA	NA	0.00E+00
Vanadium and compounds	-	NA	NA	0.00E+00
Pesticides/PCBs				
Aroclor 1242	6.91E-14	NA	NA	6.91E-14
Aroclor 1254	6.53E-14	NA	NA	6.53E-14
Volatile Organic Compounds				
Dichlorobenzene, 1,4-	9.62E-13	NA	NA	9.62E-13
Chlorobenzene	-	NA	NA	0.00E+00
			Total Chemocarcinogenic Risk	**3.31E-08**
			Total Carcinogenic Risk	**4.17E-08**

NA - Not applicable
"-" indicates no PRG or RSL.
[a] Using inhalation slope factor for naked radon-222 as derived in footnote of Table 26 of Auxier 2016.
[b] Radon source term includes emissions from all OU-1 areas.

The calculated lifetime risk to the hypothetical RadCon Tech on Area 2 is 1.18 x 10^{-03}. The risks to a hypothetical receptor living at the location identified in the updated BRA as "Off-Property, Southeast"[14] were calculated as 4.17 x 10^{-08}.

5.2.4.2 Calculation of Non-Carcinogenic Effects to Selected Receptors

Site-specific parameters listed in Table 5-3 and Table 5-5 were used in the EPA RSL calculator to calculate the hazard quotients to the RadCon Tech and off-property resident, respectively. The results for the hypothetical RadCon Tech are presented in Table 5-7. Table 5-8 presents the hazard quotients calculated for the off-property resident.

Table 5-7 Hazard Index Calculated for the Hypothetical RadCon Tech During "Partial Excavation to 52.9 pCi/g" Alternative

COC	Outdoor Worker HQ = 1, Ingestion	Outdoor Worker HQ = 1, Direct Radiation from Soil	Outdoor Worker HQ = 1, Dermal	Outdoor Worker HQ = 1, Inhalation of Dust	Outdoor Worker HQ = 1, Inhalation of Radon	Outdoor Worker HQ = 1, Submersion in Air	Calculated HQ to Outdoor Worker, All Pathways
Inorganic Chemicals							
Antimony (metallic)	1.15E-02	NA	-	-	NA	NA	1.15E-02
Arsenic, Inorganic	6.19E-02	NA	1.31E-02	4.01E-03	NA	NA	7.90E-02
Chromium(VI)	1.67E-02	NA	-	9.71E-04	NA	NA	1.76E-02
Cobalt	8.96E-01	NA	-	8.70E-02	NA	NA	9.83E-01
Lead and Compounds	-	NA	-	-	NA	NA	0.00E+00
Mercury (elemental)	-	NA	-	3.49E-06	NA	NA	3.49E-06
Nickel Oxide	1.66E-02	NA	-	7.20E-03	NA	NA	2.38E-02
Uranium (Soluble Salts)	4.00E-02	NA	-	5.82E-03	NA	NA	4.58E-02
Vanadium and compounds	2.41E-02	NA	-	2.36E-03	NA	NA	2.65E-02
Pesticides/PCBs							
Aroclor 1242	-	NA	-	-	NA	NA	0.00E+00
Aroclor 1254	1.57E-02	NA	9.35E-03	-	NA	NA	2.51E-02
Volatile Organic Compounds							
Dichlorobenzene, 1,4-	3.44E-03	NA	-	5.86E-07	NA	NA	3.45E-03
Chlorobenzene	1.02E-03	NA	-	7.94E-07	NA	NA	1.02E-03
					Total Hazard Index (HI)		**1.22E+00**

NA - Not applicable
"-" indicates no PRG or RSL.

[14] The updated BRA (Auxier 2016) identified the "Off-Property, Southeast" receptor as the RME receptor of the two residents assessed.

Table 5-8 Hazard Index Calculated for the Off- Property Resident During "Partial Excavation to 52.9 pCi/g" Alternative

COC	Resident RSL, HQ = 1, Inhalation of Dust	Resident RSL, HQ = 1, Inhalation of Radon	Resident RSL, HQ = 1, Inhalation of Radon	Calculated HQ to Resident, All Pathways
Inorganic Chemicals				
Antimony (metallic)	-	NA	NA	0.00E+00
Arsenic, Inorganic	1.54E-05	NA	NA	1.54E-05
Chromium(VI)	3.74E-06	NA	NA	3.74E-06
Cobalt	3.34E-04	NA	NA	3.34E-04
Lead and Compounds	-	NA	NA	0.00E+00
Mercury (elemental)	1.34E-08	NA	NA	1.34E-08
Nickel Oxide	2.76E-05	NA	NA	2.76E-05
Uranium (Soluble Salts)	2.24E-05	NA	NA	2.24E-05
Vanadium and compounds	9.08E-06	NA	NA	9.08E-06
Pesticides/PCBs				
Aroclor 1242	-	NA	NA	0.00E+00
Aroclor 1254	-	NA	NA	0.00E+00
Volatile Organic Compounds				
Dichlorobenzene, 1,4-	2.25E-09	NA	NA	2.25E-09
Chlorobenzene	3.04E-09	NA	NA	3.04E-09
			Total Hazard Index (HI)	**4.12E-04**

NA - Not applicable
"-" indicates no PRG or RSL.

The calculated HI for the hypothetical RadCon Tech located on Area 2 is 1.22. The HI for a receptor living at the location identified in the updated BRA as "Off-Property, Southeast" was calculated as 4.12 x 10^{-04}. The EPA has previously determined that an HI of greater than one (1) for a particular COPC may represent a potential health risk.

5.3 QUANTIFICATION OF INDUSTRIAL INCIDENT RISKS

There is a risk of occupational and traffic accidents during earthmoving or transportation of materials on public roads. Generally, the risk of occurrence is time dependent, increasing as the duration of the activity lengthens. The severity of the accident depends, in part, on the activity itself.

In order to assess the likelihood and severity of possible accidents, OSHA and NHTSA statistics for workers in different occupations and transportation records were used in conjunction with manpower and resource projections from remedial alternative construction schedules to calculate the risks for accidents.

5.3.1 **Transportation Hazards**

Table 5-9 lists statistics on the rate that traffic accidents involving heavy trucks occurred in 2012 (NHTSA 2014). The projection for heavy truck use on public roads during construction of the "partial excavation to 52.9 pCi/g" alternative is 3,600,000 miles. Multiplying this mileage by the injury and fatality rates in Table 5-9 yields the transportation incident forecast presented Table 5-10.

Table 5-9 Accident Incident Rate for Trucks on Public Roads

Incident	Published rate [a]	Per mile rate [b]
Injury Crashes	2.90E+01	2.90E-07
Fatal Crashes	1.42E+00	1.42E-08

[a] Rate per 100 million miles (NHTSA 2014).
[b] Derived from rate (incidents/100,000,000 mile)

Table 5-10 Traffic Injury and Fatality Forecast for the "Partial Excavation to 52.9 pCi/g" Alternative

Parameter	Value
Total miles for all hauling on public roads [a]	3.60E+06
Injury risk for the project	1.04E+00
Fatality risk for the project	5.11E-02
Forecast of accidents involving injuries or fatalities	**1.10E+00**

[a] Estimate provided by Feezor Engineering, Inc., September 27, 2016, "Total Delivery Miles (Totals)"

Hazards from transporting the RIM by rail from the local railhead to the off-site destination can be similarly assessed (Table 5-11 and Table 5-12).

Table 5-11 Accident Incident Rate for Railroads

Incident	Published Per Mile Rate [a]
Injury Rate	1.20E-05
Fatality Rate	1.04E-06

[a] Rate per mile (FRAOSA 2016).

Table 5-12 Railroad Injury and Fatality Forecast for the "Partial Excavation to 52.9 pCi/g" Alternative

Parameter	Value
Rail mile [a]	7.26E+05
Injury risk for the project	8.71E+00
Fatality risk for the project	7.57E-01
Forecast of rail accidents involving injuries or fatalities	**9.46E+00**

[a] Rail distance calculated as 227 trains x 3,200 miles round trip

The projected number of on-site and off-site transportation accidents involving injury or death during construction of the "partial excavation to 52.9 pCi/g" alternative of 10.56 is related primarily to the number of trucks hauling materials onto the site and transporting the RIM via rail to an off-site disposal facility. It should be noted that this projection includes injuries and deaths of people other than the truck occupants. In 2012, 3% of the injuries and 10% of the fatalities from traffic accidents on public roads were to people not riding in the truck involved in the incident (NHTSA 2014).

5.3.2 Industrial Hazards

As in the previous assessment, the workers involved with remedial alternative construction have been divided into two groups: general construction and driver/operators. The BLS maintains historical information on the rate that accidents occur in the U.S. These statistics are available grouped by job description, and Table 5-13 and Table 5-14 list accident statistics for general construction and off-road drivers, respectively.

Table 5-13 Accident Rate for General Construction and Support Workers

Parameter	Value
Injury accident rate per 100 full-time workers [a]	2.90E+00
Accident rate per man-hour worked	1.45E-05
Accident rate per man-day worked	1.16E-04
Number of general construction + support man-days worked [b]	5.98E+04
Number of Accidents Forecast	**6.94E+00**

[a] Bureau of Labor Statistics News Release, October 29, 2014 "Employer-Reported Workplace Injuries and Illnesses – 2014" for Heavy and civil engineering construction (237). (BLS 2015)
[b] Estimate provided by Feezor Engineering, Inc., September 27, 2016, "Crew Man-Days Overall"

Table 5-14 Occupational Accident Rate for Truck Drivers

Parameter	Value
Injury accident rate per 100 full-time workers [a]	4.40E+00
Accident rate per hour worked	2.20E-05
Hours spent driving [b]	5.81E+04
Other transportation activities (hrs) [c]	1.16E+04
Total transportation man-hours worked	6.97E+04
Number of Accidents Forecast [d]	**1.53E+00**

[a] Bureau of Labor Statistics News Release, October 29, 2014 "Employer-Reported Workplace Injuries and Illnesses – 2014" for Heavy and civil engineering construction (484). (BLS 2015)

[b] Estimate provided by Feezor Engineering, Inc., September 27, 2016, "Crew Man-Days On-site Haul Trucks" x 8 h/d

[c] Hours assumed - Driving hours x 0.2.

[d] Accident Rate per hour x Total Transportation Man-hours

Table 5-13 and Table 5-14 also list the remedial alternative construction time in either man-days or man-hours that can be grouped into each of those broad labor categories. Multiplying the total time by the appropriate accident rate will yield an accident forecast for this group's activities during this project. The number of accidents forecast for the general construction and off-road drivers are presented in bold on the last line of Table 5-13 and Table 5-14, respectively. Summing the number of accidents forecast for both labor groups yields the total accident projection for the project.

For example, it is estimated that it will require 59,800 man-days of general construction and support labor to construct the "partial excavation to 52.9 pCi/g" alternative. Multiplying this duration by the injury and fatality rate of 1.16 x 10^{-04} accidents per man-day in Table 5-13 yields the construction incident forecast of 6.94 accidents. Adding this to the project risk of non-traffic accidents for truck drivers in Table 5-14 yields a total accident projection for general construction and off-road activities of 8.47.

5.4 QUANTIFICATION OF OCCUPATIONAL EXTERNAL RADIATION EXPOSURE

Remedial workers were assumed to be classified as radiation workers in this assessment. As such, the RadCon Tech is expected to be the RME individual in the short-term. Unit dose factors to those workers were calculated using MicroShield 9.02[15]. The current exposure point concentrations from Table 5-1 were multiplied by the unit dose rate to calculate the average dose rate for the worker. Multiplying the average of these dose rates and the total projected time spent exposed to RIM yields the estimated annual TEDE to RadCon Techs on the project (Table 5-15).

Table 5-15 Radiation Dose to RadCon Tech

	Area 2
Days per Project	762
Average TEDE on surface (mrem/hour)	4.00E-01
Hours spent exposed to RIM (per year)	1.80E+03 [b]
TEDE for Reasonably Maximally-Exposed Individual (mrem/y)	**7.20E+02**

[a] Calculated by MicroShield.
[b] 762 worker exposure days / 3.4 year project duration= 225 days/year x 8 hours/day = 1,800 hours/year

The calculated average exposure rate to the hypothetical RadCon Tech would be approximately 0.4 mrem/hr. If the RadCon Tech spent 1,800 hours per year working on the RIM, the TEDE would be 720 mrem/y. To put this in perspective, according to 10 CFR § 20.1201, a radiation worker has an occupational exposure limit of 5,000 mrem/y, assuming no administrative limits are imposed for the Site (NRC 1991).

5.5 SUMMARY

The short-term human health risks and hazard projections are summarized in Table 5-16.

[15] Grove Software

Table 5-16 Summary of Short-Term Hazards and Risks Associated with "Partial Excavation to 52.9 pCi/g" Alternative

Category of Hazard or Risk	Value
Projected Incidence of Transportation Accidents	1.06E+01
Projected Incidence of Industrial Accidents	8.47E+00
Carcinogenic Risk to Rad Con Tec	1.18E-03
Carcinogenic Risk to Off-Property Resident	4.17E-08
HI to RadCon Tech	1.22E+00
HI to Off-Property Resident	4.12E-04
TEDE to Reasonably Maximally-Exposed Individual	7.20E+02

It is projected that 10.6 individuals could be injured or killed on public roads during implementation of the "partial excavation to 52.9 pCi/g" alternative, and 8.47 injuries or deaths are projected to be related to industrial activities. There is also a 5.1% chance of a fatal transportation accident and a 104% chance that a person will be injured as a result of a transportation accident.

Carcinogenic risks from exposure to RIM encountered during construction are expected to be no greater than the risk calculated for the RadCon Tech. The lifetime risk to the RadCon Tech was calculated to be 1.18 x 10^{-03}. This calculated risk exceeds EPA's acceptable risk range of 10^{-06} to 10^{-04}. The most important single contributor to this risk is the gamma radiation from RIM on and near the surface of the contamination area. Note that the carcinogenic risk to the off-property resident is less than 10^{-06}.

6 SHORT-TERM RISKS FOR THE "COMPLETE RAD REMOVAL" ALTERNATIVE

6.1 ALTERNATIVE DESCRIPTION

In this remedial alternative, the RIM above 7.9 pCi/g would be excavated and shipped to an out-of-state disposal facility. Areas 1 and 2 would be regraded and capped as part of the overall Site closure plan. The overburden and final cap will provide a physical barrier for other non-RIM landfill wastes and will incidentally isolate surface receptors from any RIM below cleanup levels that remains in place at the Site. Controls intended to address radiological occurrences would no longer be required under this remedial alternative, but the same or similar controls would still be required because the Site will remain an inactive municipal waste landfill.

This risk analysis identifies and evaluates the major short-term hazards and exposures from the construction and transportation activities during excavation, capping, and restoration of Areas 1 and 2 that would occur during construction of the "complete rad removal" alternative. It also evaluates the human health risks from exposure to chemicals and radionuclides that may occur during remedial alternative construction.

6.2 QUANTIFICATION OF SHORT-TERM COPC EXPOSURE RISKS

As discussed in Section 2, a human health assessment considers the following components: COPC selection, exposure assessment (exposure point concentrations, potential receptors, and exposure pathways), toxicity assessment, and risk characterization. This section combines the three components to characterize health risks to both on-property and off-property receptors from exposure to COPCs. The following sections combine information from Section 3 with remedial alternative-specific information and present the calculations specific to the "complete rad removal" alternative.

6.2.1 **Exposure Point Concentrations in Soil**

The exposure point concentration is the concentration of a contaminant in an exposure medium that may be contacted by a real or hypothetical receptor. As previously discussed in 2.2.1.1, the average concentration of radionuclides in the total volume of excavated materials was calculated and used for radionuclide exposure point concentrations. Radionuclide concentrations in Area 2 were selected to evaluate human health effects because the radionuclide concentrations with the greatest impact on health (Ra-226 and Th-230) are in Area 2.

Chemical exposure point concentrations were calculated from combined OU-1data as described in Section 2.2.1.2. Table 6-1presents the representative concentrations of radionuclides and chemicals in soil used in this short-term risk assessment.

Table 6-1 Short-Term Soil Exposure Point Concentrations for the "Complete Rad Removal" Alternative

Analyte	Soil Exposure Point Concentrations	Units
Radionuclides [a]		
Uranium Series		
Uranium-238 + 3 dtrs	24.35	pCi/g
Uranium-234	25.52	pCi/g
Thorium-230	300.33	pCi/g
Radium-226 + 8 dtrs	128.83	pCi/g
Lead-210 + 2 dtrs	27.08	pCi/g
Actinium Series		
Uranium-235 + 1 dtr	1.24	pCi/g
Protactinium-231	35.46	pCi/g
Actinium-227 + 9 dtrs	23.96	pCi/g
Thorium Series		
Thorium-232 + 10 dtrs	4.29	pCi/g
Inorganic Chemicals [b]		
Antimony (metallic)	5.97	mg/kg
Arsenic, Inorganic	40.18	mg/kg
Chromium, total	64.87	mg/kg
Cobalt	349.00	mg/kg
Lead and Compounds	785.80	mg/kg
Mercury	0.70	mg/kg
Nickel Soluble Salts	432.40	mg/kg
Uranium (Soluble Salts)	156.00 [c]	mg/kg
Vanadium and Compounds	158.00	mg/kg
Pesticides/PCBs [b]		
Aroclor 1242	0.43	mg/kg
Aroclor 1254	0.40	mg/kg
Volatile Organic Compounds [b]		
Dichlorobenzene, 1,4-	312.79	mg/kg
Chlorobenzene	26.45	mg/kg

[a] Based on average concentration of excavated material in Area 2 only..
[b] Based on 95% UCLs of sample results for all OU-1 soils combined.
[c] The names listed reflect the lab chemical designation. There are no RSL values within the EPA calculator for these laboratory chemical names. As such, risk is calculated using the RSL values within the EPA calculator for related chemicals (i.e., chromium (VI) for chromium, total, and mercury (elemental) for mercury.
[d] Of the isotopes of natural uranium, uranium-238 accounts for more than 99 percent of the mass of uranium. The 95% UCL mass concentration of uranium-238 for all OU-1 soils of 52.3 pCi/g was divided by the specific activity of 0.336 pCi/µg, resulting in a mass concentration of 156 mg of uranium (soluble salts) per kg of soil (mg/kg).

6.2.2 **Exposure Point Concentrations in Air**

As previously discussed in Section 2.2.8.3, AERMOD was used to simulate aerial transport of both fugitive dust and radon. Radon concentrations in the short-term are the same values as presented in the updated BRA, and are presented in Table 2-3. Particulate air concentrations for selected locations are dependent on soil concentrations and are presented in Table 6-2 below.

Table 6-2 Short-Term Air Exposure Point Concentrations for the "Complete Rad Removal" Alternative

Analyte	Off-Property, Southeast (722898 E 4293620 N)	On-site, Area 2 (721720 E 4294785 N)
Uranium Series (pCi/m^3)		
Uranium-238 + D	1.46E-07	1.78E-04
Uranium-234	1.53E-07	1.86E-04
Thorium-230	1.80E-06	2.19E-03
Radium-226 + D	7.72E-07	9.39E-04
Lead-210 + D	1.62E-07	1.97E-04
Actinium Series (pCi/m^3)		
Uranium-235 + 1 D	7.45E-09	9.06E-06
Protactinium-231 + D	3.00E-08	3.65E-05
Actinium-227 + D	8.86E-09	1.08E-05
Thorium-232 Series (pCi/m^3)		
Thorium-232 + 10 D	2.74E-14	4.05E-08
Inorganic Chemicals (µg/m^3)		
Antimony	3.57E-08	4.34E-05
Arsenic	2.41E-07	2.93E-04
Chromium (as IV)	3.89E-07	4.73E-04
Cobalt	2.09E-06	2.54E-03
Lead	4.71E-06	5.73E-03
Mercury	4.19E-09	5.10E-06
Nickel	2.59E-06	3.15E-03
Uranium	9.33E-07	1.13E-03
Vanadium	9.45E-07	1.15E-03
Pesticides/PCBs (µg/m^3)		
Aroclor-1242	2.60E-09	3.16E-06
Aroclor-1254	2.45E-09	2.98E-06
Volatile Organic Compounds (µg/m^3)		
1,4-Dichlorobenzene	1.88E-06	2.28E-03
Chlorobenzene	1.59E-07	1.93E-04

6.2.3 Exposure Pathways

During remedial alternative construction, the RIM and chemicals will be disturbed by excavation and loading into open-topped trucks for on-property transport. The receptors identified in Section 3.3 could be exposed to this material by inhalation of fugitive dust, inhalation of radon, incidental ingestion of soil, direct exposure to radiation from soil, direct exposure to radiation and chemicals from submersion in air, or dermal contact, depending on the receptor and their locations.

6.2.4 **Quantification of Human Health COPC Exposure Risks**

6.2.4.1 Calculation of Carcinogenic Risk to Selected Receptors

Calculations of carcinogenic risks to potential receptors were based on the relationships between risk and concentration produced by Site-specific scenario descriptions input into EPA's PRG and RSL calculators. The major difference between the default parameter values used by EPA to calculate health effects to default receptors and the values used to describe Site-specific receptors at this Site is the amount of time that the receptors are assumed to spend exposed to RIM. For example, EPA's PRG calculations for an outdoor worker assume the workers spends 5,625 days on the Site[16] during a 25 year period, and scheduling information suggests the worker will be exposed to RIM for 8 hours a day over a 2,531 day period[17] during the excavation from the three areas where RIM has been identified (Areas 1 and 2 and the Buffer Zone).

The work is scheduled to be performed over 11.2 years, and the period of exposure was allocated equally between the 11.2 years. The RadCon Tech was assumed to be exposed for 225 days a year over the duration of the construction. The off-property resident may also be exposed for a longer period while the RIM is exposed but no work is ongoing (nights, weekends, etc.). Therefore, the default EPA annual exposure frequency of 350 days a year was used.

Table 6-3 and Table 6-5 provide the input parameters for EPA's Soil and Air PRG and RSL Calculators for outdoor workers and off-property residents. Table 6-4 and Table 6-6 provide the results of the calculations using these parameters.

Table 6-3 Input for EPA's Soil and Air PRG and RSL Calculators, RadCon Tech, "Complete Rad Removal" Alternative

Variable	Radionuclide PRG Calculator Value	Chemical RSL Calculator Value
Slab size for ACF (area correction factor) m^2	2000	NA
t_{ow} (time – outdoor worker) yr	11.2	NA
ED_{ow} (exposure duration – outdoor worker) yr	11.2	11.2
ET_{ow} (exposure time – outdoor worker) hr/day	8	8
EF_{ow} (exposure frequency - outdoor worker) day/yr	225	225

Note: Other parameters were left at their default values.

[16] Total days = Exposure Duration 25 (y/lifetime) x 225 (d/y) = 5,625 (d/lifetime)

[17] Derived from project schedule provided by Feezor Engineering, Inc., dated July 26, 2016.

Table 6-4 Calculated Risks to the Hypothetical RadCon Tech During "Complete Rad Removal" Alternative

COC	Inhalation of Dust	Inhalation of Radon [a]	Direct Radiation from Soil	Direct Radiation, Submersion in Air	Incidental Soil Ingestion	Dermal	All Routes
Uranium Series							
Uranium-238 + 2 dtrs	2.12E-07	NA	5.72E-06	5.21E-14	3.45E-07	NA	6.27E-06
Uranium-234	2.61E-07	NA	1.49E-08	2.19E-16	3.28E-07	NA	6.04E-07
Thorium-230	3.76E-06	NA	5.62E-07	6.76E-15	5.85E-06	NA	1.02E-05
Radium-226 + 8 dtrs	1.64E-06	NA	2.09E-03	1.67E-11	1.35E-05	NA	2.11E-03
Actinium Series							
Uranium-235 + 1 dtr	1.14E-08	NA	1.22E-06	1.40E-14	1.57E-08	NA	1.25E-06
Protactinium-231 + 10 dtrs	2.56E-07	NA	9.04E-06	5.62E-14	2.41E-06	NA	1.17E-05
Thorium Series							
Thorium-232 + 10 dtrs	4.71E-10	NA	3.43E-05	3.54E-16	8.32E-07	NA	3.51E-05
Radon-222 Series in Air [b]							
Rn-222	NA	3.31E-07	NA	8.05E-12	NA	NA	3.31E-07
Po-218	NA	-	NA	6.46E-17	NA	NA	6.46E-17
Pb-214	NA	3.46E-08	NA	4.04E-11	NA	NA	3.47E-08
Bi-214 + 1 dtr	NA	5.69E-10	NA	5.61E-12	NA	NA	5.74E-10
						Total Radiocarcinogenic Risk	**2.18E-03**
Inorganic Chemicals							
Antimony (metallic)	-	NA	NA	NA	-	-	0.00E+00
Arsenic, Inorganic	4.14E-08	NA	NA	NA	4.46E-06	9.43E-07	5.44E-06
Chromium(VI)	1.31E-06	NA	NA	NA	4.00E-06	-	5.31E-06
Cobalt	7.52E-07	NA	NA	NA	-	-	7.52E-07
Lead and Compounds	-	NA	NA	NA	-	-	0.00E+00
Mercury (elemental)	-	NA	NA	NA	-	-	0.00E+00
Nickel Oxide	2.69E-08	NA	NA	NA	-	-	2.69E-08
Uranium (Soluble Salts)	-	NA	NA	NA	-	-	0.00E+00
Vanadium and compounds	-	NA	NA	NA	-	-	0.00E+00
Pesticides/PCBs							
Aroclor 1242	5.94E-11	NA	NA	NA	1.07E-07	6.34E-08	1.70E-07
Aroclor 1254	5.61E-11	NA	NA	NA	1.01E-07	5.99E-08	1.61E-07
Volatile Organic Compounds							
Dichlorobenzene, 1,4-	8.23E-10	NA	NA	NA	2.09E-07	-	2.09E-07
Chlorobenzene	-	NA	NA	NA	-	-	0.00E+00
						Total Chemocarcinogenic Risk	**1.21E-05**
						Total Carcinogenic Risk	**2.19E-03**

NA - Not applicable

"-" indicates no PRG or RSL.

[a] Using inhalation slope factor for naked radon-222 as derived in footnote of Table 26 of Auxier 2016.

[b] Radon source term includes emissions from all OU-1 areas.

Table 6-5 Input for EPA's Air PRG and RSL Calculators, Off- Property Resident, " Complete Rad Removal" Alternative

Variable	Radionuclide PRG Calculator Value	Chemical RSL Calculator Value
TR (target cancer risk) unitless	0.000001	0.000001
THQ (target hazard quotient) unitless	NA	1
$EF_{\mathbf{res}}$ (exposure frequency) day/yr	350	350
$ET_{\mathbf{res}}$ (exposure time - resident) hr	24	24
$ED_{\mathbf{res\text{-}a}}$ (exposure duration, carcinogenic – resident adult) yr	11.2	11.2
LT (lifetime - resident) year	NA	70
$t_{\mathbf{res}}$ (time - resident) yr	11.2	NA

Note: Other parameters were left at their default values.

Table 6-6 Calculated Risks to the Off-Property Resident During "Complete Rad Removal" Alternative

COC	Inhalation of Dust	Inhalation of Radon [a]	Direct Radiation, Submersion in Air	All Routes
Uranium Series				
Uranium-238 + 2 dtrs	2.71E-10	NA	1.99E-16	2.71E-10
Uranium-234	3.34E-10	NA	8.41E-19	3.34E-10
Thorium-230	4.81E-09	NA	2.60E-17	4.81E-09
Radium-226 + 8 dtrs	2.10E-09	NA	6.44E-14	2.10E-09
Actinium Series				
Uranium-235 + 1 dtr	1.46E-11	NA	5.36E-17	1.46E-11
Protactinium-231 + 10 dtrs	3.28E-10	NA	1.62E-16	3.28E-10
Thorium Series				
Thorium-232 + 10 dtrs	4.95E-16	NA	1.12E-21	4.95E-16
Radon-222 Series in Air [b]				
Rn-222	NA	5.54E-09	4.05E-13	5.54E-09
Po-218	NA	-	6.19E-18	6.19E-18
Pb-214	NA	2.92E-09	1.02E-11	2.93E-09
Bi-214 + 1 dtr	NA	1.22E-10	3.61E-12	1.26E-10
			Total Radiocarcinogenic Risk	**1.65E-08**
Inorganic Chemicals				
Antimony (metallic)	-	NA	NA	0.00E+00
Arsenic, Inorganic	1.58E-10	NA	NA	1.58E-10
Chromium(VI)	3.21E-08	NA	NA	3.21E-08
Cobalt	2.89E-09	NA	NA	2.89E-09
Lead and Compounds	-	NA	NA	0.00E+00
Mercury (elemental)	-	NA	NA	0.00E+00
Nickel Oxide	1.03E-10	NA	NA	1.03E-10
Uranium (Soluble Salts)	-	NA	NA	0.00E+00
Vanadium and compounds	-	NA	NA	0.00E+00
Pesticides/PCBs				
Aroclor 1242	2.28E-13	NA	NA	2.28E-13
Aroclor 1254	2.15E-13	NA	NA	2.15E-13
Volatile Organic Compounds				
Dichlorobenzene, 1,4-	3.16E-12	NA	NA	3.16E-12
Chlorobenzene	-	NA	NA	0.00E+00
			Total Chemocarcinogenic Risk	**3.53E-08**
			Total Carcinogenic Risk	**5.17E-08**

NA - Not applicable
"-" indicates no PRG or RSL.
[a] Using inhalation slope factor for naked radon-222 as derived in footnote of Table 26 of Auxier 2016.
[b] Radon source term includes emissions from all OU-1 areas.

The calculated lifetime risk to the hypothetical RadCon Tech on Area 2 is 2.19 x 10^{-03}. The risks to a hypothetical receptor living at the location identified in the updated BRA as "Off-Property, Southeast"[18] were calculated as 5.17 x 10^{-08}.

6.2.4.2 Calculation of Non-Carcinogenic Effects to Selected Receptors

Site-specific parameters listed in Table 6-3 and Table 6-5 were used in the EPA RSL calculator to calculate the hazard quotients to the RadCon Tech and off-property resident, respectively. The results for the hypothetical RadCon Tech are presented in Table 6-7. Table 6-8presents the hazard quotients calculated for the off-property resident.

Table 6-7 Hazard Index Calculated for the Hypothetical RadCon Tech During "Complete Rad Removal" Alternative

COC	Outdoor Worker HQ = 1, Inhalation of Dust	Outdoor Worker HQ = 1, Inhalation of Radon	Outdoor Worker HQ = 1, Direct Radiation from Soil	Outdoor Worker HQ = 1, Submersion in Air	Outdoor Worker HQ = 1, Ingestion	Outdoor Worker HQ = 1, Dermal	Calculated HQ to Outdoor Worker, All Pathways
Inorganic Chemicals							
Antimony (metallic)	-	NA	NA	NA	1.15E-02	-	1.15E-02
Arsenic, Inorganic	4.01E-03	NA	NA	NA	6.19E-02	1.31E-02	7.90E-02
Chromium(VI)	9.71E-04	NA	NA	NA	1.67E-02	-	1.76E-02
Cobalt	8.70E-02	NA	NA	NA	8.96E-01	-	9.83E-01
Lead and Compounds	-	NA	NA	NA	-	-	0.00E+00
Mercury (elemental)	3.49E-06	NA	NA	NA	-	-	3.49E-06
Nickel Oxide	7.20E-03	NA	NA	NA	1.66E-02	-	2.38E-02
Uranium (Soluble Salts)	5.82E-03	NA	NA	NA	4.00E-02	-	4.58E-02
Vanadium and compounds	2.36E-03	NA	NA	NA	2.41E-02	-	2.65E-02
Pesticides/PCBs							
Aroclor 1242	-	NA	NA	NA	-	-	0.00E+00
Aroclor 1254	-	NA	NA	NA	1.57E-02	9.35E-03	2.51E-02
Volatile Organic Compounds							
Dichlorobenzene, 1,4-	5.86E-07	NA	NA	NA	3.44E-03	-	3.45E-03
Chlorobenzene	7.94E-07	NA	NA	NA	1.02E-03	-	1.02E-03
					Total Hazard Index (HI)		**1.22E+00**

NA - Not applicable
"-" indicates no PRG or RSL.

[18] The updated BRA (Auxier 2016) identified the "Off-Property, Southeast" receptor as the RME receptor of the two residents assessed.

Table 6-8 Hazard Index Calculated for the Off- Property Resident During "Complete Rad Removal" Alternative

COC	Resident RSL, HQ = 1, Inhalation of Dust	Resident RSL, HQ = 1, Inhalation of Radon	Resident RSL, HQ = 1, Inhalation of Radon	Calculated HQ to Resident, All Pathways
Inorganic Chemicals				
Antimony (metallic)	-	NA	NA	0.00E+00
Arsenic, Inorganic	1.54E-05	NA	NA	1.54E-05
Chromium(VI)	3.74E-06	NA	NA	3.74E-06
Cobalt	3.34E-04	NA	NA	3.34E-04
Lead and Compounds	-	NA	NA	0.00E+00
Mercury (elemental)	1.34E-08	NA	NA	1.34E-08
Nickel Oxide	2.76E-05	NA	NA	2.76E-05
Uranium (Soluble Salts)	2.24E-05	NA	NA	2.24E-05
Vanadium and compounds	9.08E-06	NA	NA	9.08E-06
Pesticides/PCBs				
Aroclor 1242	-	NA	NA	0.00E+00
Aroclor 1254	-	NA	NA	0.00E+00
Volatile Organic Compounds				
Dichlorobenzene, 1,4-	2.25E-09	NA	NA	2.25E-09
Chlorobenzene	3.04E-09	NA	NA	3.04E-09
			Total Hazard Index (HI)	**4.12E-04**

NA - Not applicable
"-" indicates no PRG or RSL.

The calculated HI for the hypothetical RadCon Tech located on Area 2 is 1.22. The HI for a receptor living at the location identified in the updated BRA as "Off-Property, Southeast" was calculated as 4.12 x 10^{-04}. The EPA has previously determined that an HI of greater than one (1) for a particular COPC may represent a potential health risk.

6.3 QUANTIFICATION OF INDUSTRIAL INCIDENT RISKS

There is a risk of occupational and traffic accidents during earthmoving or transportation of materials on public roads. Generally, the risk of occurrence is time dependent, increasing as the duration of the activity lengthens. The severity of the accident depends, in part, on the activity itself.

In order to assess the likelihood and severity of possible accidents, OSHA and NHTSA statistics for workers in different occupations and transportation records were used in conjunction with manpower and resource projections from remedial alternative construction schedules to calculate the risks for accidents.

6.3.1 Transportation Hazards

Table 6-9 lists statistics on the rate that traffic accidents involving heavy trucks occurred in 2012 (NHTSA 2014). The projection for heavy truck use on public roads during construction of the "complete rad removal" alternative is 4,990,000 miles. Multiplying this mileage by the injury and fatality rates in Table 6-9 yields the transportation incident forecast presented Table 6-10.

Table 6-9 Accident Incident Rate for Trucks on Public Roads

Incident	Published rate [a]	Per mile rate [b]
Injury Crashes	2.90E+01	2.90E-07
Fatal Crashes	1.42E+00	1.42E-08

[a] Rate per 100 million miles (NHTSA 2014).
[b] Derived from rate (incidents/100,000,000 mile)

Table 6-10 Traffic Injury and Fatality Forecast for the "Complete Rad Removal" Alternative

Parameter	Value
Total miles for all hauling on public roads [a]	4.99E+06
Injury risk for the project	1.45E+00
Fatality risk for the project	7.09E-02
Forecast of accidents involving injuries or fatalities	**1.52E+00**

[a] Estimate provided by Feezor Engineering, Inc., September 27, 2016, "Total Delivery Miles (Totals)"

Hazards from transporting the RIM by rail from the local railhead to the off-site destination can be similarly assessed (Table 6-11 and Table 6-12).

Table 6-11 Accident Incident Rate for Railroads

Incident	Published Per Mile Rate [a]
Injury Rate	1.20E-05
Fatality Rate	1.04E-06

[a] Rate per mile (FRAOSA 2016).

Table 6-12 Railroad Injury and Fatality Forecast for the "Complete Rad Removal" Alternative

Parameter	Value
Rail mile [a]	2.56E+06
Injury risk for the project	3.07E+01
Fatality risk for the project	2.66E+00
Forecast of rail accidents involving injuries or fatalities	**3.33E+01**

[a] Rail distance calculated as 783 trains x 3,200 miles round trip

The projected number of on-site and off-site transportation accidents involving injury or death during construction of the "complete rad removal" alternative of 34.86 is related primarily to the number of trucks hauling materials onto the site and transporting the RIM via rail to an off-site disposal facility. It should be noted that this projection includes injuries and deaths of people other than the truck occupants. In 2012, 3% of the injuries and 10% of the fatalities from traffic accidents on public roads were to people not riding in the truck involved in the incident (NHTSA 2014).

6.3.2 Industrial Hazards

As in the previous assessment, the workers involved with remedial alternative construction have been divided into two groups: general construction and driver/operators. The Bureau of Labor Statistics (BLS) maintains historical information on the rate that accidents occur in the U.S. These statistics are available grouped by job description, and Table 6-13 and Table 6-14 list accident statistics for general construction and off-road drivers, respectively.

Table 6-13 Accident Rate for General Construction and Support Workers

Parameter	Value
Injury accident rate per 100 full-time workers [a]	2.90E+00
Accident rate per man-hour worked	1.45E-05
Accident rate per man-day worked	1.16E-04
Number of general construction + support man-days worked [b]	1.18E+05
Number of Accidents Forecast	**1.37E+01**

[a] Bureau of Labor Statistics News Release, October 29, 2014 "Employer-Reported Workplace Injuries and Illnesses – 2014" for Heavy and civil engineering construction (237). (BLS 2015)
[b] Estimate provided by Feezor Engineering, Inc., September 27, 2016, "Crew Man-Days Overall"

Table 6-14 Occupational Accident Rate for Truck Drivers

Parameter	Value
Injury accident rate per 100 full-time workers [a]	4.40E+00
Accident rate per hour worked	2.20E-05
Hours spent driving [b]	1.55E+05
Other transportation activities (hrs) [c]	3.10E+04
Total transportation man-hours worked	1.86E+05
Number of Accidents Forecast [d]	**4.10E+00**

[a] Bureau of Labor Statistics News Release, October 29, 2014 "Employer-Reported Workplace Injuries and Illnesses – 2014" for Heavy and civil engineering construction (484). (BLS 2015)

[b] Estimate provided by Feezor Engineering, Inc., September 27, 2016, "Crew Man-Days On-site Haul Trucks" x 8 h/d

[c] Hours assumed - Driving hours x 0.2.

[d] Accident Rate per hour x Total Transportation Man-hours

Table 6-13 and Table 6-14 also list the remedial alternative construction time in either man-days or man-hours that can be grouped into each of those broad labor categories. Multiplying the total time by the appropriate accident rate will yield an accident forecast for this group's activities during this project. The number of accidents forecast for the general construction and off-road drivers are presented in bold on the last line of Table 6-13 and Table 6-14, respectively. Summing the number of accidents forecast for both labor groups yields the total accident projection for the project.

For example, it is estimated that it will require 118,000 man-days of general construction and support labor to construct the "complete rad removal" alternative. Multiplying this duration by the injury and fatality rate of 1.16×10^{-04} accidents per man-day in Table 6-13 yields the construction incident forecast of 13.7 accidents. Adding this to the project risk of non-traffic accidents for truck drivers in Table 6-14 yields a total accident projection for general construction and off-road activities of 17.78.

6.4 QUANTIFICATION OF OCCUPATIONAL EXTERNAL RADIATION EXPOSURE

Remedial workers were assumed to be classified as radiation workers in this assessment. As such, the RadCon Tech is expected to be the RME individual in the short-term. Unit dose factors to those workers were calculated using MicroShield 9.02[19]. The current exposure point concentrations from Table 6-1 were multiplied by the unit dose rate to calculate the average dose rate for the worker. Multiplying the average of these dose rates and the total projected time spent exposed to RIM yields the estimated annual TEDE to RadCon Techs on the project (Table 6-15).

Table 6-15 Radiation Dose to RadCon Tech

	Area 2
Days per Project	2531
Average TEDE on surface (mrem/hour)	2.25E-01
Hours spent exposed to RIM (per year)	1.80E+03 [b]
TEDE for Reasonably Maximally-Exposed Individual (mrem/y)	**4.05E+02**

[a] Calculated by MicroShield.
[b] 2,531 worker exposure days / 11.2 year project duration= 225 days/year x 8 hours/day = 1,800 hours/year

The calculated average exposure rate to the hypothetical RadCon Tech would be approximately 0.225 mrem/hr. If the RadCon Tech spent 1,800 hours per year working on the RIM, the TEDE would be 405 mrem/y. To put this in perspective, according to 10 CFR § 20.1201, a radiation worker has an occupational exposure limit of 5,000 mrem/y, assuming no administrative limits are imposed for the Site (NRC 1991).

6.5 SUMMARY

The short-term human health risks and hazard projections are summarized in Table 6-16.

Table 6-16 Summary of Short-Term Hazards and Risks Associated with "Complete Rad Removal" Alternative

Category of Hazard or Risk	Value
Projected Incidence of Transportation Accidents	3.49E+01
Projected Incidence of Industrial Accidents	1.78E+01
Carcinogenic Risk to Rad Con Tech	2.19E-03
Carcinogenic Risk to Off-Property Residents	5.17E-08
HI to RadCon Tech	1.22E+00
HI to Off-Property Resident	4.12E-04
TEDE to Reasonably Maximally-Exposed Individual	4.05E+02

It is projected that 34.9 individuals could be injured or killed on public roads during implementation of the "complete rad removal" alternative, and 17.8 injuries or deaths are projected to be related to industrial activities. There is also a 7.1% chance of a fatal

[19] Grove Software

transportation accident and a 145% chance that a person will be injured as a result of a transportation accident.

Carcinogenic risks from exposure to RIM encountered during construction are expected to be no greater than the risk calculated for the RadCon Tech. The lifetime risk to the RadCon Tech was calculated to be 2.19×10^{-03}. This calculated risk exceeds EPA's acceptable risk range of 10^{-06} to 10^{-04}. The most important single contributor to this risk is the gamma radiation from RIM on and near the surface of the contamination area. Note that the carcinogenic risk to the off-property resident is less than 10^{-06}.

7 SHORT-TERM RISKS FOR THE ROD-SELECTED REMEDY

7.1 ALTERNATIVE DESCRIPTION

In this alternative, the RIM will remain in place with Site improvements to meet the stated goals of the ROD. This remedy is a containment remedy for OU-1 intended to protect human health by regrading part of the Site and placing an engineered cap over all of OU-1. This will provide a physical barrier that isolates the RIM from surface receptors.

Field investigations indicate that RIM is present at or near the surface in Areas 1 and 2. The ROD-selected remedy requires recontouring the surface of OU-1 and installing a cover designed to meet Missouri Department of Natural Resources (MDNR) landfill closure requirements. The design also includes an underlying rock/concrete rubble layer to enhance long-term stability, protect the RIM from bio- or human intrusion, and prevent erosion of the underlying waste materials. These Site improvements will bring the upper surface to an acceptable slope and improve surface drainage of Areas 1 and 2.

This risk analysis identifies and evaluates the major short-term hazards and exposures from the construction and transportation activities during grading and capping of Areas 1 and 2 under the ROD-selected remedy. It also evaluates the human health risks from exposure to chemicals and radionuclides that may occur during the construction of the remedy.

7.2 QUANTIFICATION OF SHORT-TERM COPC EXPOSURE RISKS

As discussed in Section 2, a human health assessment considers the following components: COPC selection, exposure assessment (exposure point concentrations, potential receptors, and exposure pathways), toxicity assessment, and risk characterization. This section combines the first three components to characterize risks to both on-property and off-property receptors from exposure to COPCs. The following sections combine information from Section 3 with alternative-specific information and present the calculations specific to the ROD-selected remedy.

7.2.1 **Exposure Point Concentrations in Soil**

The exposure point concentration is the concentration of a contaminant in an exposure medium that may be contacted by a real or hypothetical receptor. As previously discussed in Section 2.2.1.1, the average concentration of radionuclides in the total volume of excavated materials was calculated and used for radionuclide exposure point concentrations. Radionuclide concentrations in Area 2 were selected to evaluate human health effects because the radionuclide concentrations with the greatest impact on health (Ra-226 and Th-230) are greater in Area 2.

Chemical exposure point concentrations were calculated from combined OU-1data as described in Section 2.2.1.2. Table 7-1 presents the representative concentrations of radionuclides and chemicals in soil used in this short-term risk assessment.

Table 7-1 Short-term Soil Exposure Point Concentrations for the ROD-Selected Remedy

Analyte	Soil Exposure Point Concentrations	Units
Radionuclides [a]		
Uranium Series		
Uranium-238 + 3 dtrs	11.47	pCi/g
Uranium-234	12.03	pCi/g
Thorium-230	150.00	pCi/g
Radium-226 + 8 dtrs	60.00	pCi/g
Lead-210 + 2 dtrs	12.76	pCi/g
Actinium Series		
Uranium-235 + 1 dtr	0.59	pCi/g
Protactinium-231	16.71	pCi/g
Actinium-227 + 9 dtrs	11.29	pCi/g
Thorium Series		
Thorium-232 + 10 dtrs	2.02	pCi/g
Inorganic Chemicals [b]		
Antimony (metallic)	5.97	mg/kg
Arsenic, Inorganic	40.18	mg/kg
Chromium, total	64.87	mg/kg
Cobalt	349.00	mg/kg
Lead and Compounds	785.80	mg/kg
Mercury	0.70	mg/kg
Nickel Soluble Salts	432.40	mg/kg
Uranium (Soluble Salts)	156.00 [c]	mg/kg
Vanadium and Compounds	158.00	mg/kg
Pesticides/PCBs [b]		
Aroclor 1242	0.43	mg/kg
Aroclor 1254	0.40	mg/kg
Volatile Organic Compounds [b]		
Dichlorobenzene, 1,4-	312.79	mg/kg
Chlorobenzene	26.45	mg/kg

[a] Based on average concentration of excavated material in Area 2 only..
[b] Based on 95% UCLs of sample results for all OU-1 soils combined.
[c] The names listed reflect the lab chemical designation. There are no RSL values within the EPA calculator for these laboratory chemical names. As such, risk is calculated using the RSL values within the EPA calculator for related chemicals (i.e., chromium (VI) for chromium, total, and mercury (elemental) for mercury.
[d] Of the isotopes of natural uranium, uranium-238 accounts for more than 99 percent of the mass of uranium. The 95% UCL mass concentration of uranium-238 for all OU-1 soils of 52.3 pCi/g was divided by the specific activity of 0.336 pCi/µg, resulting in a mass concentration of 156 mg of uranium (soluble salts) per kg of soil (mg/kg).

7.2.2 **Exposure Point Concentrations in Air**

As previously discussed in Section 2.2.8.3, AERMOD was used to simulate aerial transport of both fugitive dust and radon. Radon concentrations in the short-term are the same values as presented in the updated BRA, and are presented in Table 2-3. Particulate air concentrations for selected locations are dependent on soil concentrations and are presented in Table 7-2 below.

Table 7-2 Short-term Air Exposure Point Concentrations for the ROD-Selected Remedy

Analyte	Off-Property, Southeast (722898 E 4293620 N)	On-site, Area 2 (721720 E 4294785 N)
Uranium Series (pCi/m^3)		
Uranium-238 + D	6.88E-08	8.37E-05
Uranium-234	7.21E-08	8.77E-05
Thorium-230	8.99E-07	1.09E-03
Radium-226 + D	3.60E-07	4.37E-04
Lead-210 + D	7.65E-08	9.30E-05
Actinium Series (pCi/m^3)		
Uranium-235 + 1 D	3.51E-09	4.27E-06
Protactinium-231 + D	1.00E-07	1.22E-04
Actinium-227 + D	6.77E-08	8.23E-05
Thorium-232 Series (pCi/m^3)		
Thorium-232 + 10 D	1.29E-14	1.91E-08
Inorganic Chemicals (µg/m^3)		
Antimony	3.57E-08	4.34E-05
Arsenic	2.41E-07	2.93E-04
Chromium (as IV)	3.89E-07	4.73E-04
Cobalt	2.09E-06	2.54E-03
Lead	4.71E-06	5.73E-03
Mercury	4.19E-09	5.10E-06
Nickel	2.59E-06	3.15E-03
Uranium	9.33E-07	1.13E-03
Vanadium	9.45E-07	1.15E-03
Pesticides/PCBs (µg/m^3)		
Aroclor-1242	2.60E-09	3.16E-06
Aroclor-1254	2.45E-09	2.98E-06
Volatile Organic Compounds (µg/m^3)		
1,4-Dichlorobenzene	1.88E-06	2.28E-03
Chlorobenzene	1.59E-07	1.93E-04

7.2.3 Exposure Pathways

During remedy construction, the RIM and chemicals will be disturbed by grading and limited excavation, for example from the Buffer Zone. The receptors identified in Section 3.3 could be exposed to this material by inhalation of fugitive dust, inhalation of radon, incidental ingestion of soil, direct exposure to radiation from soil, direct exposure to radiation and chemicals from submersion in air, or dermal contact, depending on the receptor and their locations.

7.2.4 Quantification of Human Health COPC Exposure Risks

7.2.4.1 Calculation of Carcinogenic Risk to Selected Receptors

Calculations of carcinogenic risks to potential receptors were based on the relationships between risk and concentration produced by Site-specific scenario descriptions input into EPA's PRG and RSL calculators. The major difference between the default parameter values used by EPA to calculate health effects to default receptors and the values used to describe Site-specific receptors at this Site is the amount of time that the receptors are assumed to spend exposed to RIM. For example, EPA's PRG calculations for an outdoor worker assume the worker spends 5,625 days on a generic Site[20] during a 25 year period, and scheduling information suggests a West Lake Landfill remediation worker would be exposed to RIM for 8 hours a day over 223 days[21] during the relocation of the RIM from the Buffer Zone and grading of Areas 1 and 2.

The RadCon Tech was assumed to be exposed for 225 days a year over the 1 year of construction. The off-property resident may be exposed for a longer period but no work is ongoing (nights, weekends, etc.). Therefore, the default EPA annual exposure frequency of 350 days a year was used over the 1 year of construction.

Table 7-3 and Table 7-5 provide the input parameters for EPA's Soil and Air PRG and RSL Calculators for outdoor workers and off-property residents. Table 7-4 and Table 7-6 provide the results of the calculations using these parameters.

Table 7-3 Input for EPA's Soil and Air PRG and RSL Calculators, RadCon Tech, ROD-Selected Remedy

Variable	Radionuclide PRG Calculator Value	Chemical RSL Calculator Value
Slab size for ACF (area correction factor) m^2	2,000	NA
t_{ow} (time - outdoor worker) yr	1	NA
ED_{ow} (exposure duration - worker) yr	1	1
ET_{ow} (exposure time - worker) hr/day	8	8
EF_{ow} (exposure frequency - worker) day/yr	225	225

Note: Other parameters were left at default values.

[20] Total days = Exposure Duration 25 (y/lifetime) x 225 (d/y) = 5,625 (d/lifetime)

[21] Derived from project schedule provided by Feezor Engineering, Inc., dated October 20, 2016.

Table 7-4 Calculated Risks to the Hypothetical RadCon Tech During Construction of the ROD-Selected Remedy

COC	Incidental Soil Ingestion	Direct Radiation from Soil	Dermal	Inhalation of Dust	Inhalation of Radon [a]	Direct Radiation, Submersion in Air	All Routes
Uranium Series							
Uranium-238 + 2 dtrs	1.45E-08	2.41E-07	NA	8.92E-09	NA	2.19E-15	2.64E-07
Uranium-234	1.38E-08	6.26E-10	NA	1.10E-08	NA	9.24E-18	2.54E-08
Thorium-230	2.61E-07	2.51E-08	NA	1.68E-07	NA	3.02E-16	4.54E-07
Radium-226 + 8 dtrs	7.56E-07	8.73E-05	NA	6.85E-08	NA	6.96E-13	8.82E-05
Actinium Series							
Uranium-235 + 1 dtr	6.58E-10	5.14E-08	NA	4.81E-10	NA	5.89E-16	5.25E-08
Protactinium-231 + 10 dtrs	1.10E-07	4.88E-07	NA	1.21E-07	NA	2.45E-14	7.19E-07
Thorium Series							
Thorium-232 + 10 dtrs	3.68E-08	1.45E-06	NA	1.98E-11	NA	1.50E-17	1.49E-06
Radon-222 Series in Air [b]							
Rn-222	NA	NA	NA	NA	2.95E-08	7.19E-13	2.95E-08
Po-218	NA	NA	NA	NA	-	5.77E-18	5.77E-18
Pb-214	NA	NA	NA	NA	3.09E-09	3.61E-12	3.10E-09
Bi-214 + 1 dtr	NA	NA	NA	NA	5.08E-11	5.01E-13	5.13E-11
					Total Radiocarcinogenic Risk		**9.12E-05**
Inorganic Chemicals							
Antimony (metallic)	-	NA	-	-	NA	NA	0.00E+00
Arsenic, Inorganic	3.98E-07	NA	8.42E-08	3.70E-09	NA	NA	4.86E-07
Chromium(VI)	3.56E-07	NA	-	1.16E-07	NA	NA	4.73E-07
Cobalt	-	NA	-	6.71E-08	NA	NA	6.71E-08
Lead and Compounds	-	NA	-	-	NA	NA	0.00E+00
Mercury (elemental)	-	NA	-	-	NA	NA	0.00E+00
Nickel Oxide	-	NA	-	2.41E-09	NA	NA	2.41E-09
Uranium (Soluble Salts)	-	NA	-	-	NA	NA	0.00E+00
Vanadium and compounds	-	NA	-	-	NA	NA	0.00E+00
Pesticides/PCBs							
Aroclor 1242	9.55E-09	NA	5.65E-09	5.30E-12	NA	NA	1.52E-08
Aroclor 1254	9.02E-09	NA	5.34E-09	5.01E-12	NA	NA	1.44E-08
Volatile Organic Compounds							
Dichlorobenzene, 1,4-	1.86E-08	NA	-	7.36E-11	NA	NA	1.87E-08
Chlorobenzene	-	NA	-	-	NA	NA	0.00E+00
					Total Chemocarcinogenic Risk		**1.08E-06**
					Total Carcinogenic Risk		**9.23E-05**

NA - Not applicable
"-" indicates no PRG or RSL.
[a] Using inhalation slope factor for naked radon-222 as derived in footnote of Table 26 of Auxier 2016.
[b] Radon source term includes emissions from all OU-1 areas.

Table 7-5 Input for EPA's Air PRG and RSL Calculators, Off- Property Resident, ROD-Selected Remedy

Variable	Radionuclide PRG Calculator Value	Chemical RSL Calculator Value
TR (target cancer risk) unitless	0.000001	0.000001
THQ (target hazard quotient) unitless	NA	1
EF_{res} (exposure frequency) day/yr	350	350
ET_{res} (exposure time - resident) hr	24	24
ED_{res-a} (exposure duration, carcinogenic – resident adult) yr	1	1
LT (lifetime - resident) year	NA	70
t_{res} (time - resident) yr	1	NA

Table 7-6 Calculated Risks to the Off- Property Resident During Construction of the ROD-Selected Remedy

COC	Inhalation of Dust	Inhalation of Radon [a]	Direct Radiation, Submersion in Air	All Routes
Uranium Series				
Uranium-238 + 2 dtrs	1.14E-11	NA	8.40E-18	1.14E-11
Uranium-234	1.41E-11	NA	3.55E-20	1.41E-11
Thorium-230	2.15E-10	NA	1.16E-18	2.15E-10
Radium-226 + 8 dtrs	8.76E-11	NA	2.66E-15	8.76E-11
Actinium Series				
Uranium-235 + 1 dtr	6.15E-13	NA	2.27E-18	6.15E-13
Protactinium-231 + 10 dtrs	1.55E-10	NA	9.39E-17	1.55E-10
Thorium Series				
Thorium-232 + 10 dtrs	2.08E-17	NA	4.72E-23	2.08E-17
Radon-222 Series in Air [b]				
Rn-222	NA	4.95E-10	3.62E-14	4.95E-10
Po-218	NA	-	5.53E-19	5.53E-19
Pb-214	NA	2.61E-10	9.14E-13	2.61E-10
Bi-214 + 1 dtr	NA	1.09E-11	3.21E-13	1.12E-11
			Total Radiocarcinogenic Risk	**1.25E-09**
Inorganic Chemicals				
Antimony (metallic)	-	NA	NA	0.00E+00
Arsenic, Inorganic	1.42E-11	NA	NA	1.42E-11
Chromium(VI)	3.21E-08	NA	NA	3.21E-08
Cobalt	2.58E-10	NA	NA	2.58E-10
Lead and Compounds	-	NA	NA	0.00E+00
Mercury (elemental)	-	NA	NA	0.00E+00
Nickel Oxide	9.22E-12	NA	NA	9.22E-12
Uranium (Soluble Salts)	-	NA	NA	0.00E+00
Vanadium and compounds	-	NA	NA	0.00E+00
Pesticides/PCBs				
Aroclor 1242	2.03E-14	NA	NA	2.03E-14
Aroclor 1254	1.92E-14	NA	NA	1.92E-14
Volatile Organic Compounds				
Dichlorobenzene, 1,4-	2.82E-13	NA	NA	2.82E-13
Chlorobenzene	-	NA	NA	0.00E+00
			Total Chemocarcinogenic Risk	**3.24E-08**
			Total Carcinogenic Risk	**3.37E-08**

NA - Not applicable
"-" indicates no PRG or RSL.
[a] Using inhalation slope factor for naked radon-222 as derived in footnote of Table 26 of Auxier 2016.
[b] Radon source term includes emissions from all OU-1 areas.

The calculated risks to the hypothetical RadCon Tech on Area 2 are 9.23 x 10^{-05}. The risks to a hypothetical receptor living at the location identified in the updated BRA as "Off-Property, Southeast"[22] were calculated as 3.37 x 10^{-08}.

7.2.4.2 Calculation of Non-Carcinogenic Effects to Selected Receptors

Site-specific parameters listed in Table 7-3 and Table 7-5 were used in the EPA RSL calculator to calculate the hazard quotients to the RadCon Tech and off-property resident, respectively. The results for the hypothetical RadCon Tech are presented in Table 7-7. Table 7-8 presents the hazard quotients and hazard index calculated for the off-property resident.

Table 7-7 Hazard Index Calculated for the Hypothetical RadCon Tech During Construction of the ROD-Selected Remedy

COC	Outdoor Worker HQ = 1, Ingestion	Outdoor Worker HQ = 1, Direct Radiation from Soil	Outdoor Worker HQ = 1, Dermal	Outdoor Worker HQ = 1, Inhalation of Dust	Outdoor Worker HQ = 1, Inhalation of Radon	Outdoor Worker HQ = 1, Submersion in Air	Calculated HQ to Outdoor Worker, All Pathways
Inorganic Chemicals							
Antimony (metallic)	1.15E-02	NA	-	-	NA	NA	1.15E-02
Arsenic, Inorganic	6.19E-02	NA	1.31E-02	4.01E-03	NA	NA	7.90E-02
Chromium(VI)	1.67E-02	NA	-	9.71E-04	NA	NA	1.76E-02
Cobalt	8.96E-01	NA	-	8.70E-02	NA	NA	9.83E-01
Lead and Compounds	-	NA	-	-	NA	NA	0.00E+00
Mercury (elemental)	-	NA	-	3.49E-06	NA	NA	3.49E-06
Nickel Oxide	1.66E-02	NA	-	7.20E-03	NA	NA	2.38E-02
Uranium (Soluble Salts)	4.00E-02	NA	-	5.82E-03	NA	NA	4.58E-02
Vanadium and compounds	2.41E-02	NA	-	2.36E-03	NA	NA	2.65E-02
Pesticides/PCBs							
Aroclor 1242	-	NA	-	-	NA	NA	0.00E+00
Aroclor 1254	1.57E-02	NA	9.35E-03	-	NA	NA	2.51E-02
Volatile Organic Compounds							
Dichlorobenzene, 1,4-	3.44E-03	NA	-	5.86E-07	NA	NA	3.45E-03
Chlorobenzene	1.02E-03	NA	-	7.94E-07	NA	NA	1.02E-03
					Total Hazard Index (HI)		**1.22E+00**

NA - Not applicable
"-" indicates no PRG or RSL.

[22] The updated BRA (Auxier 2016) identified the "Off-Property, Southeast" receptor as the RME receptor of the two residents assessed.

Table 7-8 Hazard Index Calculated for the Off-Property Resident During Construction of the ROD-Selected Remedy

COC	Resident RSL, HQ = 1, Inhalation of Dust	Resident RSL, HQ = 1, Inhalation of Radon	Resident RSL, HQ = 1, Inhalation of Radon	Calculated HQ to Resident, All Pathways
Inorganic Chemicals				
Antimony (metallic)	-	NA	NA	0.00E+00
Arsenic, Inorganic	1.54E-05	NA	NA	1.54E-05
Chromium(VI)	3.74E-06	NA	NA	3.74E-06
Cobalt	3.34E-04	NA	NA	3.34E-04
Lead and Compounds	-	NA	NA	0.00E+00
Mercury (elemental)	1.34E-08	NA	NA	1.34E-08
Nickel Oxide	2.76E-05	NA	NA	2.76E-05
Uranium (Soluble Salts)	2.24E-05	NA	NA	2.24E-05
Vanadium and compounds	9.08E-06	NA	NA	9.08E-06
Pesticides/PCBs				
Aroclor 1242	-	NA	NA	0.00E+00
Aroclor 1254	-	NA	NA	0.00E+00
Volatile Organic Compounds				
Dichlorobenzene, 1,4-	2.25E-09	NA	NA	2.25E-09
Chlorobenzene	3.04E-09	NA	NA	3.04E-09
			Total Hazard Index (HI)	**4.12E-04**

NA - Not applicable
"-" indicates no PRG or RSL.

The calculated HI for the hypothetical RadCon Tech located on Area 2 is 1.22. The HI for a receptor living at the location identified in the updated BRA as "Off-Property, Southeast" was calculated as 4.12×10^{-04}. The EPA has previously determined that an HI of greater than one (1) for a particular COPC may represent a potential health risk.

7.3 QUANTIFICATION OF INDUSTRIAL INCIDENT RISKS

There is a risk of occupational and traffic accidents during earthmoving or transportation of materials on public roads. Generally, the risk of occurrence is time dependent, increasing as the duration of the activity lengthens. The severity of the accident depends, in part, on the activity itself.

To assess the likelihood and severity of possible accidents, OSHA and NHTSA statistics for workers in different occupations and transportation records were used in conjunction with manpower and resource projections from remedy construction schedules to calculate the risks for accidents.

7.3.1 Transportation Hazards

Table 7-9 lists statistics on the rate that traffic accidents involving heavy trucks occurred in 2012 (NCSA 2014). The projection for heavy truck use on public roads during construction of the ROD-selected Remedy is 2,020,000 miles. Multiplying this mileage by the injury and fatality rates in Table 7-9 yields the transportation incident forecast presented Table 7-10.

Table 7-9 Accident Incident Rate for Trucks on Public Roads

Incident	Published rate [a]	Per mile rate [b]
Injury Crashes	2.90E+01	2.90E-07
Fatal Crashes	1.42E+00	1.42E-08

[a] Rate per 100 million miles (NHTSA 2014).
[b] Derived from rate (incidents/100,000,000 mile)

Table 7-10 Traffic Injury and Fatality Forecast for the ROD-Selected Remedy

Parameter	Value
Total miles for all hauling on public roads [a]	2.02E+06
Injury risk for the project	5.86E-01
Fatality risk for the project	2.87E-02
Forecast of accidents involving injuries or fatalities	**6.14E-01**

[a] Estimate provided by Feezor Engineering, Inc., October 20, 2016, "Total Delivery Miles (Totals)"

The projected number of transportation accidents involving injury or death of 0.61 is related primarily to the number of trucks hauling materials to the site.

7.3.2 Industrial Hazards

As in the previous assessments, the workers involved with remedy construction have been divided into two groups: general construction and driver/operators. The BLS maintains historical information on the rate that accidents occur in the U.S. These statistics are available grouped by job description, and Table 7-11 and Table 7-12 list occupational statistics for general construction and off-road drivers, respectively.

Table 7-11 Accident Rate for General Construction and Support Workers

Parameter	Value
Injury accident rate per 100 full-time workers [a]	2.90E+00
Accident rate per man-hour worked	1.45E-05
Accident rate per man-day worked	1.16E-04
Number of general construction + support man-days worked [b]	2.11E+04
Number of Accidents Forecast	**2.45E+00**

[a] Bureau of Labor Statistics News Release, October 29, 2014 "Employer-Reported Workplace Injuries and Illnesses – 2014" for Heavy and civil engineering construction (237). (BLS 2015)
[b] Estimate provided by Feezor Engineering, Inc., September 27, 2016, "Crew Man-Days Overall"

Table 7-12 Occupational Accident Rate for Truck Drivers

Parameter	Value
Injury accident rate per 100 full-time workers [a]	4.40E+00
Accident rate per hour worked	2.20E-05
Hours spent driving [b]	1.18E+04
Other transportation activities (hrs) [c]	2.35E+03
Total transportation man-hours worked	1.41E+04
Number of Accidents Forecast [d]	**3.10E-01**

[a] Bureau of Labor Statistics News Release, October 29, 2014 "Employer-Reported Workplace Injuries and Illnesses – 2014" for Heavy and civil engineering construction (484). (BLS 2015)

[b] Estimate provided by Feezor Engineering, Inc., September 27, 2016, "Crew Man-Days On-site Haul Trucks" x 8 h/d

[c] Hours assumed - Driving hours x 0.2.

[d] Accident Rate per hour x Total Transportation Man-hours

Table 7-11 and Table 7-12 also list the remedy construction time in either man-days or man-hours that can be grouped into each of those broad labor categories. Multiplying the total time by the appropriate accident rate will yield an accident forecast for this group's activities during this project. The number of accidents forecast for the general construction and off-road drivers are presented in bold on the last line of Table 7-11 and Table 7-12, respectively. Summing the number of accidents forecast for both labor groups yields the total accident projection for the project.

For example, it is estimated that it will require 21,100 man-days of general construction and support labor to construct the ROD-selected remedy. Multiplying this duration by the injury and fatality rate of 1.16 x 10^{-04} accidents per man-day in Table 7-11 yields the construction incident forecast of 2.45 in Table 7-11. Adding this to the projected risk of non-traffic accidents for truck drivers in Table 7-12 yields a total injury accident projection for general construction and off-road activities of 2.76.

7.4 QUANTIFICATION OF OCCUPATIONAL EXTERNAL RADIATION EXPOSURE

Remedial workers were assumed to be classified as radiation workers in this assessment. Unit dose factors to those workers were calculated using MicroShield 9.02[23]. The current exposure point concentrations from Table 7-1 were multiplied by the unit dose rate to calculate the average dose rate for the worker. Multiplying the average of these dose rates and the total projected time spent exposed to RIM yields the estimated annual TEDE to RadCon Techs on the project (Table 7-13).

[23] Grove Software

Table 7-13 Radiation Dose to RadCon Tech

	Area 2
Days per Project	223
Average TEDE on surface (mrem/hour)	1.05E-01
Hours spent exposed to RIM (per year)	1.78E+03 [b]
TEDE for Reasonably Maximally-Exposed Individual (mrem/y)	**1.87E+02**

[a] Calculated by MicroShield.
[b] 223 worker exposure days x 8 hours/day = 1,780 hours/year

The calculated average exposure rate to the hypothetical RadCon Tech would be approximately 0.105 mrem/hr. If the RadCon Tech spent 1,780 hours per year working on the RIM, the TEDE would be 187 mrem/y. To put this in perspective, according to 10 CFR § 20.1201, a radiation worker has an occupational exposure limit of 5,000 mrem/y, assuming no administrative limits are imposed for the Site (NRC 1991).

7.5 SUMMARY

The short-term human health risks and hazard projections are summarized in Table 7-14.

Table 7-14 Summary of Short-Term Hazards and Risks Associated with ROD-Selected Remedy

Category of Hazard or Risk	Value
Projected Incidence of Transportation Accidents	6.14E-01
Projected Incidence of Industrial Accidents	2.76E+00
Carcinogenic Risk to RadCon Tech	9.23E-05
Carcinogenic Risks to Off-Property Residents	3.37E-08
HI to RadCon Tech	1.22E+00
HI to Off-Property Resident	4.12E-04
TEDE to Reasonably Maximally-Exposed Individual	1.87E+02

It is projected that 0.614 individuals could be injured or killed on public roads during implementation of the ROD-selected remedy, and 2.76 injuries or deaths are projected to be related to industrial activities are projected to occur. There is also a 3% chance of a fatal transportation accident and a 59% chance that a person will be injured as a result of a transportation accident.

Carcinogenic risks from exposure to RIM encountered during construction are expected to be no greater than the risk calculated for the RadCon Tech. The lifetime risk to the RadCon Tech was calculated to be 9.23×10^{-05}. This calculated risk is within EPA's acceptable risk range of 10^{-06} to 10^{-04}. The most important single contributor to this risk is the gamma radiation from RIM on and near the surface of the contamination area. Note that the carcinogenic risk to the off-property resident is less than 10^{-06}.

8 LONG-TERM RISK EXPOSURE ASSESSMENT

This section presents the long-term exposure assessment, which consists of the following steps:

- Characterization of the post-remedy exposure setting (i.e., in the long-term);
- Quantification of exposure point concentrations one year post-remedy and 1,000 years post-remedy;
- Identification of receptors with potentially complete exposure pathways and selection of representative receptors for use in the FFS comparative analysis; and
- Quantification of receptor-specific intake/exposure.

This exposure assessment supports the evaluation of long-term COPC exposure risks. Information presented in this section, unless otherwise noted, is applicable to each "action" alternative (i.e., the two partial excavation alternatives, the full excavation alternative, and the ROD-selected remedy).

8.1 CHARACTERIZATION OF EXPOSURE SETTING

Under each of the OU-1 "action" alternatives, Site improvements include elimination of exposure to RIM at the surface, installation of a cap or cover, and institutional controls. Similar receptors are expected under each alternative. The post-remedy physical configuration is the key component of the exposure setting that affects the overall exposure assessment (i.e., exposure point concentration). Physical attributes of the waste and cover are described on an alternative-specific basis in Sections 9 through 12.

8.2 EXPOSURE POINT CONCENTRATIONS

Section 2.2.1 lists the OU-1 COPCs. Under future conditions, the cap or cover will prevent direct contact with RIM; potentially complete exposure pathways only exist for constituents that produce indirect exposures through the cap via gas, vapor, or radiation transport. Inorganic chemical COPCs are excluded from future exposure scenario evaluations because of their lack of volatility. Organic chemical COPCs are excluded from future exposure scenario evaluations because of their limited extent and risk under current conditions and because biological and chemical degradation is anticipated to further reduce concentrations through time. Therefore, long-term exposures are limited to radionuclides. Long-term risks were calculated based on radionuclide concentrations one year post-remedy and 1,000 years post-remedy. Long-term risks are presented separately for Area 1 and Area 2 exposures.

8.2.1 **Exposure Point Concentrations in Soil at 1 Year after Construction**

For the partial and full excavation alternatives, radionuclides at OU-1 will be excavated until residual concentrations of thorium-232 plus thorium-230, or radium-226 plus radium-228, are equal to or less than the alternative-specific criterion (i.e., 1,000, 52.9, or 7.9 pCi/g). For this evaluation, future exposure point concentrations were estimated by (i) calculating the ratio of the alternative-specific criterion to the baseline 95% UCL for thorium-230 and (ii) multiplying baseline 95% UCL concentrations for other radiological COPCs by this ratio. Thorium-230 was used because the radium 95% UCL concentrations for OU-1 were less than the target remediation goal.

For the ROD-selected remedy, the baseline 95% UCL for concentrations across all depths was used to represent radionuclide concentrations in Areas 1 and 2 immediately after remedy construction. These concentrations were assumed to be representative of the material underlying the proposed cover.[24]

8.2.2 Exposure Point Concentrations in Soil 1,000 Years after Construction

The concentrations of the radionuclides are expected to change over the course of 1,000 years due to radiological decay and in-growth[25]. For each alternative, future concentrations over the next 1,000 years were calculated using the following assumptions:

- The future RIM is unaffected by chemical degradation during the study period of 1,000 years; and
- Radiological decay and associated daughter in-growth over 1,000 years will change the concentrations of the radionuclides in a predictable manner.

The representative concentrations used in this risk assessment are listed in each alternative-specific long-term risk section.

8.3 TOXICITY ASSESSMENT

Construction of this alternative will not change the toxicity of the contaminants in the RIM. The purpose of the alternative is to eliminate unacceptable risks through the removal of potential exposure pathways to be protective of human health and the environment. The toxicity values used in the updated BRA were also used herein.

8.4 POTENTIAL RECEPTORS

The Site has historically been used as a landfill, and most property surrounding the Site is currently used for commercial or industrial purposes. Deed restrictions on the West Lake Landfill prohibit on-site residential use. A deed restriction on Areas 1 and 2 prohibits construction of buildings, installation of underground utilities or pipes, and further future excavation; these restrictions are expected to preclude workers from being present full-time at OU-1, but full-time workers will likely be employed at the Landfill and some may periodically be on OU-1. Therefore, plausible future on-property receptors are limited to workers and transient users. Future surrounding land use 1,000 years in the future is uncertain and could hypothetically include farming or residential uses. Potential on-property and off-property receptors are identified in Table 8-1.

Because potential exposures are dependent on close proximity to radionuclides, individuals with the highest potential for exposure would be the people spending the most time on or near OU-1. Based on these considerations, the future receptor with the greatest potential for exposure is the landfill grounds keeper who works outdoors on the West Lake Landfill property and will work periodically directly on and adjacent to Area 1 or Area 2 soils.

[24] Soil removed from the Crossroads Property and Buffer Zone during an interim remedial action will be added to Area 2 during remedy construction. This material contains lower concentrations of RIM and adding it to the material in Area 2 would lower the average concentration in Area 2.

[25] A 1,000-year study period was selected based on design requirements of 40 CFR Part 192.

8.5 EXPOSURE PATHWAYS

Each of the "action" alternatives would eliminate exposure via incidental ingestion, dermal contact, and inhalation of fugitive dust. Therefore, potentially complete exposure pathways evaluated for the future landfill grounds keeper are: direct radiation from soil, inhalation of radon emanating through the cover, and direct radiation from submersion in air.

Table 8-1 List of Potential Future Receptors

Receptors Identified	Scenario Considered? [a]	Exposure Route: Inhalation of Fugitive Dust	Exposure Route: Inhalation of Radon	Exposure Route: Direct Radiation from Soil	Exposure Route: Direct Radiation from Submersion in Air	Exposure Route: Incidental Soil Ingestion	Exposure Route: Dermal Contact	Selected for Quantitative Evaluation?
Landfill Farmer	No							No
Landfill Resident	No							No
Landfill Outdoor Storage Yard Worker	**Yes**		{O}	{O}	{O}			No
Landfill Commercial Building User	**Yes**		{O}	{O}	{O}			No
Landfill Construction Worker	**Yes**		{O}	{O}	{O}			No
Landfill Trespasser	**Yes**		{O}	{O}	{O}			No
Landfill Recreational/Intermittent User	**Yes**		{O}	{O}	{O}			No
Landfill Grounds Keeper	**Yes**		•	•	•			**Yes**
Off-Property Farmer	**Yes**		{O}	{O}	{O}			No
Off-Property Resident	**Yes**		{O}	{O}	{O}			No
Off-Property Commercial Building User	**Yes**		{O}	{O}	{O}			No
Off-Property Recreational/Intermittent User	**Yes**		{O}	{O}	{O}			No
Off-Property Grounds Keeper	**Yes**		{O}	{O}	{O}			No

[a] An exposure scenario was considered if it included a source, a means of moving constituents of concern to a location of interest, and a receptor at that location.

Symbol	Meaning
•	Exposure route selected for detailed analysis
(shaded box)	A shaded box indicates that the receptor/exposure route combination was not selected for quantitative analysis.
{O}	Not quantified because other receptors identified for this scenario have higher intake rates and longer exposure times.

8.6 SCENARIO-SPECIFIC ASSUMPTIONS AND EXPOSURE PARAMETERS

Some exposure parameters are dependent on receptor-specific behavior patterns and vary from receptor scenario to receptor scenario. This assessment of each alternative assumed the same receptor parameters as the hypothetical landfill grounds keeper in the updated BRA. The exposure factors listed in Table 8-2 provide a description of this receptor's projected behavior. Only Site-specific parameters are shown in the table; other input parameters are default values from ORNL or EPA.

Table 8-2 Input for EPA's Air PRG Calculator, Grounds Keeper

Variable	Radionuclide PRG Calculator Value
t_{ow} (time - outdoor worker) yr	25
ED_{ow} (exposure duration - worker) yr	25
ET_{ow} (exposure time - worker) hr/day	8.5
EF_{ow} (exposure frequency - worker) day/yr	17.6

Note: Other parameters were left at default values.

8.7 UMTRCA REQUIREMENTS

Standards for UMTRCA remedial cell performance have been established by the EPA in 40 CFR Part 192, Subpart A - Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing (UMTRCA 1983). These standards require that final cover designs limit exposures to radiation and radioactive materials, provide long-term stability, and require minimal maintenance to assure performance standards are met in the future. Control measures are to be designed to be effective for up to 1,000 years (to the extent reasonably achievable) and, in any case, for at least 200 years. The rate at which radon escapes the cover surface (the radon flux rate) is measured in picocuries per square meter per second ($pCi/m^2/s$). The control measures must provide reasonable assurance that releases of radon-222 from radioactive material to the atmosphere would not exceed an average release rate of 20 $pCi/m^2/s$ (averaged over the entire site and over a one year period) and radiation exposure rates should be limited to 20 microroentgens per hour above background.

The clay and soil cover would slow the movement of radon gas. This is important because delaying radon's arrival at the surface allows radioactive decay to reduce the amount of radon emerging from the soil's surface. The radon flux through the cover was evaluated using RAECOM for the ROD-selected remedy which leaves all RIM in Areas 1 and 2 (See the cover design description in Appendix F for details on this model and its use).

These calculations predict that very little radon-222 for each alternative would reach the surface of the cover (< 1 $pCi/m^2/s$).

9 LONG-TERM RISKS FOR THE "PARTIAL EXCAVATION TO 1,000 PCI/G" ALTERNATIVE

9.1 ALTERNATIVE DESCRIPTION

In this alternative, RIM above 1,000 pCi/g will be excavated and transported to an approved out-of-state disposal facility. This alternative is intended to protect human health by removing RIM above the established criterion and placing an engineered cap over all of OU-1. This cap design provides a physical barrier that isolates the remaining RIM from surface receptors.

This section evaluates long-term residual COPC exposure risks to human health using standard EPA methodology for conducting HHRAs, which includes the following four components: selection of constituents COPCs, exposure assessment, toxicity assessment, and risk characterization. COPC selection, portions of the exposure assessment, and the toxicity assessment were presented in Section 8. This section focuses on the alternative-specific components: exposure setting, residual exposure point concentrations, and the risk characterization. Additionally, this section evaluates remedial alternative performance relative to Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing, which were established by the EPA in 40 CFR Part 192, Subpart A ("UMTRCA Requirements").

9.2 EXPOSURE SETTING

This alternative requires excavation of RIM, re-contouring the surface of OU-1, and installation of a cover designed to meet MDNR landfill closure requirements. The design also includes an underlying rock/concrete rubble layer to enhance long-term stability, protect the remaining RIM from bio- or human intrusion, and prevent erosion of the underlying waste materials. These Site improvements will bring the upper surface to an acceptable slope and improve surface drainage of Areas 1 and 2.

9.2.1 **Physical Setting**

The physical configuration of OU-1 after completion of the alternative is summarized below:

- A portion of the RIM in Areas 1 and 2 will have been removed, leaving a layer of RIM at concentrations below criteria, and non-RIM wastes.
- Areas 1 and 2 will be graded to improve the drainage characteristics of the final cover.
- A two-foot (0.6 m) thick rock and/or concrete rubble bio-intrusion layer would be placed over the RIM in Areas 1 and 2.
- A two-foot (0.6 m) thick clay cap would be placed over the rock/rubble layer to minimize precipitation infiltration into the underlying waste materials and to attenuate radon emissions from the RIM. The permeability of this clay will be a minimum of 10^{-07} m/s (10^{-05} cm/s).
- The clay layer will be covered with one foot (0.3 m) of soil and a vegetative cover (grass) will be established on the cap. This vegetative cover is assumed to be maintained to prevent depletion of the cap.

Figure 9-1 depicts the cap design for Areas 1 and 2.

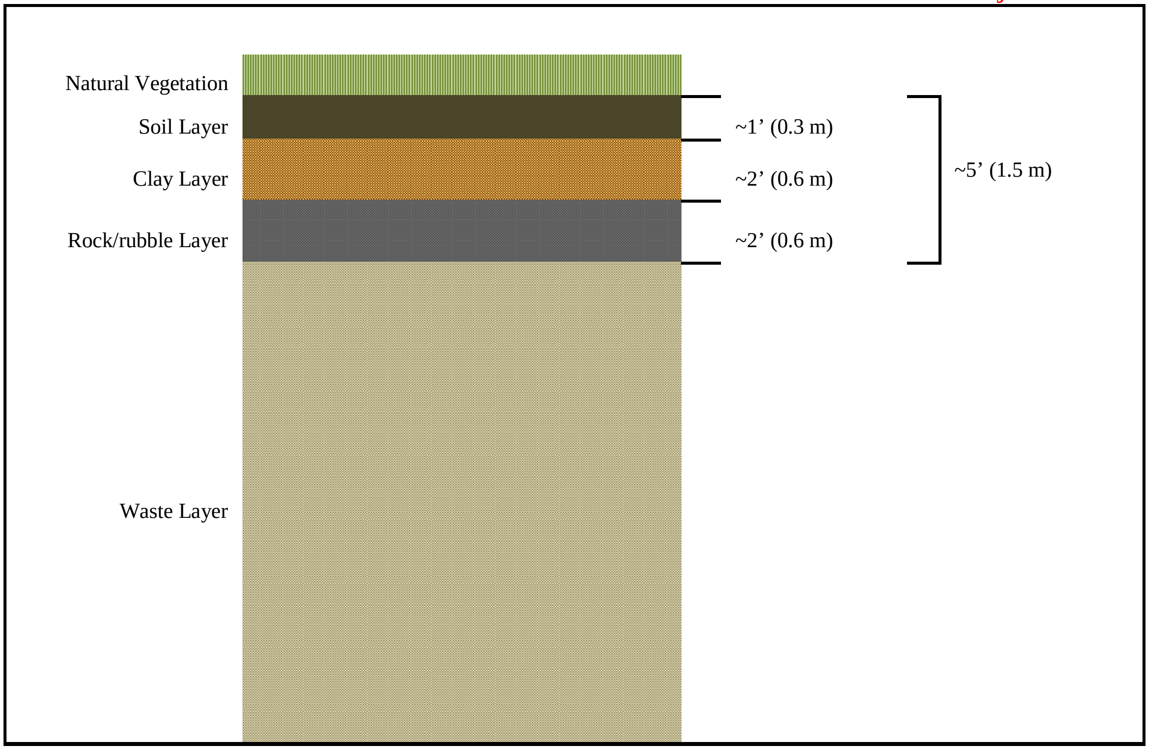

Figure 9-1 Stylized Cross-Section of RIM and Cover for the "Partial Excavation to 1,000 pCi/g" Alternative

9.2.2 Physical Attributes of the Waste and Cover

The physical properties of the remaining RIM and cover components are presented in Table 9-1. The erosion rate of the cover layer reflects the effects of maintenance and the rock/rubble layer.

Table 9-1 Physical Properties of RIM Below Criteria and Cover

Parameter	Area 1	Area 2
Contamination Zone (RIM)		
Area (m^2)	25,217	98,515
Erosion Rate (m/y)	0.001	0.001
Total Porosity (dry wt_%)	0.3	0.3
Field Capacity (vol/vol)	0.292	0.292
Hydraulic Conductivity (m/y)	5.26	5.26
Radon Diffusion Coefficient (m^2/s)	$1.806x10^{-09}$	$1.806x10^{-09}$
Cover		
Thickness (m)	1.5	1.5
Erosion Rate (m/y)	0.0001	0.0001
Total Porosity (vol/vol)	0.427	0.427
Volumetric Water Content (vol/vol)	0.367	0.367
Hydraulic Conductivity (m/y)	0.000526	0.000526

9.3 EXPOSURE POINT CONCENTRATIONS

As discussed in Section 8, the evaluation of future risks focuses on radiological COPCs. Placing the engineered cover over OU-1 will block almost all of the direct radiation exposure from the remaining RIM. Exposures from the small fraction of direct gamma radiation predicted to penetrate the cover were quantified in this assessment. This cover will also attenuate almost all of the radon-222 produced in the underlying RIM below the 1,000 pc/g excavation limit. Radium-226 in the remaining RIM will decay to radon-222, which is a noble gas. About 20% of radon gas is released to interstitial air and water in the pore spaces of the residual radium and surrounding soils, while the other 80% remains within the solid matrix of the soil particles. Once in the pore space, radon gas is free to move in the soil. The distance that radon can travel is greatly limited by its 3.8-day half-life. Covering the remaining RIM with low permeability soil/clay increases the time required for the radon to reach the ground surface. This increased travel time allows almost all of the radon to decay before it reaches the surface. Risks from residual radon gas and the risks associated with direct radiation from radon daughters if submerged in air were quantified in this assessment.

Calculated exposure point concentrations 1 year and 1,000 years post- remedial alternative are discussed below. The representative concentrations used in this risk assessment are listed in Table 9-2.

9.3.1.1 Exposure Point Concentrations in Soil at 1 Year after Construction

The RIM in each area would be removed until residual concentrations of thorium-232 plus thorium-230, or radium-226 plus radium-228, were equal to or less than 1,000 pCi/g. Beginning with the initial RIM concentrations in Area 1 and Area 2 listed in the updated BRA, and for the purposes of these calculations, the concentrations of the all radionuclides were reduced proportionally until the total thorium-230 concentration in the remaining RIM equaled 1,000 pCi/g. For example, the current 95% UCL concentration of Th-230 in Area 2 is 4,732 pCi/g and the remedial alternative-specific criterion is 1,000 pCi/g; 1,000 pCi/g divided by 4,732 pCi/g results in a ratio of 0.2113. All other current exposure point concentrations for radiological COPCs were multiplied by this ratio to reflect the approximate concentrations post- remedial alternative. Thorium-230 was used because the radium 95% UCL concentrations for OU-1 were less than the target remediation goal.

9.3.1.2 Exposure Point Concentrations in Soil at 1,000 Years after Construction

The concentrations of the radionuclides in the RIM below the remedial alternative-specific criterion are expected to change over the course of 1,000 years due to radiological decay and in-growth[26]. The 1,000 year values include the effects of radioactive in-growth and decay.

[26] A 1,000 year study period was selected based on design requirements of 40 CFR Part 192.

Table 9-2 COPC Concentrations in Areas 1 and 2, "Partial Excavation to 1,000 pCi/g" Alternative

	1 Year Post-Construction		1,000 Years Post-Construction		
COPC	**Area 1** [a]	**Area 2** [a]	**Area 1**	**Area 2**	**Units**
Uranium Series					
Uranium-238 + 3 dtrs	1.50E+01	2.64E+01	1.50E+01	2.64E+01	pCi/g
Uranium-234	1.65E+01	2.77E+01	1.65E+01	2.76E+01	pCi/g
Thorium-230	1.00E+03	1.00E+03	9.91E+02	9.91E+02	pCi/g
Radium-226 + 8 dtrs	1.69E+02	8.35E+01	4.59E+02 [b]	4.04E+02 [b]	pCi/g
Lead-210 + 2 dtrs	4.95E+01	2.94E+01	4.59E+02 [c]	4.04E+02 [c]	pCi/g
Actinium Series					
Uranium-235 + 1 dtr [d]	7.86E-01	1.35E+00	7.86E-01	1.35E+00	pCi/g
Protactinium-231	4.01E+01	3.85E+01	3.93E+01	3.77E+01	pCi/g
Actinium-227 + 9 dtrs	1.18E+01	2.60E+01	3.93E+01	3.77E+01	pCi/g
Thorium Series					
Thorium-232 + 10 dtrs	1.57E+01	4.65E+00	1.57E+01	4.65E+00	pCi/g

[a] One year after construction ceases.
[b] Includes in-growth from the decay of thorium-230.
[c] Assumed to be in secular equilibrium with radium-226.
[d] Due to the uncertainty of the uranium-235 results, these values were calculated using the more reliable uranium-238 and uranium-234 results and the expected relative abundance of uranium-235 in natural uranium.

9.3.1.3 Exposure Point Concentrations in Air at 1 and 1,000 years

Radon concentrations were also generated for the residual concentration of RIM left below 1,000 pCi/g at 1 and 1,000 years. These concentrations were generated at the same locations as the updated BRA. As the hypothetical grounds keeper will be located atop Area 1 and Area 2, those two locations were chosen and are presented in Table 9-3.

Table 9-3 Radon-222 Concentrations in Air at Exposure Point Concentrations for the "Partial Excavation to 1,000 pCi/g" Alternative

Analyte	On-site, Area 1 (722130 E 4294400 N)	On-site, Area 2 (721720 E 4294785 N)
Flight distance(m)	250	440
Flight time(min) [a]	1.0	1.8
At 1 Year		
Rn-222 (pCi/m^3)	1.6 E-3	8.9 E-4
Po-218 (pCi/m^3)	3.2 E-4	2.9 E-4
Pb-214(pCi/m^3)	4.2 E-6	7.1 E-6
Bi-214 + 1 dtr (pCi/m^3)	5.0 E-8	1.5 E-7
At 1,000 Years		
Rn-222 (pCi/m^3)	4.5 E-3	4.2 E-3
Po-218 (pCi/m^3)	9.0 E-4	1.4 E-3
Pb-214(pCi/m^3)	1.2 E-5	3.4 E-5
Bi-214 + 1 dtr (pCi/m^3)	1.4 E-7	7.1 E-7

9.4 RISK CHARACTERIZATION

The long-term risk characterization quantitatively evaluated potential risks to a landfill grounds keeper who works outdoors at the West Lake Landfill property, adjacent to and on Area 1 or Area 2. This receptor is assumed to be exposed to radiological COPCs via inhalation of radon, direct radiation from submersion in air, and exposure to direct radiation from soil. Results of the risk characterization are presented below. Potential risks are quantified using EPA RAGS methodology and based on a comparison of radiation dose rates to acceptable occupational exposure limits.

9.4.1 Risks from Inhalation of Radon and Submersion in Air

The EPA PRG calculator for air does not provide the ability to estimate air concentrations emitted from subsurface contaminants. AERMOD (see Section 2.2.8.3) was used to calculate the concentration of radon-222 and daughters at the RME receptor site with a 1.5 m cover. Radon flux as measured on OU-1 was used in conjunction with AERMOD to establish the radon and radon daughter concentrations at receptor locations. The risk was calculated for that concentration by dividing 10^{-06} by the sum of the PRGs and then multiplying by the estimated concentration of radon-222 and daughters (see Attachment A to the updated BRA).

For example, for the Area 2 "partial excavation to 1,000 pCi/g" alternative, the radon-222 concentration (4.2 x 10^{-03} pCi/m^3 from Table 9-3) at the receptor emanating from the 1.5 m cover at 1,000 years was calculated using AERMOD software and the 1,000 year post- remedial alternative concentration of radium-226 (404 pCi/g). The 10^{-06} risk was then calculated by dividing 10^{-06} by the PRG for inhalation of radon while outdoors ($3.34 \times 10^{+00}$ pCi/m^3), then multiplying by the concentration at the receptor site of 4.2×10^{-03} pCi/m^3. The risk value for radon-222 was further modified by multiplying the risk by 0.095, a factor that is described in footnote (a) of the updated BRA, Table 26. This factor was applied to account for the incorrect slope factor used in the EPA PRG calculator for radon-222. This equates to a total risk for radon-222 of 1.21×10^{-10}.

The same method was used to calculate the risks associated with submersion in air; however, because similar information does not exist to calculate an immersion slope factor, no further adjustment was made.

9.4.2 **Exposure from Direct Radiation**

In both Areas 1 and 2, the landfill cover design greatly reduces the amount of direct radiation that reaches the ground surface above the cover. This shielding increases as the thickness or density of intervening material increases.

The EPA PRG calculator was used to quantify carcinogenic risks from this remedial alternative; however, the PRG calculator does not provide the option to select the engineered cover design thickness of 1.5 meters. PRGs for a 1 pCi/g concentration associated with a 1.5 meter (150 cm) cover were established by generating PRGs for 50, 60, 70, 80, 90, 100, 200, and 300 cm covers. Scatter plots for each COPC were generated with the PRG plotted on the Y axis and the cover thickness plotted on the X axis. The equation associated with the highest correlation coefficient was then used to calculate the 1.5 meter PRGs for each COPC.

The risk was calculated by dividing 10^{-06} by the calculated 1.5 meter PRG, and then multiplying by the concentration of the COPC at 1 and 1,000 years. For example, the 1.5 meter PRG for radium-226 was calculated at $1.99 \times 10^{+06}$ pCi/g, and the radium-226 1,000 year concentration in Area 2 is 404 pCi/g. The resulting risk is calculated as 10^{-06} / ($1.99 \times 10^{+06}$ pCi/g x 404 pCi/g) $=2.03 \times 10^{-10}$.

9.4.3 **Doses from Direct Radiation**

Dose to the RME individual in mrem/h was calculated using MicroShield® software (see Section 2.2.8.2). Using the software, a unit dose rate associated with 1 pCi/g concentration, a 1.5 meter cover, 1-meter above the surface was calculated for each COPC. The 1,000 year concentrations listed in Table 9-2 were then multiplied by the unit dose rate to calculate the dose associated with the 1,000 year concentration. For example, the unit dose rate associated with 1 pCi/g of radium-226 above a 1.5 m cover and 1 m above the surface was calculated to be 8.86×10^{-09} mrem/hr. The 1,000 year radium-226 concentration in Area 2 associated with this remedial alternative is 404 pCi/g. The resulting exposure rate equals 3.58×10^{-06} mrem/hr for radium-226 (8.86×10^{-09} mrem/hr x 404 pCi/g = 3.58×10^{-06} mrem/hr). This same method was then applied to all COPCs. It is estimated that the grounds keeper will spend 52.7 hours[27] each year outdoors. Multiplying the total hours each year by the sum of the exposure rates for all the COPCs combined results in a TEDE of 2.11×10^{-04} mrem/yr.

[27] 6.2 days per year exposed to soil x 8.5 hours per day.

9.4.4 **Risk Summary**

The parameters set forth in Table 8-2 were used to calculate long-term risks. Table 9-4 and Table 9-6 contain long-term risks at year 1 and year 1,000. Table 9-5 and Table 9-7 present calculated doses to the receptor during those same time periods.

Table 9-4 Long-term Risks to the Grounds Keeper on Area 1 for the "Partial Excavation to 1,000 pCi/g" Alternative

COC	Direct Radiation from Soil	Inhalation of Radon [a]	Direct Radiation, Submersion in Air	All Routes
Uranium Series				
Uranium-238 + 2 dtrs	1.41E-14	NA	NA	1.41E-14
Uranium-234	2.95E-20	NA	NA	2.95E-20
Thorium-230	1.27E-23	NA	NA	1.27E-23
Radium-226 + 8 dtrs	8.48E-11	NA	NA	8.48E-11
Actinium Series				
Uranium-235 + 1 dtr	1.02E-16	NA	NA	1.02E-16
Protactinium-231 + 10 dtrs	7.35E-20	NA	NA	7.35E-20
Thorium Series				
Thorium-232 + 10 dtrs	3.17E-13	NA	NA	3.17E-13
Radon-222 Series in Air [b]				
Rn-222	NA	4.50E-11	1.10E-15	4.50E-11
Po-218	NA	-	5.35E-21	5.35E-21
Pb-214	NA	1.57E-12	1.83E-15	1.58E-12
Bi-214 + 1 dtr	NA	1.44E-14	1.42E-16	1.45E-14
1 y Total Radiocarcinogenic Risk				**1.32E-10**
Uranium Series				
Uranium-238 + 2 dtrs	1.41E-14	NA	NA	1.41E-14
Uranium-234	2.95E-20	NA	NA	2.95E-20
Thorium-230	1.26E-23	NA	NA	1.26E-23
Radium-226 + 8 dtrs	2.31E-10	NA	NA	2.31E-10
Actinium Series				
Uranium-235 + 1 dtr	1.02E-16	NA	NA	1.02E-16
Protactinium-231 + 10 dtrs	1.05E-19	NA	NA	1.05E-19
Thorium Series				
Thorium-232 + 10 dtrs	3.17E-13	NA	NA	3.17E-13
Radon-222 Series in Air [b]				
Rn-222	NA	1.27E-10	3.11E-15	1.27E-10
Po-218	NA	-	1.51E-20	1.51E-20
Pb-214	NA	4.46E-12	5.19E-15	4.46E-12
Bi-214 + 1 dtr	NA	4.07E-14	4.01E-16	4.11E-14
1,000 y Total Radiocarcinogenic Risk				**3.63E-10**

NA - Not applicable

"-" indicates no PRG or RSL.

[a] Using inhalation slope factor for naked radon-222 as derived in footnote of Table 26 of Auxier 2016.

[b] Radon source term includes emissions from all OU-1 areas.

Table 9-5 Doses from Area 1 to the Grounds Keeper for the "Partial Excavation to 1,000 pCi/g" Alternative

Receptor	Dose (mrem/y) Year 1	Year 1,000
Grounds Keeper (52.7 h/y)	1.53E-04	2.89E-04

Table 9-6 Long-term Risks to the Grounds Keeper on Area 2 for the "Partial Excavation to 1,000 pCi/g" Alternative

COC	Direct Radiation from Soil	Inhalation of Radon [a]	Direct Radiation, Submersion in Air	All Routes
Uranium Series				
Uranium-238 + 2 dtrs	2.48E-14	NA	NA	2.48E-14
Uranium-234	4.95E-20	NA	NA	4.95E-20
Thorium-230	1.27E-23	NA	NA	1.27E-23
Radium-226 + 8 dtrs	4.20E-11	NA	NA	4.20E-11
Actinium Series				
Uranium-235 + 1 dtr	1.75E-16	NA	NA	1.75E-16
Protactinium-231 + 10 dtrs	8.81E-20	NA	NA	8.81E-20
Thorium Series				
Thorium-232 + 10 dtrs	9.37E-14	NA	NA	9.37E-14
Radon-222 Series in Air [b]				
Rn-222	NA	2.54E-11	6.19E-16	2.54E-11
Po-218	NA	-	4.95E-21	4.95E-21
Pb-214	NA	2.65E-12	3.09E-15	2.66E-12
Bi-214 + 1 dtr	NA	4.36E-14	4.29E-16	4.40E-14
			1 y Total Radiocarcinogenic Risk	**7.01E-11**
Uranium Series				
Uranium-238 + 2 dtrs	2.48E-14	NA	NA	2.48E-14
Uranium-234	4.93E-20	NA	NA	4.93E-20
Thorium-230	1.26E-23	NA	NA	1.26E-23
Radium-226 + 8 dtrs	2.03E-10	NA	NA	2.03E-10
Actinium Series				
Uranium-235 + 1 dtr	1.75E-16	NA	NA	1.75E-16
Protactinium-231 + 10 dtrs	1.01E-19	NA	NA	1.01E-19
Thorium Series				
Thorium-232 + 10 dtrs	9.37E-14	NA	NA	9.37E-14
Radon-222 Series in Air [b]				
Rn-222	NA	1.21E-10	2.94E-15	1.21E-10
Po-218	NA	-	2.35E-20	2.35E-20
Pb-214	NA	1.26E-11	1.47E-14	1.26E-11
Bi-214 + 1 dtr	NA	2.07E-13	2.04E-15	2.09E-13
			1,000 y Total Radiocarcinogenic Risk	**3.37E-10**

NA - Not applicable
"-" indicates no PRG or RSL.
[a] Using inhalation slope factor for naked radon-222 as derived in footnote of Table 26 of Auxier 2016.
[b] Radon source term includes emissions from all OU-1 areas.

Table 9-7 Doses from Area 2 to the Grounds Keeper for the "Partial Excavation to 1,000 pCi/g" Alternative

	Dose (mrem/y)	
Receptor	Year 1	Year 1,000
Grounds Keeper (52.7 h/y)	6.10E-05	2.11E-04

9.5 SUMMARY

Risk and dose estimates for the RME individual on Areas 1 and 2 in the first year after remedial alternative construction and 1,000 years after remedial alternative completion are listed in Table 9-8. Calculated exposures to the hypothetical grounds keeper receptor were dominated by exposures from radon daughters produced by decay of radium-226 in any remaining RIM.

Table 9-8 Long-term Risks and Doses to the Grounds Keeper for the "Partial Excavation to 1,000 pCi/g" Alternative

	Area 1	Area 2	Total
Risk at 1 year	1.32E-10	7.01E-11	2.02E-10
Risk a 1,000 years	3.63E-10	3.37E-10	7.00E-10
Dose at 1 year (mrem/y)	1.53E-04	6.10E-05	2.14E-04
Dose at 1,000 years (mrem/y)	2.89E-04	2.11E-04	4.99E-04

The cancer risk estimate for the RME individual under this remedial alternative at 1,000 years after remedial alternative construction is complete is 7.00×10^{-10} for Area 1 and Area 2 combined. This risk is well-below EPA's acceptable risk range. The greatest risk to on-site workers after the cap is applied is direct exposure to ionizing gamma radiation. Risks for external exposure to ionizing gamma radiation are driven by radium-226 concentrations. Originally, radium-226 concentrations in Area 2 were greater than those in Area 1; therefore, one would expect the risk to be higher for Area 2. The concentration of radium-226 was normalized for each area based on thorium-230 concentrations. After normalization, Area 2 radium-226 concentrations were less than the concentrations in Area 1; therefore, the risks are higher in Area 1. The predicted radiation doses are also well below the occupational exposure limit of 5,000 mrem/y. Therefore, the "partial excavation to 1,000 pCi/g" alternative satisfies the threshold criterion for the protection of human health.

10 LONG-TERM RISK FOR THE "PARTIAL EXCAVATION TO 52.9 PCI/G" ALTERNATIVE

10.1 ALTERNATIVE DESCRIPTION

In this remedial alternative the RIM above 52.9 pCi/g will be excavated and transported to an approved out-of-state disposal facility. This remedial alternative is intended to protect human health by removing RIM above the established criterion and placing an engineered cap over all of OU-1. This cap design provides a physical barrier that isolates the remaining RIM from surface receptors.

This section evaluates long-term residual COPC exposure risks to human health using standard EPA methodology for conducting HHRAs, which includes the following four components: selection of constituents COPCs, exposure assessment, toxicity assessment, and risk characterization. COPC selection, portions of the exposure assessment, and the toxicity assessment were presented in previous sections. This section focuses on the remedial alternative-specific components: exposure setting, residual exposure point concentrations, and the risk characterization. Additionally, this section evaluates remedial alternative performance relative to the UMTRCA requirements.

10.2 EXPOSURE SETTING

This remedial alternative requires excavation of RIM to 52.9 pCi/g, re-contouring the surface of OU-1, and installation of a cover designed to meet MDNR landfill closure requirements. The design also includes an underlying rock/concrete rubble layer to enhance long-term stability, protect remaining RIM from bio- or human intrusion, and prevent erosion of the underlying waste materials. These Site improvements will bring the upper surface to an acceptable slope and improve surface drainage of Areas 1 and 2.

10.2.1 Physical Setting

The physical configuration of OU-1 after completion of the remedial alternative is summarized below:

- A portion of the RIM in Areas 1 and 2 will have been removed, leaving a layer of RIM at concentrations below criteria, and non-RIM wastes.
- Areas 1 and 2 will be graded to improve the drainage characteristics of the final cover.
- A two-foot (0.6 m) thick rock and/or concrete rubble bio-intrusion layer will be placed over the RIM in Areas 1 and 2.
- A two-foot (0.6 m) thick clay cap will be placed over the rock/rubble layer to minimize precipitation infiltration into the underlying waste materials and to attenuate radon emissions from the RIM. The permeability of this clay will be a minimum of 10^{-07} m/s (10^{-05} cm/s).
- The clay layer will be covered with one foot (0.3 m) of soil and a vegetative cover (grass) will be established on the cap. This vegetative cover is assumed to be maintained to prevent depletion of the cap.

Figure 10-1 depicts the cap design for Areas 1 and 2.

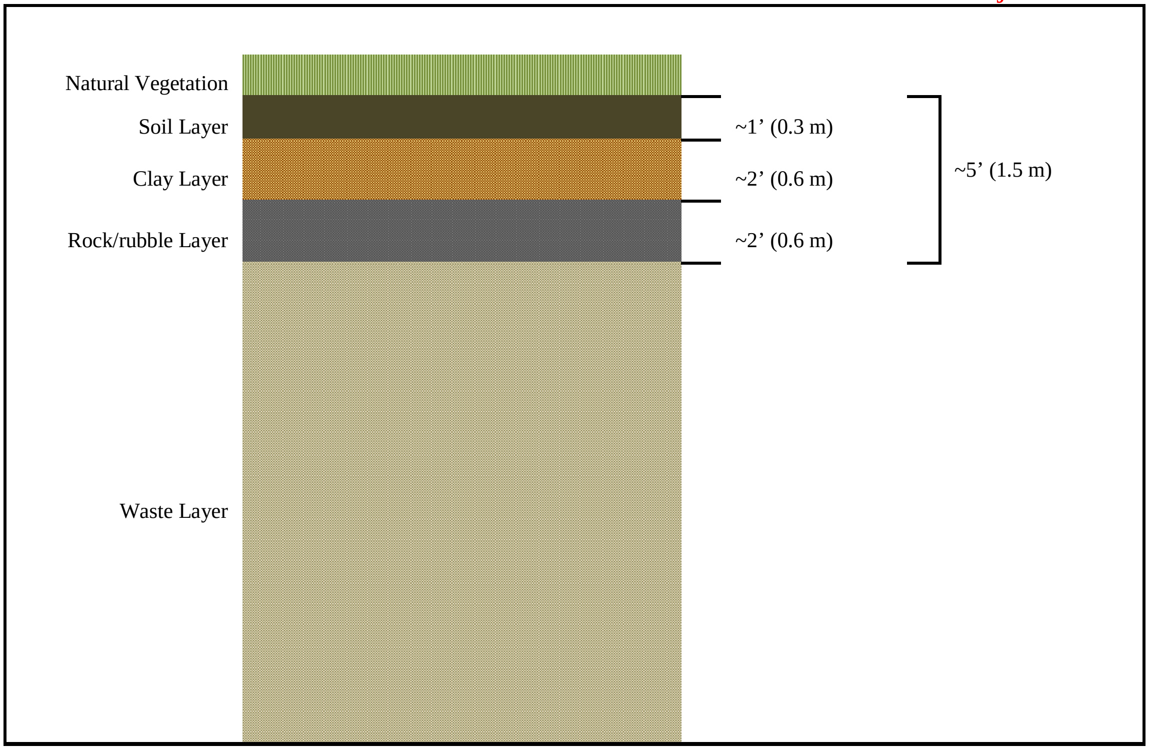

Figure 10-1 Stylized Cross-Section of RIM and Cover for the "Partial Excavation to 52.9 pCi/g" Alternative

10.2.2 **Physical Attributes of the Waste and Cover**

The physical properties of the remaining RIM and cover components are presented in Table 10-1. The erosion rate of the cover layer reflects the effects of maintenance and the rock/rubble layer.

Table 10-1 Physical Properties of RIM Below Criteria and Cover

Parameter	Area 1	Area 2
Contamination Zone (RIM)		
Area (m^2)	25,217	98,515
Erosion Rate (m/y)	0.001	0.001
Total Porosity (dry wt_%)	0.3	0.3
Field Capacity (vol/vol)	0.292	0.292
Hydraulic Conductivity (m/y)	5.26	5.26
Radon Diffusion Coefficient (m^2/s)	1.806×10^{-09}	1.806×10^{-09}
Cover		
Thickness (m)	1.5	1.5
Erosion Rate (m/y)	0.0001	0.0001
Total Porosity (vol/vol)	0.427	0.427
Volumetric Water Content (vol/vol)	0.367	0.367
Hydraulic Conductivity (m/y)	0.000526	0.000526

10.3 EXPOSURE POINT CONCENTRATIONS

As discussed in Section 8, the evaluation of future risks focuses on radiological COPCs. Placing the engineered cover over OU-1 will block almost all of the direct radiation exposure from the remaining RIM. Exposures from the small fraction of radiation predicted to penetrate the cover were quantified in this assessment. This cover will also attenuate almost all of the radon-222 produced in the underlying RIM below 52.9 pCi/g. Radium-226 in the remaining RIM will decay to radon-222, which is a noble gas. About 20% of radon gas is released to interstitial air and water in the pore spaces of the residual radium and surrounding soils, while the other 80% remains within the solid matrix of the soil particles. Once in the pore space, radon gas is free to move in the soil. The distance that radon can travel is greatly limited by its 3.8-day half-life. Covering the remaining RIM with low permeability soil/clay increases the time required for the radon to reach the ground surface. This increased travel time allows almost all of the radon to decay before it reaches the surface. Risks from residual radon gas and the risks associated with direct radiation from radon daughters if submerged in air were quantified in this assessment.

Calculated exposure point concentrations 1 year and 1,000 years post- remedial alternative are discussed below. The representative concentrations used in this risk assessment are listed in Table 10-2.

10.3.1 **Exposure Point Concentrations in Soil at 1 Year after Construction**

Under this remedial alternative, the RIM in each area would be removed until residual concentrations of thorium-232 plus thorium-230, or radium-226 plus radium-228, were equal to or less than 52.9 pCi/g. Beginning with the initial RIM concentrations in Area 1 and Area 2 listed in the updated BRA, and for the purposes of these calculations, the concentrations of the radionuclides were reduced proportionally until the total thorium-230 concentration in the remaining RIM equaled 52.9 pCi/g. For example, the current 95% UCL concentration of Th-230 in Area 2 is 4,732 pCi/g and the remedial alternative-specific concentration is 52.9 pCi/g; 52.9 pCi/g divided by 4,732 pCi/g results in a ratio of 0.0112. All other current radiological COPCs were multiplied by this ratio to reflect the approximate concentrations post- remedial alternative. Thorium-230 was used because the radium 95% UCL concentrations for OU-1 were less than the target remediation goal.

10.3.2 **Exposure Point Concentrations in Soil at 1,000 Years after Construction**

The concentrations of the radionuclides in the RIM below criteria are expected to change over the course of 1,000 years due to radiological decay and in-growth[28]. The 1,000-year values include the effects of radioactive in-growth and decay.

Table 10-2 COPC Concentrations in Areas 1 and 2, "Partial Excavation to 52.9 pCi/g" Alternative

	1 Year Post-Construction		1,000 Year		
COPC	**Area 1 [a]**	**Area 2 [a]**	**Area 1**	**Area 2**	**Units**
Uranium Series					
Uranium-238 + 3 dtrs	7.95E-01	1.40E+00	7.95E-01	1.40E+00	pCi/g
Uranium-234	8.74E-01	1.46E+00	8.72E-01	1.46E+00	pCi/g
Thorium-230	5.29E+01	5.29E+01	5.24E+01	5.24E+01	pCi/g
Radium-226 + 8 dtrs	8.93E+00	4.42E+00	2.40E+01	2.10E+01	pCi/g
Lead-210 + 2 dtrs	2.62E+00	1.55E+00	2.40E+01	2.10E+01	pCi/g
Actinium Series					
Uranium-235 + 1 dtr [d]	4.16E-02	7.13E-02	4.16E-02	7.13E-02	pCi/g
Protactinium-231	2.12E+00	2.03E+00	2.08E+00	1.99E+00	pCi/g
Actinium-227 + 9 dtrs	6.25E-01	1.38E+00	2.08E+00	1.99E+00	pCi/g
Thorium Series					
Thorium-232 + 10 dtrs	8.31E-01	2.46E-01	8.31E-01	2.46E-01	pCi/g

[a] One year after construction ceases.
[b] Includes in-growth from the decay of thorium-230.
[c] Assumed to be in secular equilibrium with radium-226.
[d] Due to the uncertainty of the uranium-235 results, these values were calculated using the more reliable uranium-238 and uranium-234 results and the expected relative abundance of uranium-235 in natural uranium.

10.3.3 **Exposure Point Concentrations in Air at 1 and 1,000 years**

Radon concentrations were also generated for the residual concentration of RIM left below 52.9 pCi/g at 1 and 1,000 years. These concentrations were generated at the same locations as the updated BRA. As the hypothetical grounds keeper will be located atop Area 1 and Area 2, those two locations were chosen and are presented in Table 10-3.

[28] A 1,000-year study period was selected based on design requirements of 40 CFR Part 192.

Table 10-3 Radon-222 Concentrations in Air at Exposure Point Concentrations for the "Partial Excavation to 52.9 pCi/g" Alternative

Analyte	On-site, Area 1 (722130 E 4294400 N)	On-site, Area 2 (721720 E 4294785 N)
Flight distance(m)	250	440
Flight time(min) [a]	1.0	1.8
At 1 Year		
Rn-222 (pCi/m^3)	8.4 E-5	4.7 E-5
Po-218 (pCi/m^3)	1.7 E-5	1.6 E-5
Pb-214(pCi/m^3)	2.2 E-7	3.8 E-7
Bi-214 + 1 dtr (pCi/m^3)	2.6 E-9	8.0 E-9
At 1,000 Years		
Rn-222 (pCi/m^3)	2.3 E-4	2.2 E-4
Po-218 (pCi/m^3)	4.7 E-5	7.3 E-5
Pb-214(pCi/m^3)	6.2 E-7	1.8 E-6
Bi-214 + 1 dtr (pCi/m^3)	7.3 E-9	3.7 E-8

10.4 RISK CHARACTERIZATION

The long-term risk characterization quantitatively evaluated potential risks to a landfill grounds keeper who works outdoors at the West Lake Landfill property, adjacent to and on Area 1 or Area 2. This receptor is assumed to be exposed to radiological COPCs via inhalation of radon, direct radiation from submersion in air, and exposure to direct radiation from soil. Results of the risk characterization are presented below. Potential risks are quantified using EPA RAGS methodology and based on a comparison of radiation dose rates to acceptable occupational exposure limits.

10.4.1 Risks from Inhalation of Radon and Submersion in Air

The EPA PRG calculator for air does not provide the ability to estimate air concentrations emitted from subsurface contaminants. AERMOD (see Section 2.2.8.3) was used to calculate the concentration of radon-222 and daughters in on-property air, assuming a 1.5 m cover. The risk was calculated for that concentration by dividing 10^{-06} by the sum of the PRGs and then multiplying by the estimated concentration of radon-222 and daughters.

For example, for the Area 2 "partial excavation to 52.9 pCi/g" alternative, the radon-222 concentration (2.2×10^{-04} pCi/m^3 from Table 10-3) at the receptor emanating from the 1.5 m cover at 1,000 years was calculated using AERMOD software and the 1,000 year post- remedial alternative concentration of radium-226 (21 pCi/g). The risk was then calculated by dividing 10^{-06} by the PRG for inhalation of radon while outdoors ($3.34 \times 10^{+00}$ pCi/m^3), then multiplying by the concentration at the receptor site of 2.2×10^{-04} pCi/m^3. The risk value for radon-222 was further modified by multiplying the risk by 0.095, a factor that is described in footnote (a) of the updated BRA, Table 26. This factor was applied to account for the incorrect slope factor used in the EPA PRG calculator for radon-222. This equates to a total risk for radon-222 of 6.27 x 10^{-12}.

The same method was used to calculate the risks associated with submersion in air; however, because similar information does not exist to calculate an immersion slope factor, no further adjustment was made.

10.4.2 **Exposure from Direct Radiation**

In both Areas 1 and 2, the landfill cover design greatly reduces the amount of direct radiation that reaches the ground surface above the cover. This shielding increases as the thickness or density of intervening material increases.

The EPA PRG calculator was used to quantify carcinogenic risks from this remedial alternative; however, the PRG calculator does not provide the option to select the engineered cover design thickness of 1.5 meters. PRGs for a 1 pCi/g concentration associated with a 1.5 meter (150 cm) cover were established by generating PRGs for 50, 60, 70, 80, 90, 100, 200, and 300 cm covers. Scatter plots for each COPC were generated with the PRG plotted on the Y axis and the cover thickness plotted on the X axis. The equation associated with the highest correlation coefficient was then used to calculate the 1.5 meter PRGs for each COPC.

The risk was calculated by dividing 10^{-06} by the calculated 1.5 meter PRG, and then multiplying by the concentration of the COPC at 1 and 1,000 years. For example, the 1.5 meter PRG for radium-226 was calculated at 1.99 x 10^{+06} pCi/g, and the radium-226 1,000 year concentration in Area 2 is 21 pCi/g. The resulting risk is calculated as 10^{-06}/1.99 x 10^{+06} pCi/g x 21 pCi/g =1.06 x 10^{-11}.

10.4.3 **Doses from Direct Radiation**

Dose to the RME individual in mrem/h was calculated using MicroShield® software (see Section 2.2.8.2). Using the software, a unit dose rate associated with 1 pCi/g concentration, a 1.5 meter cover, 1-meter above the surface was calculated for each COPC. The 1,000 year concentrations listed in Table 10-2 were then multiplied by the unit dose rate to calculate the dose associated with the 1,000 year concentration. For example, the unit dose rate associated with 1 pCi/g of radium-226 above a 1.5 m cover and 1 m above the surface was calculated to be 8.86 x 10^{-09} mrem/hr. The 1,000 year radium-226 concentration in Area 2 associated with this remedial alternative is 21 pCi/g. The resulting exposure rate equals 1.86 x 10^{-07} mrem/hr for radium-226 (8.86 x 10^{-09} mrem/hr x 21 pCi/g = 1.86 x 10^{-07} mrem/hr). This same method was then applied to all COPCs. It is estimated that the grounds keeper will spend 52.7 hours[29] each year outdoors. Multiplying the total hours each year by the sum of the exposure rates for all the COPCs combined results in a TEDE of 1.1 x 10^{-05} mrem/yr.

10.4.4 **Risk Summary**

Long-term risks and doses are presented in Table 10-4 through Table 10-7. Table 10-4 and Table 10-6 contain excerpts of the output files generated by EPA PRG calculators for long-term risks at year 1 and year 1,000. Table 10-5 and Table 10-7 present calculated doses to the receptor during those same time periods.

[29] 6.2 days per year exposed to soil x 8.5 hours per day.

Table 10-4 Long-term Risks to the Grounds Keeper on Area 1 for the "Partial Excavation to 52.9 pCi/g" Alternative

COC	Direct Radiation from Soil	Inhalation of Radon [a]	Direct Radiation, Submersion in Air	All Routes
Uranium Series				
Uranium-238 + 2 dtrs	7.46E-16	NA	NA	7.46E-16
Uranium-234	1.56E-21	NA	NA	1.56E-21
Thorium-230	6.71E-25	NA	NA	6.71E-25
Radium-226 + 8 dtrs	4.49E-12	NA	NA	4.49E-12
Actinium Series				
Uranium-235 + 1 dtr	5.40E-18	NA	NA	5.40E-18
Protactinium-231 + 10 dtrs	3.89E-21	NA	NA	3.89E-21
Thorium Series				
Thorium-232 + 10 dtrs	1.68E-14	NA	NA	1.68E-14
Radon-222 Series in Air [b]				
Rn-222	NA	2.38E-12	5.82E-17	2.38E-12
Po-218	NA	-	2.83E-22	2.83E-22
Pb-214	NA	8.33E-14	9.70E-17	8.34E-14
Bi-214 + 1 dtr	NA	7.60E-16	7.49E-18	7.67E-16
			1 y Total Radiocarcinogenic Risk	**6.97E-12**
Uranium Series				
Uranium-238 + 2 dtrs	7.46E-16	NA	NA	7.46E-16
Uranium-234	1.56E-21	NA	NA	1.56E-21
Thorium-230	6.65E-25	NA	NA	6.65E-25
Radium-226 + 8 dtrs	1.21E-11	NA	NA	1.21E-11
Actinium Series				
Uranium-235 + 1 dtr	5.40E-18	NA	NA	5.40E-18
Protactinium-231 + 10 dtrs	5.56E-21	NA	NA	5.56E-21
Thorium Series				
Thorium-232 + 10 dtrs	1.68E-14	NA	NA	1.68E-14
Radon-222 Series in Air [b]				
Rn-222	NA	6.66E-12	1.63E-16	6.66E-12
Po-218	NA	-	7.91E-22	7.91E-22
Pb-214	NA	2.33E-13	2.71E-16	2.33E-13
Bi-214 + 1 dtr	NA	2.12E-15	2.09E-17	2.15E-15
			1,000 y Total Radiocarcinogenic Risk	**1.90E-11**

NA - Not applicable
"-" indicates no PRG or RSL.
[a] Using inhalation slope factor for naked radon-222 as derived in footnote of Table 26 of Auxier 2016.
[b] Radon source term includes emissions from all OU-1 areas.

Table 10-5 Doses from Area 1 to the Grounds Keeper for the "Partial Excavation to 52.9 pCi/g" Alternative

Receptor	Dose (mrem/y) Year 1	Dose (mrem/y) Year 1,000
Grounds Keeper (52.7 h/y)	8.10E-06	1.51E-05

Table 10-6 Long-term Risks to the Grounds Keeper on Area 2 for the "Partial Excavation to 52.9 pCi/g" Alternative

COC	Direct Radiation from Soil	Inhalation of Radon [a]	Direct Radiation, Submersion in Air	All Routes
Uranium Series				
Uranium-238 + 2 dtrs	1.31E-15	NA	NA	1.31E-15
Uranium-234	2.62E-21	NA	NA	2.62E-21
Thorium-230	6.71E-25	NA	NA	6.71E-25
Radium-226 + 8 dtrs	2.22E-12	NA	NA	2.22E-12
Actinium Series				
Uranium-235 + 1 dtr	9.27E-18	NA	NA	9.27E-18
Protactinium-231 + 10 dtrs	4.66E-21	NA	NA	4.66E-21
Thorium Series				
Thorium-232 + 10 dtrs	4.96E-15	NA	NA	4.96E-15
Radon-222 Series in Air [b]				
Rn-222	NA	1.34E-12	3.27E-17	1.34E-12
Po-218	NA	-	2.62E-22	2.62E-22
Pb-214	NA	1.40E-13	1.63E-16	1.40E-13
Bi-214 + 1 dtr	NA	2.30E-15	2.27E-17	2.33E-15
		1 y Total Radiocarcinogenic Risk		**3.71E-12**
Uranium Series				
Uranium-238 + 2 dtrs	1.31E-15	NA	NA	1.31E-15
Uranium-234	2.61E-21	NA	NA	2.61E-21
Thorium-230	6.59E-25	NA	NA	6.59E-25
Radium-226 + 8 dtrs	1.06E-11	NA	NA	1.06E-11
Actinium Series				
Uranium-235 + 1 dtr	9.27E-18	NA	NA	9.27E-18
Protactinium-231 + 10 dtrs	5.33E-21	NA	NA	5.33E-21
Thorium Series				
Thorium-232 + 10 dtrs	4.96E-15	NA	NA	4.96E-15
Radon-222 Series in Air [b]				
Rn-222	NA	6.27E-12	1.53E-16	6.27E-12
Po-218	NA	-	1.22E-21	1.22E-21
Pb-214	NA	6.56E-13	7.64E-16	6.56E-13
Bi-214 + 1 dtr	NA	1.08E-14	1.06E-16	1.09E-14
		1,000 y Total Radiocarcinogenic Risk		**1.75E-11**

NA - Not applicable
"-" indicates no PRG or RSL.
[a] Using inhalation slope factor for naked radon-222 as derived in footnote of Table 26 of Auxier 2016.
[b] Radon source term includes emissions from all OU-1 areas.

Table 10-7 Doses from Area 2 to the Grounds Keeper for the "Partial Excavation to 52.9 pCi/g" Alternative

Receptor	Dose (mrem/y) Year 1	Dose (mrem/y) Year 1,000
Grounds Keeper (52.7 h/y)	3.23E-06	1.10E-05

10.5 SUMMARY

Risk and dose estimates for the RME individual on Areas 1 and 2 in the first year after remedial alternative construction and 1,000 years after remedial alternative completion are listed in Table 10-8. Calculated exposures to the hypothetical grounds keeper receptor were dominated by exposures from radon daughters produced by decay of radium-226 in any remaining RIM.

Table 10-8 Long-term Risks and Doses to the Grounds Keeper for the "Partial Excavation to 52.9 pCi/g" Alternative

	Area 1	Area 2	Total
Risk at 1 year	6.97E-12	3.71E-12	1.07E-11
Risk a 1,000 years	1.90E-11	1.75E-11	3.65E-11
Dose at 1 year (mrem/y)	8.10E-06	3.23E-06	1.13E-05
Dose at 1,000 years (mrem/y)	1.51E-05	1.10E-05	2.61E-05

The cancer risk estimate for the RME individual under this remedial alternative at 1,000 years after remedial alternative construction is complete is 3.65×10^{-11} for Area 1 and Area 2 combined. This risk is well-below EPA's acceptable risk range. The greatest risk to on-site workers after the cap is applied is direct exposure to ionizing gamma radiation. Risks for external exposure to ionizing gamma radiation are driven by radium-226 concentrations. Originally, radium-226 concentrations in Area 2 were greater than those in Area 1; therefore, one would expect the risk to be higher for Area 2. The concentration of radium-226 was normalized for each area based on thorium-230 concentrations. After normalization, Area 2 radium-226 concentrations were less than the concentrations in Area 1; therefore, the risks are higher in Area 1. The predicted radiation doses are also well below the occupational exposure limit of 5,000 mrem/y. Therefore, the "partial excavation to 52.9 pCi/g" alternative satisfies the threshold criterion for the protection of human health.

11 LONG-TERM RISKS FOR THE "COMPLETE RAD REMOVAL" ALTERNATIVE

11.1 ALTERNATIVE DESCRIPTION

In this remedial alternative RIM above 7.9 pCi/g will be excavated and transported to an out-of-state disposal facility. This remedial alternative is intended to protect human health by removing RIM above the established criterion and placing an engineered cap over all of Areas 1 and 2 as part of the overall landfill closure plan. The overburden and final cap will provide a physical barrier for other non-RIM landfill wastes and will incidentally isolate surface receptors from any remaining RIM below cleanup levels which remains in place at the Site. Controls intended to address radiological occurrences would no longer be required under this remedial alternative, but the same or similar controls would still be required because the Site will remain an inactive municipal waste landfill.

This section evaluates long-term residual COPC exposure risks to human health using standard EPA methodology for conducting HHRAs, which includes the following four components: selection of constituents COPCs, exposure assessment, toxicity assessment, and risk characterization. COPC selection, portions of the exposure assessment, and the toxicity assessment were presented in previous sections. This section focuses on the remedial alternative-specific components: exposure setting, residual exposure point concentrations, and the risk characterization. Additionally, this section evaluates remedial alternative performance relative to the UMTRCA requirements.

11.2 EXPOSURE SETTING

This remedial alternative requires excavation of RIM, re-contouring the surface of OU-1, and installation of a cover designed to meet MDNR landfill closure requirements. These improvements will bring the upper surface to an acceptable slope and improve surface drainage of Areas 1 and 2.

11.2.1 **Physical Setting**

The physical configuration of OU-1 after completion of the remedy is summarized below:

- The bulk of the RIM in Areas 1 and 2 will have been removed, leaving both a layer of RIM at concentrations below criteria and non-RIM wastes.
- A two foot (0.6 m) thick layer of clay would be placed over the waste materials in Areas 1 and 2. The permeability of this clay would be a minimum of 10^{-07} m/s (10^{-05} cm/s).
- Areas 1 and 2 would be covered with one foot (0.3 m) of soil and a vegetative cover will be established on the cap. This vegetative cover is assumed to be maintained to prevent depletion of the cap.

Figure 11-1 depicts the cap design for Areas 1 and 2.

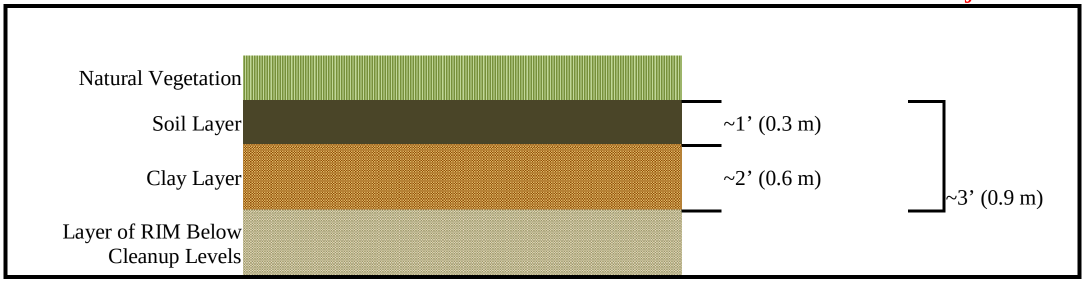

Figure 11-1 Stylized Cross-Section of RIM and Cover for the "Complete Rad Removal" Alternative

11.2.2 **Physical Attributes of the Waste and Cover**

The physical properties of the remaining RIM and cover components are presented in Table 11-1. The erosion rate of the cover layer reflects the effects of maintenance.

Table 11-1 Physical Properties of RIM Below Cleanup Levels and Cover

Parameter	Area 1	Area 2
Contamination Zone (RIM)		
Area (m^2)	25,217	98,515
Erosion Rate (m/y)	0.001	0.001
Total Porosity (dry wt_%)	0.3	0.3
Field Capacity (vol/vol)	0.292	0.292
Hydraulic Conductivity (m/y)	5.26	5.26
Radon Diffusion Coefficient (m^2/s)	1.806×10^{-09}	1.806×10^{-09}
Cover		
Thickness (m)	0.9	0.9
Erosion Rate (m/y)	0.0001	0.0001
Total Porosity (vol/vol)	0.427	0.427
Volumetric Water Content (vol/vol)	0.367	0.367
Hydraulic Conductivity (m/y)	0.000526	0.000526

11.3 EXPOSURE POINT CONCENTRATIONS

As discussed in Section 8, the evaluation of future risks focuses on radiological COPCs. Placing the engineered cover over OU-1 will block almost all of the direct radiation exposure from the remaining RIM. Exposures from the small fraction of radiation predicted to penetrate the cover were quantified in this assessment. This cover will also attenuate almost all of the radon-222 produced in the underlying RIM below 7.9 pCi/g. Radium-226 in the remaining RIM will decay to radon-222, which is a noble gas. About 20% of radon gas is released to interstitial air and water in the pore spaces of the residual radium and surrounding soils, while the other 80% remains within the solid matrix of the soil particles. Once in the pore space, radon gas is free to move in the soil. The distance that radon can travel is greatly limited by its 3.8-day half-life. Covering the remaining RIM with low permeability soil/clay increases the time required for the radon to reach the ground surface. This increased travel time allows almost all of the radon to decay before it reaches the surface. Risks from residual radon gas and the risks associated with direct radiation from radon daughters if submerged in air were quantified in this assessment.

Calculated exposure point concentrations 1 year and 1,000 years post- remedial alternative are discussed below. The representative concentrations used in this risk assessment are listed in Table 11-2.

11.3.1 Exposure Point Concentrations in Soil at 1 Year after Construction

Under this remedial alternative, the RIM in each area would be removed until residual concentrations of thorium-232 plus thorium-230, or radium-226 plus radium-228, were equal to or less than 7.9 pCi/g. Beginning with the initial RIM concentrations in Area 1 and Area 2 listed in the updated BRA, and for the purposes of these calculations, the concentrations of the radionuclides were reduced proportionally until the total thorium-230 concentration in the remaining RIM equaled 7.9 pCi/g. For example, the current 95% UCL concentration of Th-230 in Area 2 is 4,732 pCi/g and the remedial alternative-specific concentration is 7.9 pCi/g; 7.9 pCi/g divided by 4,732 pCi/g results in a ratio of 0.0017. All other current radiological COPCs were multiplied by this ratio to reflect the approximate concentrations post- remedial alternative. Thorium-230 was used because the radium 95% UCL concentrations for OU-1 were less than the target remediation goal.

11.3.2 Exposure Point Concentrations in Soil at 1,000 Years after Construction

The concentrations of the radionuclides in the RIM below criteria are expected to change over the course of 1,000 years due to radiological decay and in-growth[30]. The 1,000-year values include the effects of radioactive in-growth and decay.

[30] A 1,000-year study period was selected based on design requirements of 40 CFR Part 192.

Table 11-2 COPC Concentrations in Areas 1 and 2, "Complete Rad Removal" Alternative

COPC	1 Year Post-Construction Area 1 [a]	1 Year Post-Construction Area 2 [a]	1,000 Year Area 1	1,000 Year Area 2	Units
Uranium Series					
Uranium-238 + 3 dtrs	1.19E-01	2.09E-01	1.19E-01	2.09E-01	pCi/g
Uranium-234	1.31E-01	2.19E-01	1.30E-01	2.18E-01	pCi/g
Thorium-230	7.90E+00	7.90E+00	7.83E+00	7.83E+00	pCi/g
Radium-226 + 8 dtrs	1.33E+00	6.59E-01	4.00E+00	3.00E+00	pCi/g
Lead-210 + 2 dtrs	3.91E-01	2.32E-01	4.00E+00	3.00E+00	pCi/g
Actinium Series					
Uranium-235 + 1 dtr [d]	6.21E-03	1.07E-02	6.21E-03	1.07E-02	pCi/g
Protactinium-231	3.17E-01	3.04E-01	3.10E-01	2.97E-01	pCi/g
Actinium-227 + 9 dtrs	9.34E-02	2.05E-01	3.10E-01	2.97E-01	pCi/g
Thorium Series					
Thorium-232 + 10 dtrs	1.24E-01	3.67E-02	1.24E-01	3.67E-02	pCi/g

[a] One year after construction ceases.
[b] Includes in-growth from the decay of thorium-230.
[c] Assumed to be in secular equilibrium with radium-226.
[d] Due to the uncertainty of the uranium-235 results, these values were calculated using the more reliable uranium-238 and uranium-234 results and the expected relative abundance of uranium-235 in natural uranium.

11.3.3 **Exposure Point Concentrations in Air at 1 and 1,000 years**

Radon concentrations were also generated for the residual concentration of any residual materials at 1 and 1,000 years. These concentrations were generated at the same locations as the updated BRA. As the hypothetical grounds keeper will be located atop Area 1 and Area 2, those two locations were chosen and are presented in Table 11-3.

Table 11-3 Radon-222 Concentrations in Air at Exposure Point Concentrations for the "Complete Rad Removal Option" Alternative

Analyte	On-site, Area 1 (722130 E 4294400 N)	On-site, Area 2 (721720 E 4294785 N)
Flight distance(m)	250	440
Flight time(min) [a]	1.0	1.8
At 1 Year		
Rn-222 (pCi/m^3)	3.6 E-5	2.0 E-5
Po-218 (pCi/m^3)	7.3 E-6	6.7 E-6
Pb-214(pCi/m^3)	9.6 E-8	1.6 E-7
Bi-214 + 1 dtr (pCi/m^3)	1.1 E-9	3.4 E-9
At 1000 Years		
Rn-222 (pCi/m^3)	1.1 E-4	9.1 E-5
Po-218 (pCi/m^3)	2.2 E-5	3.0 E-5
Pb-214(pCi/m^3)	3.0 E-7	7.3 E-7
Bi-214 + 1 dtr (pCi/m^3)	3.5 E-9	1.5 E-8

11.4 RECEPTOR BEHAVIOR

This assessment of the remedial alternative assumed the same receptor parameters as the hypothetical grounds keeper in the updated BRA. The cover for the "complete rad removal" alternative is a 0.9 m cap. This is different than the other remedial alternatives that all have a 1.5 m cover. As a result of this different cover, the receptor in this remedial alternative would have both soil and air EPA PRG's obtained directly from the EPA calculator (as opposed to the other remedial alternatives in which the PRG's for the 1.5 m cover had to be calculated). The air assumptions and parameters for air are the same as previously discussed in Section 8.6. In addition to those parameters, however, Table 11-4 provides a description of this receptor's projected behavior on soil.

Table 11-4 Input for EPA's Soil PRG Calculator, Grounds Keeper, "Complete Rad Removal" Alternative

Variable	PRG Calculator Value
Slab size for ACF (area correction factor) m^2	2,000
EF_{ow} Soil (exposure frequency - worker) day/yr	6.2

Note: Other parameters were left at default values.

11.5 RISK CHARACTERIZATION

The long-term risk characterization quantitatively evaluated potential risks to a landfill grounds keeper who works outdoors at the West Lake Landfill property, adjacent to and on Area 1 or Area 2. This receptor is assumed to be exposed to radiological COPCs via inhalation of radon, direct radiation from submersion in air, and exposure to direct radiation from soil. Results of the risk characterization are presented below. Potential risks are quantified using EPA RAGS methodology and based on a comparison of radiation dose rates to acceptable occupational exposure limits.

11.5.1 **Risks from Inhalation of Radon and Submersion in Air**

The EPA PRG calculator for air does not provide the ability to estimate air concentrations emitted from subsurface contaminants. AERMOD (see Section 2.2.8.3) was used to calculate the concentration of radon-222 and daughters in on-property air, assuming a 0.9 m cover. The risk was calculated for that concentration by dividing 10^{-06} by the sum of the PRGs and then multiplying by the estimated concentration of radon-222 and daughters.

For example, for the Area 2 "complete rad removal" alternative, the radon-222 concentration (9.1×10^{-05} pCi/m^3) at the receptor emanating from the 0.9 m cover at 1,000 years was calculated using AERMOD software and the 1,000 year post- remedial alternative concentration of radium-226 (3 pCi/g). The risk was then calculated by dividing 10^{-06} by the PRG for inhalation of radon while outdoors ($3.34 \times 10^{+00}$ pCi/m^3) then multiplying by the concentration at the receptor site of 9.1×10^{-05}pCi/m^3. The risk value for radon-222 was further modified by multiplying the risk by 0.095, a factor that is described in footnote (a) of the updated BRA, Table 26. This factor was applied to account for the incorrect slope factor used in the EPA PRG calculator for radon-222. This equates to a total risk for radon-222 of 2.6×10^{-12}.

The same method was used to calculate the risks associated with submersion in air, however because similar information does not exist to calculate an immersion slope factor, no further adjustment was made.

11.5.2 **Exposure from Direct Radiation**

In both Areas 1 and 2, the landfill cover design greatly reduces the amount of direct radiation that reaches the ground surface above the cover. This shielding increases as the thickness or density of intervening material increases.

Unlike the other remedial alternatives, the EPA PRG calculator was used to quantify carcinogenic risks. The risk was calculated by dividing 10^{-06} by the calculated 0.9 m PRG, and then multiplying by the concentration of the COPC at 1 and 1,000 years. For example, the 0.9 m PRG for radium-226 was calculated at $2.72 \times 10^{+03}$ pCi/g, and the radium-226 1,000 year concentration in Area 2 is 3 pCi/g. The resulting risk is calculated as $10^{-06}/ (2.72 \times 10^{+03}$ pCi/g x 3 pCi/g) $=1.10 \times 10^{-09}$.

11.5.3 **Doses from Direct Radiation**

Dose to the RME individual in mrem/h was calculated using MicroShield® software (see Section 2.2.8.2). Using the software, a unit dose rate associated with 1 pCi/g concentration, a 0.9 meter cover, 1-meter above the surface was calculated for each COPC. The 1,000 year concentrations listed in Table 11-2 were then multiplied by the unit dose rate to calculate the dose associated with the 1,000 year concentration. For example, the unit dose rate associated with 1 pCi/g of radium-226 above a 0.9 m cover and 1 m above the surface was calculated to be 7.11×10^{-07} mrem/hr. The 1,000 year radium-226 concentration in Area 2 associated with this remedial alternative is 3 pCi/g. The resulting exposure rate equals 2.13×10^{-06} mrem/hr for radium-226 (7.11×10^{-07} mrem/hr x 3 pCi/g = 2.13×10^{-06} mrem/hr). This same method was then applied to all COPCs. It is estimated that the grounds keeper will spend 52.7 hours[31] each year outdoors. Multiplying the total hours each year by the sum of the exposure rates for all the COPCs combined results in a TEDE of 1.19 x 10^{-04} mrem/yr.

11.5.4 **Risk Summary**

Long-term risks and doses are presented in Table 11-5 through Table 11-8. Table 11-5 and Table 11-7 contain excerpts of the output files generated by EPA PRG calculators for long-term risks at year 1 and year 1,000. Table 11-6 and Table 11-8 present calculated doses to the receptor during those same time periods.

[31] 6.2 days per year exposed to soil x 8.5 hours per day.

Table 11-5 Long-term Risks to the Grounds Keeper on Area 1 for the "Complete Rad Removal" Alternative

COC	Direct Radiation from Soil	Inhalation of Radon [a]	Direct Radiation, Submersion in Air	All Routes
Uranium Series				
Uranium-238 + 2 dtrs	1.81E-13	NA	NA	1.81E-13
Uranium-234	9.82E-21	NA	NA	9.82E-21
Thorium-230	3.35E-19	NA	NA	3.35E-19
Radium-226 + 8 dtrs	4.90E-10	NA	NA	4.90E-10
Actinium Series				
Uranium-235 + 1 dtr	2.87E-18	NA	NA	2.87E-18
Protactinium-231 + 10 dtrs	1.08E-15	NA	NA	1.08E-15
Thorium Series				
Thorium-232 + 10 dtrs	8.44E-12	NA	NA	8.44E-12
Radon-222 Series in Air [b]				
Rn-222	NA	1.03E-12	2.52E-17	1.03E-12
Po-218	NA	-	1.22E-22	1.22E-22
Pb-214	NA	3.60E-14	4.20E-17	3.60E-14
Bi-214 + 1 dtr	NA	3.29E-16	3.24E-18	3.32E-16
			1 y Total Radiocarcinogenic Risk	**5.00E-10**
Uranium Series				
Uranium-238 + 2 dtrs	1.81E-13	NA	NA	1.81E-13
Uranium-234	9.79E-21	NA	NA	9.79E-21
Thorium-230	3.32E-19	NA	NA	3.32E-19
Radium-226 + 8 dtrs	1.47E-09	NA	NA	1.47E-09
Actinium Series				
Uranium-235 + 1 dtr	2.87E-18	NA	NA	2.87E-18
Protactinium-231 + 10 dtrs	1.09E-15	NA	NA	1.09E-15
Thorium Series				
Thorium-232 + 10 dtrs	8.44E-12	NA	NA	8.44E-12
Radon-222 Series in Air [b]				
Rn-222	NA	3.17E-12	7.75E-17	3.17E-12
Po-218	NA	-	3.77E-22	3.77E-22
Pb-214	NA	1.11E-13	1.29E-16	1.11E-13
Bi-214 + 1 dtr	NA	1.01E-15	9.98E-18	1.02E-15
			1,000 y Total Radiocarcinogenic Risk	**1.48E-09**

NA - Not applicable
"-" indicates no PRG or RSL.
[a] Using inhalation slope factor for naked radon-222 as derived in footnote of Table 26 of Auxier 2016.
[b] Radon source term includes emissions from all OU-1 areas.

Table 11-6 Doses from Area 1 to the Grounds Keeper for the "Complete Rad Removal" Alternative

Receptor	Dose (mrem/y) Year 1	Dose (mrem/y) Year 1,000
Grounds Keeper (52.7 h/y)	7.06E-05	1.71E-04

Table 11-7 Long-term Risks to the Grounds Keeper on Area 2 for the "Complete Rad Removal" Alternative

COC	Direct Radiation from Soil	Inhalation of Radon [a]	Direct Radiation, Submersion in Air	All Routes
Uranium Series				
Uranium-238 + 2 dtrs	3.18E-13	NA	NA	3.18E-13
Uranium-234	1.64E-20	NA	NA	1.64E-20
Thorium-230	3.35E-19	NA	NA	3.35E-19
Radium-226 + 8 dtrs	2.42E-10	NA	NA	2.42E-10
Actinium Series				
Uranium-235 + 1 dtr	4.93E-18	NA	NA	4.93E-18
Protactinium-231 + 10 dtrs	1.05E-15	NA	NA	1.05E-15
Thorium Series				
Thorium-232 + 10 dtrs	2.50E-12	NA	NA	2.50E-12
Radon-222 Series in Air [b]				
Rn-222	NA	5.80E-13	1.42E-17	5.80E-13
Po-218	NA	-	1.13E-22	1.13E-22
Pb-214	NA	6.07E-14	7.07E-17	6.07E-14
Bi-214 + 1 dtr	NA	9.96E-16	9.82E-18	1.01E-15
			1 y Total Radiocarcinogenic Risk	**2.46E-10**
Uranium Series				
Uranium-238 + 2 dtrs	3.18E-13	NA	NA	3.18E-13
Uranium-234	1.64E-20	NA	NA	1.64E-20
Thorium-230	3.32E-19	NA	NA	3.32E-19
Radium-226 + 8 dtrs	1.10E-09	NA	NA	1.10E-09
Actinium Series				
Uranium-235 + 1 dtr	4.93E-18	NA	NA	4.93E-18
Protactinium-231 + 10 dtrs	1.05E-15	NA	NA	1.05E-15
Thorium Series				
Thorium-232 + 10 dtrs	2.50E-12	NA	NA	2.50E-12
Radon-222 Series in Air [b]				
Rn-222	NA	2.60E-12	6.35E-17	2.60E-12
Po-218	NA	-	5.08E-22	5.08E-22
Pb-214	NA	2.72E-13	3.17E-16	2.72E-13
Bi-214 + 1 dtr	NA	4.47E-15	4.41E-17	4.51E-15
			1,000 y Total Radiocarcinogenic Risk	**1.11E-09**

NA - Not applicable
"-" indicates no PRG or RSL.
[a] Using inhalation slope factor for naked radon-222 as derived in footnote of Table 26 of Auxier 2016.
[b] Radon source term includes emissions from all OU-1 areas.

Table 11-8 Doses from Area 2 to the Grounds Keeper for the "Complete Rad Removal" Alternative

Receptor	Dose (mrem/y) Year 1	Dose (mrem/y) Year 1,000
Grounds Keeper (52.7 h/y)	3.09E-05	1.19E-04

11.6 SUMMARY

Risk and dose estimates for the RME individual on Areas 1 and 2 in the first year after remedial alternative construction and 1,000 years after remedial alternative completion are listed in Table 11-9. Calculated exposures to the hypothetical grounds keeper receptor were dominated by exposures from radon daughters produced by decay of radium-226 in any remaining RIM.

Table 11-9 Long-term Risks and Doses to the Grounds Keeper for the "Complete Rad Removal" Alternative

	Area 1	Area 2	Total
Risk at 1 year	5.00E-10	2.46E-10	7.46E-10
Risk a 1,000 years	1.48E-09	1.11E-09	2.59E-09
Dose at 1 year (mrem/y)	7.06E-05	3.09E-05	1.01E-04
Dose at 1,000 years (mrem/y)	1.71E-04	1.19E-04	2.89E-04

The cancer risk estimate for the RME individual under this remedial alternative at 1,000 years after remedial alternative construction is complete is 2.59 x 10^{-09} for Area 1 and Area 2 combined. This risk is well-below EPA's acceptable risk range. The greatest risk to on-site workers after the cap is applied is direct exposure to ionizing gamma radiation. Risks for external exposure to ionizing gamma radiation are driven by radium-226 concentrations. Originally, radium-226 concentrations in Area 2 were greater than those in Area 1; therefore, one would expect the risk to be higher for Area 2. The concentration of radium-226 was normalized for each area based on thorium-230 concentrations. After normalization, Area 2 radium-226 concentrations were less than the concentrations in Area 1; therefore, the risks are higher in Area 1. The predicted radiation doses are also well below the occupational exposure limit of 5,000 mrem/y. Therefore, the "complete rad removal" alternative satisfies the threshold criterion for the protection of human health.

12 LONG-TERM RISKS FOR THE ROD-SELECTED REMEDY

12.1 ALTERNATIVE DESCRIPTION

In this alternative, RIM will remain in place with Site improvements to meet the stated goals of the ROD. This remedy is a containment remedy for OU-1 intended to protect human health by regrading part of the Site and placing an engineered cap over all of OU-1, including the RIM. This will provide a physical barrier above the RIM that isolates the RIM from surface receptors.

Field investigations indicate that RIM is present at or near the surface in Areas 1 and 2. The ROD-selected remedy requires recontouring the surface of OU-1 and installing a cover designed to meet MDNR landfill closure requirements. The design also includes an underlying rock/concrete rubble layer to enhance long-term stability, protects the RIM from bio- or human intrusion, and prevents erosion of the underlying waste materials. These Site improvements will bring the upper surface to an acceptable slope and improve surface drainage of Areas 1 and 2.

This section evaluates long-term residual COPC exposure risks to human health using standard EPA methodology for conducting HHRAs, which includes the following four components: selection of constituents COPCs, exposure assessment, toxicity assessment, and risk characterization. COPC selection, portions of the exposure assessment, and the toxicity assessment were presented in previous sections. This section focuses on the alternative-specific components: exposure setting, residual exposure point concentrations, and the risk characterization. Additionally, this section evaluates remedial alternative performance relative to the UMTRCA Requirements.

12.2 EXPOSURE SETTING

Under this alternative, OU-1 would be graded and covered with an engineered cap consisting of two feet of rock, two feet of soil/clay and a one foot topsoil layer that would support vegetation for the final cover. These improvements would eliminate the exposed RIM at the surface of Areas 1 and 2 and constitute a physical barrier between the RIM and the ground surface.

12.2.1 **Physical Setting**

The physical configuration of OU-1 after completion of the remedy is summarized below:

- The contaminated material in Area 1 remains the same as in the description published in the updated BRA (Auxier 2016). The contaminated material from the Crossroads Property and Buffer Zone will have been consolidated into Area 2, below the cap. This will add approximately 3,500 cubic yards of RIM to Area 2.
- Areas 1 and 2 will be graded to improve the drainage characteristics of the final cover.
- A two-foot (0.6 m) thick rock and/or concrete rubble layer will have been placed over the RIM in Areas 1 and 2.
- A two-foot (0.6 m) thick clay cap will have been placed over the rock/rubble layer to minimize precipitation infiltration into the underlying waste materials and to attenuate radon emissions from the RIM. The permeability of this clay will be a minimum of 10^{-07} m/s (10^{-05} cm/s).

- The clay layer will have been covered with one foot (0.3 m) of soil and a vegetative cover will be established on the cap. This vegetative cover is assumed to be maintained to prevent depletion of the cap.

Figure 12-1 depicts the cap design for Areas 1 and 2.

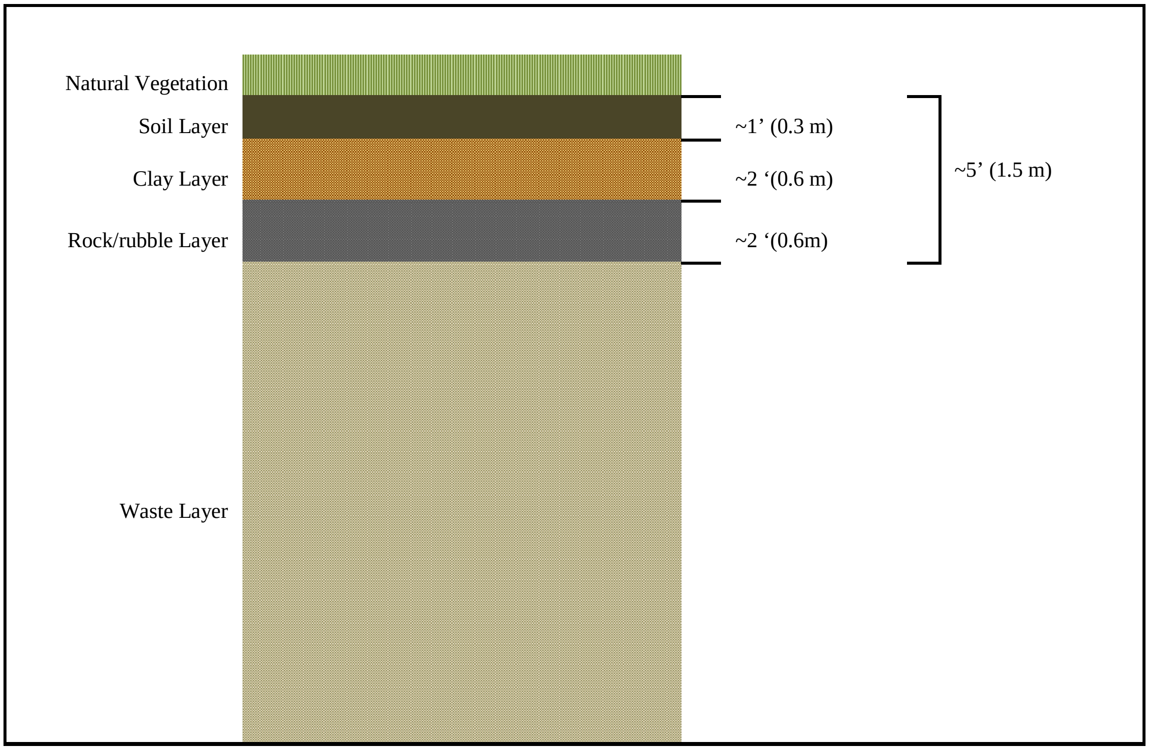

Figure 12-1 Stylized Cross-Section of RIM and Cover for the ROD-Selected Remedy

12.2.1.1 Physical Attributes of the Waste and Cover

The physical properties of the remaining RIM and cover components are presented in Table 12-1. The erosion rate of the cover layer reflects the effects of maintenance and the rock/rubble layer.

Table 12-1 Physical Properties of RIM and Cover

Parameter	Area 1	Area 2
Contamination Zone (RIM)		
Area (m^2)	25,217	98,515
Erosion Rate (m/y)	0.001	0.001
Total Porosity (dry wt_%)	0.3	0.3
Field Capacity (vol/vol)	0.292	0.292
Hydraulic Conductivity (m/y)	5.26	5.26
Radon Diffusion Coefficient (m^2/s)	1.806×10^{-09}	1.806×10^{-09}
Cover		
Thickness (m)	1.5	1.5
Erosion Rate (m/y)	0.0001	0.0001
Total Porosity (vol/vol)	0.427	0.427
Volumetric Water Content (vol/vol)	0.367	0.367
Hydraulic Conductivity (m/y)	0.000526	0.000526

12.3 EXPOSURE POINT CONCENTRATIONS

As discussed in Section 8, the evaluation of future risks focuses on radiological COPCs. Placing the engineered cover over OU-1 will block almost all of the direct radiation exposure from the RIM. Exposures from the small fraction of radiation predicted to penetrate the cover were quantified in this assessment. This cover will also attenuate almost all of the radon-222 produced in the underlying RIM. Radium-226 in the RIM will decay to radon-222, which is a noble gas. About 20% of radon gas is released to interstitial air and water in the pore spaces of the radium and surrounding soils, while the other 80% remains within the solid matrix of the soil particles. Once in the pore space, radon gas is free to move in the soil. The distance that radon can travel is greatly limited by its 3.8-day half-life. Covering the RIM with low permeability soil/clay increases the time required for the radon to reach the ground surface. This increased travel time allows almost all of the radon to decay before it reaches the surface. Risks from residual radon gas and the risks associated with direct radiation from radon daughters if submerged in air were quantified in this assessment.

Calculated exposure point concentrations 1 year and 1,000 years post-remedy are discussed below. The representative concentrations used in this risk assessment are listed in Table 12-2.

12.3.1 **Exposure Point Concentrations in Soil at 1 Year after Construction**

The current 95% UCL for concentrations across all depths was used to represent RIM concentrations in Areas 1 and 2 immediately after remedy construction. These concentrations were assumed to be representative of the entire volume of RIM in the respective areas underlying the proposed cover.[32]

[32] Soil removed from the Crossroads Property and Buffer Zone during an interim remedial action will be added to Area 2 during remedy construction. This material contains lower concentrations of RIM and adding it to the material in Area 2 would lower the average concentration in Area 2.

12.3.2 **Exposure Point Concentrations in Soil at 1,000 Years after Construction**

The concentrations of the radionuclides in the RIM are expected to change over the course of 1,000 years due to radiological decay and in-growth[33]. The 1,000-year values include the effects of radioactive in-growth and decay for radionuclides.

Table 12-2 Characterization of RIM in Areas 1 and 2, ROD-Selected Remedy

	1 Year Post-Construction		1,000 Year		
COPC	**Area 1 [a]**	**Area 2 [a]**	**Area 1**	**Area 2**	**Units**
Uranium Series					
Uranium-238 + 3 dtrs	2.20E+01	1.25E+02	2.20E+01	1.25E+02	pCi/g
Uranium-234	2.42E+01	1.31E+02	2.42E+01	1.31E+02	pCi/g
Thorium-230	1.46E+03	4.73E+03	1.45E+03	4.69E+03	pCi/g
Radium-226 + 8 dtrs	2.47E+02	3.95E+02	6.72E+02	1.91E+03	pCi/g
Lead-210 + 2 dtrs	7.25E+01	1.39E+02	6.72E+02	1.91E+03	pCi/g
Actinium Series					
Uranium-235 + 1 dtr [d]	1.15E+00	6.38E+00	1.15E+00	6.38E+00	pCi/g
Protactinium-231	5.87E+01	1.82E+02	5.87E+01	1.82E+02	pCi/g
Actinium-227 + 9 dtrs	1.73E+01	1.23E+02	5.87E+01	1.82E+02	pCi/g
Thorium Series					
Thorium-232 + 10 dtrs	2.30E+01	2.20E+01	2.30E+01	2.20E+01	pCi/g

[a] One year after construction ceases.
[b] Includes in-growth from the decay of thorium-230.
[c] Assumed to be in secular equilibrium with radium-226.
[d] Due to the uncertainty of the uranium-235 results, these values were calculated using the more reliable uranium-238 and uranium-234 results and the expected relative abundance of uranium-235 in natural uranium.

12.3.3 **Exposure Point Concentrations in Air at 1 and 1,000 years**

Radon concentrations were also generated for the concentration of RIM at 1 and 1,000 years. These concentrations were generated at the same locations as the updated BRA. As the hypothetical grounds keeper will be located atop Area 1 and Area 2, those two locations were chosen and are presented in Table 12-3.

[33] A 1,000-year study period was selected based on design requirements of 40 CFR Part 192.

Table 12-3 Radon-222 Concentrations in Air at Exposure Point Concentrations for the ROD-Selected Remedy

Analyte	On-site, Area 1 (722130 E 4294400 N)	On-site, Area 2 (721720 E 4294785 N)
Flight distance(m)	250	440
Flight time(min) [a]	1.0	1.8
At 1 Year		
Rn-222 (pCi/m^3)	7.5 E-3	1.2 E-2
Po-218 (pCi/m^3)	1.5 E-3	3.9 E-3
Pb-214(pCi/m^3)	2.0 E-5	9.5 E-5
Bi-214 + 1 dtr (pCi/m^3)	2.3 E-7	2.0 E-6
At 1,000 Years		
Rn-222 (pCi/m^3)	2.3 E-2	5.7 E-2
Po-218 (pCi/m^3)	4.6 E-3	1.9 E-2
Pb-214(pCi/m^3)	6.1 E-5	4.6 E-4
Bi-214 + 1 dtr (pCi/m^3)	7.1 E-7	9.6 E-6

12.4 RISK CHARACTERIZATION

The long-term risk characterization quantitatively evaluated potential risks to a landfill grounds keeper who works outdoors at the West Lake Landfill property, adjacent to and on Area 1 or Area 2. This receptor is assumed to be exposed to radiological COPCs via inhalation of radon, direct radiation from submersion in air, and exposure to direct radiation from soil. Results of the risk characterization are presented below. Potential risks are quantified using EPA RAGS methodology and based on a comparison of radiation dose rates to acceptable occupational exposure limits.

12.4.1 Risks from Inhalation of Radon and Submersion in Air

The EPA PRG calculator for air does not provide the ability to estimate air concentrations emitted from subsurface contaminants. AERMOD (see Section 2.2.8.3) was used to calculate the concentration of radon-222 and daughters in on-property air, assuming a 1.5 m cover. The risk was calculated for that concentration by dividing 10^{-06} by the sum of the PRGs and then multiplying by the estimated concentration of radon-222 and daughters.

For example, for the Area 2 ROD-selected remedy, the radon-222 concentration (5.7×10^{-02} pCi/m^3 from Table 12-3) at the receptor emanating from the 1.5 m cover at 1,000 years was calculated using AERMOD software and the 1,000 year post-alternative concentration of radium-226 (1,910 pCi/g). The risk was then calculated by dividing 10^{-06} by the PRG for inhalation of radon while outdoors ($3.34 \times 10^{+00}$ pCi/m^3), then multiplying by the concentration at the receptor site of 5.7×10^{-02} pCi/m^3. The risk value for radon-222 was further modified by multiplying the risk by 0.095, a factor that is described in footnote (a) of the updated BRA, Table

26. This factor was applied to account for the incorrect slope factor used in the EPA PRG calculator for radon-222. This equates to a total risk for radon-222 of 1.62 x 10^{-09}.

The same method was used to calculate the risks associated with submersion in air; however, because similar information does not exist to calculate an immersion slope factor, no further adjustment was made.

12.4.2 **Exposure from Direct Radiation**

In both Areas 1 and 2, the landfill cover design greatly reduces the amount of direct radiation that reaches the ground surface above the cover. This shielding increases as the thickness or density of intervening material increases.

The EPA PRG calculator was used to quantify carcinogenic risks from this remedy; however, the PRG calculator does not provide the option to select the engineered cover design thickness of 1.5 meters. PRGs for a 1 pCi/g concentration associated with a 1.5 meter (150 cm) cover were established by generating PRGs for 50, 60, 70, 80, 90, 100, 200, and 300 cm covers. Scatter plots for each COPC were generated with the PRG plotted on the Y axis and the cover thickness plotted on the X axis. The equation associated with the highest correlation coefficient was then used to calculate the 1.5 meter PRGs for each COPC.

The risk was calculated by dividing 10^{-06} by the calculated 1.5 meter PRG, and then multiplying by the concentration of the COPC at 1 and 1,000 years. For example, the 1.5 meter PRG for radium-226 was calculated at 1.99 x 10^{+06} pCi/g, and the radium-226 1,000 year concentration in Area 2 is 1,910 pCi/g. The resulting risk is calculated as 10^{-06}/ (1.99 x 10^{+06} pCi/g x 1,910 pCi/g) = 9.60x 10^{-10}.

12.4.3 **Doses from Direct Radiation**

Dose to the RME individual in mrem/h was calculated using MicroShield® software (see Section 2.2.8.2). Using the software, a unit dose rate associated with 1 pCi/g concentration, a 1.5 meter cover, 1-meter above the surface was calculated for each COPC. The 1,000 year concentrations listed in Table 12-2were then multiplied by the unit dose rate to calculate the dose associated with the 1,000 year concentration. For example, the unit dose rate associated with 1 pCi/g of radium-226 above a 1.5 m cover and 1 m above the surface was calculated to be 8.86 x 10^{-09} mrem/hr. The 1,000 year radium-226 concentration in Area 2 associated with this alternative is 1,910 pCi/g. The resulting exposure rate equals 1.69 x 10^{-05} mrem/hr for radium-226 (8.86 x 10^{-09} mrem/hr x 1,910pCi/g = 1.69 x 10^{-05} mrem/hr). This same method was then applied to all COPCs. It is estimated that the grounds keeper will spend 52.7 hours[34] each year outdoors. Multiplying the total hours each year by the sum of the exposure rates for all the COPCs combined results in a TEDE of 9.96 x 10^{-04} mrem/yr.

12.4.4 **Risk Summary**

Long-term risks and doses are presented in Table 12-4 through Table 12-7. Table 12-4 and Table 12-6 contain excerpts of the output files generated by EPA PRG calculators for long-term risks at year 1 and year 1,000. Table 12-5 and Table 12-7 present calculated doses to the receptor during those same time periods.

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[34] 6.2 days per year exposed to soil x 8.5 hours per day.

Table 12-4 Long-term Risks to the Grounds Keeper on Area 1 for the ROD-Selected Remedy

COC	Direct Radiation from Soil	Inhalation of Radon [a]	Direct Radiation, Submersion in Air	All Routes
Uranium Series				
Uranium-238 + 2 dtrs	2.06E-14	NA	NA	2.06E-14
Uranium-234	4.32E-20	NA	NA	4.32E-20
Thorium-230	1.86E-23	NA	NA	1.86E-23
Radium-226 + 8 dtrs	1.24E-10	NA	NA	1.24E-10
Actinium Series				
Uranium-235 + 1 dtr	1.49E-16	NA	NA	1.49E-16
Protactinium-231 + 10 dtrs	1.08E-19	NA	NA	1.08E-19
Thorium Series				
Thorium-232 + 10 dtrs	4.64E-13	NA	NA	4.64E-13
Radon-222 Series in Air [b]				
Rn-222	NA	2.13E-10	5.20E-15	2.13E-10
Po-218	NA	-	2.53E-20	2.53E-20
Pb-214	NA	7.44E-12	8.67E-15	7.45E-12
Bi-214 + 1 dtr	NA	6.79E-14	6.69E-16	6.86E-14
			1 y Total Radiocarcinogenic Risk	**3.45E-10**
Uranium Series				
Uranium-238 + 2 dtrs	2.06E-14	NA	NA	2.06E-14
Uranium-234	4.32E-20	NA	NA	4.32E-20
Thorium-230	1.84E-23	NA	NA	1.84E-23
Radium-226 + 8 dtrs	3.38E-10	NA	NA	3.38E-10
Actinium Series				
Uranium-235 + 1 dtr	1.49E-16	NA	NA	1.49E-16
Protactinium-231 + 10 dtrs	1.57E-19	NA	NA	1.57E-19
Thorium Series				
Thorium-232 + 10 dtrs	4.64E-13	NA	NA	4.64E-13
Radon-222 Series in Air [b]				
Rn-222	NA	6.47E-10	1.58E-14	6.47E-10
Po-218	NA	-	7.68E-20	7.68E-20
Pb-214	NA	2.26E-11	2.63E-14	2.26E-11
Bi-214 + 1 dtr	NA	2.06E-13	2.03E-15	2.08E-13
			1,000 y Total Radiocarcinogenic Risk	**1.01E-09**

NA - Not applicable
"-" indicates no PRG or RSL.
[a] Using inhalation slope factor for naked radon-222 as derived in footnote of Table 26 of Auxier 2016.
[b] Radon source term includes emissions from all OU-1 areas.

Table 12-5 Doses from Area 1 to the Grounds Keeper for the ROD-Selected Remedy

Receptor	Dose (mrem/y) Year 1	Dose (mrem/y) Year 1,000
Grounds Keeper (52.7 h/y)	2.24E-04	4.23E-04

Table 12-6 Long-term Risks to the Grounds Keeper on Area 2 for the ROD-Selected Remedy

COC	Direct Radiation from Soil	Inhalation of Radon [a]	Direct Radiation, Submersion in Air	All Routes
Uranium Series				
Uranium-238 + 2 dtrs	1.17E-13	NA	NA	1.17E-13
Uranium-234	2.34E-19	NA	NA	2.34E-19
Thorium-230	6.00E-23	NA	NA	6.00E-23
Radium-226 + 8 dtrs	1.99E-10	NA	NA	1.99E-10
Actinium Series				
Uranium-235 + 1 dtr	8.29E-16	NA	NA	8.29E-16
Protactinium-231 + 10 dtrs	4.17E-19	NA	NA	4.17E-19
Thorium Series				
Thorium-232 + 10 dtrs	4.44E-13	NA	NA	4.44E-13
Radon-222 Series in Air [b]				
Rn-222	NA	3.38E-10	8.24E-15	3.38E-10
Po-218	NA	-	6.59E-20	6.59E-20
Pb-214	NA	3.53E-11	4.11E-14	3.54E-11
Bi-214 + 1 dtr	NA	5.80E-13	5.72E-15	5.86E-13
			1 y Total Radiocarcinogenic Risk	**5.73E-10**
Uranium Series				
Uranium-238 + 2 dtrs	1.17E-13	NA	NA	1.17E-13
Uranium-234	2.34E-19	NA	NA	2.34E-19
Thorium-230	5.95E-23	NA	NA	5.95E-23
Radium-226 + 8 dtrs	9.60E-10	NA	NA	9.60E-10
Actinium Series				
Uranium-235 + 1 dtr	8.29E-16	NA	NA	8.29E-16
Protactinium-231 + 10 dtrs	4.87E-19	NA	NA	4.87E-19
Thorium Series				
Thorium-232 + 10 dtrs	4.44E-13	NA	NA	4.44E-13
Radon-222 Series in Air [b]				
Rn-222	NA	1.62E-09	3.96E-14	1.62E-09
Po-218	NA	-	3.17E-19	3.17E-19
Pb-214	NA	1.70E-10	1.98E-13	1.70E-10
Bi-214 + 1 dtr	NA	2.79E-12	2.75E-14	2.82E-12
			1,000 y Total Radiocarcinogenic Risk	**2.76E-09**

NA - Not applicable
"-" indicates no PRG or RSL.
[a] Using inhalation slope factor for naked radon-222 as derived in footnote of Table 26 of Auxier 2016.
[b] Radon source term includes emissions from all OU-1 areas.

Table 12-7 Doses from Area 2 to the Grounds Keeper for the ROD-Selected Remedy

Receptor	Dose (mrem/y) Year 1	Dose (mrem/y) Year 1,000
Grounds Keeper (52.7 h/y)	2.89E-04	9.96E-04

12.5 SUMMARY

Risk and dose estimates for the RME individual on Areas 1 and 2 in the first year after alternative construction and 1,000 years after remedy completion are listed in Table 11-9. Calculated exposures to the hypothetical grounds keeper receptor were dominated by exposures from radon daughters produced by decay of radium-226.

Table 12-8 Long-term Risks and Doses to the Grounds Keeper for the ROD-Selected Remedy Alternative

	Area 1	Area 2	Total
Risk at 1 year	3.45E-10	5.73E-10	9.18E-10
Risk a 1,000 years	1.01E-09	2.76E-09	3.76E-09
Dose at 1 year (mrem/y)	2.24E-04	2.89E-04	5.13E-04
Dose at 1,000 years (mrem/y)	4.23E-04	9.96E-04	1.42E-03

The cancer risk estimate for the RME individual under this remedy at 1,000 years after construction is complete is 3.76×10^{-09} for Area 1 and Area 2 combined. This risk is well-below EPA's acceptable risk range. The greatest risk to on-site workers after the cap is applied is direct exposure to ionizing gamma radiation. Risks for external exposure to ionizing gamma radiation are driven by radium-226 concentrations. Originally, radium-226 concentrations in Area 2 were greater than those in Area 1; therefore, one would expect the risk to be higher for Area 2. The concentration of radium-226 was normalized for each area based on thorium-230 concentrations. After normalization, Area 2 radium-226 concentrations were less than the concentrations in Area 1; therefore, the risks are higher in Area 1. The predicted radiation doses are also well below the occupational exposure limit of 5,000 mrem/y. Therefore, the ROD-selected remedy satisfies the threshold criterion for the protection of human health.

13 SUMMARY

13.1 PRESENTATION OF CALCULATED RESULTS

A compilation of short-term and long-term risks calculated during this risk assessment is presented in Table 13-1.

Table 13-1 Compilation of Calculated Short-term and Long-term Hazards and Risks

	Category of Hazard or Risk	Partial Excavation to 1,000 pCi/g Alternative	Partial Excavation to 52.9 pCi/g Alternative	Full Excavation with Off-Site Disposal Alternative	ROD-Selected Remedy
Short-term	Projected Incidence of Transportation Accidents [a]	1.66E+01	1.06E+01	3.49E+01	6.14E-01
	Projected Incidence of Industrial Accidents [b]	1.17E+01	8.47E+00	1.78E+01	2.76E+00
	Carcinogenic Risk to Reasonably Maximally-Exposed RadCon Tech during Construction [c]	2.38E-03	1.18E-03	2.19E-03	9.23E-05
	Hazard Index for Reasonably Maximally-Exposed RadCon Tech during Construction [c]	1.22E+00	1.22E+00	1.22E+00	1.22E+00
	Carcinogenic Risk to Reasonably Maximally-Exposed Off-property Resident during Construction [c]	5.26E-08	4.17E-08	5.17E-08	3.37E-08
	Hazard Index for Reasonably Maximally-Exposed Off-property Resident during Construction [c]	4.12E-04	4.12E-04	4.12E-04	4.12E-04
	Dose (TEDE) to Qualified Radiation Remediation Worker (mrem/y) [d]	8.67E+02	7.20E+02	4.05E+02	1.87E+02
Long-term	Carcinogenic Risk to Reasonably Maximally-Exposed Individual after Construction [e]	3.63E-10	1.90E-11	1.48E-09	1.01E-09
	Dose (TEDE) to Reasonably Maximally-Exposed Individual after Construction (mrem/y) [d]	2.89E-04	1.51E-05	1.71E-04	4.23E-04

[a] Dependent on mileage on public roads.
[b] Dependent on man-hours worked.
[c] Dependent on man-hours worked while RIM exposed and will vary depending on length of project. Note systemic effects from lead were evaluated separately from other non-carcinogens; no unacceptable risks were predicted for lead.
[d] Annual dose limited by concentration and 1 year reporting period.
[e] Highest risks are in year 1,000 at Area 1.

13.2 UNCERTAINTIES ASSOCIATED WITH HUMAN HEALTH EFFECTS AND ACCIDENT PROJECTIONS

A risk assessment contains uncertainties associated with measured or estimated quantities and uncertainties associated with a lack of information.

To compensate for these data uncertainties, risk assessors often use numerical values that are in the higher range of the distribution of data to ensure that the result of any single step is not underestimated. When this is done repeatedly for many parameters, the compound effect is to elevate the calculated risk well above what individuals would likely encounter. Although it is possible that such an exposure involving the highest possible value at each step in the evaluation process can occur, the probability of an individual actually being exposed to this combination of events and conditions is considered low. The human health results of the risk assessments for the four OU-1 remedial alternatives presented in this Appendix are based on such conservatism.

Because this evaluation is intended to provide a comparative rather than absolute evaluation of hazards/risks and similar conservative assumptions were made for each alternative, these uncertainties are unlikely to have affected the conclusions of this evaluation.

Traffic and industrial accident predictions for the remedial alternatives are based on observed incident rates among the American population. There are uncertainties associated with these predictions, but given enough operational time, the injury and fatality rate of any remediation project (or collection of projects) is expected to approach industry norms.

13.3 COMPARISON OF ALTERNATIVE RESULTS

Short-term risks to the RME individual (the Radiation Control Technician) associated with implementation of the ROD-selected remedy are substantially lower than those associated with the two partial and the full excavation alternatives in all on-property risk categories evaluated. In fact, only the risks associated with the RME individual during implementation of the ROD-selected remedy are within the EPA's generally acceptable risk range at CERCLA sites. The risks associated with the other alternatives are up to an order of magnitude greater than EPA's generally accepted risk range at CERCLA sites. The risks for the off-property resident for all alternatives are less than 10^{-07}. Construction and industrial accident forecasts for all excavation alternatives were higher than the ROD-selected remedy. The estimated short-term radiation dose to the RME individual for the ROD-selected remedy is also the least of all the alternatives.

A large contributor to risk is time. When analyzing short-term risks, it should be noted that "complete rad removal" alternative has the highest risk. This is due to the 11.2 year duration of the remedial alternative construction. The next longest duration is the "partial excavation to 1,000 pCi/g" alternative (6.5 years); therefore, its risk, in the short-term, is the second highest. The "partial excavations to 52.9 pCi/g" alternative (3.4 years due to the limited excavation depth) and the ROD-selected remedy (1 year) follow in descending order of risk.

All long-term risks are well below EPA's maximum acceptable risk of 10^{-04} (and are in fact below 10^{-08}). The predicted radiation doses to the landfill grounds keeper for all alternatives are also several orders of magnitude below the occupational exposure limit of 5,000 mrem/y.

The short-term risks from the ROD-selected remedy are the only set of risks that are less than the upper bound of EPA's acceptable risk range.

13.4 COMPARISON OF RADIOCARCINOGENIC RISKS WITH RISKS FROM OTHER RADIATION SOURCES

The long-term and short-term human health risks are dominated by radiological exposures. These calculated long-term and short-term risks can be compared to radiological risks from other commonly encountered radiation sources to provide perspective on the numerical results. For example, the long-term radiological risks from any of the alternatives are all less than the radiological risk associated with one transcontinental airplane flight. Table 13-2 presents a comparison of the relative risks associated with the long- and short-term risks for the four alternatives.

Table 13-2 Comparison of Risks from a Variety of Radiation Sources

Activity/Exposure	Risk (___ x 10^{-6})
Long-term risk to West Lake RME Individual (Grounds Keeper), "Partial Excavation to 52.9 pCi/g" Alternative at 1 year post-construction	**0.000011[a]**
Long-term risk to West Lake RME Individual (Grounds Keeper), "Partial Excavation to 52.9 pCi/g" Alternative at 1,000 years post-construction	**0.000036[a]**
Long-term risk to West Lake RME Individual (Grounds Keeper), "Partial Excavation to 1,000 pCi/g" Alternative at 1 year post-construction	**0.00020 [a]**
Long-term risk to West Lake RME Individual (Grounds Keeper), "Partial Excavation to 1,000 pCi/g" Alternative at 1,000 years post-construction	**0.00070[a]**
Long-term risk to West Lake RME Individual (Grounds Keeper), "Full Excavation with Off-site Disposal" Alternative at 1 year post-construction	**0.00075 [a]**
Long-term risk to West Lake RME Individual (Grounds Keeper), ROD-Selected Remedy at 1 year post-construction	**0.00092[a]**
Long-term risk to West Lake RME Individual (Grounds Keeper), "Full Excavation with Off-site Disposal" Alternative at 1,000 years post-construction	**0.0026[a]**
Long-term risk to West Lake RME Individual (Grounds Keeper), ROD-Selected Remedy at 1,000 years post-excavation	**0.0038 [a]**
Point of departure for EPA's generally acceptable risk range at CERCLA Sites	**1**
Radiation from a transcontinental plane flight, one-way	2 [b]
Cooking or heating with natural gas (radon in the gas)	5 [b]
Radiation from one routine chest X-ray	6 [b]
Annual radiation exposure to cosmic rays at sea level	18 [b]
Watching a cathode-ray TV or computer screen	18 [b]
Annual radiation exposure from internal exposure to naturally-occurring radionuclides in the human body (such as potassium-40)	23 [b]
Annual radiation exposure from cosmic rays in Denver	30 [b]
Living in a brick house	45 [b]
Short-term risk to West Lake RME Individual (RadCon Tech) during construction of ROD-Selected Remedy	**92.3 [a]**
Top of EPA's generally acceptable risk range at CERCLA Sites	**100**
Annual exposure to naturally occurring radon in air	120 [b]
Nuclear medicine bone scan (Tc-99)	258 [b]
EPA published value for acceptable risk from 20 pCi/m^2/s radon emitted by tailings piles (preamble to NESHAPS)	300 [c]
Annual radiation exposure from smoking a pack and a half of cigarettes a day	780 [b]
Short-term risk to West Lake RME Individual (RadCon Tech) during construction of the "Partial Excavation to 52.9 pCi/g" Alternative	**1,200 [a]**
Short-term risk to West Lake RME Individual (RadCon Tech) during construction of the "Complete Rad Removal" Alternative	**2,400 [a]**
Short-term risk to West Lake RME Individual (RadCon Tech) during construction of the "Partial Excavation to 1,000 pCi/g" Alternative	**2,200 [a]**

[a] Calculated in this report and values greater than 10^{-7} rounded to two (2) significant figures.

[b] Calculated using the dose to risk conversion factor of 6×10^{-04} per rem Total Effective Dose Equivalent (TEDE) recommended by EPA (ISCORS, 2003) (http://homer.ornl.gov/oepa/guidance/risk/iscors.pdf).
Dose information supplied by the University of Iowa,
http://www.uihealthcare.com/topics/medicaldepartments/cancercenter/prevention/preventionradiation.html.

[c] Preamble to 40 CFR Part 61, "National Emission Standards of Hazardous Air Pollutants; Radionuclides; Final Rule and Notice of Reconsideration Federal Register" Vol. 54, No.240, pg 51682. (Subsection VI.L.3 Disposal of Uranium Mill Tailings Piles).

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Appendix I:

Estimated Greenhouse Gas Emissions Associated with the Alternatives

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Appendix I

Estimated Greenhouse Gas Emissions Associated with the Alternatives

Introduction

This appendix presents the results of calculations to estimate the quantity of carbon dioxide equivalent (CO2e) greenhouse gas emissions predicted for each remedial alternative. Each alternative will involve the use of various types of vehicles and heavy equipment to implement the remedy, resulting in the combustion of diesel fuel and subsequent emission of greenhouse gas into the atmosphere. Gasoline will also be consumed by the vehicles of workers when the workers commute to and from the Site during construction of the remedy. The estimated volume of diesel fuel and gasoline that would be consumed, number of vehicle-miles, and number of ton-miles (for rail transport) were calculated for each remedy alternative for the construction heavy equipment and vehicles anticipated to be used onsite during construction; for trucks transporting materials, equipment, and supplies to the West Lake Landfill site; for truck and rail transport of RIM to an off-site disposal facility (for the "complete rad removal" and partial excavation alternatives only); and for vehicles transporting workers, supervisory and support personnel, and regulatory agency personnel commuting to/from the Site during remedy implementation. The total volume of fuel, number of vehicle miles, and number of ton-miles were converted to equivalent tons of CO2e using the Emission Factors for Greenhouse Gas Inventories published by EPA at https://www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf (EPA, 2014d) and in EPA's "Emissions Facts: Calculating Emissions of Greenhouse Gases - Key Facts and Figures", Office of Transportation and Air Quality, EPA 420-F-05-003, February 2005

Recent guidance indicates that total CO2e greenhouse gas emissions is comprised of the total of CO_2, CH_4 and N_2O. Initial calculations to estimate the total CO2e greenhouse gas emissions were conducted using the Emission Factors in Tables 2, 4, 5, 7, and 8 found in https://www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf for the three emission components (CO_2, CH_4 and N_2O) for the various vehicles (light duty pickup trucks, heavy-duty diesel dump and semi-trucks, on-site construction heavy equipment and vehicles, and diesel locomotives [rail]) assumed to be used during implementation of a remedy at the Site. The result from the initial calculations indicated that a very minor amount of CO2e emissions were contributed by the CH_4 and N_2O components; therefore, the estimates provided in this Appendix are comprised of only the CO_2 component.

Step 1) Calculate Fuel Consumption

Diesel fuel and gasoline consumption for construction heavy equipment used on-site, for trucks delivering materials/equipment to the Site, for transporting RIM to an off-site disposal facility, and for workers commuting to and from the Site was calculated as outlined below.

Construction Heavy Equipment Used On-site

The "Construction Cost Worksheet" pages for each of the remedial alternatives (Appendix K) list the estimated Crew Type (from RS Means), daily construction rate, and crew man-days for each construction step/task.

- The Crew Type assigned to each line item in the construction cost worksheet was assessed for the type, size, and quantity of construction equipment used.

- To the extent practicable, the type and size of each piece of construction equipment was then equated to a Caterpillar® construction equipment model number and the hourly fuel consumption rate for that equipment model was estimated using fuel consumption tables and load factor guidelines provided in the Caterpillar® Performance Handbook, Edition 46 (Caterpillar, 2016). A "medium" load factor was considered in most cases. For equipment where Caterpillar®-equivalents could not be determined, such as flatbed trucks and general service vehicles and tools, professional judgment was applied in estimating an hourly diesel fuel consumption rate. Table I-1 provides the unit fuel consumption estimated for each Crew Type.

- The hourly fuel consumption rates were then multiplied by the Time of Construction (*i.e.*, the number of crew-days worked) times 9 hours per crew-day. The product was gallons of diesel fuel burned for each construction task in the cost estimate.

Trucks Delivering Material/Equipment to the Site

- The number of "Delivery Truckloads" for those tasks in the Construction Cost Worksheet involving delivery of materials and/or equipment were multiplied by the Delivery Distances (round-trip) provided in Appendix K-1 (Costing Assumptions) for the respective material/equipment to derive the Total Miles for Delivery.

- The Total Miles for Delivery were then divided by an average diesel fuel consumption rate of 4 miles per gallon (mpg) for a double-axle dump truck; end-, side-, or belly-dump semi-truck; or flatbed semi-truck to obtain the estimated gallons of diesel fuel consumed.

Rail Transport of RIM to an Off-site Disposal Facility

For transporting radiologically-impacted material (RIM) to an off-site disposal facility in intermodal containers via railcar, the distance between a leased rail spur in the St. Louis area near the Site and the US Ecology-Idaho rail/truck transloading facility in Grandview, ID is 1,600 miles via the route shown on Figure 4-3 of the FFS text. A rail fuel consumption rate of 408 ton-miles per gallon of diesel fuel (UPRR, 2007) was used to estimate the diesel fuel consumption for delivery of the intermodals containing RIM to Idaho. For purposes of preparing the emissions estimates, for the 1,600 mile return of the empty intermodals from Idaho to St. Louis, a rail fuel consumption rate of one-half of the 408 ton-miles per gallon of diesel fuel (*i.e.*, 204 ton miles per gallon of diesel) was used. Therefore, a total rail fuel consumption rate of 612 ton-miles per gallon of diesel fuel was estimated for the 3,200 mile round-trip. Assuming a unit weight for RIM of 1,000 lbs per lcy (0.5 tons per lcy), the rail diesel fuel consumption unit rate was calculated to be 2.61 gallons per lcy of RIM. For the alternatives that involve excavation and off-site disposal of RIM, the total lcy of RIM estimated to be hauled off-site for disposal were multiplied by 2.61 gallons of diesel fuel per lcy to provide an estimate of the volume of diesel fuel that would be consumed in transporting RIM via rail to an off-site facility.

Gasoline Consumed by Worker Vehicles

To estimate the volume of gasoline fuel consumed by the vehicles of workers commuting to and from the Site during construction of each of the remedial alternatives, an estimated average roundtrip commute distance of 20 miles was multiplied by the number of crew man-days in the Construction Cost Worksheet, and divided by the average fuel economy of 17.4 mpg for a light duty pickup truck (EPA, 2005b).

Step 2) Conversion of Fuel Consumption to CO_2 Factor Component of CO2e Emissions

One gallon of burned diesel fuel yields the equivalent of 22.2 pounds of the CO_2 component of the total CO2e greenhouse gas emissions and one gallon of gasoline yields the equivalent of 19.4 pounds of the CO_2 component of the total CO2e greenhouse gas emissions (EPA, 2005b). Accordingly, the estimated gallons of diesel fuel and gasoline consumed for each alternative were converted to the equivalent tons of the CO_2 component of the total CO2e greenhouse gas emissions.

The total estimated mass of greenhouse gas emissions for each alternative are provided in the text of Section 6 and on Table 7-1 (Summary of Comparative Analysis of Alternatives). Tables I-2 (ROD-Selected Remedy), I-3 (52.9 pCi/g Partial Excavation), I-4 (1,000 pCi/g Partial Excavation), and I-5 ("Complete Rad Removal") provide detail for the greenhouse gas emissions estimates.

Table I-1: Unit Fuel Consumption Rates

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Crew Type	Equipment	Fuel (diesel) consumption (gph) a/	Fuel (diesel) consumption (gal/crew day) b/
A2	Flatbed truck (1.5 ton) (professional judgement)		10
A3A	Pickup truck (4x4, 3/4 ton)		10
A3E	Pickup truck (4x4, 3/4 ton)		10
A3I	Hydraulic Crane (25 ton)	3	27
A3Q	Pickup truck (4x4, 3/4 ton), Flatbed Trailer (3 ton)		10
C8	1 concrete pump (prof jdgmt)	6	54
B7	1 brush clipper, 130 hp (prof jdgmt) + 1 loader, 3cy (use CAT 930), + 2 chain saws (prof jdgmt)	6	54
B9A	1 Truck Tractor, 220 HP (prof jdmt)	6	54
B10B	1 dozer, 200 hp (use CAT D-6)	7.7	69.3
B10G	1 sheepsft roller, 240 hp (use CAT 815F2)	10	90
B10I	1 diaphram water pump, (assume 5 hp)	1	9
B10L	1 dozer, 80 hp (use CAT D-4)	3.9	35.1
B10M	Dozer (300 HP) use CAT D-6	6.5	58.5
B10N	Front End Loader (Track Mounted, 1.5 CY) use CAT 953D	6.4	57.6
B10O	Front End Loader (Track Mounted, 2.25 CY) use CAT 953D	6.4	57.6
B10P	1 crawler loader, 3CY (use CAT 930H)	3.5	31.5
B10T	Front End Loader (Wheel Mounted, 5.5 CY) use CAT 966H	4.4	39.6
B10Y	1 vib roller, 12 ton, towed (use CAT D-4)	3.9	35.1
B11A	Dozer (200 HP) CAT D-6	6.5	58.5
B11L	Grader (30,000 lbs) CAT 140M AWD	6.6	59.4
B12D	1 excavator, 3.5 cy (use CAT 365CL)	16.5	148.5
B12G	Crawler Crane (15 ton), Clamshell Bucket (.5 CY) use CAT 587T	3	27
B13	1 hydraulic crane, 25 ton (use CAT 587T)	3	27
B14	1 backhoe loader, 48 hp (use CAT 416E)	2.8	25.2
B15	2 Dump Trucks (12 CY, 400 HP) CAT 725C, 1 Dozer (200 HP) CAT D-6	18.9	170.1
B20	labor only	0	0
B22A	1 SP Crane, 5 ton (use Cat 561N)	2.5	22.5
B25	Ashphalt Paver (130 HP) CAT AP555E, Tandem Roller (10 ton) CAT CB54B, Pneum Whl Roller (12 ton) CAT CB54XW	8	72
B30	1 Hyd. Excavator (1.5 CY) CAT M315D, 2 Dump Trucks (12 CY, 400 HP) CAT 725C	17.2	154.8
B34A	Dump Truck (8 CY, 220 HP) CAT 725C	6.2	55.8
B34B	Dump Truck (12 CY, 400 HP) CAT 725C	6.2	55.8
B34D	1 truck tractor, 380 hp (use CAT 735)	6.5	58.5
B34E	Dump Truck - Off-Highway (25 ton) CAT 725C	6.2	55.8
B34F	1 dump truck, 35 ton (use Cat 725)	5	45
B34K	1 truck tractor, 450 hp (use CAT 770)	8.3	74.7
B34N	1 dump truck, 40 ton (use CAT 772)	10	90
B34U	Truck Tractor (220 HP) CAT CT681SFA, Flatbed Trailer (25 ton)	6	54
B34V	Truck Tractor (6x4, 450 HP) CAT CT681SFA, Equipment Trailer (50 ton), Pickup Truck (4x4, 3/4 ton) prof judgement	6	54
B62	Skid Steer (30 HP) CAT 216B3	1.95	17.55
B80C	Flatbed truck (Gas, 1.5 ton), Manual Fence Post Auger (Gas)	2	18
B81	1 truck tractor, 200 hp (use Cat 725) + 1 hydromulcher (TM, 3000 gal)	6.2	55.8
B84	1 rotary mower/tractor (prof jdgmt)	2	18
C14E	Gas Engine Vibrator	1.5	13.5
C20	2 gas engine vibrators, 1 concr pump (small)	3	27
E2	Lattice Boom Crane (90 ton) CAT 587T	4	36
E8	1 lattice boom crane, 90 ton (Use Cat 587T) + 4 welders, 300 amp (prof jdgmt)	4	36
Transport via Railcar to USE-Idaho Offload Spur	Use 408 ton miles/gal for rail transport (UPRR Env facts, 2007) between Missouri and Idaho. Assume 50% of this rate for return trip empty. Therefore, use average of 612 ton miles/gal for R/T of 3,200 miles. Use 1,000 lbs/lcy = 0.5 tons/lcy.	2.61	gal/lcy

a/ From Caterpillar Performance Handbook, Edition 46. Assumes medium fuel consumption factor.
b/ Assumes 9 hr/day

Shaded cells indicate fuel consumption for transport to Idaho at unit rates of gallons of diesel per loose cubic yard of RIM material

Table I-2: Calculations for Estimated Greenhouse Gas Emissions (ROD-Selected Remedy Alternative)

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Step #	Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
ROD 1	Temporary Construction Facilities / Utilities / Personnel	Construction Trailers	Capital Expenses	Group of Trailers		See separate Assumptions sheet							39.3	-	10	-	200		4 mpg	50			
ROD 2			Operating Expenses	Group of Trailers	Months	See separate Assumptions sheet																	
ROD 3			Parking Area	Gravel Area	S.Y.	RS Means, Year 2016 Quarter 1	Temporary, roads, gravel fill, 4" gravel depth, excl surfacing	B14	715	6.0	1.0	50%	37.3	-					25.20	940			
ROD 4			Portable Toilets in Construction Areas	Portable Toilets	Month	RS Means, Year 2016 Quarter 1	Rent portable toilet chemical, recycle, flush type, Incl. Hourly Oper. Cost.					50%											
ROD 5		Contractor's Construction Management Personnel	Project Manager	Personnel	Week	RS Means, Year 2016 Quarter 1	Field personnel, project manager, maximum		0	1.0	1.0	100%	414.4	-			8,288		17.4 mpg			476	-
ROD 6			Construction Superintendent(s)	Personnel	Week	RS Means, Year 2016 Quarter 1	Field personnel, superintendent, average		0	1.0	1.0	100%	496.6	-			9,932		17.4 mpg			571	-
ROD 7			Clerk(s)	Personnel	Week	RS Means, Year 2016 Quarter 1	Field personnel, clerk, average		0	1.0	1.0	100%	496.6	-			9,932		17.4 mpg			571	-
ROD 8			Field Engineer(s) / Safety Officer(s)	Personnel	Week	RS Means, Year 2016 Quarter 1	Field personnel, field engineer, average		0	1.0	1.0	100%	496.6	-			9,932		17.4 mpg			571	-
ROD 9	Temporary Stormwater Infrastructure (for stormwater during construction)	Frac Tanks	Delivery	Frac Tanks	Ea.	See separate Assumptions sheet			3	2.0	2.0	100%	38.7	38.7	58	58	3,480	3,480	4 mpg	870	870		
ROD 10			Monthly Rental	Frac Tanks	Month	See separate Assumptions sheet						100%											
ROD 11			Cleaning	Frac Tanks	Ea.	See separate Assumptions sheet			1	2.0	1.0	100%	116.0	116.0			2,320	2,320	17.4 mpg			133	133
ROD 12			Removal	Frac Tanks	Ea.	See separate Assumptions sheet			3	2.0	2.0	100%	38.7	38.7	58	58	3,480	3,480	4 mpg	870	870		
ROD 13		Forcemain	Install forcemain from Excavation Area to Tank Area	HDPE Pipe	L.F.	RS Means, Year 2016 Quarter 1	Water supply distribution piping, piping HDPE, butt fusion joints, 40' lengths, 4" diameter, SDR 21	B22A	400	5.0	1.0	100%	56.3	87.5			1,125	1,750	22.5	1,266	1,969	65	101
ROD 14			Install forcemain from Tank Area to Treatment Plant and Discharge Point	HDPE Pipe	L.F.	RS Means, Year 2016 Quarter 1	Water supply distribution piping, piping HDPE, butt fusion joints, 40' lengths, 4" diameter, SDR 21	B22A	400	5.0	1.0	100%	6.3	6.3			125	125	22.5	141	141	7	7
ROD 15			Install forcemain valves	Pipe Valves	Ea.	RS Means, Year 2016 Quarter 1	Valves, plastic, PVC, ball, true union, socket or threaded, 4"	Q1	20	2.0	1.0	100%	0.6	0.8			12	16	17.4 mpg			1	1
ROD 16		Treatment Facility	Construct Treatment Facility	Treatment Facility	Each	EMSI Estimate			0	2.0	1.0	100%	30.0	-			600	0	17.4 mpg			34	-
ROD 17			Treatment Facility Demolition	Treatment Facility	Months	EMSI Estimate			0	2.0	1.0	100%	19.0	-			380	0	17.4 mpg			22	-
ROD 18			Monthly Rent	Treatment Facility Operation	Each	EMSI Estimate			0	1.0	1.0	100%	-	-			-	0				-	-
ROD 19			Monthly Operation during construction	Treatment Facility Operation	Months	EMSI Estimate			0	1.0	1.0	100%	31.6	-			632	0	17.4 mpg			36	-
ROD 20		Stormwater events during construction	Dewater construction after rain events	Days of Pumping Construction Stormwater	Day	RS Means, Year 2016 Quarter 1	Dewatering, pumping 8 hours, attended 2 hrs per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose	B10I	4	1.5	4.0	100%	6.5	58.8			130	1,176	9	59	529	7	68
ROD 21			Dispose of contact stormwater to MSD	Contact Stormwater	Gallons	St. Louis Sewer District, May 2011						100%	-	-									
ROD 22	Leachate Handling	Frac Tanks	Delivery	Frac Tanks	Ea.	See separate Assumptions sheet			3	2.0	2.0	100%	10.7	13.3	16	20	960	1,200	4 mpg	240	300		
ROD 23			Monthly Rental (or Purchase)	Frac Tanks	Month	See separate Assumptions sheet						100%	-	-									
ROD 24			Cleaning	Frac Tanks	Ea.	See separate Assumptions sheet			1	2.0	1.0	100%	32.0	40.0			640	800	17.4 mpg			37	46
ROD 25			Removal	Frac Tanks	Ea.	See separate Assumptions sheet			3	2.0	2.0	100%	10.7	13.3	16	20	960	1,200	4 mpg	240	300		
ROD 26		Secondary Containment for Frac Tanks	Purchase and deliver liner & berm material	Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	50.0	100%	30.4	37.6	147	182	607	751	58.5	1,777	2,197	35	43
															Delivery		5,880	7,280	4 mpg	1,470	1,820		
ROD 27			Spread loose lift before compaction	Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	2.1	100%	2.6	3.3			53	65	69	183	226	3	4
ROD 28			Compact Liner & Berms	Clay	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	1,300	1.5	2.0	100%	1.5	1.8			29	36	90	131	162	2	2
ROD 29			Pumping from Excavation Site	Leachate	Day	RS Means, Year 2016 Quarter 1	Dewatering, pumping 8 hours, attended 2 hrs per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose	B10I	4	1.5	1.0	100%	0.2	0.5			4	9	9	2	4	0	1

Table I-2: Calculations for Estimated Greenhouse Gas Emissions (ROD-Selected Remedy Alternative)

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Step #	Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
ROD 30		Leachate Storage & Testing	Move Tank from Tank Area to Excavation Site	Tanks	Ea.	See separate Assumptions sheet			4	2.0	1.0	100%	3.0	6.0			60	120	2 gal/trip	6	12		
ROD 31			Leachate Sampling	Lab Tests	Ea.	RS Means, Year 2016 Quarter 1	Field testing equipment, sampling & testing soil/sediment, sample collection, field samples, sludge	1 Skwk	32	1.0	1.0	100%	0.2	0.4			4	8	17.4 mpg			0.2	0
ROD 32			Leachate Testing - VOC's	Lab Tests	Ea.	RS Means, Year 2016 Quarter 1	Laboratory analytical services, laboratory testing, volatile organics without GC/MS					100%											
ROD 33			Hauling and Disposal	Leachate	Gallons	See separate Assumptions sheet		B34B	5,000	1.0	2	100%	20.7	47.8	21	48	413	955	55.8	1,153	2,666	24	55
															Delivery		12,600	28,800	4 mpg	3,150	7,200		
ROD 34			Budget for Contaminated Stormwater Prevention or Disposal	Budget	Months	Budgeted Monthly Amount						100%											
ROD 35	Site-wide Preparation	Mobilization	Mobilize and Demobilize Equipment by Pickup Truck	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for small equipment, placed in rear of, or towed by pickup truck	A3A	4	1.0	1.0	100%	4.0	-			80	0	10	40	-	5	-
ROD 36			Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	A3A	72	1.0	1.0	100%	3.3	-			67	0	10	33	-	4	-
ROD 37			Mobilize and Demobilize Equipment by 3-Ton Trailer	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for equipment, hauled on 3-ton capacity towed trailer	A3Q	3	1.0	1.0	100%	2.2	-			45	0	10	22	-	3	-
ROD 38			Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	A3Q	72	1.0	1.0	100%	1.3	-			25	0	10	13	-	1	-
ROD 39			Mobilize and Demobilize Equipment by 20-Ton Trailer	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for equipment, hauled on 20-ton capacity towed trailer	B34U	2	2.0	3.0	100%	32.0	-			640	0	54	1,728	-	37	-
ROD 40			Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	B34U	72	2.0	3.0	100%	13.3	-			267	0	54	720	-	15	-
ROD 41			Mobilize and Demobilize Equipment by 40-Ton Trailer	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for equipment, hauled on 40-ton capacity towed trailer	B34N	2	2.0	4.0	100%	46.0	-			920	0	90	4,140	-	53	-
ROD 42			Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	B34N	72	2.0	4.0	100%	19.2	-			383	0	90	1,725	-	22	-
ROD 43			Mobilize and Demobilize Crane Equipment (more than 75 tons)	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, crane, truck-mounted, over 75 ton, (with chase vehicle)	A3E	3	2.0	1.0	100%	1.6	-			32	0	36	58	-	2	-
ROD 44			Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	A3E	72	2.0	1.0	100%	0.8	-			17	0	36	30	-	1	-
ROD 45		Supplemental Mobilizations	Mobilize and Demobilize Equipment by Pickup Truck	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for small equipment, placed in rear of, or towed by pickup truck	A3A	4	1.0	1.0	100%	4.0	-			80	0	10	40	-	5	-
ROD 46			Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	A3A	72	1.0	1.0	100%	3.3	-			67	0	10	33	-	4	-
ROD 47			Mobilize and Demobilize Equipment by 3-Ton Trailer	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for equipment, hauled on 3-ton capacity towed trailer	A3Q	3	1.0	1.0	100%	2.2	-			45	0	10	22	-	3	-
ROD 48			Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	A3Q	72	1.0	1.0	100%	1.3	-			25	0	10	13	-	1	-
ROD 49			Mobilize and Demobilize Equipment by 20-Ton Trailer	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for equipment, hauled on 20-ton capacity towed trailer	B34U	2	2.0	3.0	100%	32.0	-			640	0	54	1,728	-	37	-
ROD 50			Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	B34U	72	2.0	3.0	100%	13.3	-			267	0	54	720	-	15	-
ROD 51			Mobilize and Demobilize Equipment by 40-Ton Trailer	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for equipment, hauled on 40-ton capacity towed trailer	B34N	2	2.0	4.0	100%	46.0	-			920	0	90	4,140	-	53	-
ROD 52			Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	B34N	72	2.0	4.0	100%	19.2	-			383	0	90	1,725	-	22	-
ROD 53			Mobilize and Demobilize Crane Equipment (more than 75 tons)	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, crane, truck-mounted, over 75 ton, (with chase vehicle)	A3E	3	2.0	1.0	100%	1.6	-			32	0	36	58	-	2	-
ROD 54			Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	A3E	72	2.0	1.0	100%	0.8	-			17	0	36	30	-	1	-
ROD 55			Create Temporary Roads	Gravel Roads	S.Y.	RS Means, Year 2016 Quarter 1	Temporary, roads, gravel fill, 4" gravel depth, excl surfacing	B14	715	6.0	1.0	100%	55.9	111.9			1,119	2,238	25.2	1,410	2,820	64	129
ROD 56			Budget for Add'l Traffic Improvements	TBD (shown as budget estimate)	$	SFS budget (plus inflation)						100%	-	-			-	0		-	-	-	-
ROD 57		Dust Control	Water Truck Depreciation	Water Trucks	Trucks	Estimate																	
ROD 58			Water Truck Operation	Water Trucks	Months	Estimate			0	1.0	1.0	100%	357.2	557.4			7,144	11,148	10	3,572	5,574	411	641
ROD 59			Use Water to Control Dust	Water	Gallons	Missouri American Water Company, 7/19/2016						100%											

Table I-2: Calculations for Estimated Greenhouse Gas Emissions (ROD-Selected Remedy Alternative)

DRAFT

Step #	Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
ROD 60	Site Preparation		Prepare area with Stormwater BMPs	Silt Fence	L.F.	RS Means, Year 2016 Quarter 1	Synthetic erosion control, hay bales, staked	A2	2,500	3.0	1.0	100%	5.9	9.0			119	180	10	59	90	7	10
ROD 61		Decontamination Area	Floor	Concrete	C.Y.	RS Means, Year 2016 Quarter 1	Structural concrete, ready mix, heavyweight, 4000 psi, includes local aggregate, sand, Portland cement (Type I) and water, delivered, excludes all additives and treatments					100%											
ROD 62			Floor Installation	Concrete	C.Y.	RS Means, Year 2016 Quarter 1	Structural concrete, placing, slab on grade, pumped, over 6" thick, includes leveling (strike off) & consolidation, excludes material	C20	185	8.0	1.0	100%	2.4	2.4			48	48	27	65	65	3	3
ROD 63			Building	Steel Building	SF Flr.	RS Means, Year 2016 Quarter 1	Pre-engineered steel building, clear span rigid frame, 30 psf roof and 20 psf wind load, 20' to 29' W x 16' eave H, incl. 26 ga. colored ribbed roofing & siding, excl. footings, slab, anchor bolts	E2	320	7.0	1.0	100%	21.9	21.9			438	438	36	788	788	25	25
ROD 64		Clearing & Grubbing	Clear Vegetation (Light)	Vegetation	Acre	RS Means, Year 2016 Quarter 1	Selective tree and shrub removal, selective clearing brush mowing, light density, tractor with rotary mower, excludes removal offsite	B84	2	1.0	1.0	100%	0.1	1.3			2	26	18	2	23	0	1
ROD 65			Clear Vegetation (Heavy)	Vegetation	Acre	RS Means, Year 2016 Quarter 1	Clearing & grubbing, cut & chip light trees, to 6" diameter	B7	1	6.0	1.0	100%	50.9	91.7			1,019	1,835	54	2,751	4,954	59	105
ROD 66			Clear Small Trees	Trees	Ea.	RS Means, Year 2016 Quarter 1	Selective felling trees and piling, large tract clearing & piling, firm level terrain, no boulders, hardwood, per tree, 300 H.P. dozer, 12" to 24" diameter	B10M	80	1.5	8.0	100%	2.2	6.7			44	133	59	128	389	3	8
ROD 67			Clear Large Trees	Trees	Ea.	RS Means, Year 2016 Quarter 1	Selective felling trees and piling, large tract clearing & piling, firm level terrain, no boulders, hardwood, per tree, 300 H.P. dozer, 24" to 36" diameter	B10M	50	1.5	4.0	100%	1.0	2.9			20	59	59	58	172	1	3
ROD 68			Clear Small Stumps	Trees	Ea.	RS Means, Year 2016 Quarter 1	Selective clearing and grubbing, 1-1/2 C.Y. excavator, 14" to 24" diameter, stump removal on site by hydraulic excavator	B30	25	3.0	1.0	100%	14.0	42.6			281	852	155	2,173	6,594	16	49
ROD 69			Clear Large Stumps	Trees	Ea.	RS Means, Year 2016 Quarter 1	Selective clearing and grubbing, 1-1/2 C.Y. excavator, 26" to 36" diameter, stump removal on site by hydraulic excavator	B30	16	3.0	1.0	100%	6.2	18.4			124	368	155	958	2,844	7	21
ROD 71		Bird Mitigation	Monthly Expenses	Months	Months	Estimate	See separate Assumptions sheet	Bird Mitigation Crew	0	2.0	1.0	100%	63.0	189.1			1,260	3,782				72	217
ROD 72	Regrading	C&D Rubble Stockpiles	Relocate Stockpiled Material on-site - Excavate	C&D Rubble	B.C.Y.	RS Means, Year 2016 Quarter 1	Drilling and blasting rock, less than 0.5 C.Y., excavate and load boulders	B10T	80	1.5	10.0	100%	146.1	627.5			2,923	12,551	39.6	5,787	24,850	168	721
ROD 73			Relocate Stockpiled Material on-site - Haul and Dump	C&D Rubble	B.C.Y.	RS Means, Year 2016 Quarter 1	Drilling and blasting rock, 25 ton off-highway dump, 1 mile round trip, haul boulders	B34E	330	1.0	5.3	100%	23.6	101.4			472	2,028	55.8	1,318	5,659	27	117
ROD 74			Bury Stockpiled Material	C&D Rubble	B.C.Y.	RS Means, Year 2016 Quarter 1	Drilling and blasting rock, 300 H.P. dozer, less than 0.5 C.Y., 150' haul, bury boulders on site	B10M	310	1.5	12.0	100%	37.7	161.9			754	3,239	58.5	2,206	9,474	43	186
ROD 75		General Waste	Apply daily cover to remaining excavation of Landfilled Material	Soil	C.Y.	RS Means, Year 2016 Quarter 1	Soils for earthwork, common borrow, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15/B34B	600	7.4	1.0	100%	31.5	72.9	352	814	631	1,459	225.90	7,125	16,475	36	84
															Delivery		5,280	12,210	4 mpg	1,320	3,053		
ROD 76			Relocate Landfilled Material on-site - Excavate	RAD Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	46.9	108.4			938	2,168	149	6,963	16,099	54	125
ROD 77			(additional cost to previous line)	RAD Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	7.1	16.5			143	330	149	1,059	2,448	8	19
ROD 78			Relocate Landfilled Material on-site - Haul and Dump	RAD Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2000 ft, 10 MPH, excludes loading equipment	B34F	594	1.0	3.5	100%	68.9	159.3			1,378	3,186	45	3,100	7,168	79	183
ROD 79			Apply daily cover to relocated Landfilled Material	Soil	C.Y.	RS Means, Year 2016 Quarter 1	Soils for earthwork, common borrow, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15/B34B	600	7.4	1.0	100%	31.5	72.9	352	814	631	1,459	226	7,125	16,475	36	84
															Delivery		5,280	12,210	4 mpg	1,320	3,053		
ROD 80			Spread Landfilled Material	RAD Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	10.0	100%	65.2	150.8			1,304	3,016	69	4,519	10,450	75	173
ROD 81			Compact Landfilled Material	RAD Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%	17.7	40.9			354	819	90	1,593	3,684	20	47
ROD 82	Buffer Zone		Buffer Zone Activity	See separate Assumptions sheet		See separate Assumptions sheet					1.0	100%	-	42.0			-	840				-	48
ROD 83	Final Cover	Starter Berms	Purchase and deliver material	Riprap	Ton	RS Means, Year 2016 Quarter 1	Rip-rap and rock lining, random, broken stone, 100 lb. average, dumped	B11A	700	2.0	8.0	100%	21.4	158.6	376	2,776	429	3,172	59	1,254	9,280	25	182
															Delivery		15,040	111,040	4 mpg	3,760	27,760		
ROD 84			Spread loose lift before compaction	Riprap	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	4.0	100%	6.8	50.0			135	999	69	468	3,463	8	57

Table I-2: Calculations for Estimated Greenhouse Gas Emissions (ROD-Selected Remedy Alternative)

DRAFT

Step #	Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Crew Man-days		Delivery Truckloads		Total Miles for Delivery of Materials/ Equipment or Worker Commute		Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery)		Gallons gasoline consumed (worker commute to/from Site)	
													Area 1	Area 2	Area 1	Area 2	Area 1	Area 2		Area 1	Area 2	Area 1	Area 2
ROD 85			Special grading for steep slopes	Riprap	S.Y.	RS Means, Year 2016 Quarter 1	Fine grading, slopes, steep, finish grading	B11L	7,100	2.0	1.0	100%	0.6	3.6			11	72	59	33	214	1	4
ROD 86			Compact starter berms	Riprap	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, riding, vibrating roller, 2 passes, 12" lifts	B10Y	5,200	1.5	2.0	100%	1.1	8.0			22	160	35	38	281	1	9
ROD 87		Bio-Intrusion	Purchase and Spread Bio-Intrusion Layer Material	4-in Minus Aggregate	L.C.Y.	RS Means, Year 2016 Quarter 1	Aggregate for earthwork, crushed stone, 1.40 tons per C.Y., 1-1/2", spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	12.0	100%	461.7	1,396.2	6,596	19,947	9,234	27,924	170	78,535	237,494	531	1,605
															Delivery		98,940	299,205	4 mpg	24,735	74,801		
ROD 88			Deliver Bio-Intrusion Layer Material	4-in Minus Aggregate (per Hauling Increment)	L.C.Y.	RS Means, Year 2016 Quarter 1	Aggregate for earthwork, aggregate or sand, spread with 200 HP dozer, includes load at pit and haul, round trip, for 5 mile haul add	B34B	200	1.0	50.0	100%	514.4	1,555.8			10,288	31,116	56	28,704	86,814	591	1,788
ROD 89			Compact Bio-Intrusion Layer Material	4-in Minus Aggregate	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, riding, vibrating roller, 2 passes, 12" lifts	B10Y	5,200	1.5	2.0	100%	13.8	41.8			276	837	35	484	1,468	16	48
ROD 90		Clay	Purchase and deliver clay material	Clay Material	L.C.Y.	RS Means, Year 2016 Quarter 1	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	50.0	100%	1,212.9	3,668.3	5,863	17,731	24,258	73,366	56	67,680	204,691	1,394	4,216
															Delivery		234,520	709,240	4 mpg	58,630	177,310		
ROD 91			Spread loose lift before compaction	Clay Material	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	12.0	100%	105.5	319.1			2,110	6,381	69	7,311	22,111	121	367
ROD 92			Compact Clay (Final Cover)	Clay Material	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	1,300	1.5	2.0	100%	58.0	175.4			1,160	3,508	90	5,220	15,786	67	202
ROD 93		Top Soil	Purchase and place Topsoil	Topsoil	C.Y.	RS Means, Year 2016 Quarter 1	Soils for earthwork, topsoil borrow, weed free, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	12.0	100%	133.2	403.0	2,380	7,196	2,664	8,060	170	22,657	68,550	153	463
															Delivery		35,700	107,940	4 mpg	8,925	26,985		
ROD 94			Addition for Topsoil Delivery	Topsoil (per Hauling Increment)	C.Y.	RS Means, Year 2016 Quarter 1	Soils for earthwork, borrow, spread with 200 HP dozer, includes load at pit and haul, round trip, excludes compaction, for 5 mile haul, add	B34B	200	1.0	50.0	100%	148.5	449.0			2,970	8,980	56	8,286	25,054	171	516
ROD 95		Terraces	Purchase and place Topsoil	Topsoil	C.Y.	RS Means, Year 2016 Quarter 1	Soils for earthwork, topsoil borrow, weed free, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	2.0	100%	9.5	30.1	171	537	191	602	170	1,624	5,120	11	35
															Delivery		2,565	8,055	4 mpg	641	2,014		
ROD 96			Addition for Topsoil Delivery	Topsoil (per Hauling Increment)	C.Y.	RS Means, Year 2016 Quarter 1	Soils for earthwork, borrow, spread with 200 HP dozer, includes load at pit and haul, round trip, excludes compaction, for 5 mile haul, add	B34B	200	1.0	50.0	100%	10.6	33.5			213	670	56	594	1,869	12	39
ROD 97		Pond	Purchase and deliver liner & berm material	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	50.0	100%	-	237.2	-	1,147	-	4,745	56	-	13,238	-	273
															Delivery		-	45,880	4 mpg	-	11,470		
ROD 98			Spread loose lift before compaction (Pond)	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	2.1	100%	-	20.6			-	413	69	-	1,430	-	24
ROD 99			Compact Liner & Berm (Pond)	Structural Fill / Clay	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	1,300	1.5	2.0	100%	-	11.3			-	227	90	-	1,021	-	13
ROD 100			Pond Perimeter Berm Structural Rock	Structural Rock	L.C.Y.	RS Means, Year 2016 Quarter 1	Rip-rap and rock lining, random, broken stone, machine placed for slope protection	B12G	62	2.0	1.0	100%	-	36.5			-	729	27	-	984	-	42
ROD 101			Final Stormwater Controls	Riprap	S.Y.	RS Means, Year 2016 Quarter 1	Rip-rap and rock lining, random, broken stone, 3/8 to 1/4 C.Y. pieces, machine placed for slope protection, grouted	B13	80	7.0	3.0	100%	155.6	175.0			3,111	3,500	27	4,200	4,725	179	201
ROD 102		Diverson Berms	Purchase and deliver berm material	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	50.0	100%	54.6	397.4	265	1,921	1,093	7,948	59	3,197	23,248	63	457
															Delivery		10,600	76,840	4 mpg	2,650	19,210		
ROD 103			Spread loose lift before compaction	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	2.1	100%	4.8	34.6			95	691	69	329	2,396	5	40
ROD 104			Compact Berms	Structural Fill / Clay	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, riding, vibrating roller, 2 passes, 12" lifts	B10Y	5,200	1.5	2.0	100%	0.7	4.7			13	95	35	23	167	1	5
ROD 105			Perimeter Road Stormwater Crossings	Riprap	L.C.Y.	RS Means, Year 2016 Quarter 1	Rip-rap and rock lining, random, broken stone, machine placed for slope protection	B12G	62	2.0	1.0	100%	-	4.0			-	79	27	-	107	-	5
ROD 106	Site		Apply seeding to cover	Seeding	M.S.F.	RS Means, Year 2016 Quarter 1	Seeding athletic fields, seeding fescue, tall with mulch and fertilizer, 5.5 lb. per M.S.F., hydro/air seeding	B81	80	3.0	1.0	100%	27.8	83.9			556	1,678	56	1,551	4,682	32	96
ROD 107			Install temporary irrigation system	Irrigation System	S.F.	RS Means, Year 2016 Quarter 1	Underground sprinklers irrigation system, for lawns, residential system, custom, 1" supply	B20	2,000	3.0	10.0	100%	92.5	279.8			1,850	5,596	-	-	-	106	322

Table I-2: Calculations for Estimated Greenhouse Gas Emissions (ROD-Selected Remedy Alternative)

DRAFT

Step #	Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
ROD 108	Completion		Install Fencing	Fencing	L.F.	RS Means, Year 2016 Quarter 1	Fence, chain link industrial, galvanized steel, 6 ga. wire, 2-1/2" posts @ 10' OC, 8' high, includes excavation, in concrete, excludes barbed wire	B80C	180	3.0	2.0	100%	82.6	111.2			1,651	2,224	18	1,486	2,001	95	128

	Diesel Area 1	Diesel Area 2	Gasoline Area 1	Gasoline Area 2
Gallons of Fuel Consumed	417,980	1,238,211	7,677	14,597
Total Gallons (Areas 1 and 2)		**1,656,191**		**22,274**
Conversion Factor (lbs CO_2 component of CO2e emissions per Gallon of Fuel Burned)	22.2 lb/gal			19.4 lb/gal
Subtotal - Pounds of CO2e emissions		36,767,434		432,115
Subtotal - Tons of CO2e emission		18,384		216
Total Tons of CO2e Emissions (diesel plus gasoline)			***19,000***	

Table I-3: Calculations for Estimated Greenhouse Gas Emissions (52.9 pCi/g Partial Excavation Alternative)

DRAFT

Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
Temporary Construction Facilitities / Utilities / Personnel	Construction Trailers	Capital Expenses	Group of Trailers		See separate Assumptions sheet							FFS 52.9 DRAFT 1	39.3	-	10	-	200		4 mpg	50			
		Operating Expenses	Group of Trailers	Months	See separate Assumptions sheet							FFS 52.9 DRAFT 2											
		Parking Area	Gravel Area	S.Y.	RS Means, Year 2016 Quarter 1	Temporary, roads, gravel fill, 4" gravel depth, excl surfacing	B14	715	6.0	1.0	50%	FFS 52.9 DRAFT 3	37.3	-					25	940			
		Portable Toilets in Construction Areas	Portable Toilets	Month	RS Means, Year 2016 Quarter 1	Rent portable toilet chemical, recycle, flush type, Incl. Hourly Oper. Cost.					50%	FFS 52.9 DRAFT 4											
	Contractor's Construction Management Personnel	Project Manager	Personnel	Week	RS Means, Year 2016 Quarter 1	Field personnel, project manager, maximum		0	1.0	1.0	100%	FFS 52.9 DRAFT 5	1,138	-			22,760		17.4 mpg			1,308	-
		Construction Superintendent(s)	Personnel	Week	RS Means, Year 2016 Quarter 1	Field personnel, superintendent, average		0	1.0	1.0	100%	FFS 52.9 DRAFT 6	1,507	-			30,140		17.4 mpg			1,732	-
		Clerk(s)	Personnel	Week	RS Means, Year 2016 Quarter 1	Field personnel, clerk, average		0	1.0	1.0	100%	FFS 52.9 DRAFT 7	1,507	-			30,140		17.4 mpg			1,732	-
		Field Engineer(s) / Safety Officer(s)	Personnel	Week	RS Means, Year 2016 Quarter 1	Field personnel, field engineer, average		0	1.0	1.0	100%	FFS 52.9 DRAFT 8	1,507	-			30,140		17.4 mpg			1,732	-
Temporary Stormwater Infrastructure (for stormwater during construction)	Frac Tanks	Delivery	Frac Tanks	Ea.	See separate Assumptions sheet			3	2.0	2.0	100%	FFS 52.9 DRAFT 9	38.7	38.7	58	58	3,480	3,480	4 mpg	870	870		
		Monthly Rental (or Purchase)	Frac Tanks	Month	See separate Assumptions sheet						100%	FFS 52.9 DRAFT 10											
		Cleaning	Frac Tanks	Ea.	See separate Assumptions sheet			1	2.0	1.0	100%	FFS 52.9 DRAFT 11	116.0	116.0			2,320	2,320	17.4 mpg			133	133
		Removal	Frac Tanks	Ea.	See separate Assumptions sheet			3	2.0	2.0	100%	FFS 52.9 DRAFT 12	38.7	38.7	58	58	3,480	3,480	4 mpg	870	870		
	Forcemain	Install forcemain from Excavation Area to Tank Area	HDPE Pipe	L.F.	RS Means, Year 2016 Quarter 1	Water supply distribution piping, piping HDPE, butt fusion joints, 40' lengths, 4" diameter, SDR 21	B22A	400	5.0	1.0	100%	FFS 52.9 DRAFT 13	56.3	87.5			1,125	1,750	23	1,266	1,969	65	101
		Install forcemain from Tank Area to Treatment Plant and Discharge Point	HDPE Pipe	L.F.	RS Means, Year 2016 Quarter 1	Water supply distribution piping, piping HDPE, butt fusion joints, 40' lengths, 4" diameter, SDR 21	B22A	400	5.0	1.0	100%	FFS 52.9 DRAFT 14	6.3	6.3			125	125	23	141	141	7	7
		Install forcemain valves	Pipe Valves	Ea.	RS Means, Year 2016 Quarter 1	Valves, plastic, PVC, ball, true union, socket or threaded, 4"	Q1	20	2.0	1.0	100%	FFS 52.9 DRAFT 15	0.6	0.8			12	16	17.4 mpg			1	1
	Treatment Facility	Construct Treatment Facility	Treatment Facility	Each	EMSI Estimate			0	2.0	1.0	100%	FFS 52.9 DRAFT 16	30.0	-			600	0	17.4 mpg			34	-
		Treatment Facility Demolition	Treatment Facility	Each	EMSI Estimate			0	2.0	1.0	100%	FFS 52.9 DRAFT 17	19.0	-			380	0	17.4 mpg			22	-
		Monthly Rent	Treatment Facility Operation	Each	EMSI Estimate			0	2.0	1.0	100%	FFS 52.9 DRAFT 18										-	-
		Monthly Operation during remediation	Treatment Facility Operation	Months	EMSI Estimate			0	1.0	1.0	100%	FFS 52.9 DRAFT 19	180	-			3,600	0	17.4 mpg			207	-
	Stormwater events during construction	Dewater excavation construction after rain events	Days of Pumping Construction Stormwater	Day	RS Means, Year 2016 Quarter 1	Dewatering, pumping 8 hours, attended 2 hrs per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose	B10I	4	1.5	4.0	100%	FFS 52.9 DRAFT 20	42.2	168.3			844	3,366	9	380	1,515	49	193
		Dewater backfill construction after rain events	Days of Pumping Construction Stormwater	Day	RS Means, Year 2016 Quarter 1	Dewatering, pumping 8 hours, attended 2 hrs per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose	B10I	4	1.5	4.0	100%	FFS 52.9 DRAFT 21	49.4	94.1			988	1,882	9	445	847	57	108
		Dispose of contact stormwater to MSD	Contact Stormwater	Gallons	St. Louis Sewer District, May 2011						100%	FFS 52.9 DRAFT 22											
Leachate Handling	Frac Tanks	Delivery	Frac Tanks	Ea.	See separate Assumptions sheet			3	2.0	2.0	100%	FFS 52.9 DRAFT 23	13.3	13.3	20	20	1,200	1,200	4 mpg	300	300		
		Monthly Rental (or Purchase)	Frac Tanks	Month	See separate Assumptions sheet						100%	FFS 52.9 DRAFT 24											
		Cleaning	Frac Tanks	Ea.	See separate Assumptions sheet			1	2.0	1.0	100%	FFS 52.9 DRAFT 25	40.0	40.0			800	800	17.4 mpg			46	46
		Removal	Frac Tanks	Ea.	See separate Assumptions sheet			3	2.0	2.0	100%	FFS 52.9 DRAFT 26	13.3	13.3	20	20	1,200	1,200	4 mpg	300	300		
	Secondary Containment for Frac Tanks	Purchase and deliver liner & berm material	Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	50.0	100%	FFS 52.9 DRAFT 27	37.6	37.6	182	182	751	751	59	2,197	2,197	43	43
															Delivery		7,280	7,280	4 mpg	1,820	1,820		
		Spread loose lift before compaction	Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	2.1	100%	FFS 52.9 DRAFT 28	3.3	3.3			65	65	69	226	226	4	4

Table I-3: Calculations for Estimated Greenhouse Gas Emissions (52.9 pCi/g Partial Excavation Alternative)

DRAFT

Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
		Compact Liner & Berms	Clay	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	1,300	1.5	2.0	100%	FFS 52.9 DRAFT 29	1.8	1.8			36	36	90	162	162	2	2
	Leachate Storage & Testing	Pumping from Excavation Site	Leachate	Day	RS Means, Year 2016 Quarter 1	Dewatering, pumping 8 hours, attended 2 hrs per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose	B10I	4	1.5	1.0	100%	FFS 52.9 DRAFT 30	0.6	2.3			12	45	9	5	20	1	3
		Move Tank from Tank Area to Excavation Site	Tanks	Ea.	See separate Assumptions sheet			4	2.0	1.0	100%	FFS 52.9 DRAFT 31	7.5	29			150	580	2 gal/trip	15	58		
		Leachate Sampling	Lab Tests	Ea.	RS Means, Year 2016 Quarter 1	Field testing equipment, sampling & testing soil/sediment, sample collection, field samples, sludge	1 Skwk	32	1.0	1.0	100%	FFS 52.9 DRAFT 32	0.5	1.8			9	36	17.4 mpg			1	2
		Leachate Testing - VOC's	Lab Tests	Ea.	RS Means, Year 2016 Quarter 1	Laboratory analytical services, laboratory testing, volatile organics without GC/MS					100%	FFS 52.9 DRAFT 33											
		Hauling and Disposal	Leachate	Gallons	See separate Assumptions sheet		B34B	5,000	1.0	2.0	100%	FFS 52.9 DRAFT 34	59.5	230.9	60	231	1,189	4,618	55.8	3,318	12,884	68	265
		Budget for Contaminated Stormwater Prevention or Disposal	Budget	Months	Budgeted Monthly Amount						100%	FFS 52.9 DRAFT 35											
																Delivery to Off-site Disposal	36,000	138,600	4 mpg	9,000	34,650		
RIM Loading Station	Structure	Structure Construction	Clear Span Structure	Ea.	See separate Assumptions sheet		Structure Construction Crew	0	30.0	1	100%	FFS 52.9 DRAFT 36	3,300	-	30		66,000	0	17.4 mpg			3,793	-
																Delivery of Structure Components	19,860		4 mpg	4,965			
		Demolition	Clear Span Structure	Ea.	See separate Assumptions sheet		Structure Demolition Crew	0	30.0	1	100%	FFS 52.9 DRAFT 37	450	-	30		9,000	0	17.4 mpg			517	-
																Haul Structure Components to Local Metal Recycler (40 miles R-T)	1,200		4 mpg	300			
	Air Treatment System	Startup Capital Expenses	Air Treatment System	Ea.	See separate Assumptions sheet		Treatment System Crew			1	100%	FFS 52.9 DRAFT 38	71	-	9		1,420	0	17.4 mpg			82	-
																Delivery of Air Treatment systems (Roseville, MN)	9,360		4 mpg	2,340			
		Vessel Rental Costs (Project Total)	Air Treatment System	Ea.	See separate Assumptions sheet					1	100%	FFS 52.9 DRAFT 39	-	-									
		Blower Costs (Purchase or Rental Total)	Air Treatment System	Ea.	See separate Assumptions sheet					1	100%	FFS 52.9 DRAFT 40	-	-									
		Media Replacement (Project Total)	Air Treatment System	Ea.	See separate Assumptions sheet		Treatment System Crew			1	100%	FFS 52.9 DRAFT 41	30	-	1		600	0	17.4 mpg			34	-
																Delivery of replacement media (from Roseville, MN) - 3 semis	3,120		4 mpg	780			
																Return of spent media (to Roseville, MN) - 3 semis	3,120		4 mpg	780			
		Demobilization	Air Treatment System	Ea.	See separate Assumptions sheet		Treatment System Crew			1	100%	FFS 52.9 DRAFT 42	41	-	9	-	820	0	17.4 mpg			47	-
																Return of Air Treatment Systems (Roseville, MN)	9,360		4 mpg	2,340			
																Return of spent media (to Roseville, MN) - 3 semis	3,120		4 mpg	780	-		
	Haul Road Improvements	Fencing along road for RIM hauling	Fencing	L.F.	RS Means, Year 2016 Quarter 1	Fence, chain link industrial, galvanized steel, 6 ga. wire, 2" posts @ 10' OC, 6' high, includes excavation, & concrete, excludes barbed wire	B80C	250	3.0	2.0	100%	FFS 52.9 DRAFT 43	19.2	19.2			384	384	18	346	346	22	22
		Silt Fencing along road for RIM hauling	Silt Fence	Per L.F., per Month	See separate Assumptions sheet	Monthly cost for Silt fence, 3' high. Install, maintain monthly, and replace each 6 months.	B62	3,120	3.0	1.0	100%	FFS 52.9 DRAFT 44	13.5	26.9			270	538	17.55	237	472	16	31
		Remove potentially contaminated road surface	Roadway Gravel	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk, dozer, open site, bank measure, sand and gravel, 300 H.P. dozer, 50' haul	B10M	1,900	1.5	1.0	100%	FFS 52.9 DRAFT 45	0.3	0.3			6	6	59	16	16	0	0
		Loading for previous line	Roadway Gravel	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B10O	5,016	1.5	1.0	100%	FFS 52.9 DRAFT 46	0.1	0.1			2	2	58	6	6	0	0
		Hauling for previous line	Roadway Gravel	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2000 ft, 10 MPH, excludes loading equipment	B34F	594	1.0	1.0	100%	FFS 52.9 DRAFT 47	0.7	0.7			14	14	45	32	32	1	1
		Repairs to road remediation	Gravel Roads	S.Y.	RS Means, Year 2016 Quarter 1	Temporary, roads, gravel fill, 8" gravel depth, excl surfacing	B14	615	6.0	1.0	100%	FFS 52.9 DRAFT 48	20.8	20.8			416	416	25	524	524	24	24
Site-wide Preparation	Mobilization	Mobilize and Demobilize Equipment by Pickup Truck	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for small equipment, placed in rear of, or towed by pickup truck	A3A	4	1.0	1.0	100%	FFS 52.9 DRAFT 49	4.0	-			80	0	10	40	-	5	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	A3A	72	1.0	1.0	100%	FFS 52.9 DRAFT 50	3.3	-			67	0	10	33	-	4	-

Table I-3: Calculations for Estimated Greenhouse Gas Emissions (52.9 pCi/g Partial Excavation Alternative)

DRAFT

Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
		Mobilize and Demobilize Equipment by 3-Ton Trailer	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for equipment, hauled on 3-ton capacity towed trailer	A3Q	3	1.0	1.0	100%	FFS 52.9 DRAFT 51	2.2	-			45	0	10	22	-	3	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	A3Q	72	1.0	1.0	100%	FFS 52.9 DRAFT 52	1.3	-			25	0	10	13	-	1	-
		Mobilize and Demobilize Equipment by 20-Ton Trailer	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for equipment, hauled on 20-ton capacity towed trailer	B34U	2	2.0	4.0	100%	FFS 52.9 DRAFT 53	38.0	-			760	0	54	2,052	-	44	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	B34U	72	2.0	4.0	100%	FFS 52.9 DRAFT 54	15.8	-			316	0	54	853	-	18	-
		Mobilize and Demobilize Equipment by 40-Ton Trailer	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for equipment, hauled on 40-ton capacity towed trailer	B34N	2	2.0	4.0	100%	FFS 52.9 DRAFT 55	50	-			1,000	0	90	4,500	-	57	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	B34N	72	2.0	4.0	100%	FFS 52.9 DRAFT 56	20.8	-			416	0	90	1,872	-	24	-
		Mobilize and Demobilize Crane Equipment (more than 75 tons)	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, crane, truck-mounted, over 75 ton, (with chase vehicle)	E2	3	2.0	1.0	100%	FFS 52.9 DRAFT 57	1.6	-			32	0	36	58	-	2	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	E2	72	2.0	1.0	100%	FFS 52.9 DRAFT 58	0.8	-			17	0	36	30	-	1	-
	Supplemental Mobilizations	Mobilize and Demobilize Equipment by Pickup Truck	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for small equipment, placed in rear of, or towed by pickup truck	A3A	4	1.0	1.0	100%	FFS 52.9 DRAFT 59	4.0	-			80	0	10	40	-	5	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	A3A	72	1.0	1.0	100%	FFS 52.9 DRAFT 60	3.3	-			67	0	10	33	-	4	-
		Mobilize and Demobilize Equipment by 3-Ton Trailer	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for equipment, hauled on 3-ton capacity towed trailer	A3Q	3	1.0	1.0	100%	FFS 52.9 DRAFT 61	2.2	-			45	0	10	22	-	3	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	A3Q	72	1.0	1.0	100%	FFS 52.9 DRAFT 62	1.3	-			25	0	10	13	-	1	-
		Mobilize and Demobilize Equipment by 20-Ton Trailer	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for equipment, hauled on 20-ton capacity towed trailer	B34U	2	2.0	4.0	100%	FFS 52.9 DRAFT 63	38	-			760	0	54	2,052	-	44	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	B34U	72	2.0	4.0	100%	FFS 52.9 DRAFT 64	15.8	-			316	0	54	853	-	18	-
		Mobilize and Demobilize Equipment by 40-Ton Trailer	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for equipment, hauled on 40-ton capacity towed trailer	B34N	2	2.0	4.0	100%	FFS 52.9 DRAFT 65	50	-			1,000	0	90	4,500	-	57	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	B34N	72	2.0	4.0	100%	FFS 52.9 DRAFT 66	20.8	-			416	0	90	1,872	-	24	-
		Mobilize and Demobilize Crane Equipment (more than 75 tons)	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, crane, truck-mounted, over 75 ton, (with chase vehicle)	E2	3	2.0	1.0	100%	FFS 52.9 DRAFT 67	1.6	-			32	0	36	58	-	2	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	E2	72	2.0	1.0	100%	FFS 52.9 DRAFT 68	0.8	-			17	0	36	30	-	1	-
	Traffic Improvements	Create Temporary Roads	Gravel Roads	S.Y.	RS Means, Year 2016 Quarter 1	Temporary, roads, gravel fill, 4" gravel depth, excl surfacing	B14	715	6.0	1.0	100%	FFS 52.9 DRAFT 69	129.8	223.8			2,596	4,476	25.2	3,271	5,639	149	257
		Bridge from Area 1 to Area 2 over Site Entrance Road	Modular Bridge	Ea.	See separate Assumptions sheet		Bridge Construction Crew	0	1.0	1.0	100%	FFS 52.9 DRAFT 70	143.2	-	549		2,863	0				165	-
															Delivery		21,960		4 mpg	5,490			
		Bridge Demolition	Modular Bridge	Ea.	See separate Assumptions sheet		Bridge Construction Crew	2	1.0	1.0	100%	FFS 52.9 DRAFT 71	2.0	-			40	0				2	-
		Extend Permanent Road to new Transfer Station Location	Roadway	Ft.	Estimate		B25	34	11.0	1.0	100%	FFS 52.9 DRAFT 72	643.1	-			12,862	0	72	46,302	-	739	-
		Budget for Add'l Traffic Improvements	TBD (shown as budget estimate)	$	SFS budget (plus inflation)				6.0	1.0	100%	FFS 52.9 DRAFT 73	60	60			1,200	1,200		-	-	69	69
	Dust Control	Water Truck Depreciation	Water Trucks	Trucks	Estimate							FFS 52.9 DRAFT 74										-	-
		Water Truck Operation	Water Trucks	Months	Estimate			0	1.0	1.0	100%	FFS 52.9 DRAFT 75	1,584	2,610			31,680	52,200	10	15,840	26,100	1,821	3,000
		Use Water to Control Dust	Water	Gallons	Missouri American Water Company, 7/19/2016						100%	FFS 52.9 DRAFT 76											
Site Preparation		Prepare area with Stormwater BMPs	Silt Fence / Hay Bales	L.F.	RS Means, Year 2016 Quarter 1	Synthetic erosion control, hay bales, staked	A2	2,500	3.0	1.0	100%	FFS 52.9 DRAFT 77	5.9	9.0			118	180	10	59	90	7	10
	Decontamination Area	Floor	Concrete	C.Y.	RS Means, Year 2016 Quarter 1	Structural concrete, ready mix, heavyweight, 4000 psi, includes local aggregate, sand, Portland cement (Type I) and water, delivered, excludes all additives and treatments					100%	FFS 52.9 DRAFT 78										-	-
		Floor Installation	Concrete	C.Y.	RS Means, Year 2016 Quarter 1	Structural concrete, placing, slab on grade, pumped, over 6" thick, includes leveling (strike off) & consolidation, excludes material	C20	185	8.0	1.0	100%	FFS 52.9 DRAFT 79	2.4	2.4			48	48	27	65	65	3	3

Table I-3: Calculations for Estimated Greenhouse Gas Emissions (52.9 pCi/g Partial Excavation Alternative)

DRAFT

Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
		Building	Steel Building	SF Flr.	RS Means, Year 2016 Quarter 1	Pre-engineered steel building, clear span rigid frame, 30 psf roof and 20 psf wind load, 20' to 29' W x 16' eave H, incl. 26 ga. colored ribbed roofing & siding, excl. footings, slab, anchor bolts	E2	320	7.0	1.0	100%	FFS 52.9 DRAFT 80	21.9	21.9			438	438	36	788	788	25	25
	Clearing & Grubbing	Clear Vegetation (Light)	Vegetation	Acre	RS Means, Year 2016 Quarter 1	Selective tree and shrub removal, selective clearing brush mowing, light density, tractor with rotary mower, excludes removal offsite	B84	2	1.0	1.0	100%	FFS 52.9 DRAFT 81	0.1	1.3			2	26	18	2	24	0	2
		Clear Vegetation (Heavy)	Vegetation	Acre	RS Means, Year 2016 Quarter 1	Clearing & grubbing, cut & chip light trees, to 6" diameter	B7	1	6.0	1.0	100%	FFS 52.9 DRAFT 82	50.9	91.7			1,019	1,835	54	2,751	4,954	59	105
		Clear Small Trees	Trees	Ea.	RS Means, Year 2016 Quarter 1	Selective felling trees and piling, large tract clearing & piling, firm level terrain, no boulders, hardwood, per tree, 300 H.P. dozer, 12" to 24" diameter	B10M	80	1.5	8.0	100%	FFS 52.9 DRAFT 83	2.2	6.7			44	133	59	128	389	3	8
		Clear Large Trees	Trees	Ea.	RS Means, Year 2016 Quarter 1	Selective felling trees and piling, large tract clearing & piling, firm level terrain, no boulders, hardwood, per tree, 300 H.P. dozer, 24" to 36" diameter	B10M	50	1.5	4.0	100%	FFS 52.9 DRAFT 84	1.0	2.9			20	59	59	58	172	1	3
		Clear Small Stumps	Trees	Ea.	RS Means, Year 2016 Quarter 1	Selective clearing and grubbing, 1-1/2 C.Y. excavator, 14" to 24" diameter, stump removal on site by hydraulic excavator	B30	25	3.0	2.0	100%	FFS 52.9 DRAFT 85	14.0	42.6			281	852	155	2,173	6,594	16	49
		Clear Large Stumps	Trees	Ea.	RS Means, Year 2016 Quarter 1	Selective clearing and grubbing, 1-1/2 C.Y. excavator, 26" to 36" diameter, stump removal on site by hydraulic excavator	B30	16	3.0	2.0	100%	FFS 52.9 DRAFT 86	6.2	18.4			124	368	155	958	2,844	7	21
	Bird Mitigation	Monthly Expenses	Months	Months	Estimate	See separate Assumptions sheet	Bird Mitigation Crew	0	2.0	1.0	100%	FFS 52.9 DRAFT 88	1,151	1,674			23,020	33,480				1,323	1,924
	Temporary Gas System for Stockpile in Area 2	Capital Expenses	Temporary Gas System	Ea.	See separate Assumptions sheet			0	6.0	1.0	100%	FFS 52.9 DRAFT 89	372	-			7,439	0				428	-
		Monthly Expenses	Months	Months	See separate Assumptions sheet			1	1.0	1.0	100%	FFS 52.9 DRAFT 90	20.5	-			410	0				24	-
Excavate Waste	Area 1	Apply daily cover to remaining excavation	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 52.9 DRAFT 91	90.8	-	1,013	-	1,816	0	226	20,507	-	104	-
															Delivery		15,195	0	4 mpg	3,799	-		
		Excavate and Sort RIM and Overburden (incl. minor sources)	RIM and Overburden	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.4	50%	FFS 52.9 DRAFT 92	147.9	-			2,959	0	149	21,968	-	170	-
	Area 2 SW	Apply daily cover to remaining excavation	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 52.9 DRAFT 93	-	194.9	-	2,173	-	3,897	226	-	44,020	-	224
															Delivery		-	32,595	4 mpg	-	8,149		
		Excavate and Sort RIM and Overburden (incl. minor sources)	RIM and Overburden	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.6	50%	FFS 52.9 DRAFT 94	-	321.3			-	6,425	149	-	47,707	-	369
	Area 2 NE	Apply daily cover to remaining excavation	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 52.9 DRAFT 95	-	154	-	1,718	-	3,081	226	-	34,798	-	177
																	-	25,770	4 mpg	-	6,443		
		Excavate and Sort RIM and Overburden (NOT incl. minor sources)	RIM and Overburden	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.4	50%	FFS 52.9 DRAFT 96	-	256			-	5,117	149	-	37,992	-	294
Handle Excavated RIM	Area 1	Load piled RIM into Haul Trucks	RIM	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 2-1/2 C.Y. capacity = 95 C.Y./hour, front end loader, track mounted, excluding truck loading	B10O	760	1.5	1.0	50%	FFS 52.9 DRAFT 97	90.1	-			1,803	0	58	5,192	-	104	-
		(additional cost to previous line)	RIM		RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B10O	5,016	1.5	1.0	50%	FFS 52.9 DRAFT 98	13.7	-			273	0	58	787	-	16	-
		Haul RIM to on-site Loading Station (incl. RIM from minor sources)	RIM	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 52.9 DRAFT 99	91.6	-			1,832	0	45	4,121	-	105	-
		RIM Hauling & Disposal (during 3-month learning curve for loading)	RIM	L.C.Y.	Off-site Disposal Facility estimate	Custom line item: Transport and dispose of RIM at off-site disposal facility. Assume 3-month learning curve from 0 to 100% production (averaging 50%).	RIM Shipping Crew	150	8.0	1.0	50%	FFS 52.9 DRAFT 100	1,500	-	1,668	-	30,000	0				1,724	-
													Trucks to/from rail transloading facilities				75,060	0	4 mpg	18,765	-		
			This line is for calculating Rail Transport Emissions. LCY of RIM are shown in Area 1 Crew Man-days column										25,000	-					2.61	65,250	-		

Table I-3: Calculations for Estimated Greenhouse Gas Emissions (52.9 pCi/g Partial Excavation Alternative)

DRAFT

Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
		RIM Hauling & Disposal (normal production)	RIM	L.C.Y.	Off-site Disposal Facility estimate	Custom line item: Transport and dispose of RIM at off-site disposal facility. (Full production for remainder of project.)	RIM Shipping Crew	150	8.0	1.0	100%	FFS 52.9 DRAFT 101	277.6	-	618	-	5,552	0				319	-
													Trucks to/from rail transloading facilities				27,810	0	4 mpg	6,953	-		
			This line is for calculating Rail Transport Emissions. LCY of RIM are shown in Area 1 Crew Man-days column										9,254	-					2.61	24,153	-		
		Off-Site Disposal Facility Coordinator	Personnel	Work Days	Off-site Disposal Facility estimate	Custom line item: Oversight of RIM shipping process by off-site disposal facility's coordinator.	Coordinator	1	1.0	1.0	100%	FFS 52.9 DRAFT 102	82	-			1,640	0				94	-
		RIM Loading Crew	Personnel	Work Days	See separate Assumptions sheet	Custom line item: Stockpile and Load RIM in RIM Loading Station	RIM Loading Crew	1	4.0	1.0	100%	FFS 52.9 DRAFT 103	902	-			18,040	0				1,037	-
	Area 2 SW	Load piled RIM into Haul Trucks	RIM	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 2-1/2 C.Y. capacity = 95 C.Y./hour, front end loader, track mounted, excluding truck loading	B10O	760	1.5	2.0	50%	FFS 52.9 DRAFT 104	-	289.8			-	5,796	58	-	16,693	-	333
		(additional cost to previous line)	RIM		RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B10O	5,016	1.5	2.0	50%	FFS 52.9 DRAFT 105	-	43.9			-	878	58	-	2,529	-	50
		Haul RIM to on-site Loading Station (incl. RIM from minor sources)	RIM	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 1 mile, 10 MPH, excludes loading equipment	B34F	506	1.0	4.2	100%	FFS 52.9 DRAFT 106	-	217.6			-	4,353	45	-	9,794	-	250
		RIM Hauling & Disposal (normal production)	RIM	L.C.Y.	Off-site Disposal Facility estimate	Custom line item: Transport and dispose of RIM at off-site disposal facility. (Full production for remainder of project.)	RIM Shipping Crew	1,000	30.0	1.0	100%	FFS 52.9 DRAFT 107	-	3,303.8	-	7,342	-	66,077				-	3,798
													Trucks to/from rail transloading facilities				-	330,390	4 mpg	-	82,598		
			This line is for calculating Rail Transport Emissions. LCY of RIM are shown in Area 2 Crew Man-days column										-	110,128					2.61	-	287,434		
		Off-Site Disposal Facility Coordinator	Personnel	Work Days	Off-site Disposal Facility estimate	Custom line item: Oversight of RIM shipping process by off-site disposal facility's coordinator.	Coordinator	1	1.0	1.0	100%	FFS 52.9 DRAFT 108	-	158			-	3,160				-	182
		RIM Loading Crew	Personnel	Work Days	See separate Assumptions sheet	Custom line item: Stockpile and Load RIM in RIM Loading Station	RIM Loading Crew	1	13.0	1.0	100%	FFS 52.9 DRAFT 109	-	2,054			-	41,080				-	2,361
	Area 2 NE	Load piled RIM into Haul Trucks	RIM	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 2-1/2 C.Y. capacity = 95 C.Y./hour, front end loader, track mounted, excluding truck loading	B10O	760	1.5	2.0	50%	FFS 52.9 DRAFT 110	-	274.1			-	5,483	58	-	15,790	-	315
		(additional cost to previous line)	RIM		RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B10O	5,016	1.5	2.0	50%	FFS 52.9 DRAFT 111	-	41.5			-	831	58	-	2,392	-	48
		Haul RIM to on-site Loading Station (NOT incl. RIM from minor sources)	RIM	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 52.9 DRAFT 112	-	278.5			-	5,571	45	-	12,534	-	320
		RIM Hauling & Disposal (normal production)	RIM	L.C.Y.	Off-site Disposal Facility estimate	Custom line item: Transport and dispose of RIM at off-site disposal facility. (Full production for remainder of project.)	RIM Shipping Crew	1,000	30.0	1.0	100%	FFS 52.9 DRAFT 113	-	3,125.1	-	6,946	-	62,503				-	3,592
													Trucks to/from rail transloading facilities				-	312,570	4 mpg	-	78,143		
			This line is for calculating Rail Transport Emissions. LCY of RIM are shown in Area 2 Crew Man-days column										-	104,171					2.61	-	271,886		
		Off-Site Disposal Facility Coordinator	Personnel	Work Days	Off-site Disposal Facility estimate	Custom line item: Oversight of RIM shipping process by off-site disposal facility's coordinator.	Coordinator	1	1.0	1.0	100%	FFS 52.9 DRAFT 114	-	124			-	2,480				-	143
		RIM Loading Crew	Personnel	Work Days	See separate Assumptions sheet	Custom line item: Stockpile and Load RIM in RIM Loading Station	RIM Loading Crew	1	13.0	1.0	100%	FFS 52.9 DRAFT 115	-	1,612			-	32,240				-	1,853
Load and Haul Overburden	Area 1	Load Overburden directly into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.4	50%	FFS 52.9 DRAFT 116	16.9	-			338	0	149	2,510	-	19	-
		Relocate Overburden to Area 2 NE Stockpile	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 52.9 DRAFT 117	267.5	-			5,351	0	45	12,039	-	308	-
	Area 2 SW	Load Overburden directly into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.6	50%	FFS 52.9 DRAFT 118	-	27.6			-	553	149	-	4,105	-	32
		Relocate Overburden to backfill Area 1	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 52.9 DRAFT 119	-	437.5			-	8,750	45	-	19,688	-	503

Table I-3: Calculations for Estimated Greenhouse Gas Emissions (52.9 pCi/g Partial Excavation Alternative)

DRAFT

Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
		Relocate any remaining Overburden to Area 2 NE Stockpile	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 52.9 DRAFT 120	-				-	0	45	-	-	-	-
	Area 2 NE	Load Overburden directly into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.4	50%	FFS 52.9 DRAFT 121	-	25.6			-	512	149	-	3,801	-	29
		Relocate Overburden to backfill Area 2 SW (if needed)	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%		-	-			-	0	45	-	-	-	-
		Relocate Overburden to Area 2 SW Stockpile	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 52.9 DRAFT 122	-	405.1			-	8,103	45	-	18,231	-	466
Place Overburden	Area 1 Overburden on NE Stockpile	Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 52.9 DRAFT 123	150.1	-			3,002	0	69	10,401	-	173	-
		Apply daily cover to stockpiled Overburden	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 52.9 DRAFT 124	82.3	-	918	-	1,645	0	226	18,584	-	95	-
															Delivery		13,770	0	4 mpg	3,443	-		
	Area 2 SW Overburden backfilled in Area 1	Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 52.9 DRAFT 125	-	245.4			-	4,908	69	-	17,006	-	282
		Apply daily cover to backfilled Overburden	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 52.9 DRAFT 126	-	134.5	-	1,500	-	2,690	226	-	30,384	-	155
															Delivery		-	22,500	4 mpg	-	5,625		
		Compact Overburden	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%	FFS 52.9 DRAFT 127	-	69.2			-	1,384	90	-	6,228	-	80
	Area 2 SW Overburden to NE Stockpile (if any remaining)	Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 52.9 DRAFT 128	-				-	0	69	-	-	-	-
		Apply daily cover to stockpiled Overburden	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 52.9 DRAFT 129	-		-		-	0	226	-	-	-	-
															Delivery		-		4 mpg	-			
	Area 2 NE Overburden backfilled in Area 2 SW (if needed)	Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%		-	-			-	0	69	-	-	-	-
		Apply daily cover to backfilled Overburden	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%		-	-	-	-	-	0	226	-	-	-	-
		Compact Overburden	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%		-	-			-	0	90	-	-	-	-
	Area 2 NE Overburden on SW Stockpile	Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 52.9 DRAFT 130	-	227.3			-	4,546	69	-	15,750	-	261
		Apply daily cover to stockpiled Overburden	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 52.9 DRAFT 131	-	124.6	-	1,389	-	2,492	226	-	28,143	-	143
															Delivery		-	20,835	4 mpg	-	5,209		
Relocate Stockpiled Overburden from NE Stockpile	From NE Stockpile to backfill remaining Area 1 (to drainage grades)	Apply daily cover to remaining stockpile	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%		35.1	-	392	-	702	0	226	7,929	-	40	-
															Delivery		5,880	0	4 mpg	1,470	-		
		Excavate Stockpile	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.4	50%		52.2	-			1,044	0	149	7,752	-	60	-

Table I-3: Calculations for Estimated Greenhouse Gas Emissions (52.9 pCi/g Partial Excavation Alternative)

DRAFT

Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
		Load into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.4	50%		7.9	-			158	0	149	1,173	-	9	-
		Relocate Overburden to backfill Area 1 (drainage grades)	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%		125.6	-			2,512	0	45	5,652	-	144	-
		Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%		70.5	-			1,410	0	69	4,886	-	81	-
		Apply daily cover to backfilled material	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%		38.6	-	431	-	772	0	226	8,720	-	44	-
															Delivery		6,465	0	4 mpg	1,616	-		
		Compact backfilled material	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%		19.9	-			398	0	90	1,791	-	23	-
	From NE Stockpile to backfill Area 2 SW (to drainage grades)	Apply daily cover to remaining stockpile	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 52.9 DRAFT 139	-	55.4	-	618	-	1,108				-	64
															Delivery		-	9,270	4 mpg	-	2,318		
		Excavate Stockpile	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.4	50%	FFS 52.9 DRAFT 140	-	82.3			-	1,646	149	-	12,222	-	95
		Load into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.4	50%	FFS 52.9 DRAFT 141	-	12.5			-	250	149	-	1,856	-	14
		Relocate Overburden to backfill Area 2 SW (drainage grades)	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 52.9 DRAFT 142	-	198.1			-	3,962	45	-	8,915	-	228
		Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 52.9 DRAFT 143	-	111.1			-	2,222	69	-	7,699	-	128
		Apply daily cover to backfilled material	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 52.9 DRAFT 144	-	60.9	-	680	-	1,218	226	-	13,757	-	70
															Delivery		-	10,200	4 mpg	-	2,550		
		Compact backfilled material	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%	FFS 52.9 DRAFT 145	-	31.3			-	626	90	-	2,817	-	36
Relocate Stockpiled Overburden from SW Stockpile	From SW Stockpile to backfill Area 2 NE (to drainage grades)	Apply daily cover to remaining stockpile	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 52.9 DRAFT 152	-	137.0	-	1,528	-	2,740	226	-	30,948	-	157
															Delivery		-	22,920	4 mpg	-	5,730		
		Excavate Stockpile	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.4	50%	FFS 52.9 DRAFT 153	-	203.7			-	4,074	149	-	30,249	-	234
		Load into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.4	50%	FFS 52.9 DRAFT 154	-	31.0			-	620	149	-	4,604	-	36
		Relocate Overburden to backfill Area 2 NE (drainage grades)	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 52.9 DRAFT 155	-	490.2			-	9,804	45	-	22,059	-	563
		Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 52.9 DRAFT 156	-	275.0			-	5,500	69	-	19,058	-	316
		Apply daily cover to backfilled material	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 52.9 DRAFT 157	-	150.7	-	1,681	-	3,014	226	-	34,043	-	173
															Delivery		-	25,215	4 mpg	-	6,304		
		Compact backfilled material	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%	FFS 52.9 DRAFT 158	-	77.6			-	1,552	90	-	6,984	-	89
Reduce Slope Steepness	Relocate within the same Area. (Area 1 and	Apply daily cover to remaining excavation	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 52.9 DRAFT 159	41.7	45.7	465	510	834	914	226	9,420	10,324	48	53
															Delivery		6,975	7,650	4 mpg	1,744	1,913		

Table I-3: Calculations for Estimated Greenhouse Gas Emissions (52.9 pCi/g Partial Excavation Alternative)

DRAFT

Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
	Area 2 SW)	Excavate	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	0.7	100%	FFS 52.9 DRAFT 160	61.9	68.0			1,238	1,360	149	9,192	10,098	71	78
		Load into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	0.7	100%	FFS 52.9 DRAFT 161	9.4	10.3			188	206	149	1,396	1,530	11	12
		Transport to new location	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2000 ft, 10 MPH, excludes loading equipment	B34F	594	1.0	3.5	100%	FFS 52.9 DRAFT 162	93.8	103.0			1,876	2,060	45	4,221	4,635	108	118
		Spread Waste	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 52.9 DRAFT 163	83.6	91.8			1,672	1,836	69	5,793	6,362	96	106
		Apply daily cover to backfilled material	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 52.9 DRAFT 164	45.8	50.3	512	561	916	1,006	226	10,346	11,363	53	58
															Delivery		7,680	8,415	4 mpg	1,920	2,104		
		Compact backfilled material	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%	FFS 52.9 DRAFT 165	23.6	25.9			472	518	90	2,124	2,331	27	30
	Same as above, for Area 2 NE	Apply daily cover to remaining excavation	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 52.9 DRAFT 166	-	34.0	-	380	-	680	226	-	7,681	-	39
															Delivery		-	5,700	4 mpg	-	1,425		
		Excavate	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.4	50%	FFS 52.9 DRAFT 167	-	50.5			-	1,010	149	-	7,499	-	58
		Load into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.4	50%	FFS 52.9 DRAFT 168	-	7.7			-	154	149	-	1,143	-	9
		Transport to new location	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2000 ft, 10 MPH, excludes loading equipment	B34F	594	1.0	3.5	100%	FFS 52.9 DRAFT 169	-	76.6			-	1,532	45	-	3,447	-	88
		Spread Waste	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 52.9 DRAFT 170	-	68.2			-	1,364	69	-	4,726	-	78
		Apply daily cover to backfilled material	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 52.9 DRAFT 171	-	37.4	-	417	-	748	226	-	8,449	-	43
															Delivery		-	6,255	4 mpg	-	1,564		
		Compact backfilled material	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%	FFS 52.9 DRAFT 172	-	19.2			-	384	90	-	1,728	-	22
Relocation of Other Waste	C&D Rubble Stockpiles	Relocate Stockpiled Material on-site - Excavate	C&D Rubble	B.C.Y.	RS Means, Year 2016 Quarter 1	Drilling and blasting rock, less than 0.5 C.Y., excavate and load boulders	B10T	80	1.5	10.0	100%	FFS 52.9 DRAFT 173	146.1	657.5			2,923	13,151	40	5,787	26,039	168	756
		Relocate Stockpiled Material on-site - Haul and Dump	C&D Rubble	B.C.Y.	RS Means, Year 2016 Quarter 1	Drilling and blasting rock, 25 ton off-highway dump, 1 mile round trip, haul boulders	B34E	330	1.0	5.3	100%	FFS 52.9 DRAFT 174	23.6	106.3			472	2,125	56	1,318	5,930	27	122
		Bury Stockpiled Material	C&D Rubble	B.C.Y.	RS Means, Year 2016 Quarter 1	Drilling and blasting rock, 300 H.P. dozer, less than 0.5 C.Y., 150' haul, bury boulders on site	B10M	310	1.5	12.0	100%	FFS 52.9 DRAFT 175	37.7	169.7			754	3,394	59	2,206	9,927	43	195
Buffer Zone		Buffer Zone Activity	See separate Assumptions sheet		See separate Assumptions sheet					1.0	100%	FFS 52.9 DRAFT 176	-	42.0			-	840				-	48
Rad. Survey		Conduct final radiological survey and wait for approval	This activity is handled by others, and does not have a direct cost to the contractor. However, there are the indirect costs due to the duration							1.0	100%	FFS 52.9 DRAFT 177	-	-			-	0				-	-
Additional Fill		Purchase material and spread					B15							1,348.1		31,777		26,962	56		75,224		1,550
															Delivery			476,655	4 mpg		119,164		
		Additional delivery distance					B34B							1,502.2				30,044	54		81,119		1,727
		Compact material					B10G							133.3				2,666	32		4,199		153
Final Cover	Starter Berms	Purchase and deliver material	Riprap	Ton	RS Means, Year 2016 Quarter 1	Rip-rap and rock lining, random, broken stone, 100 lb. average, dumped	B11A	700	2.0	8.0	100%	FFS 52.9 DRAFT 178	-	158.6	-	2,776	-	3,172	59	-	9,279	-	182
															Delivery		-	111,040	4 mpg	-	27,760		
		Spread loose lift before compaction	Riprap	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	4.0	100%	FFS 52.9 DRAFT 179	-	50.0			-	999	69	-	3,463	-	57

Table I-3: Calculations for Estimated Greenhouse Gas Emissions (52.9 pCi/g Partial Excavation Alternative)

DRAFT

Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
		Special grading for steep slopes	Riprap	S.Y.	RS Means, Year 2016 Quarter 1	Fine grading, slopes, steep, finish grading	B11L	7,100	2.0	1.0	100%	FFS 52.9 DRAFT 180	-	3.6			-	72	59	-	214	-	4
		Compact starter berms	Riprap	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, riding, vibrating roller, 2 passes, 12" lifts	B10Y	5,200	1.5	2.0	100%	FFS 52.9 DRAFT 181	-	8.0			-	160	35	-	281	-	9
	Bio-Intrusion	Purchase and Spread Bio-Intrusion Layer Material	4-in Minus Aggregate	L.C.Y.	RS Means, Year 2016 Quarter 1	Aggregate for earthwork, crushed stone, 1.40 tons per C.Y., 1-1/2", spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	12.0	100%	FFS 52.9 DRAFT 182	715.6	1,408.2	10,223	20,117	14,312	28,164	170	121,724	239,535	823	1,619
															Delivery		153,345	301,755	4 mpg	38,336	75,439		
		Deliver Bio-Intrusion Layer Material	4-in Minus Aggregate (per Hauling Increment)	L.C.Y.	RS Means, Year 2016 Quarter 1	Aggregate for earthwork, aggregate or sand, spread with 200 HP dozer, includes load at pit and haul, round trip, for 5 mile haul add	B34B	200	1.0	50.0	100%	FFS 52.9 DRAFT 183	797.4	1,569.1			15,948	31,382	56	44,495	87,556	917	1,804
		Compact Bio-Intrusion Layer Material	4-in Minus Aggregate	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, riding, vibrating roller, 2 passes, 12" lifts	B10Y	5,200	1.5	2.0	100%	FFS 52.9 DRAFT 184	21.4	42.2			428	844	35	751	1,481	25	49
	Clay	Purchase and deliver clay material	Clay Material	L.C.Y.	RS Means, Year 2016 Quarter 1	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	50.0	100%	FFS 52.9 DRAFT 185	1,880.1	3,699.6	9,088	17,882	37,602	73,992	56	104,910	206,438	2,161	4,252
															Delivery		363,520	715,280	4 mpg	90,880	178,820		
		Spread loose lift before compaction	Clay Material	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	12.0	100%	FFS 52.9 DRAFT 186	163.6	321.9			3,272	6,438	69	11,337	22,308	188	370
		Compact Clay (Final Cover)	Clay Material	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	1,300	1.5	2.0	100%	FFS 52.9 DRAFT 187	89.9	176.8			1,798	3,536	90	8,091	15,912	103	203
	Top Soil	Purchase and place Topsoil	Topsoil	C.Y.	RS Means, Year 2016 Quarter 1	Soils for earthwork, topsoil borrow, weed free, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	12.0	100%	FFS 52.9 DRAFT 188	206.5	406.4	3,688	7,258	4,130	8,128	170	35,126	69,129	237	467
															Delivery		55,320	108,870	4 mpg	13,830	27,218		
		Addition for Topsoil Delivery	Topsoil (per Hauling Increment)	C.Y.	RS Means, Year 2016 Quarter 1	Soils for earthwork, borrow, spread with 200 HP dozer, includes load at pit and haul, round trip, excludes compaction, for 5 mile haul, add	B34B	200	1.0	50.0	100%	FFS 52.9 DRAFT 189	230.1	452.8			4,602	9,056	56	12,840	25,266	264	520
Stormwater Controls (for stormwater after cover is constructed)	Terraces	Purchase and place Topsoil	Topsoil	C.Y.	RS Means, Year 2016 Quarter 1	Soils for earthwork, topsoil borrow, weed free, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	2.0	100%	FFS 52.9 DRAFT 190	9.8	19.3	176	345	196	386	170	1,667	3,283	11	22
															Delivery		2,640	5,175	4 mpg	660	1,294		
		Addition for Topsoil Delivery	Topsoil (per Hauling Increment)	C.Y.	RS Means, Year 2016 Quarter 1	Soils for earthwork, borrow, spread with 200 HP dozer, includes load at pit and haul, round trip, excludes compaction, for 5 mile haul, add	B34B	200	1.0	50.0	100%	FFS 52.9 DRAFT 191	10.9	21.5			218	430	56	608	1,200	13	25
	Pond	Purchase and deliver liner & berm material	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	50.0	100%	FFS 52.9 DRAFT 192	-	237.2	-	1,147	-	4,745	56	-	13,238	-	273
															Delivery		-	45,880	4 mpg	-	11,470		
		Spread loose lift before compaction (Pond)	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	2.1	100%	FFS 52.9 DRAFT 193	-	20.6			-	412	69	-	1,428	-	24
		Compact Liner & Berm (Pond)	Structural Fill / Clay	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	1,300	1.5	2.0	100%	FFS 52.9 DRAFT 194	-	11.3			-	226	90	-	1,017	-	13
		Pond Perimeter Berm Structural Rock	Structural Rock	L.C.Y.	RS Means, Year 2016 Quarter 1	Rip-rap and rock lining, random, broken stone, machine placed for slope protection	B12G	62	2.0	1.0	100%	FFS 52.9 DRAFT 195	-	36.5		75	-	730	27	-	986	-	42
															Delivery			1,507	4 mpg		377		
	Diversion Berms	Purchase and deliver berm material	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	50.0	100%	FFS 52.9 DRAFT 196	43.4	44.9	210	217	868	898	59	2,539	2,627	50	52
															Delivery		8,400	8,680	4 mpg	2,100	2,170		
		Spread loose lift before compaction	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	2.1	100%	FFS 52.9 DRAFT 197	3.8	3.9			76	78	69	263	270	4	4
		Compact Berms	Structural Fill / Clay	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, riding, vibrating roller, 2 passes, 12" lifts	B10Y	5,200	1.5	2.0	100%	FFS 52.9 DRAFT 198	0.5	0.5			10	10	35	18	18	1	1
		Perimeter Road Stormwater Crossings	Riprap	L.C.Y.	RS Means, Year 2016 Quarter 1	Rip-rap and rock lining, random, broken stone, machine placed for slope protection	B12G	62	2.0	1.0	100%	FFS 52.9 DRAFT 199	-	4.0			-	79	27	-	107	-	5
		Final Stormwater Controls (letdowns, swales, etc.)	Riprap	S.Y.	RS Means, Year 2016 Quarter 1	Rip-rap and rock lining, random, broken stone, 3/8 to 1/4 C.Y. pieces, machine placed for slope protection, grouted	B13	80	7.0	3.0	100%	FFS 52.9 DRAFT 200	60.3	83.6			1,206	1,672	27	1,628	2,257	69	96
Site Completion		Apply seeding to cover	Seeding	M.S.F.	RS Means, Year 2016 Quarter 1	Seeding athletic fields, seeding fescue, tall with mulch and fertilizer, 5.5 lb. per M.S.F., hydro/air seeding	B81	80	3.0	1.0	100%	FFS 52.9 DRAFT 201	43.0	84.6			860	1,692	56	2,399	4,721	49	97
		Install temporary irrigation system	Irrigation System	S.F.	RS Means, Year 2016 Quarter 1	Underground sprinklers irrigation system, for lawns, residential system, custom, 1" supply	B20	2,000	3.0	10.0	100%	FFS 52.9 DRAFT 202	143.4	282.2			2,868	5,644	-	-	-	165	324

Table I-3: Calculations for Estimated Greenhouse Gas Emissions (52.9 pCi/g Partial Excavation Alternative)

DRAFT

Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
		Install Fencing	Fencing	L.F.	RS Means, Year 2016 Quarter 1	Fence, chain link industrial, galvanized steel, 6 ga. wire, 2-1/2" posts @ 10' OC, 8' high, includes excavation, in concrete, excludes barbed wire	B80C	180	3.0	2.0	100%	FFS 52.9 DRAFT 203	84.9	112.3			1,698	2,246	18	1,528	2,021	98	129
																			Gallons of Fuel Consumed	943,238	2,881,567	27,435	40,911
																			Total Gallons (Areas 1 and 2)		**3,824,805**		**68,346**
																			Conversion Factor (lbs CO_2 component of CO2e emissions per Gallon of Fuel Burned)		22.2 lb/gal		19.4 lb/gal
																			Subtotal - Pounds of CO2e emissions		84,910,672		1,325,915
																			Subtotal - Tons of CO2e emission		42,455		663
																			Total Tons of CO2e Emissions (diesel plus gasoline)			***43,000***	

Table I-4: Calculations for Estimated Greenhouse Gas Emissions (1,000 pCi/g Partial Excavation Alternative)

DRAFT

Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days		Delivery Truckloads		Total Miles for Delivery of Materials/ Equipment or Worker Commute		Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery)		Gallons gasoline consumed (worker commute to/from Site)	
													Area 1	Area 2	Area 1	Area 2	Area 1	Area 2		Area 1	Area 2	Area 1	Area 2
Temporary Construction Facilities / Utilities / Personnel	Construction Trailers	Capital Expenses	Group of Trailers		See separate Assumptions sheet							FFS 1000 DRAFT 1	39.3	-	10	-	200		4 mpg	50			
		Operating Expenses	Group of Trailers	Months	See separate Assumptions sheet							FFS 1000 DRAFT 2											
		Parking Area	Gravel Area	S.Y.	RS Means, Year 2016 Quarter 1	Temporary, roads, gravel fill, 4" gravel depth, excl surfacing	B14	715	6.0	1.0	50%	FFS 1000 DRAFT 3	37.3	-					25.2	940			
		Portable Toilets in Construction Areas	Portable Toilets	Month	RS Means, Year 2016 Quarter 1	Rent portable toilet chemical, recycle, flush type, Incl. Hourly Oper. Cost.					50%	FFS 1000 DRAFT 4											
	Contractor's Construction Management Personnel	Project Manager	Personnel	Week	RS Means, Year 2016 Quarter 1	Field personnel, project manager, maximum		0	1.0	1.0	100%	FFS 1000 DRAFT 5	1,919	-			38,380		17.4 mpg			2,206	-
		Construction Superintendent(s)	Personnel	Week	RS Means, Year 2016 Quarter 1	Field personnel, superintendent, average		0	1.0	1.0	100%	FFS 1000 DRAFT 6	2,470	-			49,400		17.4 mpg			2,839	-
		Clerk(s)	Personnel	Week	RS Means, Year 2016 Quarter 1	Field personnel, clerk, average		0	1.0	1.0	100%	FFS 1000 DRAFT 7	2,470	-			49,400		17.4 mpg			2,839	-
		Field Engineer(s) / Safety Officer(s)	Personnel	Week	RS Means, Year 2016 Quarter 1	Field personnel, field engineer, average		0	1.0	1.0	100%	FFS 1000 DRAFT 8	2,470	-			49,400		17.4 mpg			2,839	-
Temporary Stormwater Infrastructure (for stormwater during construction)	Frac Tanks	Delivery	Frac Tanks	Ea.	See separate Assumptions sheet			3	2.0	2.0	100%	FFS 1000 DRAFT 9	38.7	38.7	58	58	3,480	3,480	4 mpg	870	870		
		Monthly Rental (or Purchase)	Frac Tanks	Month	See separate Assumptions sheet						100%	FFS 1000 DRAFT 10											
		Cleaning	Frac Tanks	Ea.	See separate Assumptions sheet			1	2.0	1.0	100%	FFS 1000 DRAFT 11	116.0	116.0					4 mpg				
		Removal	Frac Tanks	Ea.	See separate Assumptions sheet			3	2.0	2.0	100%	FFS 1000 DRAFT 12	38.7	38.7	58	58	3,480	3,480	4 mpg	870	870		
	Forcemain	Install forcemain from Excavation Area to Tank Area	HDPE Pipe	L.F.	RS Means, Year 2016 Quarter 1	Water supply distribution piping, piping HDPE, butt fusion joints, 40' lengths, 4" diameter, SDR 21	B22A	400	5.0	1.0	100%	FFS 1000 DRAFT 13	56.3	87.5			1,125	1,750	23	1,266	1,969	65	101
		Install forcemain from Tank Area to Treatment Plant and Discharge Point	HDPE Pipe	L.F.	RS Means, Year 2016 Quarter 1	Water supply distribution piping, piping HDPE, butt fusion joints, 40' lengths, 4" diameter, SDR 21	B22A	400	5.0	1.0	100%	FFS 1000 DRAFT 14	6.3	6.3			125	125	-	-	-	7	7
		Install forcemain valves	Pipe Valves	Ea.	RS Means, Year 2016 Quarter 1	Valves, plastic, PVC, ball, true union, socket or threaded, 4"	Q1	20	2.0	1.0	100%	FFS 1000 DRAFT 15	0.6	0.8			12	16	17.4 mpg			1	1
	Treatment Facility	Construct Treatment Facility	Treatment Facility	Each	EMSI Estimate			0	2.0	1.0	100%	FFS 1000 DRAFT 16	30	-			600	0	17.4 mpg			34	-
		Treatment Facility Demolition	Treatment Facility	Each	EMSI Estimate			0	2.0	1.0	100%	FFS 1000 DRAFT 17	19	-			380	0	17.4 mpg			22	-
		Monthly Rent	Treatment Facility Operation	Each	EMSI Estimate			0	2.0	1.0	100%	FFS 1000 DRAFT 18											
		Monthly Operation during construction	Treatment Facility Operation	Months	EMSI Estimate			0	1.0	1.0	100%	FFS 1000 DRAFT 19	392	-			7,840	0	17.4 mpg			451	-
	Stormwater events during construction	Dewater excavation construction after rain events	Days of Pumping Construction Stormwater	Day	RS Means, Year 2016 Quarter 1	Dewatering, pumping 8 hours, attended 2 hrs per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose	B10I	4	1.5	4.0	100%	FFS 1000 DRAFT 20	121.6	318			2,432	6,368	9	1,094	2,866	140	366
		Dewater backfill construction after rain events	Days of Pumping Construction Stormwater	Day	RS Means, Year 2016 Quarter 1	Dewatering, pumping 8 hours, attended 2 hrs per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose	B10I	4	1.5	4.0	100%	FFS 1000 DRAFT 21	78.1	212.8			1,562	4,256	9	703	1,915	90	245
		Dispose of contact stormwater to MSD	Contact Stormwater	Gallons	St. Louis Sewer District, May 2011						100%	FFS 1000 DRAFT 22											
Leachate Handling	Frac Tanks	Delivery	Frac Tanks	Ea.	See separate Assumptions sheet			3	2.0	2.0	100%	FFS 1000 DRAFT 23	13.3	13.3	20	20	1,200	1,200	4 mpg	300	300		
		Monthly Rental (or Purchase)	Frac Tanks	Month	See separate Assumptions sheet						100%	FFS 1000 DRAFT 24											
		Cleaning	Frac Tanks	Ea.	See separate Assumptions sheet			1	2.0	1.0	100%	FFS 1000 DRAFT 25	40	40			800	800	17.4 mpg			46	46
		Removal	Frac Tanks	Ea.	See separate Assumptions sheet			3	2.0	2.0	100%	FFS 1000 DRAFT 26	13.3	13.3	20	20	1,200	1,200	4 mpg	300	300		
	Secondary Containment for Frac Tanks	Purchase and deliver liner & berm material	Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	50.0	100%	FFS 1000 DRAFT 27	37.6	37.6	182	182	751	751	59	2,197	2,197	43	43
															Delivery		7,280	7,280	4 mpg	1,820	1,820		

Table I-4: Calculations for Estimated Greenhouse Gas Emissions (1,000 pCi/g Partial Excavation Alternative)

DRAFT

Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
		Spread loose lift before compaction	Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	2.1	100%	FFS 1000 DRAFT 28	3.3	3.3			65	65	69	226	226	4	4
		Compact Liner & Berms	Clay	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	1,300	1.5	2.0	100%	FFS 1000 DRAFT 29	1.8	1.8			36	36	90	162	162	2	2
	Leachate Storage & Testing	Pumping from Excavation Site	Leachate	Day	RS Means, Year 2016 Quarter 1	Dewatering, pumping 8 hours, attended 2 hrs per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose	B10I	4	1.5	1.0	100%	FFS 1000 DRAFT 30	3.4	1.8			68	37	9	31	16	4	2
		Move Tank from Tank Area to Excavation Site	Tanks	Ea.	See separate Assumptions sheet			4	2.0	1.0	100%	FFS 1000 DRAFT 31	43.5	23.5			870	470	2 gal/trip	87	47		
		Leachate Sampling	Lab Tests	Ea.	RS Means, Year 2016 Quarter 1	Field testing equipment, sampling & testing soil/sediment, sample collection, field samples, sludge	1 Skwk	32	1.0	1.0	100%	FFS 1000 DRAFT 32	2.7	1.5			54	29	17.4 mpg			3	2
		Leachate Testing - VOC's	Lab Tests	Ea.	RS Means, Year 2016 Quarter 1	Laboratory analytical services, laboratory testing, volatile organics without GC/MS					100%	FFS 1000 DRAFT 33											
		Hauling and Disposal	Leachate	Gallons	See separate Assumptions sheet		B34B	5,000	1.0	2.0	100%	FFS 1000 DRAFT 34	347.4	187.5	348	188	6,947	3,751	55.8	19,383	10,465	399	216
		Budget for Contaminated Stormwater Prevention or Disposal	Budget	Months	Budgeted Monthly Amount						100%	FFS 1000 DRAFT 35											
													Mileage to dispose off-site				208,800	112,800	4 mpg	52,200	28,200		
RIM Loading Station	Structure	Structure Construction	Clear Span Structure	Ea.	See separate Assumptions sheet		Structure Construction Crew	0	30.0	1	100%	FFS 1000 DRAFT 36	3,300	-	30		66,000	0	17.4 mpg			3,793	-
													Delivery of Structure Components (Dyersville, IA)				19,860		4 mpg	4,965			
		Demolition	Clear Span Structure	Ea.	See separate Assumptions sheet		Structure Demolition Crew	0	30.0	1	100%	FFS 1000 DRAFT 37	450	-	30		9,000	0	17.4 mpg			517	-
													Haul Structure Components to Local Metal Recycler (40 miles R-T)				1,200		4 mpg	300			
	Air Treatment System	Startup Capital Expenses	Air Treatment System	Ea.	See separate Assumptions sheet		Treatment System Crew			1	100%	FFS 1000 DRAFT 38	71	-	9		1,420	0	17.4 mpg			82	-
													Delivery of Air Treatment systems (Roseville, MN)				9,360		4 mpg	2,340			
		Vessel Rental Costs (Project Total)	Air Treatment System	Ea.	See separate Assumptions sheet					1	100%	FFS 1000 DRAFT 39	-	-									
		Blower Costs (Purchase or Rental Total)	Air Treatment System	Ea.	See separate Assumptions sheet					1	100%	FFS 1000 DRAFT 40	-	-									
		Media Replacement (Project Total)	Air Treatment System	Ea.	See separate Assumptions sheet		Treatment System Crew			1	100%	FFS 1000 DRAFT 41	60	-	2		1,200	0	17.4 mpg			69	-
													Delivery of replacement media (from Roseville, MN) - 3 semis				6,240		4 mpg	1,560			
													Return of spent media (to Roseville, MN) - 3 semis				6,240		4 mpg	1,560			
		Demobilization	Air Treatment System	Ea.	See separate Assumptions sheet		Treatment System Crew			1	100%	FFS 1000 DRAFT 42	41	-	9	-	820	0	17.4 mpg			47	-
													Return of Air Treatment Systems (Roseville, MN)				9,360		4 mpg	2,340			
													Return of spent media (to Roseville, MN) - 3 semis				3,120	0	4 mpg	780	-		
	Haul Road Improvements	Fencing along road for RIM hauling	Fencing	L.F.	RS Means, Year 2016 Quarter 1	Fence, chain link industrial, galvanized steel, 6 ga. wire, 2" posts @ 10' OC, 6' high, includes excavation, & concrete, excludes barbed wire	B80C	250	3.0	2.0	100%	FFS 1000 DRAFT 43	19.2	19.2			384	384	18	346	346	22	22
		Silt Fencing along road for RIM hauling	Silt Fence	Per L.F., per Month	See separate Assumptions sheet	Monthly cost for Silt fence, 3' high. Install, maintain monthly, and replace each 6 months.	B62	3,120	3.0	1.0	100%	FFS 1000 DRAFT 44	34.6	51.0			692	1,019	17.55	607	894	40	59
		Remove potentially contaminated road surface	Roadway Gravel	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk, dozer, open site, bank measure, sand and gravel, 300 H.P. dozer, 50' haul	B10M	1,900	1.5	1.0	100%	FFS 1000 DRAFT 45	0.3	0.3			6	6	59	16	16	0	0
		Loading for previous line	Roadway Gravel	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B10O	5,016	1.5	1.0	100%	FFS 1000 DRAFT 46	0.1	0.1			2	2	58	6	6	0	0
		Hauling for previous line	Roadway Gravel	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2000 ft, 10 MPH, excludes loading equipment	B34F	594	1.0	1.0	100%	FFS 1000 DRAFT 47	0.7	0.7			14	14	45	32	32	1	1
		Repairs to road remediation	Gravel Roads	S.Y.	RS Means, Year 2016 Quarter 1	Temporary, roads, gravel fill, 8" gravel depth, excl surfacing	B14	615	6.0	1.0	100%	FFS 1000 DRAFT 48	20.8	20.8			416	416	25	524	524	24	24
Site-wide Preparation	Mobilization	Mobilize and Demobilize Equipment by Pickup Truck	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for small equipment, placed in rear of, or towed by pickup truck	A3A	4	1.0	1.0	100%	FFS 1000 DRAFT 49	4.0	-			80	0	10	40	-	5	-

Table I-4: Calculations for Estimated Greenhouse Gas Emissions (1,000 pCi/g Partial Excavation Alternative)

DRAFT

Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	A3A	72	1.0	1.0	100%	FFS 1000 DRAFT 50	3.3	-			67	0	10	33	-	4	-
		Mobilize and Demobilize Equipment by 3-Ton Trailer	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for equipment, hauled on 3-ton capacity towed trailer	A3Q	3	1.0	1.0	100%	FFS 1000 DRAFT 51	2.2	-			45	0	10	22	-	3	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	A3Q	72	1.0	1.0	100%	FFS 1000 DRAFT 52	1.3	-			25	0	10	13	-	1	-
		Mobilize and Demobilize Equipment by 20-Ton Trailer	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for equipment, hauled on 20-ton capacity towed trailer	B34U	2	2.0	4.0	100%	FFS 1000 DRAFT 53	36	-			720	0	54	1,944	-	41	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	B34U	72	2.0	4.0	100%	FFS 1000 DRAFT 54	15	-			300	0	54	810	-	17	-
		Mobilize and Demobilize Equipment by 40-Ton Trailer	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for equipment, hauled on 40-ton capacity towed trailer	B34N	2	2.0	4.0	100%	FFS 1000 DRAFT 55	50	-			1,000	0	90	4,500	-	57	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	B34N	72	2.0	4.0	100%	FFS 1000 DRAFT 56	20.8	-			416	0	90	1,872	-	24	-
		Mobilize and Demobilize Crane Equipment (more than 75 tons)	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, crane, truck-mounted, over 75 ton, (with chase vehicle)	A3E	3	2.0	1.0	100%	FFS 1000 DRAFT 57	1.6	-			32	0	10	16	-	2	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	A3E	72	2.0	1.0	100%	FFS 1000 DRAFT 58	0.8	-			17	0	10	8	-	1	-
	Supplemental Mobilizations	Mobilize and Demobilize Equipment by Pickup Truck	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for small equipment, placed in rear of, or towed by pickup truck	A3A	4	1.0	1.0	100%	FFS 1000 DRAFT 59	4.0	-			80	0	10	40	-	5	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	A3A	72	1.0	1.0	100%	FFS 1000 DRAFT 60	3.3	-			67	0	10	33	-	4	-
		Mobilize and Demobilize Equipment by 3-Ton Trailer	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for equipment, hauled on 3-ton capacity towed trailer	A3Q	3	1.0	1.0	100%	FFS 1000 DRAFT 61	2.2	-			45	0	10	22	-	3	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	A3Q	72	1.0	1.0	100%	FFS 1000 DRAFT 62	1.3	-			25	0	10	13	-	1	-
		Mobilize and Demobilize Equipment by 20-Ton Trailer	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for equipment, hauled on 20-ton capacity towed trailer	B34U	2	2.0	4.0	100%	FFS 1000 DRAFT 63	36	-			720	0	54	1,944	-	41	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	B34U	72	2.0	4.0	100%	FFS 1000 DRAFT 64	15	-			300	0	54	810	-	17	-
		Mobilize and Demobilize Equipment by 40-Ton Trailer	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for equipment, hauled on 40-ton capacity towed trailer	B34N	2	2.0	4.0	100%	FFS 1000 DRAFT 65	50	-			1,000	0	90	4,500	-	57	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	B34N	72	2.0	4.0	100%	FFS 1000 DRAFT 66	20.8	-			416	0	90	1,872	-	24	-
		Mobilize and Demobilize Crane Equipment (more than 75 tons)	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, crane, truck-mounted, over 75 ton, (with chase vehicle)	A3E	3	2.0	1.0	100%	FFS 1000 DRAFT 67	1.6	-			32	0	10	16	-	2	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	A3E	72	2.0	1.0	100%	FFS 1000 DRAFT 68	0.8	-			17	0	10	8	-	1	-
	Traffic Improvements	Create Temporary Roads	Gravel Roads	S.Y.	RS Means, Year 2016 Quarter 1	Temporary, roads, gravel fill, 4" gravel depth, excl surfacing	B14	715	6.0	1.0	100%	FFS 1000 DRAFT 69	129.8	223.8			2,596	4,476	25	3,271	5,639	149	257
		Bridge from Area 1 to Area 2 over Site Entrance Road	Modular Bridge	Ea.	See separate Assumptions sheet		Bridge Construction Crew	0	1.0	1.0	100%	FFS 1000 DRAFT 70	143.2	-	549		2,863	0				165	-
															Delivery		21,960		4 mpg	5,490			
		Bridge Demolition	Modular Bridge	Ea.	See separate Assumptions sheet		Bridge Construction Crew	2	1.0	1.0	100%	FFS 1000 DRAFT 71	2.0	-			40	0				2	-
		Extend Permanent Road to new Transfer Station Location	Roadway	Ft.	Estimate		B25	34	11.0	1.0	100%	FFS 1000 DRAFT 72	643.1	-			12,862	0	72	46,302	-	739	-
		Budget for Add'l Traffic Improvements	TBD (shown as budget estimate)	$	SFS budget (plus inflation)				6.0	1.0	100%	FFS 1000 DRAFT 73	60	60			1,200	1,200		-	-	69	69
	Dust Control	Water Truck Depreciation	Water Trucks	Trucks	Estimate							FFS 1000 DRAFT 74										-	-
		Water Truck Operation	Water Trucks	Months	Estimate			0	1.0	1.0	100%	FFS 1000 DRAFT 75	2,950	4,055			59,000	81,100	10	29,500	40,550	3,391	4,661
		Use Water to Control Dust	Water	Gallons	Missouri American Water Company, 7/19/2016						100%	FFS 1000 DRAFT 76											
Site Preparation		Prepare area with Stormwater BMPs	Silt Fence / Hay Bales	L.F.	RS Means, Year 2016 Quarter 1	Synthetic erosion control, hay bales, staked	A2	2,500	3.0	1.0	100%	FFS 1000 DRAFT 77	6.5	9.0			130	180	10	65	90	7	10

Table I-4: Calculations for Estimated Greenhouse Gas Emissions (1,000 pCi/g Partial Excavation Alternative)

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Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
	Decontamination Area	Floor	Concrete	C.Y.	RS Means, Year 2016 Quarter 1	Structural concrete, ready mix, heavyweight, 4000 psi, includes local aggregate, sand, Portland cement (Type I) and water, delivered, excludes all additives and treatments					100%	FFS 1000 DRAFT 78										-	-
		Floor Installation	Concrete	C.Y.	RS Means, Year 2016 Quarter 1	Structural concrete, placing, slab on grade, pumped, over 6" thick, includes leveling (strike off) & consolidation, excludes material	C20	185	8.0	1.0	100%	FFS 1000 DRAFT 79	2.4	2.4			48	48	27	65	65	3	3
		Building	Steel Building	SF Flr.	RS Means, Year 2016 Quarter 1	Pre-engineered steel building, clear span rigid frame, 30 psf roof and 20 psf wind load, 20' to 29' W x 16' eave H, incl. 26 ga. colored ribbed roofing & siding, excl. footings, slab, anchor bolts	E2	320	7.0	1.0	100%	FFS 1000 DRAFT 80	21.9	21.9			438	438	36	788	788	25	25
	Clearing & Grubbing	Clear Vegetation (Light)	Vegetation	Acre	RS Means, Year 2016 Quarter 1	Selective tree and shrub removal, selective clearing brush mowing, light density, tractor with rotary mower, excludes removal offsite	B84	2	1.0	1.0	100%	FFS 1000 DRAFT 81	0.1	1.3			2	26	18	2	24	0	2
		Clear Vegetation (Heavy)	Vegetation	Acre	RS Means, Year 2016 Quarter 1	Clearing & grubbing, cut & chip light trees, to 6" diameter	B7	1	6.0	1.0	100%	FFS 1000 DRAFT 82	50.9	91.7			1,019	1,835	54	2,751	4,954	59	105
		Clear Small Trees	Trees	Ea.	RS Means, Year 2016 Quarter 1	Selective felling trees and piling, large tract clearing & piling, firm level terrain, no boulders, hardwood, per tree, 300 H.P. dozer, 12" to 24" diameter	B10M	80	1.5	8.0	100%	FFS 1000 DRAFT 83	2.2	6.7			44	133	59	128	389	3	8
		Clear Large Trees	Trees	Ea.	RS Means, Year 2016 Quarter 1	Selective felling trees and piling, large tract clearing & piling, firm level terrain, no boulders, hardwood, per tree, 300 H.P. dozer, 24" to 36" diameter	B10M	50	1.5	4.0	100%	FFS 1000 DRAFT 84	1.0	2.9			20	59	59	58	172	1	3
		Clear Small Stumps	Trees	Ea.	RS Means, Year 2016 Quarter 1	Selective clearing and grubbing, 1-1/2 C.Y. excavator, 14" to 24" diameter, stump removal on site by hydraulic excavator	B30	25	3.0	2.0	100%	FFS 1000 DRAFT 85	14.0	42.6			281	852	155	2,173	6,594	16	49
		Clear Large Stumps	Trees	Ea.	RS Means, Year 2016 Quarter 1	Selective clearing and grubbing, 1-1/2 C.Y. excavator, 26" to 36" diameter, stump removal on site by hydraulic excavator	B30	16	3.0	2.0	100%	FFS 1000 DRAFT 86	6.2	18.4			124	368	155	958	2,844	7	21
	Bird Mitigation	Monthly Expenses	Months	Months	Estimate	See separate Assumptions sheet	Bird Mitigation Crew	0	2.0	1.0	100%	FFS 1000 DRAFT 88	2,233	3,381			44,660	67,620				2,567	3,886
	Temporary Gas System for Stockpile in Area 2	Capital Expenses	Temporary Gas System	Ea.	See separate Assumptions sheet			0	6.0	1.0	100%	FFS 1000 DRAFT 89	372	-			7,439	0				428	-
		Monthly Expenses	Months	Months	See separate Assumptions sheet			1	1.0	1.0	100%	FFS 1000 DRAFT 90	39.9	-			798	0				46	-
Excavate Waste	Area 1	Apply daily cover to remaining excavation	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 1000 DRAFT 91	530.3	-	5,913	-	10,606	0	226	119,794	-	610	-
															Delivery		88,695	0	4 mpg	22,174	-		
		Excavate and Sort RIM and Overburden (incl. minor sources)	RIM and Overburden	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.4	50%	FFS 1000 DRAFT 92	801.3	-			16,025	0	149	118,988	-	921	-
	Area 2 SW	Apply daily cover to remaining excavation	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 1000 DRAFT 93	-	199.6	-	2,226	-	3,992	226	-	45,085	-	229
															Delivery		-	33,390	4 mpg	-	8,348		
		Excavate and Sort RIM and Overburden (incl. minor sources)	RIM and Overburden	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.6	50%	FFS 1000 DRAFT 94	-	337.1			-	6,741	149	-	50,054	-	387
	Area 2 NE	Apply daily cover to remaining excavation	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 1000 DRAFT 95	-	83.1	-	927	-	1,663	226	-	18,782	-	96
															Delivery		-	13,905	4 mpg	-	3,476		
		Excavate and Sort RIM and Overburden (NOT incl. minor sources)	RIM and Overburden	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.4	50%	FFS 1000 DRAFT 96	-	141.6			-	2,833	149	-	21,035	-	163
Handle Excavated RIM	Area 1	Load piled RIM into Haul Trucks	RIM	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 2-1/2 C.Y. capacity = 95 C.Y./hour, front end loader, track mounted, excluding truck loading	B10O	760	1.5	1.0	50%	FFS 1000 DRAFT 97	30.9	-			618	0	58	1,779	-	36	-
		(additional cost to previous line)	RIM		RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B10O	5,016	1.5	1.0	50%	FFS 1000 DRAFT 98	4.7	-			94	0	58	270	-	5	-

Table I-4: Calculations for Estimated Greenhouse Gas Emissions (1,000 pCi/g Partial Excavation Alternative)

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Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days		Delivery Truckloads		Total Miles for Delivery of Materials/ Equipment or Worker Commute		Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery)		Gallons gasoline consumed (worker commute to/from Site)	
													Area 1	Area 2	Area 1	Area 2	Area 1	Area 2		Area 1	Area 2	Area 1	Area 2
		Haul RIM to on-site Loading Station (incl. RIM from minor sources)	RIM	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 1000 DRAFT 99	31.4	-			628	0	45	1,412	-	36	-
		RIM Hauling & Disposal (during 3-month learning curve for loading)	RIM	L.C.Y.	Off-site Disposal Facility estimate	Custom line item: Transport and dispose of RIM at off-site disposal facility. Assume 3-month learning curve from 0 to 100% production (averaging 50%).	RIM Shipping Crew	150	8.0	1.0	50%	FFS 1000 DRAFT 100	437.5	-	210	-	8,750	0				503	-
													Trucks to/from rail transloading facilities				9,450	0	4 mpg	2,363	-		
			This line is for calculating Train Diesel. "Unit Fuel Consumption": LCY of RIM are shown in Area 1 Crew Man-days column										3,125	-					2.61	8,156	-		
		RIM Hauling & Disposal (normal production)	RIM	L.C.Y.	Off-site Disposal Facility estimate	Custom line item: Transport and dispose of RIM at off-site disposal facility. (Full production for remainder of project.)	RIM Shipping Crew	150	8.0	1.0	100%	FFS 1000 DRAFT 101	602.8	-	576	-	12,056	0				693	-
													Trucks to/from rail transloading facilities				25,920	0	4 mpg	6,480	-		
			This line is for calculating Train Diesel. "Unit Fuel Consumption": LCY of RIM are shown in Area 1 Crew Man-days column										8,611	-					2.61	22,475	-		
		Off-Site Disposal Facility Coordinator	Personnel	Work Days	Off-site Disposal Facility estimate	Custom line item: Oversight of RIM shipping process by off-site disposal facility's coordinator.	Coordinator	1	1.0	1.0	100%	FFS 1000 DRAFT 102	366	-			7,320	0				421	-
		RIM Loading Crew	Personnel	Work Days	See separate Assumptions sheet	Custom line item: Stockpile and Load RIM in RIM Loading Station	RIM Loading Crew	1	4.0	1.0	100%	FFS 1000 DRAFT 103	1,464	-			29,280	0				1,683	-
	Area 2 SW	Load piled RIM into Haul Trucks	RIM	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 2-1/2 C.Y. capacity = 95 C.Y./hour, front end loader, track mounted, excluding truck loading	B10O	760	1.5	2.0	50%	FFS 1000 DRAFT 104	-	83.3			-	1,665	58	-	4,796	-	96
		(additional cost to previous line)	RIM		RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B10O	5,016	1.5	2.0	50%	FFS 1000 DRAFT 105	-	12.6			-	252	58	-	727	-	15
		Haul RIM to on-site Loading Station (incl. RIM from minor sources)	RIM	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 1 mile, 10 MPH, excludes loading equipment	B34F	506	1.0	4.2	100%	FFS 1000 DRAFT 106	-	62.5			-	1,251	45	-	2,814	-	72
		RIM Hauling & Disposal (normal production)	RIM	L.C.Y.	Off-site Disposal Facility estimate	Custom line item: Transport and dispose of RIM at off-site disposal facility. (Full production for remainder of project.)	RIM Shipping Crew	1,000	30.0	1.0	100%	FFS 1000 DRAFT 107	-	1,186.6	-	2,110	-	23,731				-	1,364
													Trucks to/from rail transloading facilities				-	94,950	4 mpg	-	23,738		
			This line is for calculating Train Diesel. "Unit Fuel Consumption": LCY of RIM are shown in Area 1 Crew Man-days column										-	31,641					2.61	-	82,583		
		Off-Site Disposal Facility Coordinator	Personnel	Work Days	Off-site Disposal Facility estimate	Custom line item: Oversight of RIM shipping process by off-site disposal facility's coordinator.	Coordinator	1	1.0	1.0	100%	FFS 1000 DRAFT 108	-	184			-	3,680				-	211
		RIM Loading Crew	Personnel	Work Days	See separate Assumptions sheet	Custom line item: Stockpile and Load RIM in RIM Loading Station	RIM Loading Crew	1	13.0	1.0	100%	FFS 1000 DRAFT 109	-	920			-	18,400				-	1,057
	Area 2 NE	Load piled RIM into Haul Trucks	RIM	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 2-1/2 C.Y. capacity = 95 C.Y./hour, front end loader, track mounted, excluding truck loading	B10O	760	1.5	2.0	50%	FFS 1000 DRAFT 110	-	51.9			-	1,037	58	-	2,987	-	60
		(additional cost to previous line)	RIM		RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B10O	5,016	1.5	2.0	50%	FFS 1000 DRAFT 111	-	7.9			-	157	58	-	453	-	9
		Haul RIM to on-site Loading Station (NOT incl. RIM from minor sources)	RIM	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 1000 DRAFT 112	-	52.7			-	1,054	45	-	2,371	-	61
		RIM Hauling & Disposal (normal production)	RIM	L.C.Y.	Off-site Disposal Facility estimate	Custom line item: Transport and dispose of RIM at off-site disposal facility. (Full production for remainder of project.)	RIM Shipping Crew	1,000	30.0	1.0	100%	FFS 1000 DRAFT 113	-	670	-	1,314	-	13,400				-	770
													Trucks to/from rail transloading facilities				-	59,130	4 mpg	-	14,783		
			This line is for calculating Train Diesel. "Unit Fuel Consumption": LCY of RIM are shown in Area 1 Crew Man-days column										-	19,707					2.61	-	51,435		
		Off-Site Disposal Facility Coordinator	Personnel	Work Days	Off-site Disposal Facility estimate	Custom line item: Oversight of RIM shipping process by off-site disposal facility's coordinator.	Coordinator	1	1.0	1.0	100%	FFS 1000 DRAFT 114	-	70			-	1,400				-	80
		RIM Loading Crew	Personnel	Work Days	See separate Assumptions sheet	Custom line item: Stockpile and Load RIM in RIM Loading Station	RIM Loading Crew	1	13.0	1.0	100%	FFS 1000 DRAFT 115	-	420			-	8,400				-	483
Load and Haul Overburden	Area 1	Load Overburden directly into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.4	50%	FFS 1000 DRAFT 116	120	-			2,401	0	149	17,827	-	138	-

Table I-4: Calculations for Estimated Greenhouse Gas Emissions (1,000 pCi/g Partial Excavation Alternative)

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Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
		Relocate Overburden to Area 2 NE Stockpile	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 1000 DRAFT 117	1,899.9	-			37,999	0	45	85,497	-	2,184	-
	Area 2 SW	Load Overburden directly into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.6	50%	FFS 1000 DRAFT 118	-	43.4			-	869	149	-	6,450	-	50
		Relocate Overburden to backfill Area 1	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 1000 DRAFT 119	-	687.5			-	13,749	45	-	30,936	-	790
		Relocate any remaining Overburden to Area 2 NE Stockpile	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%		-	-			-	0	45	-	-	-	-
	Area 2 NE	Load Overburden directly into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.4	50%	FFS 1000 DRAFT 120	-	22.4			-	447	149	-	3,322	-	26
		Relocate Overburden to Area 2 SW Stockpile	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 1000 DRAFT 122	-	354.1			-	7,082	45	-	15,935	-	407
Place Overburden	Area 1 Overburden on NE Stockpile	Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 1000 DRAFT 123	1,065.9	-			21,317	0	69	73,864	-	1,225	-
		Apply daily cover to stockpiled Overburden	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 1000 DRAFT 124	584.2	-	6,514	-	11,685	0	226	131,982	-	672	-
															Delivery		97,710	0	4 mpg	24,428	-		
	Area 2 SW Overburden backfilled in Area 1	Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 1000 DRAFT 125	-	385.7			-	7,713	69	-	26,727	-	443
		Apply daily cover to backfilled Overburden	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 1000 DRAFT 126	-	211.4	-	2,357	-	4,228	226	-	47,756	-	243
															Delivery		-	35,355	4 mpg	-	8,839		
		Compact Overburden	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%	FFS 1000 DRAFT 127	-	108.8			-	2,176	90	-	9,790	-	125
	Area 2 NE Overburden on SW Stockpile	Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 1000 DRAFT 131	-	198.6			-	3,972	69	-	13,763	-	228
		Apply daily cover to stockpiled Overburden	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 1000 DRAFT 132	-	108.9	-	1,214	-	2,178	226	-	24,601	-	125
															Delivery		-	18,210	4 mpg	-	4,553		
Relocate Stockpiled Overburden from NE Stockpile	From NE Stockpile to backfill remaining Area 1 (to drainage grades)	Apply daily cover to remaining stockpile	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 1000 DRAFT 133	72.9	-	813	-	1,458	0	226	16,468	-	84	-
															Delivery		12,195	0	4 mpg	3,049	-		
		Excavate Stockpile	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.4	50%	FFS 1000 DRAFT 134	108.3	-			2,166	0	149	16,083	-	124	-
		Load into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.4	50%	FFS 1000 DRAFT 135	16.5	-			330	0	149	2,450	-	19	-
		Relocate Overburden to backfill Area 1 (drainage grades)	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 1000 DRAFT 136	260.6	-			5,212	0	45	11,727	-	300	-
		Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 1000 DRAFT 137	146.2	-			2,924	0	69	10,132	-	168	-

Table I-4: Calculations for Estimated Greenhouse Gas Emissions (1,000 pCi/g Partial Excavation Alternative)

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Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
		Apply daily cover to backfilled material	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 1000 DRAFT 138	80.1	-	894	-	1,602	0	226	18,095	-	92	-
															Delivery		13,410	0	4 mpg	3,353	-		
		Compact backfilled material	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%	FFS 1000 DRAFT 139	41.2	-			824	0	90	3,708	-	47	-
	From NE Stockpile to backfill Area 2 SW (to drainage grades)	Apply daily cover to remaining stockpile	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 1000 DRAFT 147	-	136.3	-	1,521	-	2,726				-	157
															Delivery		-	22,815	4 mpg	-	5,704		
		Excavate Stockpile	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.4	50%	FFS 1000 DRAFT 148	-	202.7			-	4,054	149	-	30,101	-	233
		Load into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.4	50%	FFS 1000 DRAFT 149	-	30.8			-	616	149	-	4,574	-	35
		Relocate Overburden to backfill Area 2 SW (drainage grades)	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 1000 DRAFT 150	-	487.7			-	9,754	45	-	21,947	-	561
		Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 1000 DRAFT 151	-	273.6			-	5,472	69	-	18,960	-	314
		Apply daily cover to backfilled material	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 1000 DRAFT 152	-	150.0	-	1,673	-	3,000	226	-	33,885	-	172
															Delivery		-	25,095	4 mpg	-	6,274		
		Compact backfilled material	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%	FFS 1000 DRAFT 153	-	77.2			-	1,544	90	-	6,948	-	89
	From NE Stockpile to backfill Area 2 SW (to final grades)	Apply daily cover to remaining stockpile	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 1000 DRAFT 154	-	102.3	-	1,141	-	2,046	226	-	23,110	-	118
															Delivery		-	17,115	4 mpg	-	4,279		
		Excavate Stockpile	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.4	50%	FFS 1000 DRAFT 155	-	152.1			-	3,042	149	-	22,587	-	175
		Load into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.4	50%	FFS 1000 DRAFT 156	-	23.1			-	462	149	-	3,430	-	27
		Relocate Overburden to backfill Area 2 SW (final grades)	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 1000 DRAFT 157	-	366.1			-	7,322	45	-	16,475	-	421
		Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 1000 DRAFT 158	-	205.4			-	4,108	69	-	14,234	-	236
		Apply daily cover to backfilled material	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 1000 DRAFT 159	-	112.6	-	1,256	-	2,252	226	-	25,436	-	129
															Delivery		-	18,840	4 mpg	-	4,710		
		Compact backfilled material	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%	FFS 1000 DRAFT 160	-	57.9			-	1,158	90	-	5,211	-	67
	From any remaining NE Stockpile to SW Stockpile	Apply daily cover to remaining stockpile	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%		-	331.1	-	3,692	-	6,622	226	-	74,795	-	381
															Delivery		-	55,380	4 mpg	-	13,845		
		Excavate Stockpile	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.4	50%		-	492.2			-	9,844	149	-	73,092	-	566
		Load into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.4	50%		-	74.8			-	1,496	149	-	11,108	-	86

Table I-4: Calculations for Estimated Greenhouse Gas Emissions (1,000 pCi/g Partial Excavation Alternative)

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Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
		Relocate Overburden to Area 2 SW Stockpile	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%		-	1,184.5			-	23,690	45	-	53,303	-	1,361
		Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%		-	664.5			-	13,290	69	-	46,050	-	764
		Apply daily cover to stockpiled material	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%		-	364.3	-	4,061	-	7,286	226	-	82,295	-	419
															Delivery		-	60,915	4 mpg	-	15,229		
	From SW Stockpile to backfill Area 2 NE (to drainage grades)	Apply daily cover to remaining stockpile	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 1000 DRAFT 155	-	248.2	-	2,767	-	4,964	226	-	56,068	-	285
															Delivery		-	41,505	4 mpg	-	10,376		
		Excavate Stockpile	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.4	50%	FFS 1000 DRAFT 156	-	368.9			-	7,378	149	-	54,782	-	424
		Load into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.4	50%	FFS 1000 DRAFT 157	-	56.1			-	1,122	149	-	8,331	-	64
		Relocate Overburden to backfill Area 2 NE (drainage grades)	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 1000 DRAFT 158	-	887.7			-	17,754	45	-	39,947	-	1,020
		Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 1000 DRAFT 159	-	498.0			-	9,960	69	-	34,511	-	572
		Apply daily cover to backfilled material	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 1000 DRAFT 160	-	273.0	-	3,044	-	5,460	226	-	61,671	-	314
															Delivery		-	45,660	4 mpg	-	11,415		
		Compact backfilled material	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%	FFS 1000 DRAFT 161	-	140.5			-	2,810	90	-	12,645	-	161
	From SW Stockpile to backfill Area 2 NE (to drainage grades)	Apply daily cover to remaining stockpile	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 1000 DRAFT 162	-	272.3	-	3,036	-	5,446	226	-	61,513	-	313
															Delivery		-	45,540	4 mpg	-	11,385		
		Excavate Stockpile	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.4	50%	FFS 1000 DRAFT 163	-	404.8			-	8,096	149	-	60,113	-	465
		Load into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.4	50%	FFS 1000 DRAFT 164	-	61.5			-	1,230	149	-	9,133	-	71
		Relocate Overburden to backfill Area 2 NE (drainage grades)	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 1000 DRAFT 166	-	974.0			-	19,480	69	-	67,498	-	1,120
		Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 1000 DRAFT 166	-	546.4			-	10,928	226	-	123,432	-	628
		Apply daily cover to backfilled material	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 1000 DRAFT 167	-	299.5	-	3,340	-	5,990	226	-	67,657	-	344
															Delivery		-	50,100	4 mpg	-	12,525		
		Compact backfilled material	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%	FFS 1000 DRAFT 168	-	154.1			-	3,082	90	-	13,869	-	177
Reduce Slope Steepness	Relocate within the same Area. (Area 1 and Area 2 SW)	Apply daily cover to remaining excavation	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 1000 DRAFT 169	69.6	42.8	777	477	1,392	856	226	15,723	9,669	80	49
															Delivery		11,655	7,155	4 mpg	2,914	1,789		
		Excavate	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	0.7	100%	FFS 1000 DRAFT 170	103.5	63.6			2,070	1,272	149	15,370	9,445	119	73

Table I-4: Calculations for Estimated Greenhouse Gas Emissions (1,000 pCi/g Partial Excavation Alternative)

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Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
		Load into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	0.7	100%	FFS 1000 DRAFT 171	15.7	9.7			314	194	149	2,331	1,440	18	11
		Transport to new location	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2000 ft, 10 MPH, excludes loading equipment	B34F	594	1.0	3.5	100%	FFS 1000 DRAFT 172	156.8	96.4			3,136	1,928	45	7,056	4,338	180	111
		Spread Waste	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 1000 DRAFT 173	139.7	85.9			2,794	1,718	69	9,681	5,953	161	99
		Apply daily cover to backfilled material	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 1000 DRAFT 174	76.6	47.1	854	525	1,532	942	226	17,304	10,640	88	54
															Delivery		12,810	7,875	4 mpg	3,203	1,969		
		Compact backfilled material	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%	FFS 1000 DRAFT 175	39.4	24.2			788	484	90	3,546	2,178	45	28
	Same as above, for Area 2 NE	Apply daily cover to remaining excavation	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 1000 DRAFT 175	-	35.7	-	398	-	714	226	-	8,065	-	41
															Delivery		-	5,970	4 mpg	-	1,493		
		Excavate	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.4	50%	FFS 1000 DRAFT 176	-	53.0			-	1,060	149	-	7,871	-	61
		Load into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.4	50%	FFS 1000 DRAFT 177	-	8.1			-	162	149	-	1,203	-	9
		Transport to new location	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2000 ft, 10 MPH, excludes loading equipment	B34F	594	1.0	3.5	100%	FFS 1000 DRAFT 178	-	80.4			-	1,608	45	-	3,618	-	92
		Spread Waste	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 1000 DRAFT 179	-	71.6			-	1,432	69	-	4,962	-	82
		Apply daily cover to backfilled material	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 1000 DRAFT 180	-	39.3	-	438	-	786	226	-	8,878	-	45
															Delivery		-	6,570	4 mpg	-	1,643		
		Compact backfilled material	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%	FFS 1000 DRAFT 181	-	20.2			-	404	90	-	1,818	-	23
Relocation of Other Waste	C&D Rubble Stockpiles	Relocate Stockpiled Material on-site - Excavate	C&D Rubble	B.C.Y.	RS Means, Year 2016 Quarter 1	Drilling and blasting rock, less than 0.5 C.Y., excavate and load boulders	B10T	80	1.5	10.0	100%	FFS 1000 DRAFT 182	146.1	657.5			2,923	13,151	40	5,787	26,039	168	756
		Relocate Stockpiled Material on-site - Haul and Dump	C&D Rubble	B.C.Y.	RS Means, Year 2016 Quarter 1	Drilling and blasting rock, 25 ton off-highway dump, 1 mile round trip, haul boulders	B34E	330	1.0	5.3	100%	FFS 1000 DRAFT 183	23.6	106.3			472	2,125	56	1,318	5,930	27	122
		Bury Stockpiled Material	C&D Rubble	B.C.Y.	RS Means, Year 2016 Quarter 1	Drilling and blasting rock, 300 H.P. dozer, less than 0.5 C.Y., 150' haul, bury boulders on site	B10M	310	1.5	12.0	100%	FFS 1000 DRAFT 184	37.7	169.7			754	3,394	59	2,206	9,927	43	195
Buffer Zone		Buffer Zone Activity	See separate Assumptions sheet		See separate Assumptions sheet					1.0	100%	FFS 1000 DRAFT 185	-	42.0			-	840				-	48
Rad. Survey		Conduct final radiological survey and wait for approval	This activity is handled by others, and does not have a direct cost to the contractor. However, there are the indirect costs due to the duration							1.0	100%	FFS 1000 DRAFT 186	-	-			-	0				-	-
Additional Fill		Purchase material and spread					B15							32.5		767		650	170		5,528		37
															Delivery			11,505	4 mpg		2,876		
		Additional delivery distance					B34B							36.3				726	56		2,026		42
		Compact material					B10G							3.2				64	90		288		4
	Starter Berms	Purchase and deliver material	Riprap	Ton	RS Means, Year 2016 Quarter 1	Rip-rap and rock lining, random, broken stone, 100 lb. average, dumped	B11A	700	2.0	8.0	100%	FFS 1000 DRAFT 187	-	158.6	-	2,776	-	3,172	59	-	9,279	-	182
															Delivery		-	111,040	4 mpg	-	27,760		
		Spread loose lift before compaction	Riprap	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	4.0	100%	FFS 1000 DRAFT 188	-	50.0			-	999	69	-	3,463	-	57
		Special grading for steep slopes	Riprap	S.Y.	RS Means, Year 2016 Quarter 1	Fine grading, slopes, steep, finish grading	B11L	7,100	2.0	1.0	100%	FFS 1000 DRAFT 189	-	3.6			-	72	59	-	214	-	4

Table I-4: Calculations for Estimated Greenhouse Gas Emissions (1,000 pCi/g Partial Excavation Alternative)

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Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
Final Cover		Compact starter berms	Riprap	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, riding, vibrating roller, 2 passes, 12" lifts	B10Y	5,200	1.5	2.0	100%	FFS 1000 DRAFT 190	-	8.0			-	160	35	-	281	-	9
	Bio-Intrusion	Purchase and Spread Bio-Intrusion Layer Material	4-in Minus Aggregate	L.C.Y.	RS Means, Year 2016 Quarter 1	Aggregate for earthwork, crushed stone, 1.40 tons per C.Y., 1-1/2", spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	12.0	100%	FFS 1000 DRAFT 191	803.5	1,410.4	11,480	20,148	16,070	28,208	170	136,675	239,909	924	1,621
																Delivery	172,200	302,220	4 mpg	43,050	75,555		
		Deliver Bio-Intrusion Layer Material	4-in Minus Aggregate (per Hauling Increment)	L.C.Y.	RS Means, Year 2016 Quarter 1	Aggregate for earthwork, aggregate or sand, spread with 200 HP dozer, includes load at pit and haul, round trip, for 5 mile haul add	B34B	200	1.0	50.0	100%	FFS 1000 DRAFT 192	895.4	1,571.5			17,908	31,430	56	49,963	87,690	1,029	1,806
		Compact Bio-Intrusion Layer Material	4-in Minus Aggregate	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, riding, vibrating roller, 2 passes, 12" lifts	B10Y	5,200	1.5	2.0	100%	FFS 1000 DRAFT 193	24.1	42.3			482	846	35	846	1,485	28	49
	Clay	Purchase and deliver clay material	Clay Material	L.C.Y.	RS Means, Year 2016 Quarter 1	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	50.0	100%	FFS 1000 DRAFT 194	2,111.1	3,705.4	10,204	17,910	42,222	74,108	56	117,799	206,761	2,427	4,259
															Delivery		408,160	716,400	4 mpg	102,040	179,100		
		Spread loose lift before compaction	Clay Material	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	12.0	100%	FFS 1000 DRAFT 195	183.7	322.4			3,674	6,448	69	12,730	22,342	211	371
		Compact Clay (Final Cover)	Clay Material	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	1,300	1.5	2.0	100%	FFS 1000 DRAFT 196	100.9	177.1			2,018	3,542	90	9,081	15,939	116	204
	Top Soil	Purchase and place Topsoil	Topsoil	C.Y.	RS Means, Year 2016 Quarter 1	Soils for earthwork, topsoil borrow, weed free, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	12.0	100%	FFS 1000 DRAFT 197	231.9	407.0	4,142	7,269	4,638	8,140	170	39,446	69,231	267	468
															Delivery		62,130	109,035	4 mpg	15,533	27,259		
		Addition for Topsoil Delivery	Topsoil (per Hauling Increment)	C.Y.	RS Means, Year 2016 Quarter 1	Soils for earthwork, borrow, spread with 200 HP dozer, includes load at pit and haul, round trip, excludes compaction, for 5 mile haul, add	B34B	200	1.0	50.0	100%	FFS 1000 DRAFT 198	258.4	453.5			5,168	9,070	56	14,419	25,305	297	521
Stormwater Controls (for stormwater after cover is constructed)	Terraces	Purchase and place Topsoil	Topsoil	C.Y.	RS Means, Year 2016 Quarter 1	Soils for earthwork, topsoil borrow, weed free, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	2.0	100%	FFS 1000 DRAFT 199	22.9	27.0	410	483	458	540	170	3,895	4,593	26	31
															Delivery		6,150	7,245	4 mpg	1,538	1,811		
		Addition for Topsoil Delivery	Topsoil (per Hauling Increment)	C.Y.	RS Means, Year 2016 Quarter 1	Soils for earthwork, borrow, spread with 200 HP dozer, includes load at pit and haul, round trip, excludes compaction, for 5 mile haul, add	B34B	200	1.0	50.0	100%	FFS 1000 DRAFT 200	25.5	30.1			510	602	56	1,423	1,680	29	35
	Pond	Purchase and deliver liner & berm material	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	50.0	100%	FFS 1000 DRAFT 201	-	237.2	-	1,147	-	4,745	56	-	13,238	-	273
															Delivery		-	45,880	4 mpg	-	11,470		
		Spread loose lift before compaction (Pond)	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	2.1	100%	FFS 1000 DRAFT 202	-	20.6			-	413	69	-	1,430	-	24
		Compact Liner & Berm (Pond)	Structural Fill / Clay	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	1,300	1.5	2.0	100%	FFS 1000 DRAFT 203	-	11.3			-	227	90	-	1,021	-	13
		Pond Perimeter Berm Structural Rock	Structural Rock	L.C.Y.	RS Means, Year 2016 Quarter 1	Rip-rap and rock lining, random, broken stone, machine placed for slope protection	B12G	62	2.0	1.0	100%	FFS 1000 DRAFT 204	-	36.5		75	-	729	27	-	984	-	42
															Delivery			1,507	4 mpg		377		
	Diversion Berms	Purchase and deliver berm material	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	50.0	100%	FFS 1000 DRAFT 205	24.6	12.5	119	61	492	250	59	1,439	731	28	14
															Delivery		4,760	2,440	4 mpg	1,190	610		
		Spread loose lift before compaction	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	2.1	100%	FFS 1000 DRAFT 206	2.1	1.1			42	22	69	146	76	2	1
		Compact Berms	Structural Fill / Clay	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, riding, vibrating roller, 2 passes, 12" lifts	B10Y	5,200	1.5	2.0	100%	FFS 1000 DRAFT 207	0.3	0.1			6	2	35	11	4	0	0
		Perimeter Road Stormwater Crossings	Riprap	L.C.Y.	RS Means, Year 2016 Quarter 1	Rip-rap and rock lining, random, broken stone, machine placed for slope protection	B12G	62	2.0	1.0	100%	FFS 1000 DRAFT 208	-	4.0			-	79	27	-	107	-	5
		Final Stormwater Controls (letdowns, swales, etc.)	Riprap	S.Y.	RS Means, Year 2016 Quarter 1	Rip-rap and rock lining, random, broken stone, 3/8 to 1/4 C.Y. pieces, machine placed for slope protection, grouted	B13	80	7.0	3.0	100%	FFS 1000 DRAFT 209	77.8	184.7			1,556	3,694	27	2,101	4,987	89	212
Site Completion		Apply seeding to cover	Seeding	M.S.F.	RS Means, Year 2016 Quarter 1	Seeding athletic fields, seeding fescue, tall with mulch and fertilizer, 5.5 lb. per M.S.F., hydro/air seeding	B81	80	3.0	1.0	100%	FFS 1000 DRAFT 210	48.3	84.8			966	1,696	56	2,695	4,732	56	97
		Install temporary irrigation system	Irrigation System	S.F.	RS Means, Year 2016 Quarter 1	Underground sprinklers irrigation system, for lawns, residential system, custom, 1" supply	B20	2,000	3.0	10.0	100%	FFS 1000 DRAFT 211	161.0	282.6			3,220	5,652	-	-	-	185	325

Table I-4: Calculations for Estimated Greenhouse Gas Emissions (1,000 pCi/g Partial Excavation Alternative)

DRAFT

Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days		Delivery Truckloads		Total Miles for Delivery of Materials/ Equipment or Worker Commute		Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery)		Gallons gasoline consumed (worker commute to/from Site)	
													Area 1	Area 2	Area 1	Area 2	Area 1	Area 2		Area 1	Area 2	Area 1	Area 2
		Install Fencing	Fencing	L.F.	RS Means, Year 2016 Quarter 1	Fence, chain link industrial, galvanized steel, 6 ga. wire, 2-1/2" posts @ 10' OC, 8' high, includes excavation, in concrete, excludes barbed wire	B80C	180	3.0	2.0	100%	FFS 1000 DRAFT 212	96.2	112.1			1,924	2,242	18	1,732	2,018	111	129
																			Gallons of Fuel Consumed	1,574,682	3,157,760	41,329	42,834
																				Total Gallons (Areas 1 and 2)	**4,732,443**		**84,163**
																				Conversion Factor (lbs CO_2 component of CO2e emissions per Gallon of Fuel Burned)	22.2 lb/gal		19.4 lb/gal
																				Subtotal - Pounds of CO2e emissions	105,060,231		1,632,760
																				Subtotal - Tons of CO2e emission	52,530		816
																					Total Tons of CO2e Emissions (diesel plus gasoline)	**53,000**	

Table I-5: Calculations for Estimated Greenhouse Gas Emissions ("Complete Rad Removal" Alternative)

DRAFT

Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
Temporary Construction Facilities / Utilities / Personnel	Construction Trailers	Capital Expenses	Group of Trailers		See separate Assumptions sheet							FFS 7.9 DRAFT 1	39.3	-	10	-	200		4 mpg	50			
		Operating Expenses	Group of Trailers	Months	See separate Assumptions sheet							FFS 7.9 DRAFT 2											
		Parking Area	Gravel Area	S.Y.	RS Means, Year 2016 Quarter 1	Temporary, roads, gravel fill, 4" gravel depth, excl surfacing	B14	715	6.0	1.0	50%	FFS 7.9 DRAFT 3	37.3	-					25	940			
		Portable Toilets in Construction Areas	Portable Toilets	Month	RS Means, Year 2016 Quarter 1	Rent portable toilet chemical, recycle, flush type, Incl. Hourly Oper. Cost.					50%	FFS 7.9 DRAFT 4											
	Contractor's Construction Management Personnel	Project Manager	Personnel	Week	RS Means, Year 2016 Quarter 1	Field personnel, project manager, maximum		0	1.0	1.0	100%	FFS 7.9 DRAFT 5	3,019	-			60,380		17.4 mpg			3,470	-
		Construction Superintendent(s)	Personnel	Week	RS Means, Year 2016 Quarter 1	Field personnel, superintendent, average		0	1.0	1.0	100%	FFS 7.9 DRAFT 6	3,822	-			76,440		17.4 mpg			4,393	-
		Clerk(s)	Personnel	Week	RS Means, Year 2016 Quarter 1	Field personnel, clerk, average		0	1.0	1.0	100%	FFS 7.9 DRAFT 7	3,822	-			76,440		17.4 mpg			4,393	-
		Field Engineer(s) / Safety Officer(s)	Personnel	Week	RS Means, Year 2016 Quarter 1	Field personnel, field engineer, average		0	1.0	1.0	100%	FFS 7.9 DRAFT 8	3,822	-			76,440		17.4 mpg			4,393	-
Temporary Stormwater Infrastructure (for stormwater during construction)	Frac Tanks	Delivery	Frac Tanks	Ea.	See separate Assumptions sheet			3	2.0	2.0	100%	FFS 7.9 DRAFT 9	38.7	38.7	58	58	3,480	3,480	4 mpg	870	870		
		Monthly Rental (or Purchase)	Frac Tanks	Month	See separate Assumptions sheet						100%	FFS 7.9 DRAFT 10											
		Cleaning	Frac Tanks	Ea.	See separate Assumptions sheet			1	2.0	1.0	100%	FFS 7.9 DRAFT 11	116	116					4 mpg				
		Removal	Frac Tanks	Ea.	See separate Assumptions sheet			3	2.0	2.0	100%	FFS 7.9 DRAFT 12	38.7	38.7	58	58	3,480	3,480	4 mpg	870	870		
	Forcemain	Install forcemain from Excavation Area to Tank Area	HDPE Pipe	L.F.	RS Means, Year 2016 Quarter 1	Water supply distribution piping, piping HDPE, butt fusion joints, 40' lengths, 4" diameter, SDR 21	B22A	400	5.0	1.0	100%	FFS 7.9 DRAFT 13	56.3	87.5			1,125	1,750	23	1,266	1,969	65	101
		Install forcemain from Tank Area to Treatment Plant and Discharge Point	HDPE Pipe	L.F.	RS Means, Year 2016 Quarter 1	Water supply distribution piping, piping HDPE, butt fusion joints, 40' lengths, 4" diameter, SDR 21	B22A	400	5.0	1.0	100%	FFS 7.9 DRAFT 14	6.3	6.3			125	125	23	141	141	7	7
		Install forcemain valves	Pipe Valves	Ea.	RS Means, Year 2016 Quarter 1	Valves, plastic, PVC, ball, true union, socket or threaded, 4"	Q1	20	2.0	1.0	100%	FFS 7.9 DRAFT 15	0.6	0.8			12	16	17.4 mpg			1	1
	Treatment Facility	Construct Treatment Facility	Treatment Facility	Each	EMSI Estimate			0	2.0	1.0	100%	FFS 7.9 DRAFT 16	30	-			600	0	17.4 mpg			34	-
		Treatment Facility Demolition	Treatment Facility	Each	EMSI Estimate			0	2.0	1.0	100%	FFS 7.9 DRAFT 17	19	-			380	0	17.4 mpg			22	-
		Monthly Rent	Treatment Facility Operation	Each	EMSI Estimate			0	2.0	1.0	100%	FFS 7.9 DRAFT 18											
		Monthly Operation during construction	Treatment Facility Operation	Months	EMSI Estimate			0	1.0	1.0	100%	FFS 7.9 DRAFT 19	680	-			13,600	0	17.4 mpg			782	-
	Stormwater events during construction	Dewater excavation construction after rain events	Days of Pumping Construction Stormwater	Day	RS Means, Year 2016 Quarter 1	Dewatering, pumping 8 hours, attended 2 hrs per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose	B10I	4	1.5	4.0	100%	FFS 7.9 DRAFT 20	196.4	679.1			3,928	13,582	9	1,768	6,112	226	781
		Dewater backfill construction after rain events	Days of Pumping Construction Stormwater	Day	RS Means, Year 2016 Quarter 1	Dewatering, pumping 8 hours, attended 2 hrs per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose	B10I	4	1.5	4.0	100%	FFS 7.9 DRAFT 21	190.0	313.8			3,800	6,276	9	1,710	2,824	218	361
		Dispose of contact stormwater to MSD	Contact Stormwater	Gallons	St. Louis Sewer District, May 2011						100%	FFS 7.9 DRAFT 22											
Leachate Handling	Frac Tanks	Delivery	Frac Tanks	Ea.	See separate Assumptions sheet			3	2.0	2.0	100%	FFS 7.9 DRAFT 23	13.3	13.3	20	20	1,200	1,200	4 mpg	300	300		
		Monthly Rental (or Purchase)	Frac Tanks	Month	See separate Assumptions sheet						100%	FFS 7.9 DRAFT 24											
		Cleaning	Frac Tanks	Ea.	See separate Assumptions sheet			1	2.0	1.0	100%	FFS 7.9 DRAFT 25	40.0	40.0			800	800	17.4 mpg			46	46
		Removal	Frac Tanks	Ea.	See separate Assumptions sheet			3	2.0	2.0	100%	FFS 7.9 DRAFT 26	13.3	13.3	20	20	1,200	1,200	4 mpg	300	300		
	Secondary Containment for Frac Tanks	Purchase and deliver liner & berm material	Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	50.0	100%	FFS 7.9 DRAFT 27	37.6	37.6	182	182	751	751	59	2,197	2,197	43	43
															Delivery		7,280	7,280	4 mpg	1,820	1,820		

Table I-5: Calculations for Estimated Greenhouse Gas Emissions ("Complete Rad Removal" Alternative)

DRAFT

Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
		Spread loose lift before compaction	Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	2.1	100%	FFS 7.9 DRAFT 28	3.3	3.3			65	65	69	226	226	4	4
		Compact Liner & Berms	Clay	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	1,300	1.5	2.0	100%	FFS 7.9 DRAFT 29	1.8	1.8			36	36	90	162	162	2	2
	Leachate Storage & Testing	Pumping from Excavation Site	Leachate	Day	RS Means, Year 2016 Quarter 1	Dewatering, pumping 8 hours, attended 2 hrs per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose	B10I	4	1.5	1.0	100%	FFS 7.9 DRAFT 30	6.2	5.4			123	108	9	56	48	7	6
		Move Tank from Tank Area to Excavation Site	Tanks	Ea.	See separate Assumptions sheet			4	2.0	1.0	100%	FFS 7.9 DRAFT 31	79.5	69.0			1,590	1,380	2 gal/trip	159	138		
		Leachate Sampling	Lab Tests	Ea.	RS Means, Year 2016 Quarter 1	Field testing equipment, sampling & testing soil/sediment, sample collection, field samples, sludge	1 Skwk	32	1.0	1.0	100%	FFS 7.9 DRAFT 32	5.0	4.3			99	86	17.4 mpg			6	5
		Leachate Testing - VOC's	Lab Tests	Ea.	RS Means, Year 2016 Quarter 1	Laboratory analytical services, laboratory testing, volatile organics without GC/MS					100%	FFS 7.9 DRAFT 33											
		Hauling and Disposal	Leachate	Gallons	See separate Assumptions sheet		B34B	5,000	1.0	2.0	100%	FFS 7.9 DRAFT 34	632	551	633	552	12,646	11,028	55.8	35,282	30,768	727	634
		Budget for Contaminated Stormwater Prevention or Disposal	Budget	Months	Budgeted Monthly Amount						100%	FFS 7.9 DRAFT 35											
													Mileage to dispose off-site				379,800	331,200	4 mpg	94,950	82,800		
RIM Loading Station	Structure	Structure Construction	Clear Span Structure	Ea.	See separate Assumptions sheet		Structure Construction Crew	0	30.0	1	100%	FFS 7.9 DRAFT 36	3,300	-	30		66,000	0	17.4 mpg			3,793	-
													Delivery of Structure Components (Dyersville, IA)				19,860		4 mpg	4,965			
		Demolition	Clear Span Structure	Ea.	See separate Assumptions sheet		Structure Demolition Crew	0	30.0	1	100%	FFS 7.9 DRAFT 37	450	-	30		9,000	0	17.4 mpg			517	-
													Haul Structure Components to Local Metal Recycler (40 miles R-T)				1,200		4 mpg	300			
	Air Treatment System	Startup Capital Expenses	Air Treatment System	Ea.	See separate Assumptions sheet		Treatment System Crew			1	100%	FFS 7.9 DRAFT 38	71	-	9		1,420	0	17.4 mpg			82	-
													Delivery of Air Treatment systems (Roseville, MN)				9,360		4 mpg	2,340			
		Vessel Rental Costs (Project Total)	Air Treatment System	Ea.	See separate Assumptions sheet					1	100%	FFS 7.9 DRAFT 39	-	-									
		Blower Costs (Purchase or Rental Total)	Air Treatment System	Ea.	See separate Assumptions sheet					1	100%	FFS 7.9 DRAFT 40	-	-									
		Media Replacement (Project Total)	Air Treatment System	Ea.	See separate Assumptions sheet		Treatment System Crew			1	100%	FFS 7.9 DRAFT 41	150	-	5		3,000	0	17.4 mpg			172	-
													Delivery of replacement media (from Roseville, MN) - 3 semis				15,600		4 mpg	3,900			
													Return of spent media (to Roseville, MN) - 3 semis				15,600		4 mpg	3,900			
		Demobilization	Air Treatment System	Ea.	See separate Assumptions sheet		Treatment System Crew			1	100%	FFS 7.9 DRAFT 42	41.0	-	9	-	820	0	17.4 mpg			47	-
													Return of Air Treatment Systems (Roseville, MN)				9,360		4 mpg	2,340			
													Return of spent media (to Roseville, MN) - 3 semis				3,120	0	4 mpg	780	-		
	Haul Road Improvements	Fencing along road for RIM hauling	Fencing	L.F.	RS Means, Year 2016 Quarter 1	Fence, chain link industrial, galvanized steel, 6 ga. wire, 2" posts @ 10' OC, 6' high, includes excavation, & concrete, excludes barbed wire	B80C	250	3.0	2.0	100%	FFS 7.9 DRAFT 43	19.2	19.2			384	384	18	346	346	22	22
		Silt Fencing along road for RIM hauling	Silt Fence	Per L.F., per Month	See separate Assumptions sheet	Monthly cost for Silt fence, 3' high. Install, maintain monthly, and replace each 6 months.	B62	3,120	3.0	1.0	100%	FFS 7.9 DRAFT 44	53.8	103.8			1,077	2,076	17.55	945	1,822	62	119
		Remove potentially contaminated road surface	Roadway Gravel	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk, dozer, open site, bank measure, sand and gravel, 300 H.P. dozer, 50' haul	B10M	1,900	1.5	1.0	100%	FFS 7.9 DRAFT 45	0.3	0.3			6	6	59	16	16	0	0
		Loading for previous line	Roadway Gravel	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B10O	5,016	1.5	1.0	100%	FFS 7.9 DRAFT 46	0.1	0.1			2	2	58	6	6	0	0
		Hauling for previous line	Roadway Gravel	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2000 ft, 10 MPH, excludes loading equipment	B34F	594	1.0	1.0	100%	FFS 7.9 DRAFT 47	0.7	0.7			14	14	45	32	32	1	1
		Repairs to road remediation	Gravel Roads	S.Y.	RS Means, Year 2016 Quarter 1	Temporary, roads, gravel fill, 8" gravel depth, excl surfacing	B14	615	6.0	1.0	100%	FFS 7.9 DRAFT 48	20.8	20.8			416	416	25	524	524	24	24

Table I-5: Calculations for Estimated Greenhouse Gas Emissions ("Complete Rad Removal" Alternative)

DRAFT

Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
Site-wide Preparation	Mobilization	Mobilize and Demobilize Equipment by Pickup Truck	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for small equipment, placed in rear of, or towed by pickup truck	A3A	4	1.0	1.0	100%	FFS 7.9 DRAFT 49	4.0	-			80	0	10	40	-	5	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	A3A	72	1.0	1.0	100%	FFS 7.9 DRAFT 50	3.3	-			67	0	10	33	-	4	-
		Mobilize and Demobilize Equipment by 3-Ton Trailer	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for equipment, hauled on 3-ton capacity towed trailer	A3Q	3	1.0	1.0	100%	FFS 7.9 DRAFT 51	2.2	-			45	0	10	22	-	3	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	A3Q	72	1.0	1.0	100%	FFS 7.9 DRAFT 52	1.3	-			25	0	10	13	-	1	-
		Mobilize and Demobilize Equipment by 20-Ton Trailer	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for equipment, hauled on 20-ton capacity towed trailer	B34U	2	2.0	4.0	100%	FFS 7.9 DRAFT 53	36.0	-			720	0	54	1,944	-	41	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	B34U	72	2.0	4.0	100%	FFS 7.9 DRAFT 54	15.0	-			300	0	54	810	-	17	-
		Mobilize and Demobilize Equipment by 40-Ton Trailer	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for equipment, hauled on 40-ton capacity towed trailer	B34N	2	2.0	4.0	100%	FFS 7.9 DRAFT 55	50.0	-			1,000	0	90	4,500	-	57	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	B34N	72	2.0	4.0	100%	FFS 7.9 DRAFT 56	20.8	-			416	0	90	1,872	-	24	-
		Mobilize and Demobilize Crane Equipment (more than 75 tons)	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, crane, truck-mounted, over 75 ton, (with chase vehicle)	A3E	3	2.0	1.0	100%	FFS 7.9 DRAFT 57	1.6	-			32	0	10	16	-	2	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	A3E	72	2.0	1.0	100%	FFS 7.9 DRAFT 58	0.8	-			17	0	10	8	-	1	-
	Supplemental Mobilizations	Mobilize and Demobilize Equipment by Pickup Truck	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for small equipment, placed in rear of, or towed by pickup truck	A3A	4	1.0	1.0	100%	FFS 7.9 DRAFT 59	4.0	-			80	0	10	40	-	5	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	A3A	72	1.0	1.0	100%	FFS 7.9 DRAFT 60	3.3	-			67	0	10	33	-	4	-
		Mobilize and Demobilize Equipment by 3-Ton Trailer	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for equipment, hauled on 3-ton capacity towed trailer	A3Q	3	1.0	1.0	100%	FFS 7.9 DRAFT 61	2.2	-			45	0	10	22	-	3	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	A3Q	72	1.0	1.0	100%	FFS 7.9 DRAFT 62	1.3	-			25	0	10	13	-	1	-
		Mobilize and Demobilize Equipment by 20-Ton Trailer	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for equipment, hauled on 20-ton capacity towed trailer	B34U	2	2.0	4.0	100%	FFS 7.9 DRAFT 63	36.0	-			720	0	54	1,944	-	41	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	B34U	72	2.0	4.0	100%	FFS 7.9 DRAFT 64	15.0	-			300	0	54	810	-	17	-
		Mobilize and Demobilize Equipment by 40-Ton Trailer	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, delivery charge for equipment, hauled on 40-ton capacity towed trailer	B34N	2	2.0	4.0	100%	FFS 7.9 DRAFT 65	50.0	-			1,000	0	90	4,500	-	57	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	B34N	72	2.0	4.0	100%	FFS 7.9 DRAFT 66	20.8	-			416	0	90	1,872	-	24	-
		Mobilize and Demobilize Crane Equipment (more than 75 tons)	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	Mobilization or demobilization, crane, truck-mounted, over 75 ton, (with chase vehicle)	A3E	3	2.0	1.0	100%	FFS 7.9 DRAFT 67	1.6	-			32	0	10	16	-	2	-
		Extra Mileage for Mobilizations	Per 5 additional miles		RS Means, Year 2016 Quarter 1	Mobilization or demobilization, each additional 5 miles haul distance, add	A3E	72	2.0	1.0	100%	FFS 7.9 DRAFT 68	0.8	-			17	0	10	8	-	1	-
	Traffic Improvements	Create Temporary Roads	Gravel Roads	S.Y.	RS Means, Year 2016 Quarter 1	Temporary, roads, gravel fill, 4" gravel depth, excl surfacing	B14	715	6.0	1.0	100%	FFS 7.9 DRAFT 69	129.8	223.8			2,596	4,476	25	3,271	5,639	149	257
		Bridge from Area 1 to Area 2 over Site Entrance Road	Modular Bridge	Ea.	See separate Assumptions sheet		Bridge Construction Crew	0	1.0	1.0	100%	FFS 7.9 DRAFT 70	143.2	-	549		2,863	0				165	-
																Delivery	21,960		4 mpg	5,490			
		Bridge Demolition	Modular Bridge	Ea.	See separate Assumptions sheet		Bridge Construction Crew	2	1.0	1.0	100%	FFS 7.9 DRAFT 71	2.0	-			40	0				2	-
		Extend Permanent Road to new Transfer Station Location	Roadway	Ft.	Estimate		B25	34	11.0	1.0	100%	FFS 7.9 DRAFT 72	643.1	-			12,862	0	72	46,302	-	739	-
		Budget for Add'l Traffic Improvements	TBD (shown as budget estimate)	$	SFS budget (plus inflation)				6.0	1.0	100%	FFS 7.9 DRAFT 73	60.0	60.0			1,200	1,200		-	-	69	69
	Dust Control	Water Truck Depreciation	Water Trucks	Trucks	Estimate							FFS 7.9 DRAFT 74										-	-
		Water Truck Operation	Water Trucks	Months	Estimate			0	1.0	1.0	100%	FFS 7.9 DRAFT 75	2,254	3,212			45,080	64,240	10	22,540	32,120	2,591	3,692
		Use Water to Control Dust	Water	Gallons	Missouri American Water Company, 7/19/2016						100%	FFS 7.9 DRAFT 76											

Table I-5: Calculations for Estimated Greenhouse Gas Emissions ("Complete Rad Removal" Alternative)

DRAFT

Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days		Delivery Truckloads		Total Miles for Delivery of Materials/ Equipment or Worker Commute		Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery)		Gallons gasoline consumed (worker commute to/from Site)	
													Area 1	Area 2	Area 1	Area 2	Area 1	Area 2		Area 1	Area 2	Area 1	Area 2
Site Preparation		Prepare area with Stormwater BMPs	Silt Fence / Hay Bales	L.F.	RS Means, Year 2016 Quarter 1	Synthetic erosion control, hay bales, staked	A2	2,500	3.0	1.0	100%	FFS 7.9 DRAFT 77	6.5	9.3			130	186	10	65	93	7	11
	Decontamination Area	Floor	Concrete	C.Y.	RS Means, Year 2016 Quarter 1	Structural concrete, ready mix, heavyweight, 4000 psi, includes local aggregate, sand, Portland cement (Type I) and water, delivered, excludes all additives and treatments					100%	FFS 7.9 DRAFT 78										-	-
		Floor Installation	Concrete	C.Y.	RS Means, Year 2016 Quarter 1	Structural concrete, placing, slab on grade, pumped, over 6" thick, includes leveling (strike off) & consolidation, excludes material	C20	185	8.0	1.0	100%	FFS 7.9 DRAFT 79	2.4	2.4			48	48	27	65	65	3	3
		Building	Steel Building	SF Flr.	RS Means, Year 2016 Quarter 1	Pre-engineered steel building, clear span rigid frame, 30 psf roof and 20 psf wind load, 20' to 29' W x 16' eave H, incl. 26 ga. colored ribbed roofing & siding, excl. footings, slab, anchor bolts	E2	320	7.0	1.0	100%	FFS 7.9 DRAFT 80	21.9	22			438	438	36	788	788	25	25
	Clearing & Grubbing	Clear Vegetation (Light)	Vegetation	Acre	RS Means, Year 2016 Quarter 1	Selective tree and shrub removal, selective clearing brush mowing, light density, tractor with rotary mower, excludes removal offsite	B84	2	1.0	1.0	100%	FFS 7.9 DRAFT 81	0.1	1.3			2	26	18	2	24	0	2
		Clear Vegetation (Heavy)	Vegetation	Acre	RS Means, Year 2016 Quarter 1	Clearing & grubbing, cut & chip light trees, to 6" diameter	B7	1	6.0	1.0	100%	FFS 7.9 DRAFT 82	50.9	91.7			1,019	1,835	54	2,751	4,954	59	105
		Clear Small Trees	Trees	Ea.	RS Means, Year 2016 Quarter 1	Selective felling trees and piling, large tract clearing & piling, firm level terrain, no boulders, hardwood, per tree, 300 H.P. dozer, 12" to 24" diameter	B10M	80	1.5	8.0	100%	FFS 7.9 DRAFT 83	2.2	6.7			44	133	59	128	389	3	8
		Clear Large Trees	Trees	Ea.	RS Means, Year 2016 Quarter 1	Selective felling trees and piling, large tract clearing & piling, firm level terrain, no boulders, hardwood, per tree, 300 H.P. dozer, 24" to 36" diameter	B10M	50	1.5	4.0	100%	FFS 7.9 DRAFT 84	1.0	2.9			20	59	59	58	172	1	3
		Clear Small Stumps	Trees	Ea.	RS Means, Year 2016 Quarter 1	Selective clearing and grubbing, 1-1/2 C.Y. excavator, 14" to 24" diameter, stump removal on site by hydraulic excavator	B30	25	3.0	2.0	100%	FFS 7.9 DRAFT 85	14.0	42.6			281	852	155	2,173	6,594	16	49
		Clear Large Stumps	Trees	Ea.	RS Means, Year 2016 Quarter 1	Selective clearing and grubbing, 1-1/2 C.Y. excavator, 26" to 36" diameter, stump removal on site by hydraulic excavator	B30	16	3.0	2.0	100%	FFS 7.9 DRAFT 86	6.2	18.4			124	368	155	958	2,844	7	21
	Bird Mitigation	Monthly Expenses	Months	Months	Estimate	See separate Assumptions sheet	Bird Mitigation Crew	0	2.0	1.0	100%	FFS 7.9 DRAFT 88	4,320	5,993			86,400	119,860				4,966	6,889
	Temporary Gas System for Stockpile in Area 2	Capital Expenses	Temporary Gas System	Ea.	See separate Assumptions sheet			0	6.0	1.0	100%	FFS 7.9 DRAFT 89	372	-			7,439	0				428	-
		Monthly Expenses	Months	Months	See separate Assumptions sheet			1	1.0	1.0	100%	FFS 7.9 DRAFT 90	77	-			1,542	0				89	-
Excavate Waste	Area 1	Apply daily cover to remaining excavation	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 7.9 DRAFT 91	965	-	10,762	-	19,305	0	226	218,051	-	1,109	-
															Delivery		161,430	0	4 mpg	40,358	-		
		Excavate and Sort RIM and Overburden (incl. minor sources)	RIM and Overburden	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.4	50%	FFS 7.9 DRAFT 92	1,448	-			28,957	0	149	215,002	-	1,664	-
	Area 2 SW	Apply daily cover to remaining excavation	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 7.9 DRAFT 93	-	425	-	4,742	-	8,506	226	-	96,070	-	489
															Delivery		-	71,130	4 mpg	-	17,783		
		Excavate and Sort RIM and Overburden (incl. minor sources)	RIM and Overburden	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.6	50%	FFS 7.9 DRAFT 94	-	661			-	13,224	149	-	98,191	-	760
	Area 2 NE	Apply daily cover to remaining excavation	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 7.9 DRAFT 95	-	417	-	4,644	-	8,331	226	-	94,097	-	479
															Delivery		-	69,660	4 mpg	-	17,415		
		Excavate and Sort RIM and Overburden (NOT incl. minor sources)	RIM and Overburden	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.4	50%	FFS 7.9 DRAFT 96	-	648.6			-	12,972	149	-	96,315	-	745
Handle Excavated RIM	Area 1	Load piled RIM into Haul Trucks	RIM	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 2-1/2 C.Y. capacity = 95 C.Y./hour, front end loader, track mounted, excluding truck loading	B10O	760	1.5	1.0	50%	FFS 7.9 DRAFT 97	200.8	-			4,016	0	58	11,565	-	231	-
		(additional cost to previous line)	RIM		RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B10O	5,016	1.5	1.0	50%	FFS 7.9 DRAFT 98	30.4	-			608	0	58	1,752	-	35	-

Table I-5: Calculations for Estimated Greenhouse Gas Emissions ("Complete Rad Removal" Alternative)

DRAFT

Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
		Haul RIM to on-site Loading Station (incl. RIM from minor sources)	RIM	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 7.9 DRAFT 99	204.0	-			4,080	0	45	9,180	-	234	-
		RIM Hauling & Disposal (during 3-month learning curve for loading)	RIM	L.C.Y.	Off-site Disposal Facility estimate	Custom line item: Transport and dispose of RIM at off-site disposal facility. Assume 3-month learning curve from 0 to 100% production (averaging 50%).	RIM Shipping Crew	150	8.0	1.0	50%	FFS 7.9 DRAFT 100	500.0	-	314	-	10,000	0				575	-
													Trucks to/from rail transloading facilities				14,130	0	4 mpg	3,533	-		
			This line is for calculating Train Diesel. "Unit Fuel Consumption": LCY of RIM are shown in Area 1 Crew Man-days column									LCY:	4,688	-	Train				2.61	12,236	-		
		RIM Hauling & Disposal (normal production)	RIM	L.C.Y.	Off-site Disposal Facility estimate	Custom line item: Transport and dispose of RIM at off-site disposal facility. (Full production for remainder of project.)	RIM Shipping Crew	150	8.0	1.0	100%	FFS 7.9 DRAFT 101	3,819	-	4,776	-	76,384	0				4,390	-
													Trucks to/from rail transloading facilities				214,920	0	4 mpg	53,730	-		
			This line is for calculating Train Diesel. "Unit Fuel Consumption": LCY of RIM are shown in Area 1 Crew Man-days column									LCY:	71,610	-	Train				2.61	186,902	-		
		Off-Site Disposal Facility Coordinator	Personnel	Work Days	Off-site Disposal Facility estimate	Custom line item: Oversight of RIM shipping process by off-site disposal facility's coordinator.	Coordinator	1	1.0	1.0	100%	FFS 7.9 DRAFT 102	652	-			13,040	0				749	-
		RIM Loading Crew	Personnel	Work Days	See separate Assumptions sheet	Custom line item: Stockpile and Load RIM in RIM Loading Station	RIM Loading Crew	1	4.0	1.0	100%	FFS 7.9 DRAFT 103	2,608	-			52,160	0				2,998	-
	Area 2 SW	Load piled RIM into Haul Trucks	RIM	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 2-1/2 C.Y. capacity = 95 C.Y./hour, front end loader, track mounted, excluding truck loading	B10O	760	1.5	2.0	50%	FFS 7.9 DRAFT 104	-	479.8			-	9,596	58	-	27,637	-	552
		(additional cost to previous line)	RIM		RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B10O	5,016	1.5	2.0	50%	FFS 7.9 DRAFT 105	-	72.7			-	1,454	58	-	4,187	-	84
		Haul RIM to on-site Loading Station (incl. RIM from minor sources)	RIM	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 1 mile, 10 MPH, excludes loading equipment	B34F	506	1.0	4.2	100%	FFS 7.9 DRAFT 106	-	368.9			-	7,379	45	-	16,602	-	424
		RIM Hauling & Disposal (normal production)	RIM	L.C.Y.	Off-site Disposal Facility estimate	Custom line item: Transport and dispose of RIM at off-site disposal facility. (Full production for remainder of project.)	RIM Shipping Crew	1,000	30.0	1.0	100%	FFS 7.9 DRAFT 107	-	5,600.3	-	12,446	-	112,006				-	6,437
													Trucks to/from rail transloading facilities				-	560,070	4 mpg	-	140,018		
			This line is for calculating Train Diesel. "Unit Fuel Consumption": LCY of RIM are shown in Area 1 Crew Man-days column									LCY:	-	186,677	Train				2.61	-	487,227		
		Off-Site Disposal Facility Coordinator	Personnel	Work Days	Off-site Disposal Facility estimate	Custom line item: Oversight of RIM shipping process by off-site disposal facility's coordinator.	Coordinator	1	1.0	1.0	100%	FFS 7.9 DRAFT 108	-	386			-	7,720				-	444
		RIM Loading Crew	Personnel	Work Days	See separate Assumptions sheet	Custom line item: Stockpile and Load RIM in RIM Loading Station	RIM Loading Crew	1	13.0	1.0	100%	FFS 7.9 DRAFT 109	-	5,018			-	100,360				-	5,768
	Area 2 NE	Load piled RIM into Haul Trucks	RIM	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 2-1/2 C.Y. capacity = 95 C.Y./hour, front end loader, track mounted, excluding truck loading	B10O	760	1.5	2.0	50%	FFS 7.9 DRAFT 110	-	475.6			-	9,511	58	-	27,393	-	547
		(additional cost to previous line)	RIM		RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B10O	5,016	1.5	2.0	50%	FFS 7.9 DRAFT 111	-	72.1			-	1,441	58	-	4,150	-	83
		Haul RIM to on-site Loading Station (NOT incl. RIM from minor sources)	RIM	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 7.9 DRAFT 112	-	483.2			-	9,664	45	-	21,744	-	555
		RIM Hauling & Disposal (normal production)	RIM	L.C.Y.	Off-site Disposal Facility estimate	Custom line item: Transport and dispose of RIM at off-site disposal facility. (Full production for remainder of project.)	RIM Shipping Crew	1,000	30.0	1.0	100%	FFS 7.9 DRAFT 113	-	5,421.5	-	12,048	-	108,431				-	6,232
													Trucks to/from rail transloading facilities				-	542,160	4 mpg	-	135,540		
			This line is for calculating Train Diesel. "Unit Fuel Consumption": LCY of RIM are shown in Area 1 Crew Man-days column									LCY:	-	180,718	Train				2.61	-	471,674		
		Off-Site Disposal Facility Coordinator	Personnel	Work Days	Off-site Disposal Facility estimate	Custom line item: Oversight of RIM shipping process by off-site disposal facility's coordinator.	Coordinator	1	1.0	1.0	100%	FFS 7.9 DRAFT 114	-	286			-	5,720				-	329
		RIM Loading Crew	Personnel	Work Days	See separate Assumptions sheet	Custom line item: Stockpile and Load RIM in RIM Loading Station	RIM Loading Crew	1	13.0	1.0	100%	FFS 7.9 DRAFT 115	-	3,718			-	74,360				-	4,274
Load and Haul Overburden	Area 1	Load Overburden directly into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.4	50%	FFS 7.9 DRAFT 116	207.4	-			4,149	0	149	30,806	-	238	-

Table I-5: Calculations for Estimated Greenhouse Gas Emissions ("Complete Rad Removal" Alternative)

DRAFT

Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
		Relocate Overburden to Area 2 NE Stockpile	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 7.9 DRAFT 117	3,283.2	-			65,664	0	45	147,744	-	3,774	-
	Area 2 SW	Load Overburden directly into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.6	50%	FFS 7.9 DRAFT 118	-	67.1			-	1,342	149	-	9,963	-	77
		Relocate Overburden to backfill Area 1	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 7.9 DRAFT 119	-	1,061.9			-	21,238	45	-	47,785	-	1,221
		Relocate any remaining Overburden to Area 2 NE Stockpile	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%		-	-			-	0	45	-	-	-	-
	Area 2 NE	Load Overburden directly into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.4	50%	FFS 7.9 DRAFT 120	-	71.6			-	1,432	149	-	10,634	-	82
		Relocate Overburden to backfill Area 2 SW (if needed)	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%		-	-			-	0	45	-	-	-	-
		Relocate Overburden to Area 2 SW Stockpile	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 7.9 DRAFT 121	-	1,133.4			-	22,668	45	-	51,003	-	1,303
Place Overburden	Area 1 Overburden on NE Stockpile	Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 7.9 DRAFT 122	1,841.9	-			36,837	0	69	127,642	-	2,117	-
		Apply daily cover to stockpiled Overburden	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 7.9 DRAFT 123	1,009.6	-	11,256	-	20,192	0	226	228,073	-	1,160	-
															Delivery		168,840	0	4 mpg	42,210	-		
	Area 2 SW Overburden backfilled in Area 1	Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 7.9 DRAFT 124	-	595.7			-	11,914	69	-	41,283	-	685
		Apply daily cover to backfilled Overburden	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 7.9 DRAFT 125	-	326.5	-	3,641	-	6,531	226	-	73,766	-	375
															Delivery		-	54,615	4 mpg	-	13,654		
		Compact Overburden	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%	FFS 7.9 DRAFT 126	-	168.0			-	3,360	90	-	15,122	-	193
	Area 2 NE Overburden on SW Stockpile	Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 7.9 DRAFT 127	-	635.8			-	12,717	69	-	44,063	-	731
		Apply daily cover to stockpiled Overburden	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 7.9 DRAFT 128	-	348.5	-	3,886	-	6,971	226	-	78,733	-	401
															Delivery		-	58,290	4 mpg	-	14,573		
Relocate Stockpiled Overburden from NE Stockpile	From NE Stockpile to backfill remaining Area 1 (to drainage grades)	Apply daily cover to remaining stockpile	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 7.9 DRAFT 129	367.9	-	4,102	-	7,358	0	226	83,109	-	423	-
															Delivery		61,530	0	4 mpg	15,383	-		
		Excavate Stockpile	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.4	50%	FFS 7.9 DRAFT 130	546.9	-			10,938	0	149	81,215	-	629	-
		Load into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.4	50%	FFS 7.9 DRAFT 131	83.1	-			1,662	0	149	12,340	-	96	-

Table I-5: Calculations for Estimated Greenhouse Gas Emissions ("Complete Rad Removal" Alternative)

DRAFT

Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
		Relocate Overburden to backfill Area 1 (drainage grades)	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 7.9 DRAFT 132	1,316	-			26,320	0	45	59,220	-	1,513	-
		Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 7.9 DRAFT 133	738.3				14,766	0	69	51,164	-	849	-
		Apply daily cover to backfilled material	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 7.9 DRAFT 134	404.7		4,512	-	8,094	0	226	91,422	-	465	-
															Delivery		67,680	0	4 mpg	16,920	-		
		Compact backfilled material	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%	FFS 7.9 DRAFT 135	208.2				4,164	0	90	18,738	-	239	-
	From NE Stockpile to backfill Area 2 SW (to drainage grades)	Apply daily cover to remaining stockpile	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 7.9 DRAFT 143		330.2	-	3,682	-	6,604				-	380
															Delivery		-	55,230	4 mpg	-	13,808		
		Excavate Stockpile	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.4	50%	FFS 7.9 DRAFT 144		490.9			-	9,818	149	-	72,899	-	564
		Load into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.4	50%	FFS 7.9 DRAFT 145	0	74.6			-	1,492	149	-	11,078	-	86
		Relocate Overburden to backfill Area 2 SW (drainage grades)	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 7.9 DRAFT 146	0	1,181.3			-	23,626	45	-	53,159	-	1,358
		Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 7.9 DRAFT 147	0	622.7			-	12,454	69	-	43,153	-	716
		Apply daily cover to backfilled material	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 7.9 DRAFT 148	0	363.3	-	4,050	-	7,266	226	-	82,069	-	418
															Delivery		-	60,750	4 mpg	-	15,188		
		Compact backfilled material	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%	FFS 7.9 DRAFT 149	0	186.9			-	3,738	90	-	16,821	-	215
	From NE Stockpile to backfill Area 2 SW (to final grades)	Apply daily cover to remaining stockpile	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%		0	58.3	-	651	-	1,166	226	-	13,170	-	67
															Delivery		-	9,765	4 mpg	-	2,441		
		Excavate Stockpile	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.4	50%		0	86.7			-	1,734	149	-	12,875	-	100
		Load into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.4	50%		0	13.2			-	264	149	-	1,960	-	15
		Relocate Overburden to backfill Area 2 SW (final grades)	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%		0	208.7			-	4,174	45	-	9,392	-	240
		Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%		0	117.1			-	2,342	69	-	8,115	-	135
		Apply daily cover to backfilled material	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%		0.0	64.2	-	716	-	1,284	226	-	14,503	-	74
															Delivery		-	10,740	4 mpg	-	2,685		
		Compact backfilled material	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%		0.0	33			-	660	90	-	2,970	-	38
	From any remaining NE Stockpile to SW Stockpile	Apply daily cover to remaining stockpile	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 7.9 DRAFT 150	0.0	354.1	-	3,948	-	7,082	226	-	79,991	-	407
															Delivery		-	59,220	4 mpg	-	14,805		

Table I-5: Calculations for Estimated Greenhouse Gas Emissions ("Complete Rad Removal" Alternative)

DRAFT

Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
		Excavate Stockpile	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.4	50%	FFS 7.9 DRAFT 151	0.0	526.4			-	10,528	149	-	78,170	-	605
		Load into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.4	50%	FFS 7.9 DRAFT 152	-	80.0			-	1,600	149	-	11,880	-	92
		Relocate Overburden to Area 2 SW Stockpile	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 7.9 DRAFT 153	0.0	1,266.7			-	25,334	45	-	57,002	-	1,456
		Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 7.9 DRAFT 154	0.0	710.6			-	14,212	69	-	49,245	-	817
		Apply daily cover to stockpiled material	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 7.9 DRAFT 155	0.0	389.5	-	4,343	-	7,790	226	-	87,988	-	448
															Delivery		-	65,145	4 mpg	-	16,286		
Relocate Stockpiled Overburden from SW Stockpile	From SW Stockpile to backfill Area 2 NE (to drainage grades)	Apply daily cover to remaining stockpile	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 7.9 DRAFT 156	0.0	591.4	-	6,593	-	11,828	226	-	133,597	-	680
															Delivery		-	98,895	4 mpg	-	24,724		
		Excavate Stockpile	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.4	50%	FFS 7.9 DRAFT 157	0.0	879.0			-	17,580	149	-	130,532	-	1,010
		Load into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.4	50%	FFS 7.9 DRAFT 158	0.0	133.7			-	2,674	149	-	19,854	-	154
		Relocate Overburden to backfill Area 2 NE (drainage grades)	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 7.9 DRAFT 159	0.0	2,115.3			-	42,306	45	-	95,189	-	2,431
		Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 7.9 DRAFT 160	0.0	1,186.7			-	23,734	69	-	82,238	-	1,364
		Apply daily cover to backfilled material	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 7.9 DRAFT 161	0.0	650.5	-	7,253	-	13,010	226	-	146,948	-	748
															Delivery		-	108,795	4 mpg	-	27,199		
		Compact backfilled material	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%	FFS 7.9 DRAFT 162	0.0	334.7			-	6,694	90	-	30,123	-	385
	From SW Stockpile to backfill Area 2 NE (to drainage grades)	Apply daily cover to remaining stockpile	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 7.9 DRAFT 156	0.0	220.5	-	2,459	-	4,410	226	-	49,811	-	253
															Delivery		-	36,885	4 mpg	-	9,221		
		Excavate Stockpile	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.4	50%	FFS 7.9 DRAFT 157	0.0	327.8			-	6,556	149	-	48,678	-	377
		Load into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.4	50%	FFS 7.9 DRAFT 158	0.0	49.8			-	996	149	-	7,395	-	57
		Relocate Overburden to backfill Area 2 NE (drainage grades)	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	FFS 7.9 DRAFT 159	0.0	788.8			-	15,776	69	-	54,664	-	907
		Spread Overburden	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 7.9 DRAFT 160	0.0	442.5			-	8,850	226	-	99,961	-	509
		Apply daily cover to backfilled material	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 7.9 DRAFT 161	0.0	242.6	-	2,705	-	4,852	226	-	54,803	-	279
															Delivery		-	40,575	4 mpg	-	10,144		

Table I-5: Calculations for Estimated Greenhouse Gas Emissions ("Complete Rad Removal" Alternative)

DRAFT

Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days		Delivery Truckloads		Total Miles for Delivery of Materials/ Equipment or Worker Commute		Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery)		Gallons gasoline consumed (worker commute to/from Site)	
													Area 1	Area 2	Area 1	Area 2	Area 1	Area 2		Area 1	Area 2	Area 1	Area 2
		Compact backfilled material	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%	FFS 7.9 DRAFT 162	0.0	124.8			-	2,496	90	-	11,232	-	143
Reduce Slope Steepness	Relocate within the same Area. (Area 1 and Area 2 SW)	Apply daily cover to remaining excavation	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 7.9 DRAFT 163	24.1	22.5	270	251	482	450	226	5,444	5,083	28	26
															Delivery		4,050	3,765	4 mpg	1,013	941		
		Excavate	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	0.7	100%	FFS 7.9 DRAFT 164	35.9	33.4			718	668	149	5,331	4,960	41	38
		Load into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	0.7	100%	FFS 7.9 DRAFT 165	5.5	5.1			110	102	149	817	757	6	6
		Transport to new location	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2000 ft, 10 MPH, excludes loading equipment	B34F	594	1.0	3.5	100%	FFS 7.9 DRAFT 166	54.5	50.6			1,090	1,012	45	2,453	2,277	63	58
		Spread Waste	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 7.9 DRAFT 167	48.4	45.1			968	902	69	3,354	3,125	56	52
		Apply daily cover to backfilled material	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 7.9 DRAFT 168	26.6	24.7	297	276	532	494	226	6,009	5,580	31	28
															Delivery		4,455	4,140	4 mpg	1,114	1,035		
		Compact backfilled material	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%	FFS 7.9 DRAFT 169	13.7	12.7			274	254	90	1,233	1,143	16	15
	Same as above, for Area 2 NE	Apply daily cover to remaining excavation	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 7.9 DRAFT 170	0.0	28.4	-	317	-	568	226	-	6,416	-	33
															Delivery		-	4,755	4 mpg	-	1,189		
		Excavate	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	1.4	50%	FFS 7.9 DRAFT 171	0.0	42.1			-	842	149	-	6,252	-	48
		Load into Haul Trucks	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	1.4	50%	FFS 7.9 DRAFT 172	0.0	6.4			-	128	149	-	950	-	7
		Transport to new location	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2000 ft, 10 MPH, excludes loading equipment	B34F	594	1.0	3.5	100%	FFS 7.9 DRAFT 173	0.0	63.9			-	1,278	45	-	2,876	-	73
		Spread Waste	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	FFS 7.9 DRAFT 174	0.0	56.9			-	1,138	69	-	3,943	-	65
		Apply daily cover to backfilled material	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	FFS 7.9 DRAFT 175	0.0	31.2	-	348	-	624	226	-	7,048	-	36
															Delivery		-	5,220	4 mpg	-	1,305		
		Compact backfilled material	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%	FFS 7.9 DRAFT 176	0.0	16.0			-	320	90	-	1,440	-	18
Relocation of Other Waste	C&D Rubble Stockpiles	Relocate Stockpiled Material on-site - Excavate	C&D Rubble	B.C.Y.	RS Means, Year 2016 Quarter 1	Drilling and blasting rock, less than 0.5 C.Y., excavate and load boulders	B10T	80	1.5	10.0	100%	FFS 7.9 DRAFT 177	146.1	657.5			2,923	13,151	40	5,787	26,039	168	756
		Relocate Stockpiled Material on-site - Haul and Dump	C&D Rubble	B.C.Y.	RS Means, Year 2016 Quarter 1	Drilling and blasting rock, 25 ton off-highway dump, 1 mile round trip, haul boulders	B34E	330	1.0	5.3	100%	FFS 7.9 DRAFT 178	23.6	106.3			472	2,125	56	1,318	5,930	27	122
		Bury Stockpiled Material	C&D Rubble	B.C.Y.	RS Means, Year 2016 Quarter 1	Drilling and blasting rock, 300 H.P. dozer, less than 0.5 C.Y., 150' haul, bury boulders on site	B10M	310	1.5	12.0	100%	FFS 7.9 DRAFT 179	37.7	169.7			754	3,394	59	2,206	9,927	43	195
Buffer Zone		Buffer Zone Activity	See separate Assumptions sheet		See separate Assumptions sheet					1.0	100%	FFS 7.9 DRAFT 180	0.0	42.0			-	840				-	48
Rad. Survey		Conduct final radiological survey and wait for approval	This activity is handled by others, and does not have a direct cost to the contractor. However, there are the indirect costs due to the duration							1.0	100%	FFS 7.9 DRAFT 181	0.0	0.0			-	0				-	-
Additional Fill		Purchase material and spread					B15							185.3		4,369		3,706	170		31,520		213
															Delivery			65,535	4 mpg		16,384		
		Additional delivery distance					B34B							206.5				4,130	56		11,523		237

Table I-5: Calculations for Estimated Greenhouse Gas Emissions ("Complete Rad Removal" Alternative)

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Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Crew Man-days Area 1	Crew Man-days Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 1	Total Miles for Delivery of Materials/ Equipment or Worker Commute Area 2	Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery) Area 1	Gallons diesel consumed (construction equipment, truck delivery) Area 2	Gallons gasoline consumed (worker commute to/from Site) Area 1	Gallons gasoline consumed (worker commute to/from Site) Area 2
		Compact material					B10G							18.3				366	90		1,647		21
Final Cover	Starter Berms	Purchase and deliver material	Riprap	Ton	RS Means, Year 2016 Quarter 1	Rip-rap and rock lining, random, broken stone, 100 lb. average, dumped	B11A	700	2.0	8.0	100%	FFS 7.9 DRAFT 182	0.0	158.6	-	2,776	-	3,172	59	-	9,279	-	182
															Delivery		-	111,040	4 mpg	-	27,760		
		Spread loose lift before compaction	Riprap	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	4.0	100%	FFS 7.9 DRAFT 183	0.0	50.0			-	999	69	-	3,463	-	57
		Special grading for steep slopes	Riprap	S.Y.	RS Means, Year 2016 Quarter 1	Fine grading, slopes, steep, finish grading	B11L	7,100	2.0	1.0	100%	FFS 7.9 DRAFT 184	0.0	3.6			-	72	59	-	214	-	4
		Compact starter berms	Riprap	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, riding, vibrating roller, 2 passes, 12" lifts	B10Y	5,200	1.5	2.0	100%	FFS 7.9 DRAFT 185	0.0	8.0			-	160	35	-	281	-	9
	Clay	Purchase and deliver clay material	Clay Material	L.C.Y.	RS Means, Year 2016 Quarter 1	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	50.0	100%	FFS 7.9 DRAFT 186	2,111.1	3,909.8	10,204	18,898	42,222	78,196	56	117,799	218,167	2,427	4,494
															Delivery		408,160	755,920	4 mpg	102,040	188,980		
		Spread loose lift before compaction	Clay Material	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	12.0	100%	FFS 7.9 DRAFT 187	183.7	340.2			3,674	6,804	69	12,730	23,576	211	391
		Compact Clay (Final Cover)	Clay Material	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	1,300	1.5	2.0	100%	FFS 7.9 DRAFT 188	100.9	186.9			2,018	3,738	90	9,081	16,821	116	215
	Top Soil	Purchase and place Topsoil	Topsoil	C.Y.	RS Means, Year 2016 Quarter 1	Soils for earthwork, topsoil borrow, weed free, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	12.0	100%	FFS 7.9 DRAFT 189	231.9	429.5	4,142	7,670	4,638	8,590	170	39,446	73,058	267	494
															Delivery		62,130	115,050	4 mpg	15,533	28,763		
		Addition for Topsoil Delivery	Topsoil (per Hauling Increment)	C.Y.	RS Means, Year 2016 Quarter 1	Soils for earthwork, borrow, spread with 200 HP dozer, includes load at pit and haul, round trip, excludes compaction, for 5 mile haul, add	B34B	200	1.0	50.0	100%	FFS 7.9 DRAFT 190	258.4	478.6			5,168	9,572	56	14,419	26,706	297	550
Stormwater Controls (for stormwater after cover is constructed)	Terraces	Purchase and place Topsoil	Topsoil	C.Y.	RS Means, Year 2016 Quarter 1	Soils for earthwork, topsoil borrow, weed free, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	2.0	100%	FFS 7.9 DRAFT 191	22.9	27.4	410	490	458	548	170	3,895	4,661	26	31
															Delivery		6,150	7,350	4 mpg	1,538	1,838		
		Addition for Topsoil Delivery	Topsoil (per Hauling Increment)	C.Y.	RS Means, Year 2016 Quarter 1	Soils for earthwork, borrow, spread with 200 HP dozer, includes load at pit and haul, round trip, excludes compaction, for 5 mile haul, add	B34B	200	1.0	50.0	100%	FFS 7.9 DRAFT 192	25.5	30.5			510	610	56	1,423	1,702	29	35
	Pond	Purchase and deliver liner & berm material	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	50.0	100%	FFS 7.9 DRAFT 193	0.0	237.2	-	1,147	-	4,745	56	-	13,238	-	273
															Delivery		-	45,880	4 mpg	-	11,470		
		Spread loose lift before compaction (Pond)	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	2.1	100%	FFS 7.9 DRAFT 194	0.0	20.6			-	413	69	-	1,430	-	24
		Compact Liner & Berm (Pond)	Structural Fill / Clay	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	1,300	1.5	2.0	100%	FFS 7.9 DRAFT 195	0.0	11.3			-	227	90	-	1,021	-	13
		Pond Perimeter Berm Structural Rock	Structural Rock	L.C.Y.	RS Means, Year 2016 Quarter 1	Rip-rap and rock lining, random, broken stone, machine placed for slope protection	B12G	62	2.0	1.0	100%	FFS 7.9 DRAFT 196	0.0	36.5		75	-	729	27	-	984	-	42
															Delivery			1,507	4 mpg		377		
	Diversion Berms	Purchase and deliver berm material	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	50.0	100%	FFS 7.9 DRAFT 197	24.6	11.9	119	58	492	238	59	1,439	696	28	14
															Delivery		4,760	2,320	4 mpg	1,190	580		
		Spread loose lift before compaction	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	2.1	100%	FFS 7.9 DRAFT 198	2.1	1.0			42	20	69	146	69	2	1
		Compact Berms	Structural Fill / Clay	E.C.Y.	RS Means, Year 2016 Quarter 1	Compaction, riding, vibrating roller, 2 passes, 12" lifts	B10Y	5,200	1.5	2.0	100%	FFS 7.9 DRAFT 199	0.3	0.1			6	2	35	11	4	0	0
		Perimeter Road Stormwater Crossings	Riprap	L.C.Y.	RS Means, Year 2016 Quarter 1	Rip-rap and rock lining, random, broken stone, machine placed for slope protection	B12G	62	2.0	1.0	100%	FFS 7.9 DRAFT 200	0.0	4.0			-	79	27	-	107	-	5
		Final Stormwater Controls (letdowns, swales, etc.)	Riprap	S.Y.	RS Means, Year 2016 Quarter 1	Rip-rap and rock lining, random, broken stone, 3/8 to 1/4 C.Y. pieces, machine placed for slope protection, grouted	B13	80	7.0	3.0	100%	FFS 7.9 DRAFT 201	77.8	215.8			1,556	4,316	27	2,101	5,827	89	248
Site Completion		Apply seeding to cover	Seeding	M.S.F.	RS Means, Year 2016 Quarter 1	Seeding athletic fields, seeding fescue, tall with mulch and fertilizer, 5.5 lb. per M.S.F., hydro/air seeding	B81	80	3.0	1.0	100%	FFS 7.9 DRAFT 202	48.3	89.5			966	1,790	56	2,695	4,994	56	103

Table I-5: Calculations for Estimated Greenhouse Gas Emissions ("Complete Rad Removal" Alternative)

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													Crew Man-days		Delivery Truckloads		Total Miles for Delivery of Materials/ Equipment or Worker Commute		Gallons of fuel per Crew Man-day, Mile, or LCY	Gallons diesel consumed (construction equipment, truck delivery)		Gallons gasoline consumed (worker commute to/from Site)	
Category	Sub-Category	Task	Type of Material Handled	Units	Estimate Source	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Step #	Area 1	Area 2	Area 1	Area 2	Area 1	Area 2		Area 1	Area 2	Area 1	Area 2
		Install temporary irrigation system	Irrigation System	S.F.	RS Means, Year 2016 Quarter 1	Underground sprinklers irrigation system, for lawns, residential system, custom, 1" supply	B20	2,000	3.0	10.0	100%	FFS 7.9 DRAFT 203	161.0	298.2			3,220	5,964	-	-	-	185	343
		Install Fencing	Fencing	L.F.	RS Means, Year 2016 Quarter 1	Fence, chain link industrial, galvanized steel, 6 ga. wire, 2-1/2" posts @ 10' OC, 8' high, includes excavation, in concrete, excludes barbed wire	B80C	180	3.0	2.0	100%	FFS 7.9 DRAFT 204	96.2	116.6			1,924	2,332	18	1,732	2,099	111	134
																			Gallons of Fuel Consumed	2,388,155	4,980,011	60,998	73,841
																			Total Gallons (Areas 1 and 2)		**7,368,167**		**134,839**
																			Conversion Factor (lbs CO_2 component of CO2e emissions per Gallon of Fuel Burned)		22.2 lb/gal		19.4 lb/gal
																			Subtotal - Pounds of CO2e emissions		163,573,301		2,615,877
																			Subtotal - Tons of CO2e emission		81,787		1,308
																			Total Tons of CO2e Emissions (diesel plus gasoline)			***83,000***	

APPENDIX J:

Estimated Project Schedules for the Remedial Alternatives

Estimated Schedule

ROD-Selected Remedy

OVERVIEW OF ROD CONSTRUCTION SCHEDULE

Final Feasibility Study, West Lake Landfill

OVERALL PROJECT: *MARCH 2018 – OCTOBER 2019 (1.7 YEARS)*

Site-wide Preparations – *MARCH - APRIL 2018*

- Mobilization, Construction Trailers, Project Infrastructure

Area 2 – *MARCH 2018 – OCTOBER 2019*

- Site Preparations – *MARCH - APRIL 2018*
- Waste Regrading – *APRIL - SEPTEMBER 2018*
    - Including Buffer Zone
- Final Cover – *SEPTEMBER 2018 - SEPTEMBER 2019*
    - Limited by material delivery rate and coordination with Area 1
- Stormwater Controls and Site Completion – *THROUGH OCTOBER 2019*

In parallel:

Area 1 – *APRIL 2018 - APRIL 2019*

- Site Preparations – *APRIL 2018*
- Waste Regrading – *MAY - JUNE 2018*
- Final Cover – *JUNE 2018 - APRIL 2019*
- Stormwater Controls and Site Completion – *THROUGH APRIL 2019*

West Lake FFS - ROD Remedy

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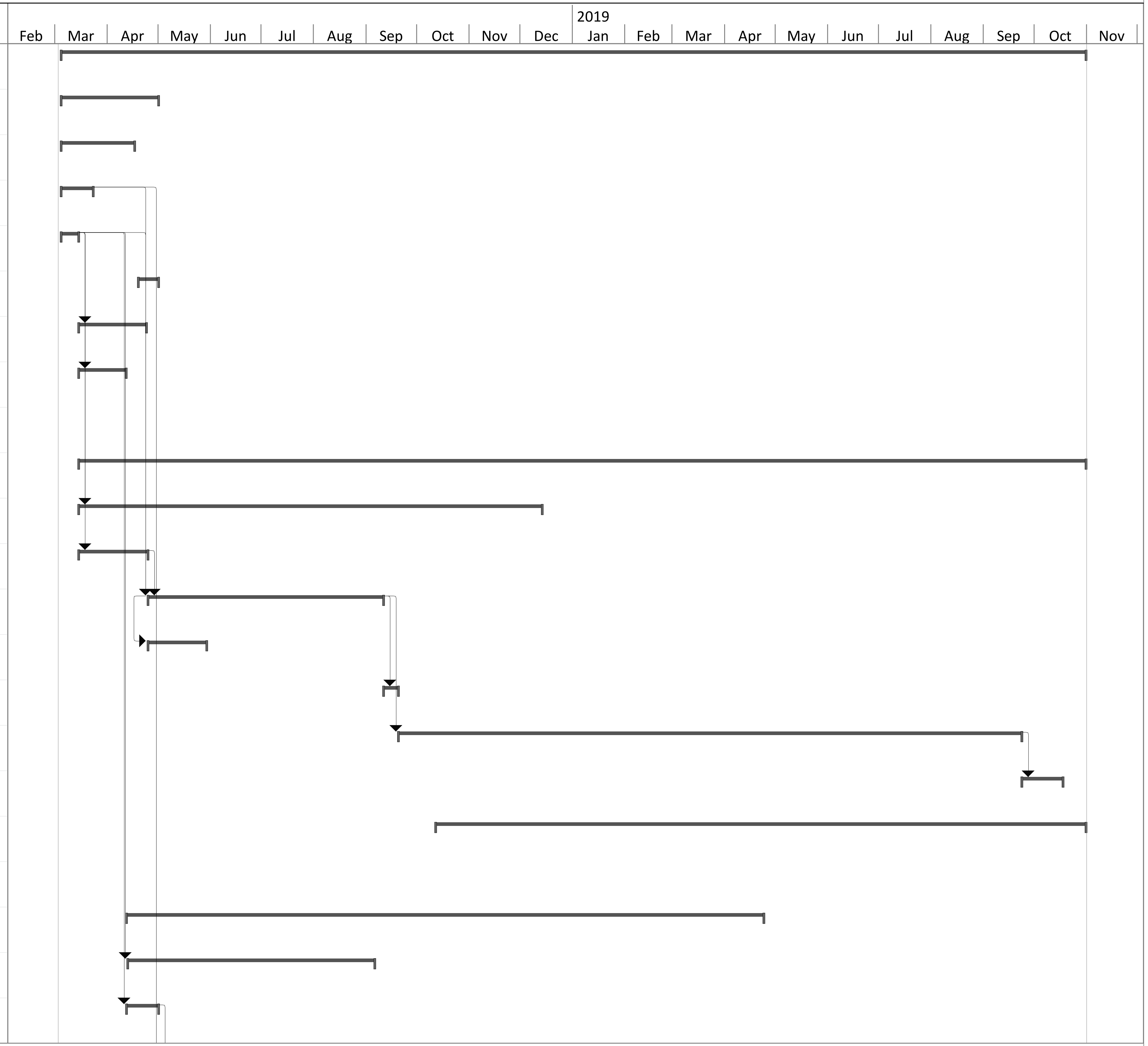
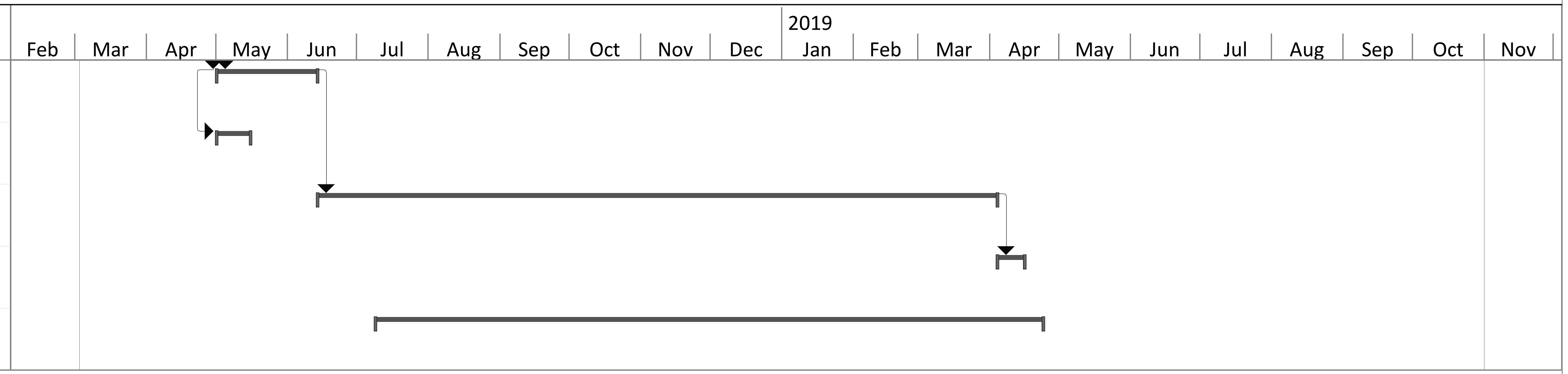
ID	Task Name	Estimated Duration	Start	Finish
1	**ROD Schedule**	**421 days**	**Mon 3/5/18**	**Thu 10/31/19**
2	**Site-wide Preparation**	**42 days**	**Mon 3/5/18**	**Tue 5/1/18**
3	**Temporary Construction Facilities / Utilities / Personnel**	**31 days**	**Mon 3/5/18**	**Tue 4/17/18**
6	**Stormwater Treatment Facility**	**15 days**	**Mon 3/5/18**	**Fri 3/23/18**
8	**Mobilization**	**8 days**	**Mon 3/5/18**	**Thu 3/15/18**
19	**Supplemental Mobilization**	**8 days**	**Thu 4/19/18**	**Tue 5/1/18**
30	**Create Temporary Roads**	**28 days**	**Thu 3/15/18**	**Tue 4/24/18**
33	**Install TBD Traffic Improvements**	**20 days**	**Thu 3/15/18**	**Thu 4/12/18**
36				
37	**Area 2**	**413 days**	**Thu 3/15/18**	**Thu 10/31/19**
38	**Temporary Stormwater Infrastructure**	**190 days**	**Thu 3/15/18**	**Fri 12/14/18**
47	**Site Preparation**	**29 days**	**Thu 3/15/18**	**Wed 4/25/18**
63	**Regrading**	**97 days**	**Wed 4/25/18**	**Tue 9/11/18**
79	**Leachate Handling**	**24 days**	**Wed 4/25/18**	**Tue 5/29/18**
84	**Buffer Zone**	**6 days**	**Tue 9/11/18**	**Thu 9/20/18**
86	**Final Cover**	**253 days**	**Thu 9/20/18**	**Mon 9/23/19**
103	**Post-Construction Stormwater Controls**	**18 days**	**Tue 9/24/19**	**Fri 10/18/19**
118	**Site Completion**	**265 days**	**Fri 10/12/18**	**Thu 10/31/19**
124				
125	**Area 1**	**259 days**	**Thu 4/12/18**	**Wed 4/24/19**
126	**Temporary Stormwater Infrastructure**	**101 days**	**Fri 4/13/18**	**Thu 9/6/18**
134	**Site Preparation**	**13 days**	**Thu 4/12/18**	**Tue 5/1/18**



West Lake FFS - ROD Remedy

DRAFT

ID	Task Name	Estimated Duration	Start	Finish
150	**Regrading**	**30 days**	**Tue 5/1/18**	**Thu 6/14/18**
166	**Leachate Handling**	**10 days**	**Tue 5/1/18**	**Wed 5/16/18**
171	**Final Cover**	**202 days**	**Thu 6/14/18**	**Thu 4/4/19**
188	**Post-Construction Stormwater Controls**	**7 days**	**Thu 4/4/19**	**Tue 4/16/19**
197	**Site Completion**	**200 days**	**Mon 7/9/18**	**Wed 4/24/19**



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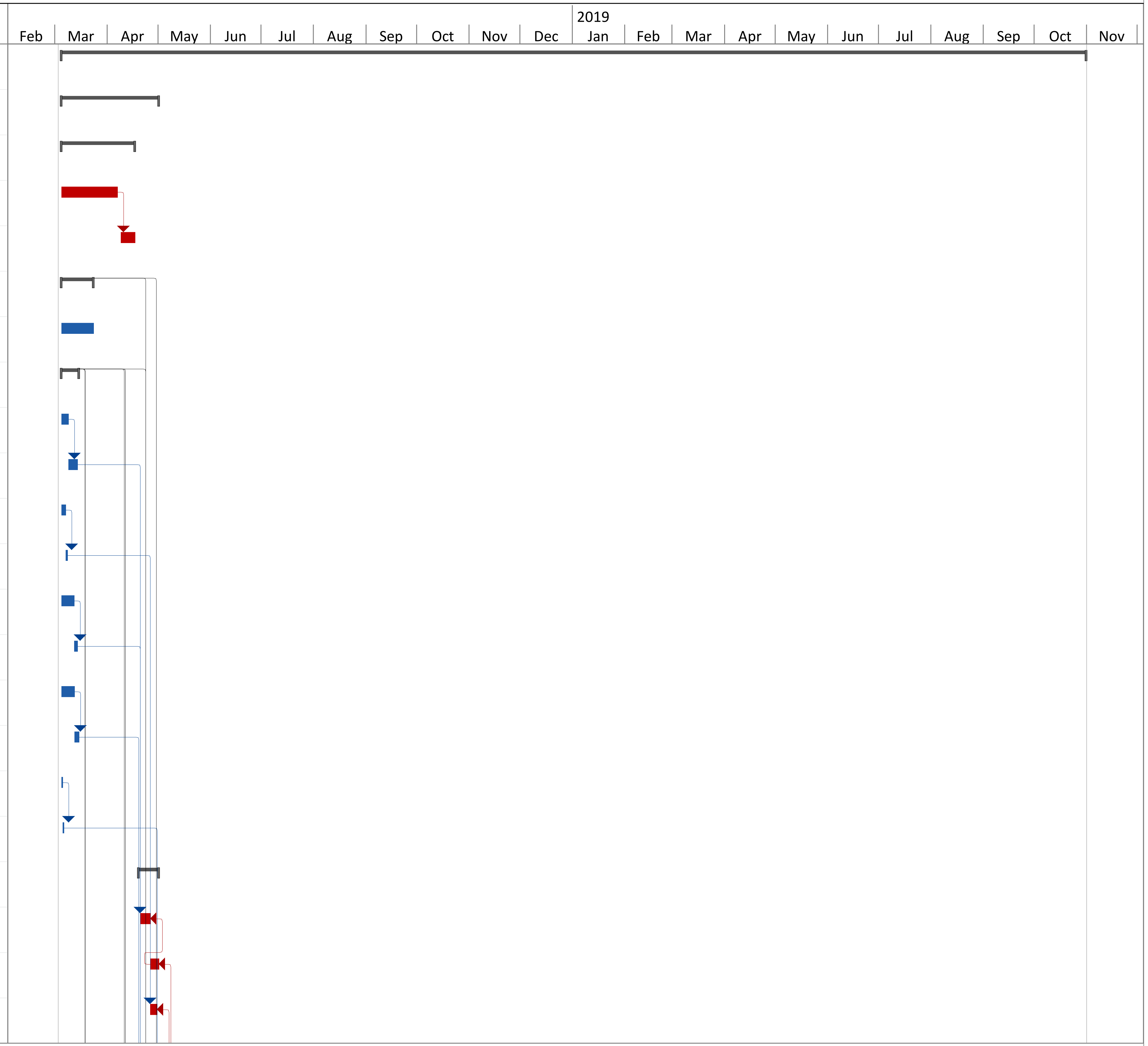
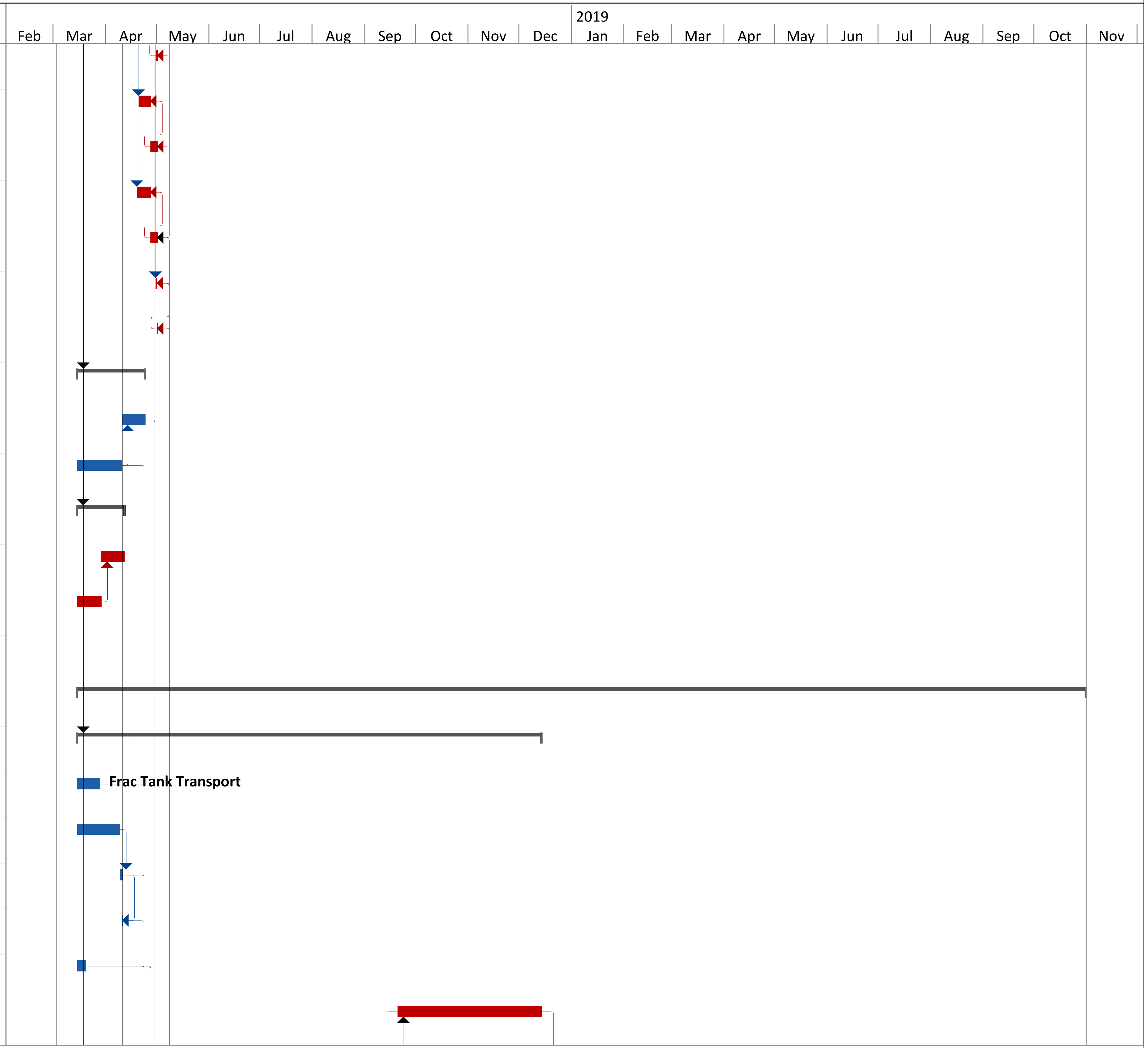
ID	Task Name	Estimated Duration	Start	Finish
1	**ROD Schedule**	**421 days**	**Mon 3/5/18**	**Thu 10/31/19**
2	**Site-wide Preparation**	**42 days**	**Mon 3/5/18**	**Tue 5/1/18**
3	**Temporary Construction Facilities / Utilities / Personnel**	**31 days**	**Mon 3/5/18**	**Tue 4/17/18**
4	Construction Trailers	25 days	Mon 3/5/18	Fri 4/6/18
5	Parking Area	6 days	Mon 4/9/18	Tue 4/17/18
6	**Stormwater Treatment Facility**	**15 days**	**Mon 3/5/18**	**Fri 3/23/18**
7	Construction	15 days	Mon 3/5/18	Fri 3/23/18
8	**Mobilization**	**8 days**	**Mon 3/5/18**	**Thu 3/15/18**
9	Mobilize and Demobilize Equipment by F	4 days	Mon 3/5/18	Thu 3/8/18
10	Extra Mileage for Mobilizations	3 days	Fri 3/9/18	Wed 3/14/18
11	Mobilize and Demobilize Equipment by 3-ton Trailer	2 days	Mon 3/5/18	Wed 3/7/18
12	Extra Mileage for Mobilizations	1 day	Wed 3/7/18	Thu 3/8/18
13	Mobilize and Demobilize Equipment by 20-ton Trailer	5 days	Mon 3/5/18	Mon 3/12/18
14	Extra Mileage for Mobilizations	2 days	Mon 3/12/18	Wed 3/14/18
15	Mobilize and Demobilize Equipment by 40-ton Trailer	6 days	Mon 3/5/18	Mon 3/12/18
16	Extra Mileage for Mobilizations	2 days	Mon 3/12/18	Thu 3/15/18
17	Mobilize and Demobilize Crane Equipment (75+ tons)	1 day	Mon 3/5/18	Mon 3/5/18
18	Extra Mileage for Mobilizations	0 days	Mon 3/5/18	Tue 3/6/18
19	**Supplemental Mobilization**	**8 days**	**Thu 4/19/18**	**Tue 5/1/18**
20	Mobilize and Demobilize Equipment by F	4 days	Fri 4/20/18	Thu 4/26/18
21	Extra Mileage for Mobilizations	3 days	Thu 4/26/18	Tue 5/1/18
22	Mobilize and Demobilize Equipment by 3-ton Trailer	2 days	Thu 4/26/18	Mon 4/30/18

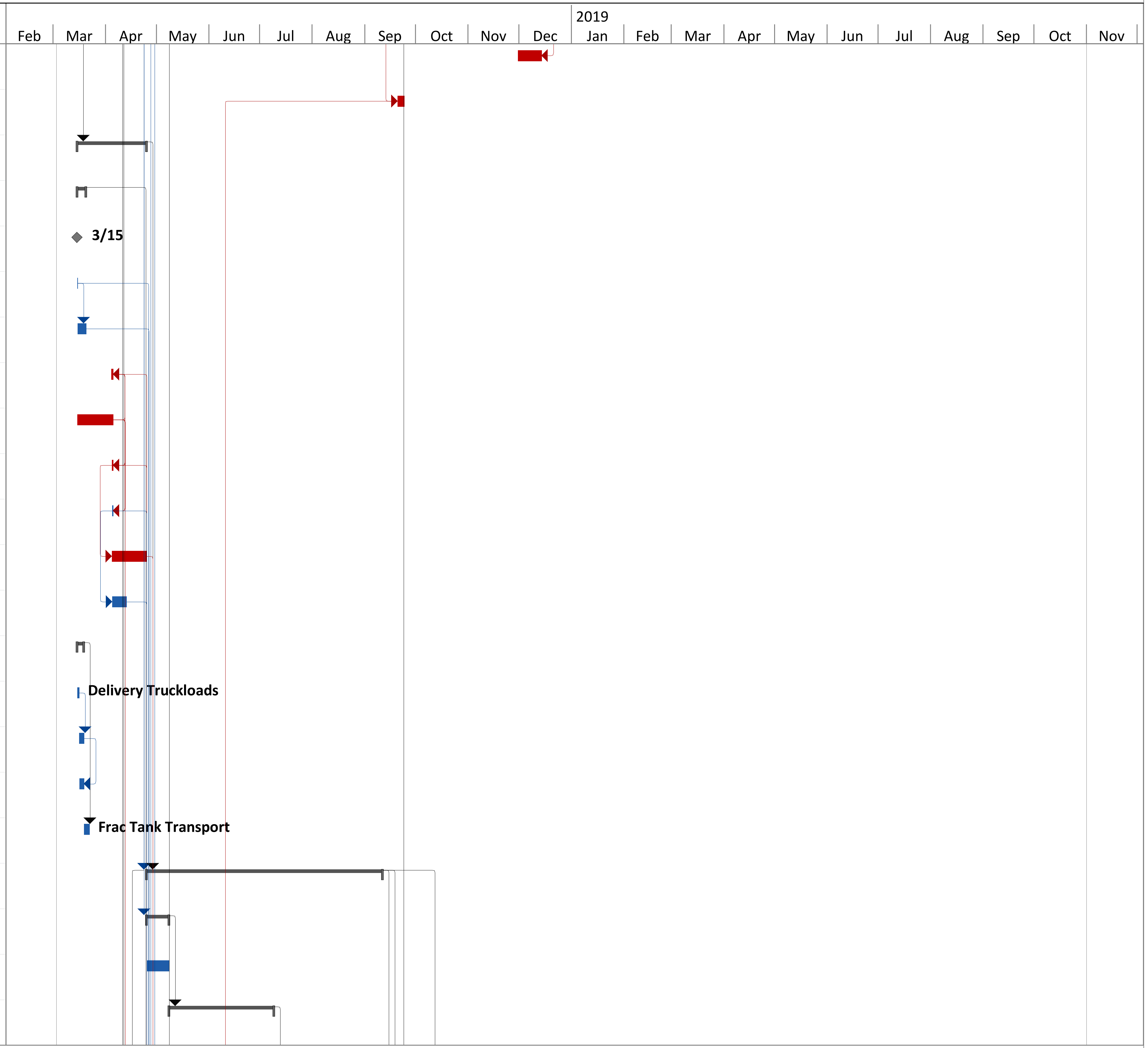


Note: All dates are for planning purposes only - not actual dates.

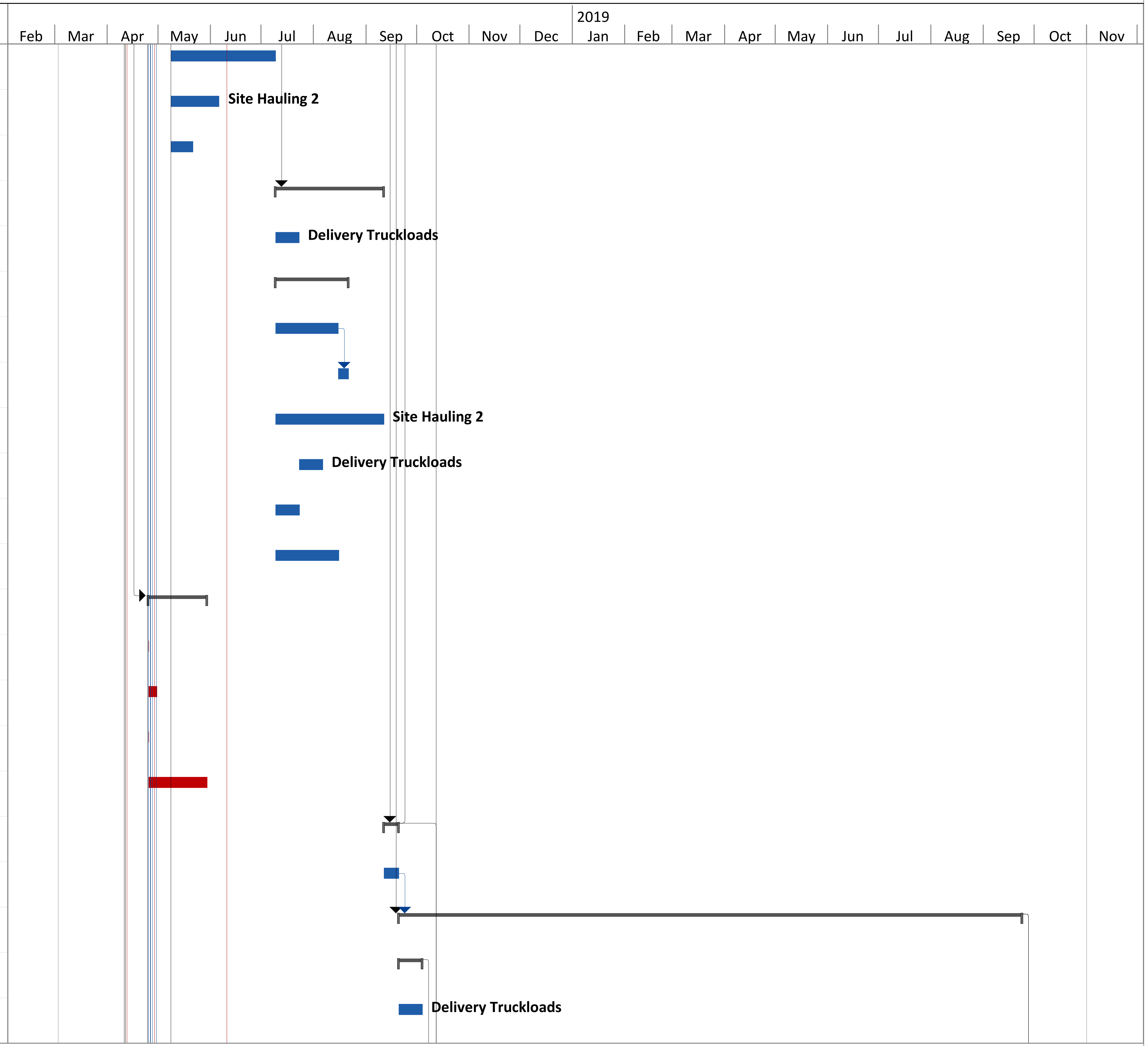
ID	Task Name	Estimated Duration	Start	Finish
23	Extra Mileage for Mobilizations	1 day	Mon 4/30/18	Tue 5/1/18
24	Mobilize and Demobilize Equipment by 20-ton Trailer	5 days	Fri 4/20/18	Fri 4/27/18
25	Extra Mileage for Mobilizations	2 days	Fri 4/27/18	Tue 5/1/18
26	Mobilize and Demobilize Equipment by 40-ton Trailer	6 days	Thu 4/19/18	Fri 4/27/18
27	Extra Mileage for Mobilizations	2 days	Fri 4/27/18	Tue 5/1/18
28	Mobilize and Demobilize Crane Equipment (75+ tons)	1 day	Mon 4/30/18	Tue 5/1/18
29	Extra Mileage for Mobilizations	0 days	Tue 5/1/18	Tue 5/1/18
30	**Create Temporary Roads**	**28 days**	**Thu 3/15/18**	**Tue 4/24/18**
31	Area 1	9 days	Tue 4/10/18	Tue 4/24/18
32	Area 2	19 days	Thu 3/15/18	Tue 4/10/18
33	**Install TBD Traffic Improvements**	**20 days**	**Thu 3/15/18**	**Thu 4/12/18**
34	Area 1	10 days	Thu 3/29/18	Thu 4/12/18
35	Area 2	10 days	Thu 3/15/18	Thu 3/29/18
36				
37	**Area 2**	**413 days**	**Thu 3/15/18**	**Thu 10/31/19**
38	**Temporary Stormwater Infrastructure**	**190 days**	**Thu 3/15/18**	**Fri 12/14/18**
39	Deliver Frac Tanks	10 days	Thu 3/15/18	Wed 3/28/18
40	Install forcemain from Excavation to Tan	18 days	Thu 3/15/18	Mon 4/9/18
41	Install forcemain from Tank Area to Treatment Facility and Discharge Point	1 day	Mon 4/9/18	Tue 4/10/18
42	Install forcemain valves	0 days	Tue 4/10/18	Tue 4/10/18
43	Prepare area with Stormwater BMPS	3 days	Thu 3/15/18	Tue 3/20/18
44	Clean Frac Tanks	58 days	Thu 9/20/18	Fri 12/14/18



ID	Task Name	Estimated Duration	Start	Finish
45	Remove Frac Tanks	10 days	Fri 11/30/18	Fri 12/14/18
46	Disassemble Stormwater Treatment Faci	2 days	Thu 9/20/18	Mon 9/24/18
47	**Site Preparation**	**29 days**	**Thu 3/15/18**	**Wed 4/25/18**
48	**Decontamination Area**	**3 days**	**Thu 3/15/18**	**Tue 3/20/18**
49	Materials	0 days	Thu 3/15/18	Thu 3/15/18
50	Installation	0 days	Thu 3/15/18	Thu 3/15/18
51	Building Construction	3 days	Thu 3/15/18	Tue 3/20/18
52	Clear Vegetation (Light)	1 day	Wed 4/4/18	Thu 4/5/18
53	Clear Vegetation (Heavy)	15 days	Thu 3/15/18	Thu 4/5/18
54	Clear Small Trees	1 day	Wed 4/4/18	Thu 4/5/18
55	Clear Large Trees	1 day	Thu 4/5/18	Thu 4/5/18
56	Clear Small Stumps	14 days	Wed 4/4/18	Wed 4/25/18
57	Clear Large Stumps	6 days	Thu 4/5/18	Fri 4/13/18
58	**Secondary Containment for Frac Tanks**	**2 days**	**Thu 3/15/18**	**Mon 3/19/18**
59	Purchase and deliver liner/berm mate	1 day	Thu 3/15/18	Fri 3/16/18
60	Spread material	1 day	Fri 3/16/18	Mon 3/19/18
61	Compact liner/berms	1 day	Fri 3/16/18	Mon 3/19/18
62	Leachate Frac Tanks Delivery	3 days	Mon 3/19/18	Thu 3/22/18
63	**Regrading**	**97 days**	**Wed 4/25/18**	**Tue 9/11/18**
64	**Stormwater Events (Weather Delays)**	**10 days**	**Wed 4/25/18**	**Tue 5/8/18**
65	Dewater construction after rain event	10 days	Wed 4/25/18	Tue 5/8/18
66	**C&D Rubble Stockpiles**	**42 days**	**Tue 5/8/18**	**Mon 7/9/18**



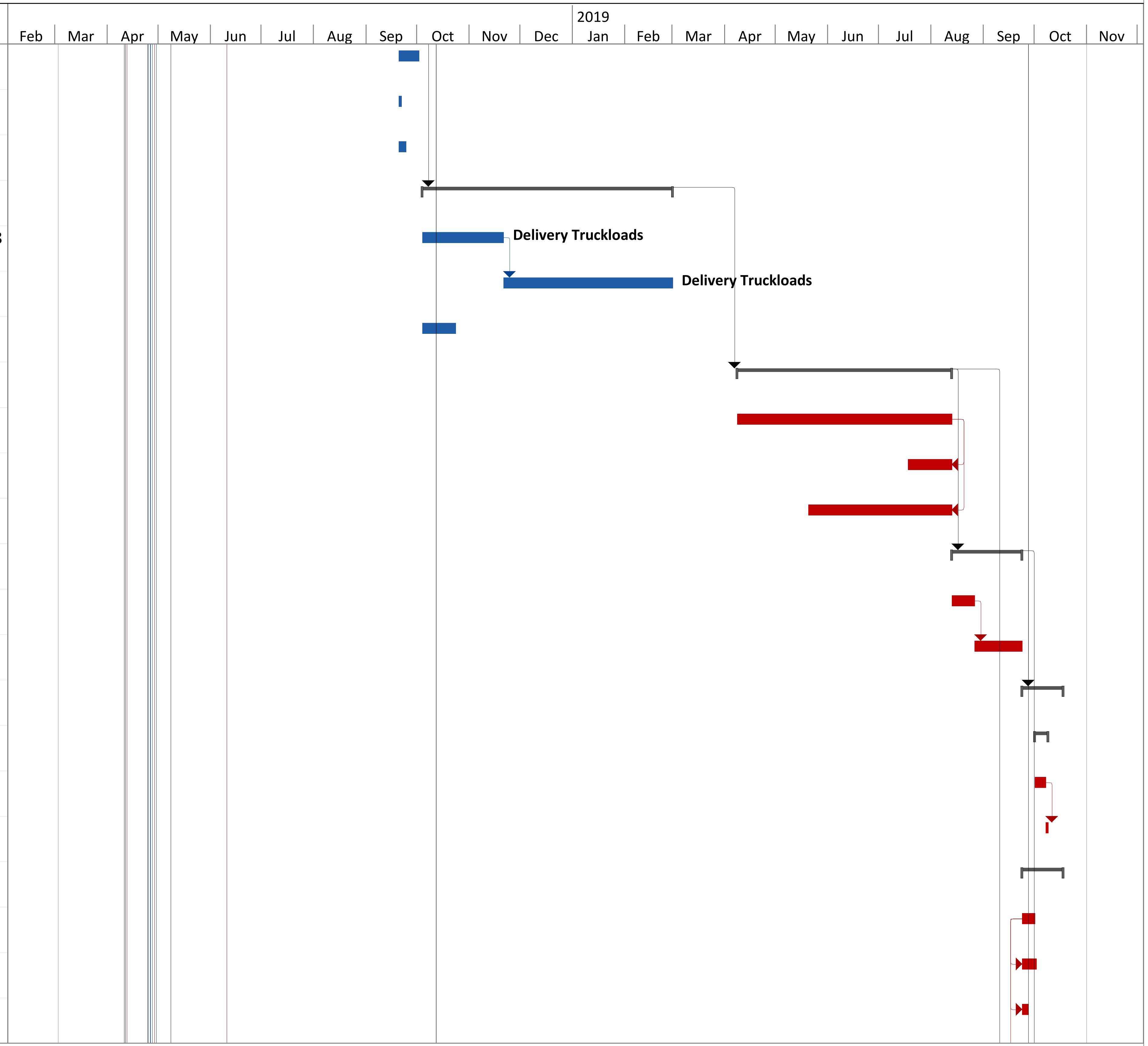
ID	Task Name	Estimated Duration	Start	Finish
67	Relocate Stockpiled Material on-site -	42 days	Tue 5/8/18	Mon 7/9/18
68	Relocate Stockpiled Material on-site - Haul and Dump	19 days	Tue 5/8/18	Tue 6/5/18
69	Bury Stockpiled Material	9 days	Tue 5/8/18	Mon 5/21/18
70	**General Waste**	**45 days**	**Mon 7/9/18**	**Tue 9/11/18**
71	Apply daily cover to remaining excavation of Landfilled Material	10 days	Mon 7/9/18	Mon 7/23/18
72	**Relocate Landfilled Material on-site**	**31 days**	**Mon 7/9/18**	**Tue 8/21/18**
73	Excavate	27 days	Mon 7/9/18	Wed 8/15/18
74	Load	4 days	Wed 8/15/18	Tue 8/21/18
75	Relocate Landfilled Material on-site - Haul and Dump	45 days	Mon 7/9/18	Tue 9/11/18
76	Apply daily cover to relocated Landfilled Material	10 days	Mon 7/23/18	Mon 8/6/18
77	Spread Landfilled Material	10 days	Mon 7/9/18	Mon 7/23/18
78	Compact Landfilled Material	27 days	Mon 7/9/18	Wed 8/15/18
79	**Leachate Handling**	**24 days**	**Wed 4/25/18**	**Tue 5/29/18**
80	Pumping	0 days	Wed 4/25/18	Wed 4/25/18
81	Tank Transportation on Site	3 days	Wed 4/25/18	Mon 4/30/18
82	Sampling	0 days	Wed 4/25/18	Wed 4/25/18
83	Hauling & Disposal	24 days	Wed 4/25/18	Tue 5/29/18
84	**Buffer Zone**	**6 days**	**Tue 9/11/18**	**Thu 9/20/18**
85	Buffer Zone Activity	6 days	Tue 9/11/18	Thu 9/20/18
86	**Final Cover**	**253 days**	**Thu 9/20/18**	**Mon 9/23/19**
87	**Starter Berms**	**10 days**	**Thu 9/20/18**	**Thu 10/4/18**
88	Purchase and deliver material	10 days	Thu 9/20/18	Thu 10/4/18



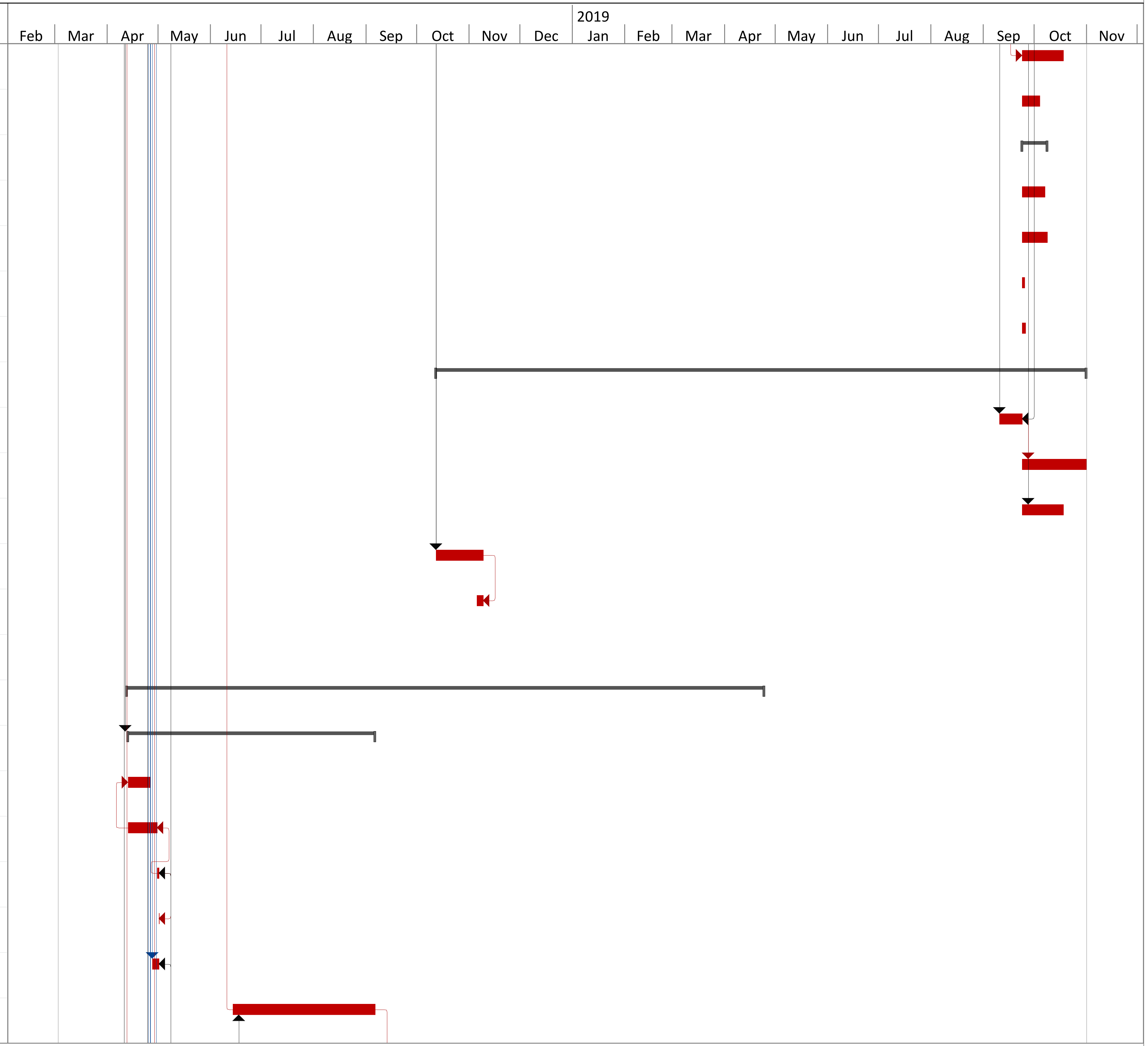
West Lake FFS - ROD Remedy

DRAFT

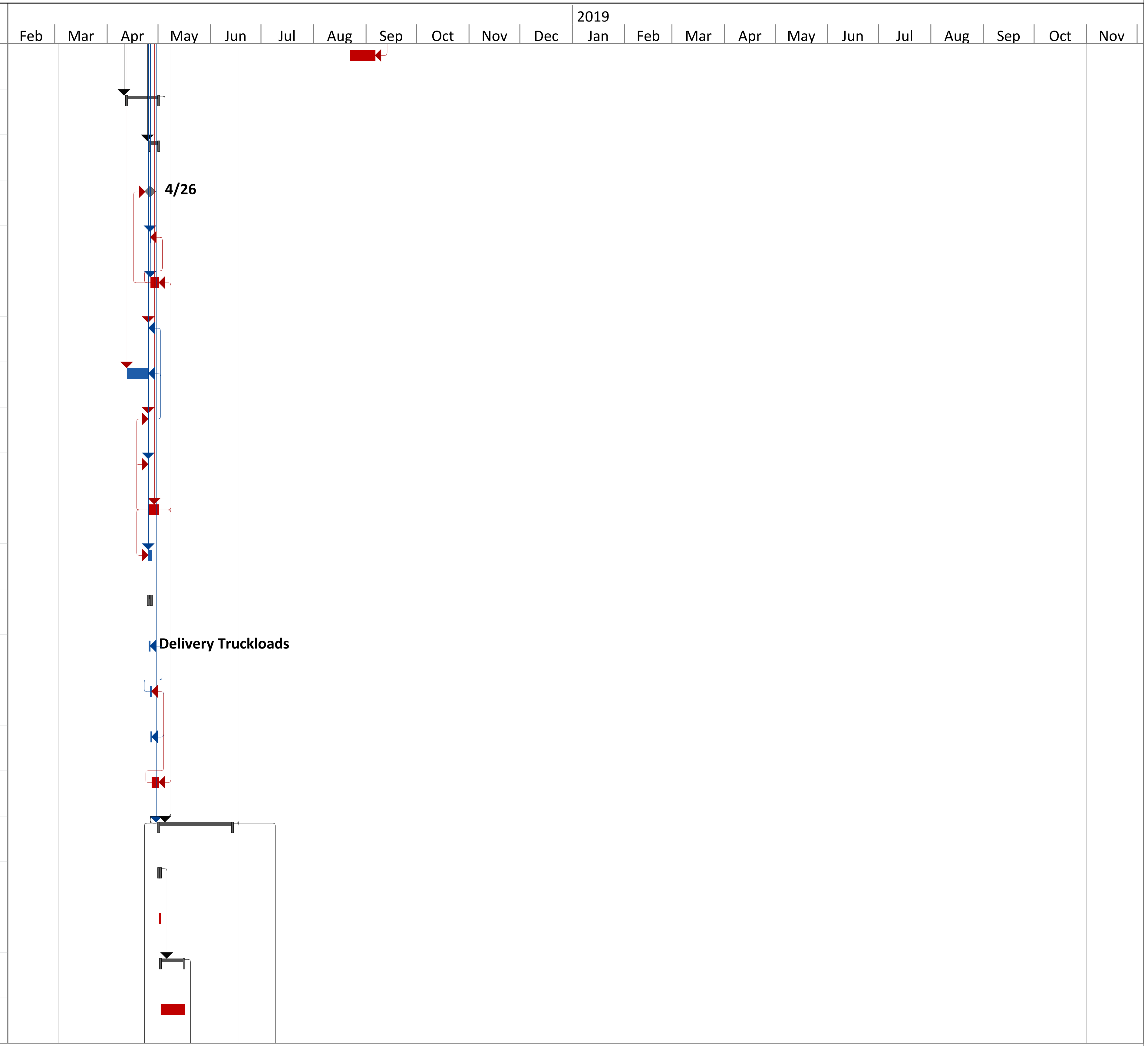
ID	Task Name	Estimated Duration	Start	Finish
89	Spread loose lift before compaction	8 days	Thu 9/20/18	Tue 10/2/18
90	Special grading for steep slopes	2 days	Thu 9/20/18	Fri 9/21/18
91	Compact starter berms	3 days	Thu 9/20/18	Mon 9/24/18
92	**Bio-Intrusion**	**99 days**	**Thu 10/4/18**	**Fri 3/1/19**
93	Purchase and Spread Bio-Intrusion Layer Material	33 days	Thu 10/4/18	Wed 11/21/18
94	Deliver Bio-Intrusion Layer Material	66 days	Wed 11/21/18	Fri 3/1/19
95	Compact Bio-Intrusion Layer Material	14 days	Thu 10/4/18	Tue 10/23/18
96	**Clay**	**89 days**	**Mon 4/8/19**	**Tue 8/13/19**
97	Purchase and deliver clay material	89 days	Mon 4/8/19	Tue 8/13/19
98	Spread loose lift before compaction	18 days	Thu 7/18/19	Tue 8/13/19
99	Compact Clay (Final Cover)	59 days	Mon 5/20/19	Tue 8/13/19
100	**Top Soil**	**29 days**	**Tue 8/13/19**	**Mon 9/23/19**
101	Purchase and place Topsoil	10 days	Tue 8/13/19	Mon 8/26/19
102	Addition for Delivery Distance	19 days	Tue 8/27/19	Mon 9/23/19
103	**Post-Construction Stormwater Controls**	**18 days**	**Tue 9/24/19**	**Fri 10/18/19**
104	**Install Terraces**	**6 days**	**Tue 10/1/19**	**Wed 10/9/19**
105	Purchase and place Topsoil	4 days	Tue 10/1/19	Mon 10/7/19
106	Addition for Delivery Distance	1 day	Tue 10/8/19	Wed 10/9/19
107	**Pond**	**18 days**	**Tue 9/24/19**	**Fri 10/18/19**
108	Purchase and deliver liner & berm ma	6 days	Tue 9/24/19	Tue 10/1/19
109	Spread loose lifts before compaction	7 days	Tue 9/24/19	Wed 10/2/19
110	Compact Liner & Berm	4 days	Tue 9/24/19	Fri 9/27/19



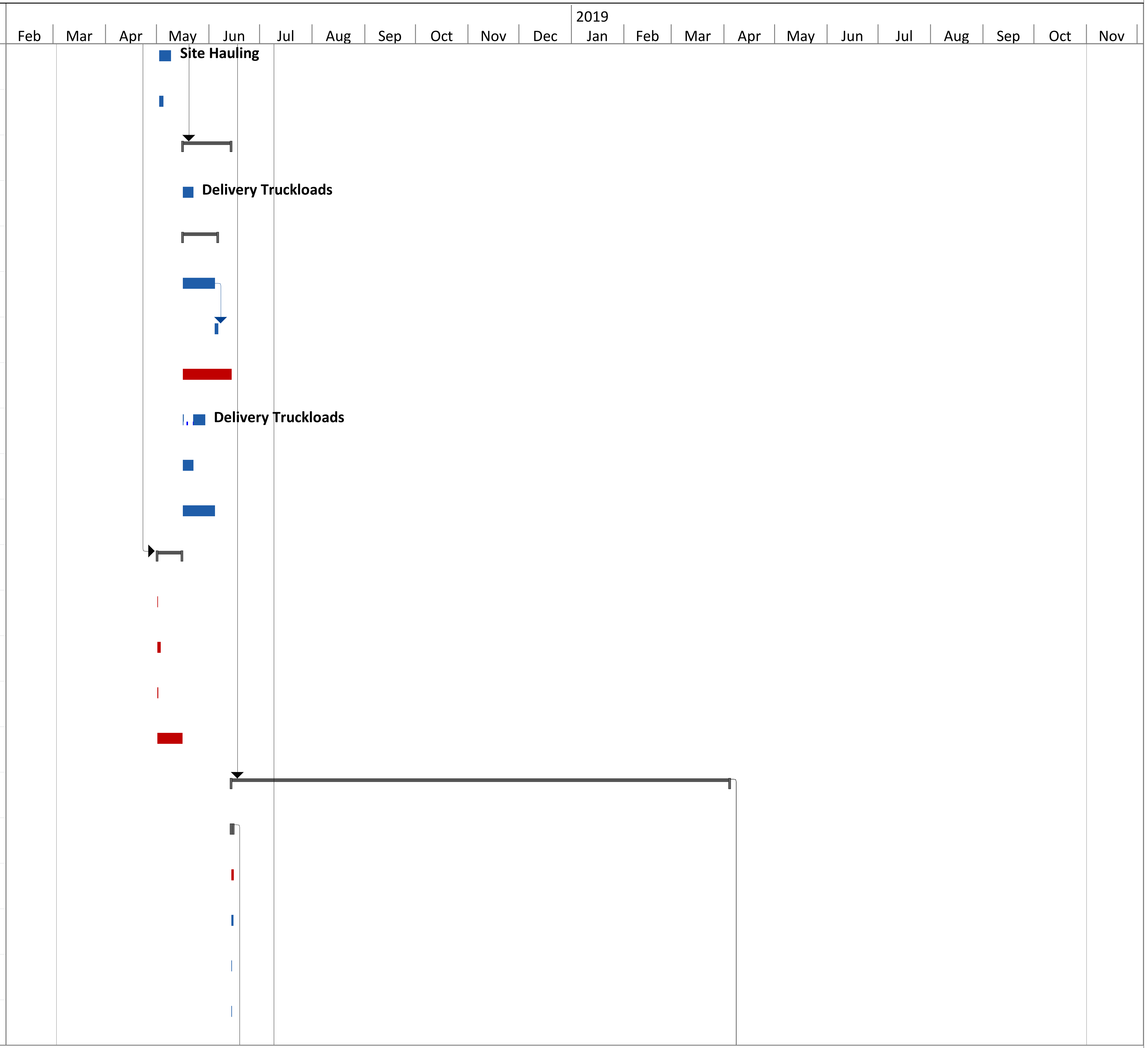
ID	Task Name	Estimated Duration	Start	Finish
111	Perimeter Berm Structural Rock	18 days	Tue 9/24/19	Fri 10/18/19
112	Final Stormwater Controls	8 days	Tue 9/24/19	Fri 10/4/19
113	**Diversion Berms**	**11 days**	**Tue 9/24/19**	**Tue 10/8/19**
114	Purchase and deliver berm material	10 days	Tue 9/24/19	Mon 10/7/19
115	Spread loose lift before compaction	11 days	Tue 9/24/19	Tue 10/8/19
116	Compact berm	2 days	Tue 9/24/19	Wed 9/25/19
117	Perimeter Road Stormwater Crossings	2 days	Tue 9/24/19	Wed 9/25/19
118	**Site Completion**	**265 days**	**Fri 10/12/18**	**Thu 10/31/19**
119	Install temporary irrigation system	9 days	Tue 9/10/19	Mon 9/23/19
120	Apply seeding to cover	28 days	Tue 9/24/19	Thu 10/31/19
121	Install Fencing	19 days	Tue 9/24/19	Fri 10/18/19
122	Clean Leachate Frac Tanks	20 days	Fri 10/12/18	Fri 11/9/18
123	Remove Leachate Frac Tanks	3 days	Mon 11/5/18	Fri 11/9/18
124				
125	**Area 1**	**259 days**	**Thu 4/12/18**	**Wed 4/24/19**
126	**Temporary Stormwater Infrastructure**	**101 days**	**Fri 4/13/18**	**Thu 9/6/18**
127	Deliver Frac Tanks	10 days	Fri 4/13/18	Thu 4/26/18
128	Install forcemain from Excavation to Tan	11 days	Fri 4/13/18	Mon 4/30/18
129	Install forcemain from Tank Area to Treatment Facility	1 day	Mon 4/30/18	Tue 5/1/18
130	Install forcemain valves	0 days	Tue 5/1/18	Tue 5/1/18
131	Prepare area with Stormwater BMPS	2 days	Fri 4/27/18	Tue 5/1/18
132	Clean Frac Tanks	58 days	Thu 6/14/18	Thu 9/6/18



ID	Task Name	Estimated Duration	Start	Finish
133	Remove Frac Tanks	10 days	Wed 8/22/18	Thu 9/6/18
134	**Site Preparation**	**13 days**	**Thu 4/12/18**	**Tue 5/1/18**
135	**Decontamination Area**	**3 days**	**Thu 4/26/18**	**Tue 5/1/18**
136	Materials	0 days	Thu 4/26/18	Thu 4/26/18
137	Installation	0 days	Thu 4/26/18	Thu 4/26/18
138	Building Construction	3 days	Thu 4/26/18	Tue 5/1/18
139	Clear Vegetation (Light)	0 days	Wed 4/25/18	Wed 4/25/18
140	Clear Vegetation (Heavy)	9 days	Thu 4/12/18	Wed 4/25/18
141	Clear Small Trees	0 days	Wed 4/25/18	Wed 4/25/18
142	Clear Large Trees	0 days	Wed 4/25/18	Wed 4/25/18
143	Clear Small Stumps	5 days	Wed 4/25/18	Tue 5/1/18
144	Clear Large Stumps	2 days	Wed 4/25/18	Fri 4/27/18
145	**Secondary Containment for Frac Tanks**	**2 days**	**Wed 4/25/18**	**Fri 4/27/18**
146	Purchase and deliver liner/berm mate	1 day	Wed 4/25/18	Thu 4/26/18
147	Spread material	1 day	Thu 4/26/18	Fri 4/27/18
148	Compact liner/berms	1 day	Thu 4/26/18	Fri 4/27/18
149	Leachate Frac Tanks Delivery	3 days	Fri 4/27/18	Tue 5/1/18
150	**Regrading**	**30 days**	**Tue 5/1/18**	**Thu 6/14/18**
151	**Stormwater Events (Weather Delays)**	**1 day**	**Tue 5/1/18**	**Wed 5/2/18**
152	Dewater construction after rain event	1 day	Tue 5/1/18	Wed 5/2/18
153	**C&D Rubble Stockpiles**	**10 days**	**Wed 5/2/18**	**Wed 5/16/18**
154	Relocate Stockpiled Material on-site -	10 days	Wed 5/2/18	Wed 5/16/18



ID	Task Name	Estimated Duration	Start	Finish
155	Relocate Stockpiled Material on-site - Haul and Dump	5 days	Wed 5/2/18	Wed 5/9/18
156	Bury Stockpiled Material	2 days	Wed 5/2/18	Fri 5/4/18
157	**General Waste**	**20 days**	**Wed 5/16/18**	**Thu 6/14/18**
158	Apply daily cover to remaining excavation of Landfilled Material	4 days	Wed 5/16/18	Tue 5/22/18
159	**Relocate Landfilled Material on-site -**	**14 days**	**Wed 5/16/18**	**Wed 6/6/18**
160	Excavate	12 days	Wed 5/16/18	Mon 6/4/18
161	Load	2 days	Mon 6/4/18	Wed 6/6/18
162	Relocate Landfilled Material on-site - Haul and Dump	20 days	Wed 5/16/18	Thu 6/14/18
163	Apply daily cover to relocated Landfilled Material	4 days	Wed 5/16/18	Tue 5/29/18
164	Spread Landfilled Material	4 days	Wed 5/16/18	Tue 5/22/18
165	Compact Landfilled Material	12 days	Wed 5/16/18	Mon 6/4/18
166	**Leachate Handling**	**10 days**	**Tue 5/1/18**	**Wed 5/16/18**
167	Pumping	0 days	Tue 5/1/18	Tue 5/1/18
168	Tank Transportation on Site	2 days	Tue 5/1/18	Thu 5/3/18
169	Sampling	0 days	Tue 5/1/18	Tue 5/1/18
170	Hauling & Disposal	10 days	Tue 5/1/18	Wed 5/16/18
171	**Final Cover**	**202 days**	**Thu 6/14/18**	**Thu 4/4/19**
172	**Starter Berms**	**1 day**	**Thu 6/14/18**	**Fri 6/15/18**
173	Purchase and deliver material	1 day	Thu 6/14/18	Fri 6/15/18
174	Spread loose lift before compaction	1 day	Thu 6/14/18	Fri 6/15/18
175	Special grading for steep slopes	0 days	Thu 6/14/18	Thu 6/14/18
176	Compact starter berms	0 days	Thu 6/14/18	Thu 6/14/18



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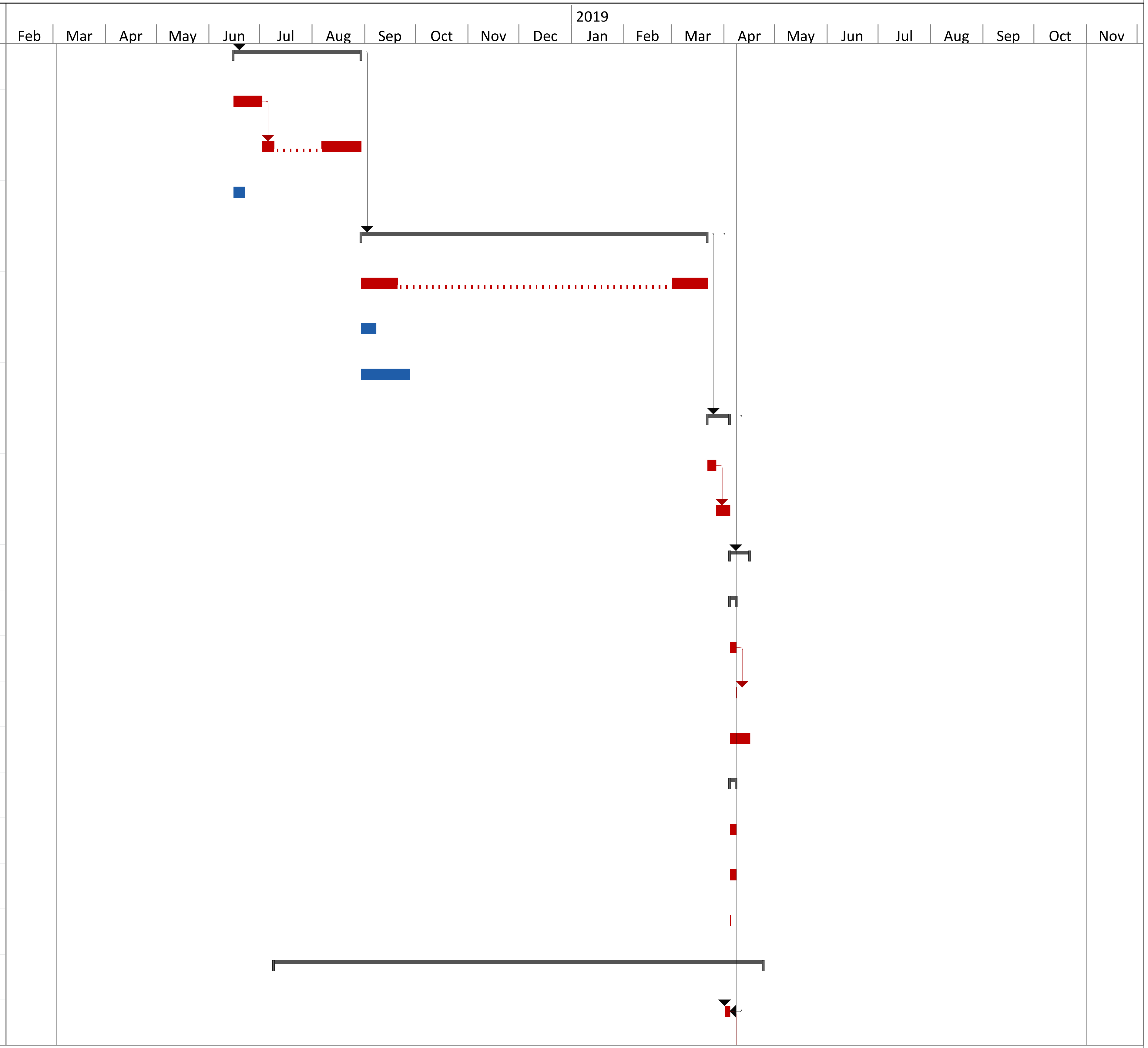
ID	Task Name	Estimated Duration	Start	Finish
177	**Bio-Intrusion**	**53 days**	**Fri 6/15/18**	**Wed 8/29/18**
178	Purchase and Spread Bio-Intrusion Layer Material	11 days	Fri 6/15/18	Mon 7/2/18
179	Deliver Bio-Intrusion Layer Material	22 days	Mon 7/2/18	Wed 8/29/18
180	Compact Bio-Intrusion Layer Material	5 days	Fri 6/15/18	Thu 6/21/18
181	**Clay**	**138 days**	**Thu 8/30/18**	**Fri 3/22/19**
182	Purchase and deliver clay material	29 days	Thu 8/30/18	Fri 3/22/19
183	Spread loose lift before compaction	6 days	Thu 8/30/18	Fri 9/7/18
184	Compact Clay (Final Cover)	19 days	Thu 8/30/18	Thu 9/27/18
185	**Top Soil**	**10 days**	**Fri 3/22/19**	**Thu 4/4/19**
186	Purchase and place Topsoil	3 days	Fri 3/22/19	Wed 3/27/19
187	Addition for Topsoil Delivery	6 days	Wed 3/27/19	Thu 4/4/19
188	**Post-Construction Stormwater Controls**	**7 days**	**Thu 4/4/19**	**Tue 4/16/19**
189	**Install Terraces**	**2 days**	**Thu 4/4/19**	**Mon 4/8/19**
190	Purchase and place Topsoil	1 day	Thu 4/4/19	Mon 4/8/19
191	Addition for Delivery Distance	1 day	Mon 4/8/19	Mon 4/8/19
192	Final Stormwater Controls	7 days	Thu 4/4/19	Tue 4/16/19
193	**Diversion Berms**	**2 days**	**Thu 4/4/19**	**Mon 4/8/19**
194	Purchase and deliver berm material	1 day	Thu 4/4/19	Mon 4/8/19
195	Spread loose lift before compaction	2 days	Thu 4/4/19	Mon 4/8/19
196	Compact berm	0 days	Thu 4/4/19	Thu 4/4/19
197	**Site Completion**	**200 days**	**Mon 7/9/18**	**Wed 4/24/19**
198	Install temporary irrigation system	3 days	Mon 4/1/19	Thu 4/4/19



West Lake FFS - ROD Remedy

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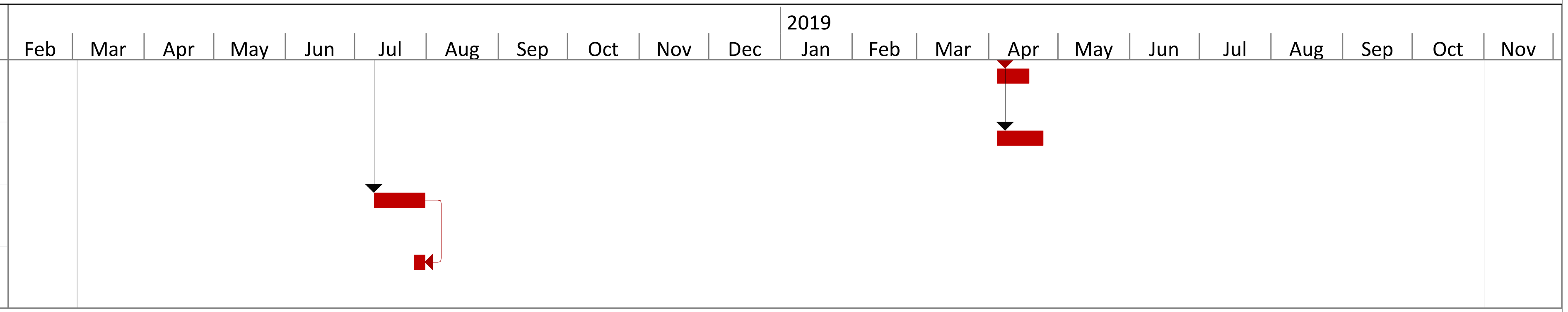
ID	Task Name	Estimated Duration	Start	Finish
199	Apply seeding to cover	9 days	Thu 4/4/19	Thu 4/18/19
200	Install Fencing	14 days	Thu 4/4/19	Wed 4/24/19
201	Clean Leachate Frac Tanks	16 days	Mon 7/9/18	Tue 7/31/18
202	Remove Leachate Frac Tanks	3 days	Thu 7/26/18	Tue 7/31/18



Note: All dates are for planning purposes only - not actual dates.

Estimated Schedule

"Complete Rad Removal" with Off-Site Disposal Alternative

OVERVIEW OF "COMPLETE RAD REMOVAL" (>7.9 PCI/G) CONSTRUCTION SCHEDULE

Final Feasibility Study, West Lake Landfill

OVERALL PROJECT: *MARCH 2018 – APRIL 2030 (12.1 YEARS)*

Site-wide Preparations – *MARCH - AUGUST 2018*

- Mobilization, Construction Trailers, Project Infrastructure, RIM Loading Station

Area 1 – *MARCH 2018 – JUNE 2024*

- Site Preparations – *MARCH - APRIL 2018*
- Waste Excavation – *AUGUST 2018 – MARCH 2021*
    - Ship RIM offsite, stockpile overburden
- Waste Backfilling and Regrading – *MARCH 2021 – FEBRUARY 2024*
    - Backfill excavation, regrade other waste as necessary
- Final Cover – *FEBRUARY - MAY 2024*
- Stormwater Controls and Site Completion – *MAY - JUNE 2024*

Partially overlapping:

Area 2 – *FEBRUARY 2021 – JANUARY 2030*

- Site Preparations – *FEBRUARY – MARCH 2021*
- Waste Excavation – *MARCH 2021 – OCTOBER 2026*
    - Ship RIM offsite, stockpile overburden, backfill where possible
    - Including Buffer Zone
- Remaining Waste Backfilling and Regrading – *OCTOBER 2026– MAY 2029*
    - Backfill excavation, regrade other waste as necessary
- Additional Fill – *MAY 2029*
- Final Cover – *MAY - DECEMBER 2029*
- Stormwater Controls and Site Completion – *THROUGH JANUARY 2030*

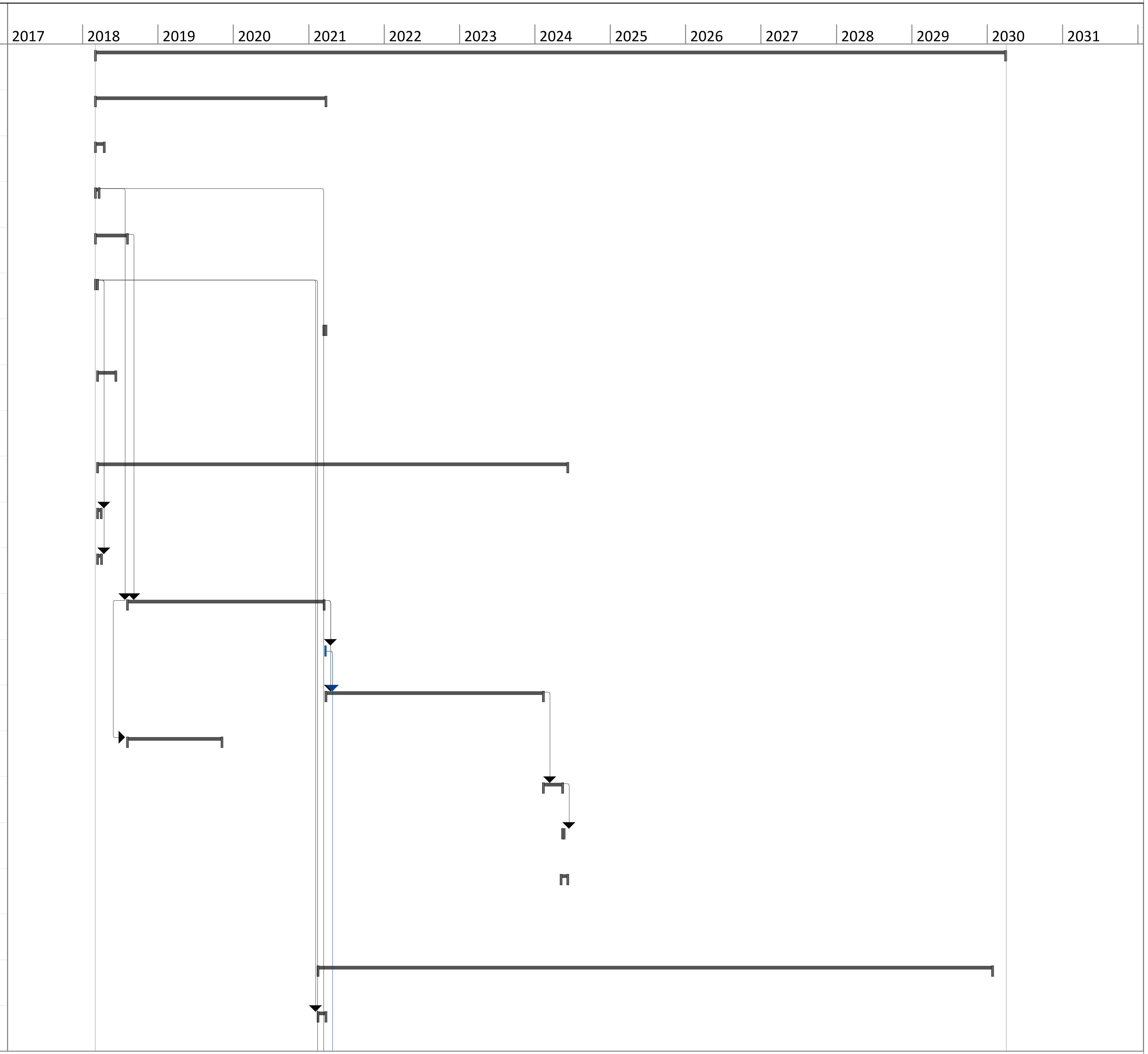
Clean-up and Demolition –*ENDING APRIL 2030*

- Takes place as appropriate throughout project

West Lake FFS - Complete Rad Removal

DRAFT - Subject to Revision

ID	Task Name	Estimated Duration	Start	Finish
1	**Complete Rad Removal Schedule**	**3039 days**	**Mon 3/5/18**	**Tue 4/2/30**
2	**Site-wide Preparation**	**771 days**	**Mon 3/5/18**	**Fri 3/26/21**
3	**Temporary Construction Facilities / Utilities**	**31 days**	**Mon 3/5/18**	**Tue 4/17/18**
6	**Stormwater Treatment Facility**	**15 days**	**Mon 3/5/18**	**Fri 3/23/18**
8	**RIM Loading Station**	**110 days**	**Mon 3/5/18**	**Tue 8/7/18**
11	**Mobilization**	**9 days**	**Mon 3/5/18**	**Thu 3/15/18**
22	**Supplemental Mobilization**	**9 days**	**Tue 3/16/21**	**Fri 3/26/21**
33	**Road & Traffic Improvements**	**62 days**	**Thu 3/15/18**	**Tue 6/12/18**
49				
50	**Area 1**	**1570 days**	**Thu 3/15/18**	**Mon 6/10/24**
51	**Temporary Stormwater Infrastructure**	**13 days**	**Thu 3/15/18**	**Tue 4/3/18**
57	**Site Preparation**	**13 days**	**Thu 3/15/18**	**Tue 4/3/18**
73	**Waste Excavation**	**654 days**	**Wed 8/8/18**	**Wed 3/17/21**
90	Final Radiological Survey	7 days	Wed 3/17/21	Fri 3/26/21
91	**Waste Backfill and Regrading**	**724 days**	**Fri 3/26/21**	**Mon 2/12/24**
119	**Leachate Handling**	**316 days**	**Wed 8/8/18**	**Fri 11/8/19**
124	**Final Cover**	**67 days**	**Mon 2/12/24**	**Thu 5/16/24**
132	**Post-Construction Stormwater Controls**	**5 days**	**Thu 5/16/24**	**Thu 5/23/24**
141	**Site Completion**	**22 days**	**Wed 5/8/24**	**Mon 6/10/24**
145				
146	**Area 2**	**2251 days**	**Tue 2/16/21**	**Tue 1/29/30**
147	**Temporary Stormwater Infrastructure**	**29 days**	**Tue 2/16/21**	**Fri 3/26/21**



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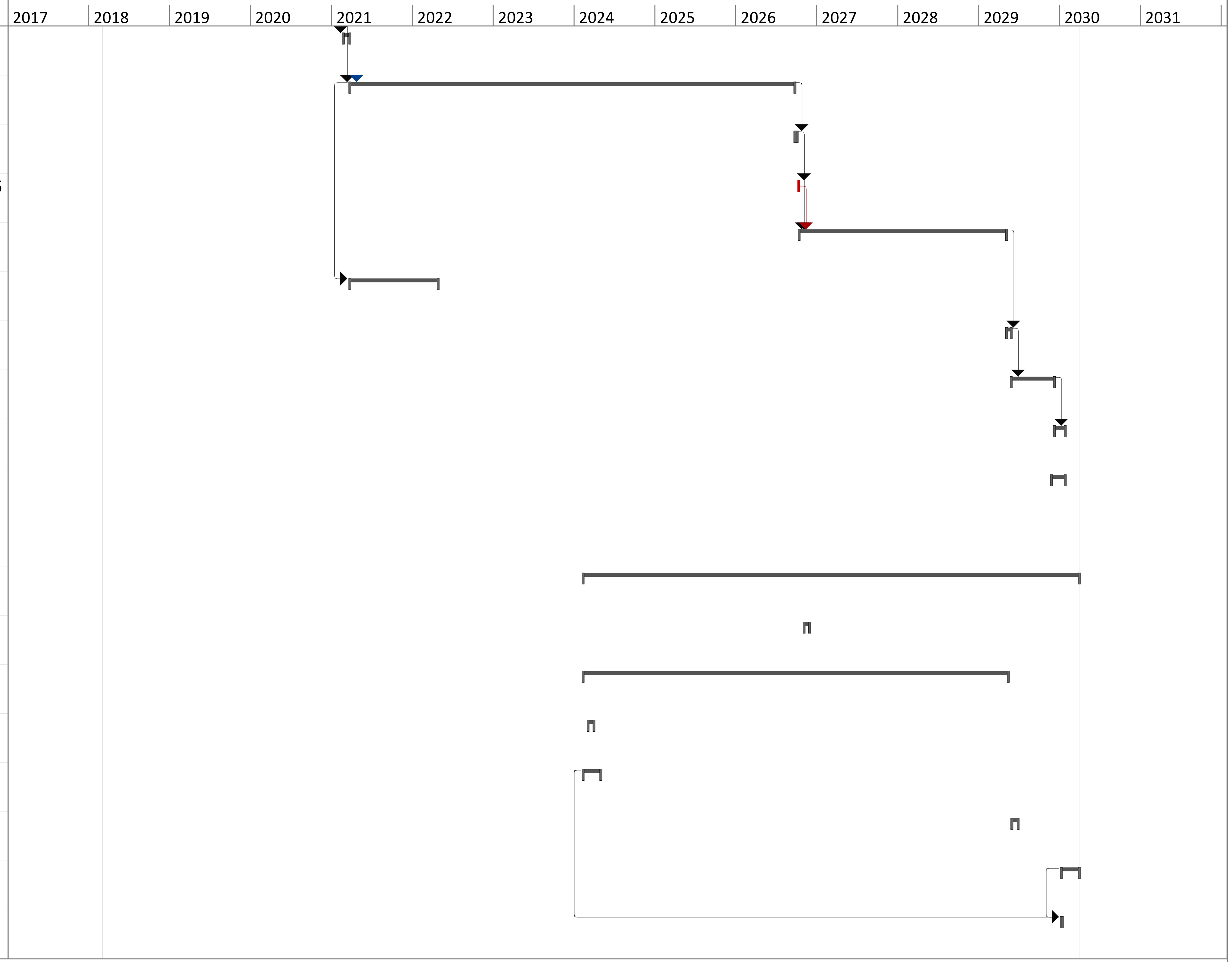
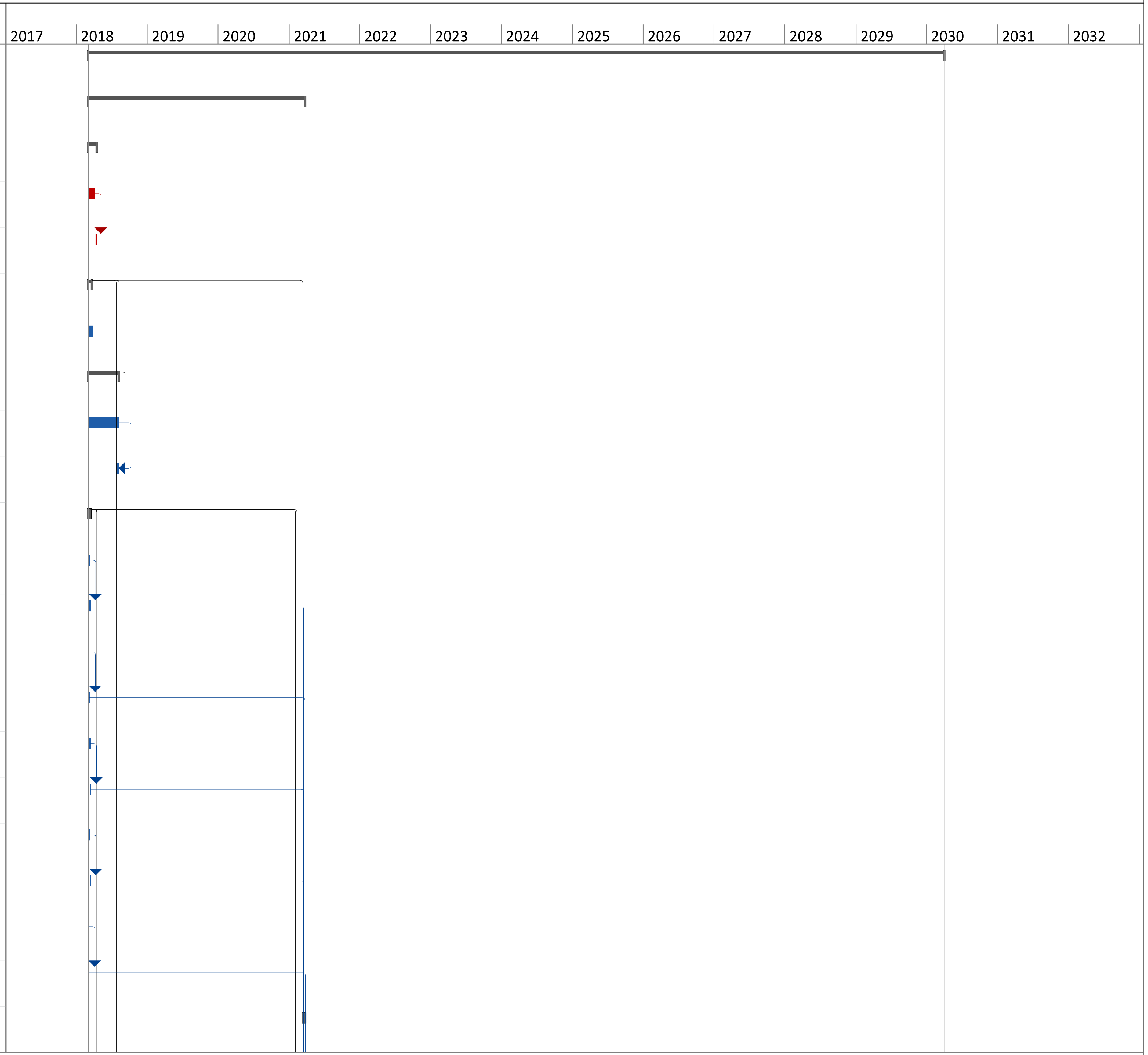
ID	Task Name	Estimated Duration	Start	Finish
153	**Site Preparation**	**22 days**	**Wed 2/24/21**	**Fri 3/26/21**
169	**Waste Excavation**	**1385 days**	**Fri 3/26/21**	**Fri 9/25/26**
228	**Buffer Zone**	**6 days**	**Fri 9/25/26**	**Mon 10/5/26**
230	Final Radiological Survey	7 days	Tue 10/6/26	Wed 10/14/26
231	**Waste Backfill and Regrading**	**646 days**	**Thu 10/15/26**	**Wed 5/9/29**
273	**Leachate Handling**	**276 days**	**Fri 3/26/21**	**Fri 4/29/22**
278	**Additional Fill**	**13 days**	**Wed 5/9/29**	**Tue 5/29/29**
282	**Final Cover**	**135 days**	**Tue 5/29/29**	**Tue 12/11/29**
295	**Post-Construction Stormwater Controls**	**31 days**	**Tue 12/11/29**	**Tue 1/29/30**
310	**Site Completion**	**40 days**	**Tue 11/27/29**	**Mon 1/28/30**
314				
315	**Clean-up and Demolition**	**1544 days**	**Mon 2/12/24**	**Tue 4/2/30**
316	**RIM Loading Station**	**15 days**	**Fri 11/6/26**	**Tue 12/1/26**
319	**Haul Road between Areas and Loading Stat**	**1324 days**	**Mon 2/12/24**	**Wed 5/16/29**
328	**Area 1 Leachate Frac Tanks**	**20 days**	**Tue 3/5/24**	**Tue 4/2/24**
331	**Area 1 Stormwater Frac Tanks**	**58 days**	**Mon 2/12/24**	**Thu 5/2/24**
334	**Area 2 Leachate Frac Tanks**	**20 days**	**Fri 6/1/29**	**Fri 6/29/29**
337	**Area 2 Stormwater Frac Tanks**	**58 days**	**Fri 1/11/30**	**Tue 4/2/30**
340	**Stormwater Treatment Facility**	**2 days**	**Fri 1/11/30**	**Tue 1/15/30**



West Lake FFS - Complete Rad Removal

DRAFT - Subject to Revision

ID	Task Name	Estimated Duration	Start	Finish
1	**Complete Rad Removal Schedule**	**3039 days**	**Mon 3/5/18**	**Tue 4/2/30**
2	**Site-wide Preparation**	**771 days**	**Mon 3/5/18**	**Fri 3/26/21**
3	**Temporary Construction Facilities / Utilities**	**31 days**	**Mon 3/5/18**	**Tue 4/17/18**
4	Construction Trailers	25 days	Mon 3/5/18	Fri 4/6/18
5	Parking Area	6 days	Mon 4/9/18	Tue 4/17/18
6	**Stormwater Treatment Facility**	**15 days**	**Mon 3/5/18**	**Fri 3/23/18**
7	Construction	15 days	Mon 3/5/18	Fri 3/23/18
8	**RIM Loading Station**	**110 days**	**Mon 3/5/18**	**Tue 8/7/18**
9	Construction	110 days	Mon 3/5/18	Tue 8/7/18
10	Air Treatment System	10 days	Wed 7/25/18	Tue 8/7/18
11	**Mobilization**	**9 days**	**Mon 3/5/18**	**Thu 3/15/18**
12	Mobilize and Demobilize Equipment by Pi	4 days	Mon 3/5/18	Thu 3/8/18
13	Extra Mileage for Mobilizations	3 days	Fri 3/9/18	Wed 3/14/18
14	Mobilize and Demobilize Equipment by 3-	2 days	Mon 3/5/18	Wed 3/7/18
15	Extra Mileage for Mobilizations	1 day	Wed 3/7/18	Thu 3/8/18
16	Mobilize and Demobilize Equipment by 20-ton Trailer	6 days	Mon 3/5/18	Mon 3/12/18
17	Extra Mileage for Mobilizations	3 days	Tue 3/13/18	Thu 3/15/18
18	Mobilize and Demobilize Equipment by 40-ton Trailer	5 days	Mon 3/5/18	Fri 3/9/18
19	Extra Mileage for Mobilizations	2 days	Mon 3/12/18	Wed 3/14/18
20	Mobilize and Demobilize Crane Equipment (75+ tons)	1 day	Mon 3/5/18	Mon 3/5/18
21	Extra Mileage for Mobilizations	0 days	Mon 3/5/18	Tue 3/6/18
22	**Supplemental Mobilization**	**9 days**	**Tue 3/16/21**	**Fri 3/26/21**



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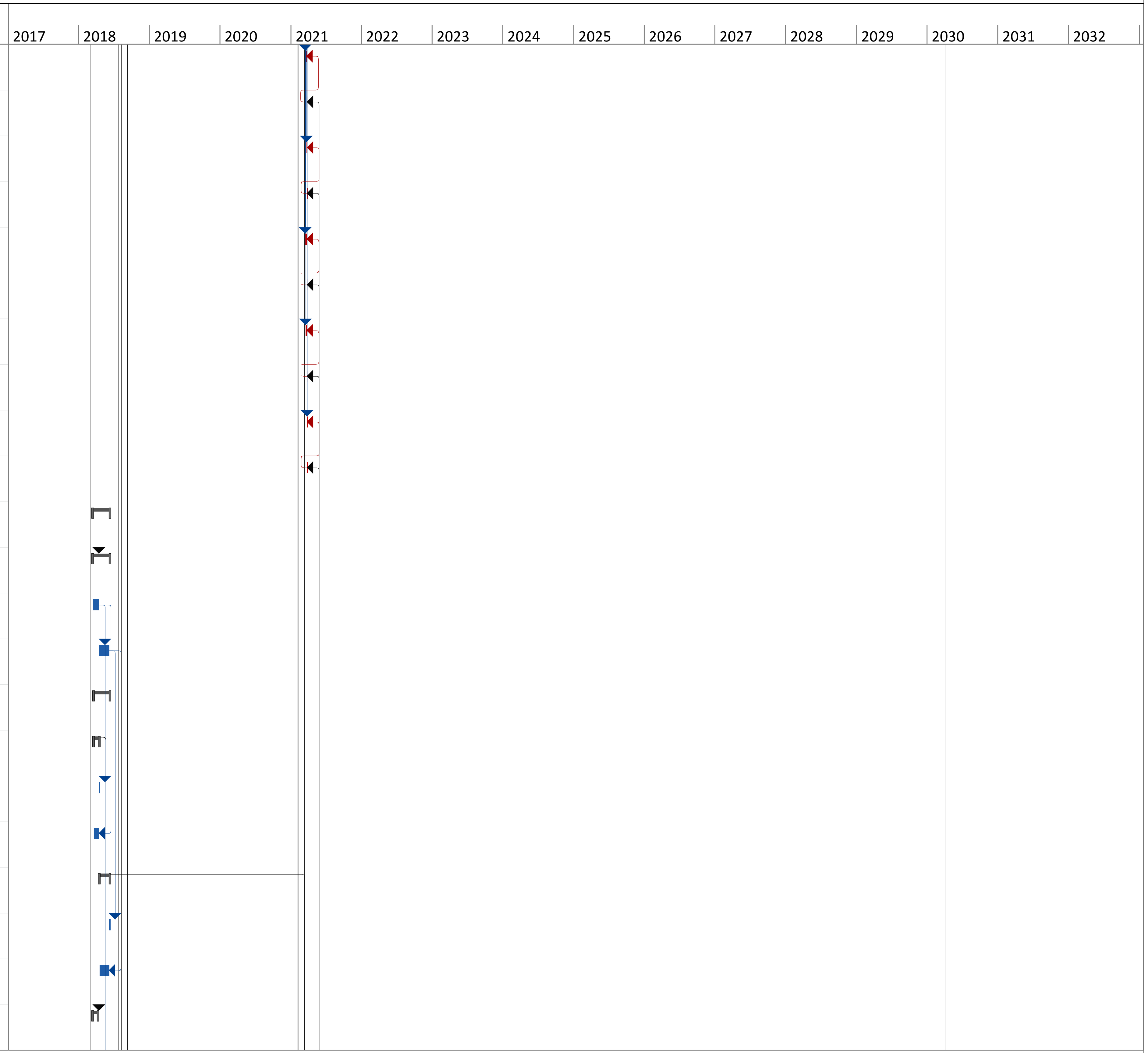
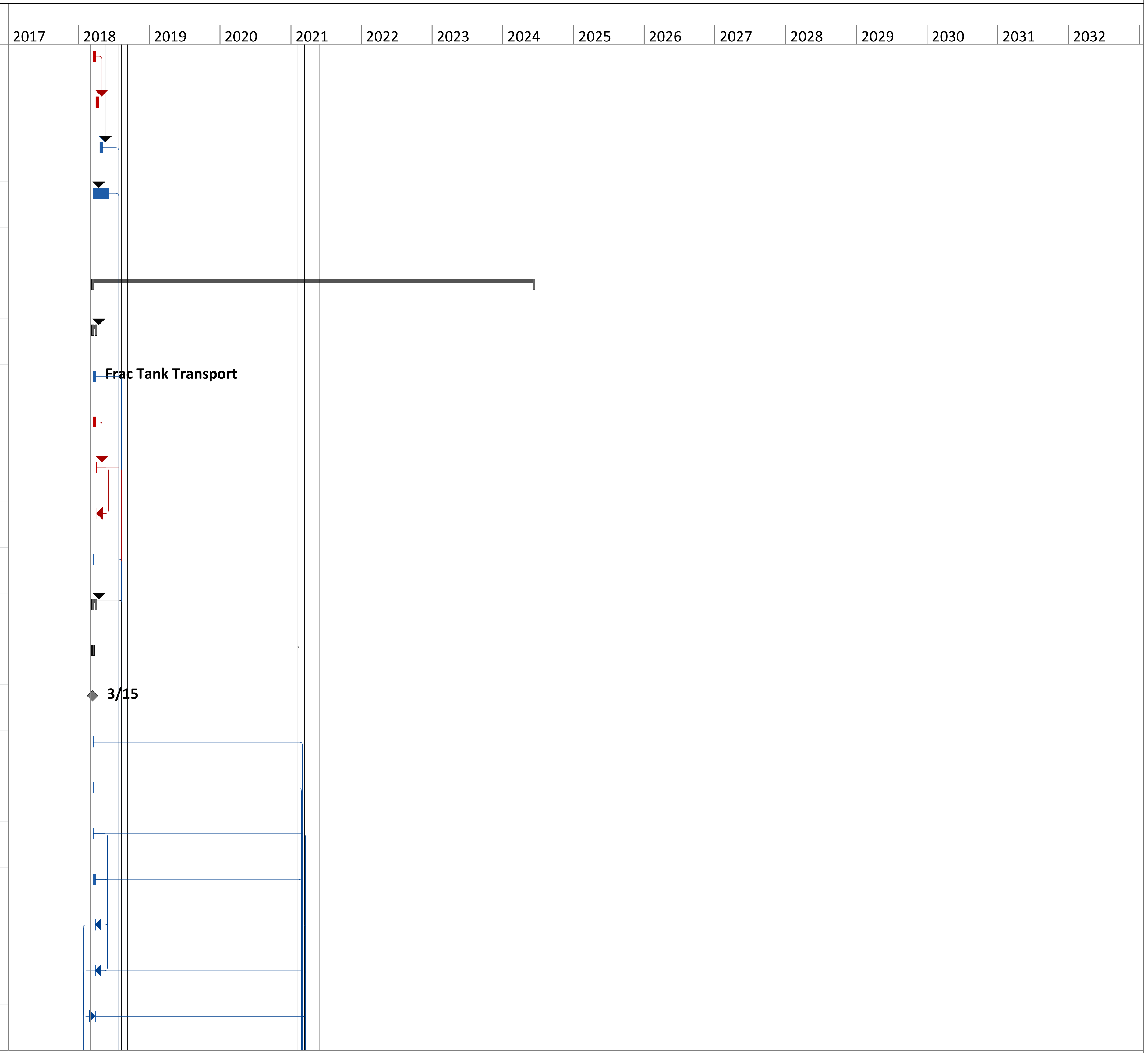
ID	Task Name	Estimated Duration	Start	Finish
23	Mobilize and Demobilize Equipment by Pi	4 days	Wed 3/17/21	Tue 3/23/21
24	Extra Mileage for Mobilizations	3 days	Tue 3/23/21	Fri 3/26/21
25	Mobilize and Demobilize Equipment by 3-	2 days	Tue 3/23/21	Thu 3/25/21
26	Extra Mileage for Mobilizations	1 day	Thu 3/25/21	Fri 3/26/21
27	Mobilize and Demobilize Equipment by 20-ton Trailer	6 days	Tue 3/16/21	Wed 3/24/21
28	Extra Mileage for Mobilizations	3 days	Wed 3/24/21	Fri 3/26/21
29	Mobilize and Demobilize Equipment by 40-ton Trailer	5 days	Wed 3/17/21	Wed 3/24/21
30	Extra Mileage for Mobilizations	2 days	Wed 3/24/21	Fri 3/26/21
31	Mobilize and Demobilize Crane Equipment (75+ tons)	1 day	Thu 3/25/21	Fri 3/26/21
32	Extra Mileage for Mobilizations	0 days	Fri 3/26/21	Fri 3/26/21
33	**Road & Traffic Improvements**	**62 days**	**Thu 3/15/18**	**Tue 6/12/18**
34	**Temporary Roads**	**62 days**	**Thu 3/15/18**	**Tue 6/12/18**
35	Area 1	22 days	Thu 3/15/18	Mon 4/16/18
36	Area 2	37 days	Mon 4/16/18	Thu 6/7/18
37	**Upgrades to Road between Areas and RIM Loading Station**	**59 days**	**Tue 3/20/18**	**Tue 6/12/18**
38	**Area 1**	**22 days**	**Tue 3/20/18**	**Thu 4/19/18**
39	Fencing	3 days	Mon 4/16/18	Thu 4/19/18
40	Silt Fencing	19 days	Tue 3/20/18	Mon 4/16/18
41	**Area 2**	**38 days**	**Wed 4/18/18**	**Tue 6/12/18**
42	Fencing	3 days	Thu 6/7/18	Tue 6/12/18
43	Silt Fencing	35 days	Wed 4/18/18	Thu 6/7/18
44	**Install TBD Traffic Improvements**	**20 days**	**Thu 3/15/18**	**Thu 4/12/18**

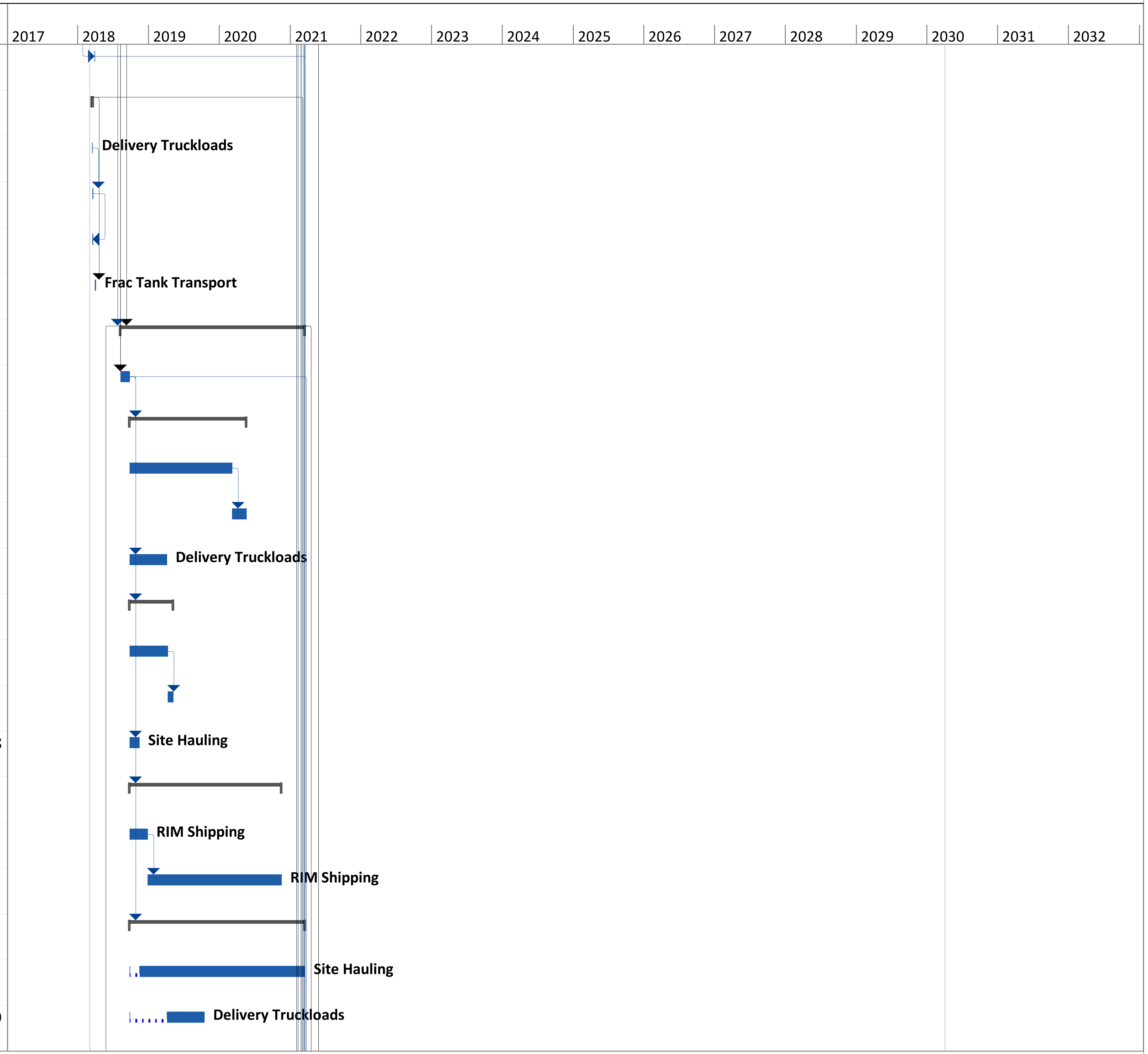


Note: All dates are for planning purposes only - not actual dates.

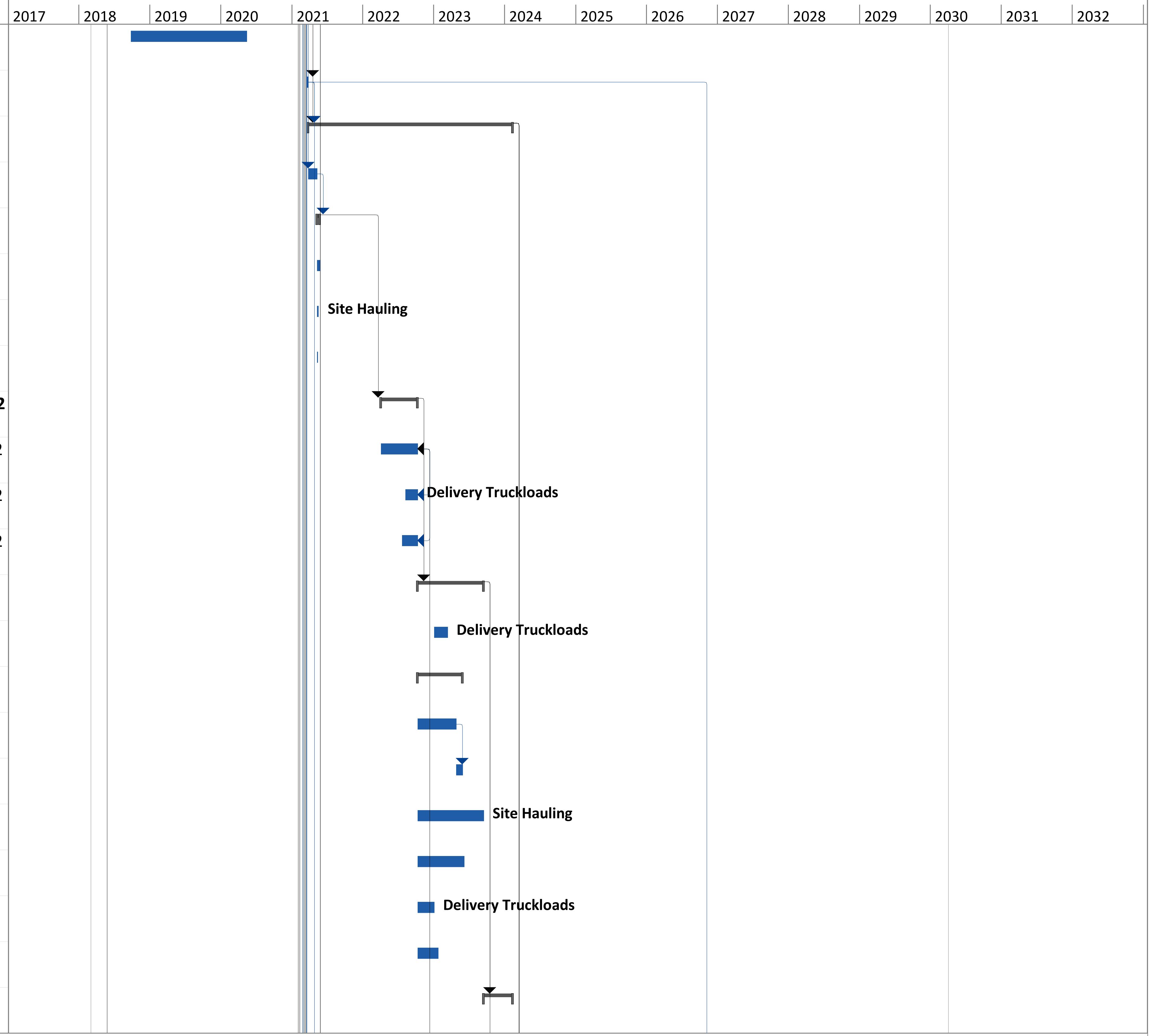
ID	Task Name	Estimated Duration	Start	Finish
45	Area 1	10 days	Thu 3/15/18	Thu 3/29/18
46	Area 2	10 days	Thu 3/29/18	Thu 4/12/18
47	Bridge over Entrance Road	9 days	Thu 4/19/18	Wed 5/2/18
48	Extend Permanent Road to new Transfer :	59 days	Thu 3/15/18	Wed 6/6/18
49				
50	**Area 1**	**1570 days**	**Thu 3/15/18**	**Mon 6/10/24**
51	**Temporary Stormwater Infrastructure**	**13 days**	**Thu 3/15/18**	**Tue 4/3/18**
52	Deliver Frac Tanks	10 days	Thu 3/15/18	Thu 3/29/18
53	Install forcemain from Excavation to Tank	11 days	Thu 3/15/18	Fri 3/30/18
54	Install forcemain from Tank Area to Treatment Facility	1 day	Fri 3/30/18	Tue 4/3/18
55	Install forcemain valves	0 days	Mon 4/2/18	Tue 4/3/18
56	Prepare area with Stormwater BMPS	2 days	Thu 3/15/18	Mon 3/19/18
57	**Site Preparation**	**13 days**	**Thu 3/15/18**	**Tue 4/3/18**
58	**Decontamination Area**	**3 days**	**Thu 3/15/18**	**Tue 3/20/18**
59	Materials	0 days	Thu 3/15/18	Thu 3/15/18
60	Installation	0 days	Thu 3/15/18	Thu 3/15/18
61	Building Construction	3 days	Thu 3/15/18	Tue 3/20/18
62	Clear Vegetation (Light)	0 days	Thu 3/15/18	Thu 3/15/18
63	Clear Vegetation (Heavy)	9 days	Thu 3/15/18	Tue 3/27/18
64	Clear Small Trees	0 days	Tue 3/27/18	Tue 3/27/18
65	Clear Large Trees	0 days	Tue 3/27/18	Tue 3/27/18
66	Clear Small Stumps	2 days	Tue 3/27/18	Fri 3/30/18



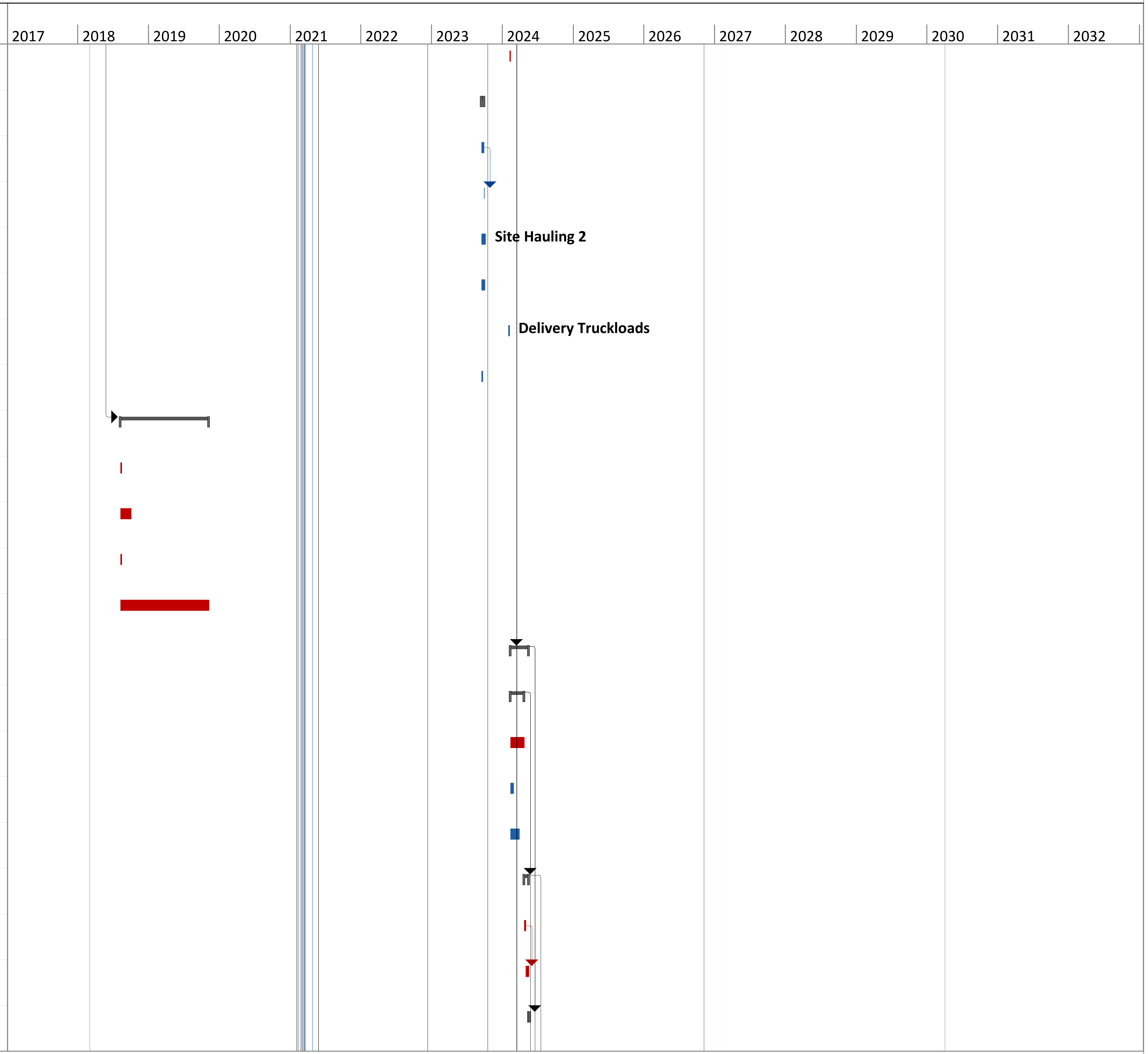
ID	Task Name	Estimated Duration	Start	Finish
67	Clear Large Stumps	1 day	Tue 3/27/18	Wed 3/28/18
68	**Secondary Containment for Frac Tanks**	**2 days**	**Thu 3/15/18**	**Mon 3/19/18**
69	Purchase and deliver liner/berm mater	1 day	Thu 3/15/18	Fri 3/16/18
70	Spread material	1 day	Fri 3/16/18	Mon 3/19/18
71	Compact liner/berms	1 day	Fri 3/16/18	Mon 3/19/18
72	Leachate Frac Tanks Delivery	3 days	Thu 3/29/18	Tue 4/3/18
73	**Waste Excavation**	**654 days**	**Wed 8/8/18**	**Wed 3/17/21**
74	Dewater excavation construction after rain events (budgeted weather delays)	33 days	Wed 8/8/18	Mon 9/24/18
75	**Excavate and Sort RIM and Overburden**	**414 days**	**Mon 9/24/18**	**Tue 5/19/20**
76	Excavate Waste & Stockpile RIM	362 days	Mon 9/24/18	Fri 3/6/20
77	Load Overburden into Haul Trucks	52 days	Fri 3/6/20	Tue 5/19/20
78	Apply daily cover to remaining excavatior	130 days	Mon 9/24/18	Thu 4/4/19
79	**Load RIM from local stockpiles onto Hau**	**154 days**	**Mon 9/24/18**	**Tue 5/7/19**
80	Excavate	134 days	Mon 9/24/18	Tue 4/9/19
81	Load	20 days	Tue 4/9/19	Tue 5/7/19
82	Haul RIM to Loading Station	36 days	Mon 9/24/18	Wed 11/14/18
83	**RIM Loading & Shipping**	**540 days**	**Mon 9/24/18**	**Tue 11/17/20**
84	Startup Rate	63 days	Mon 9/24/18	Thu 12/27/18
85	Full Production Rate	477 days	Thu 12/27/18	Tue 11/17/20
86	**Transport Overburden to Area 2 NE Stoc**	**621 days**	**Mon 9/24/18**	**Wed 3/17/21**
87	Haul to Stockpile	585 days	Mon 9/24/18	Wed 3/17/21
88	Apply daily cover to stockpile	136 days	Mon 9/24/18	Wed 10/16/19



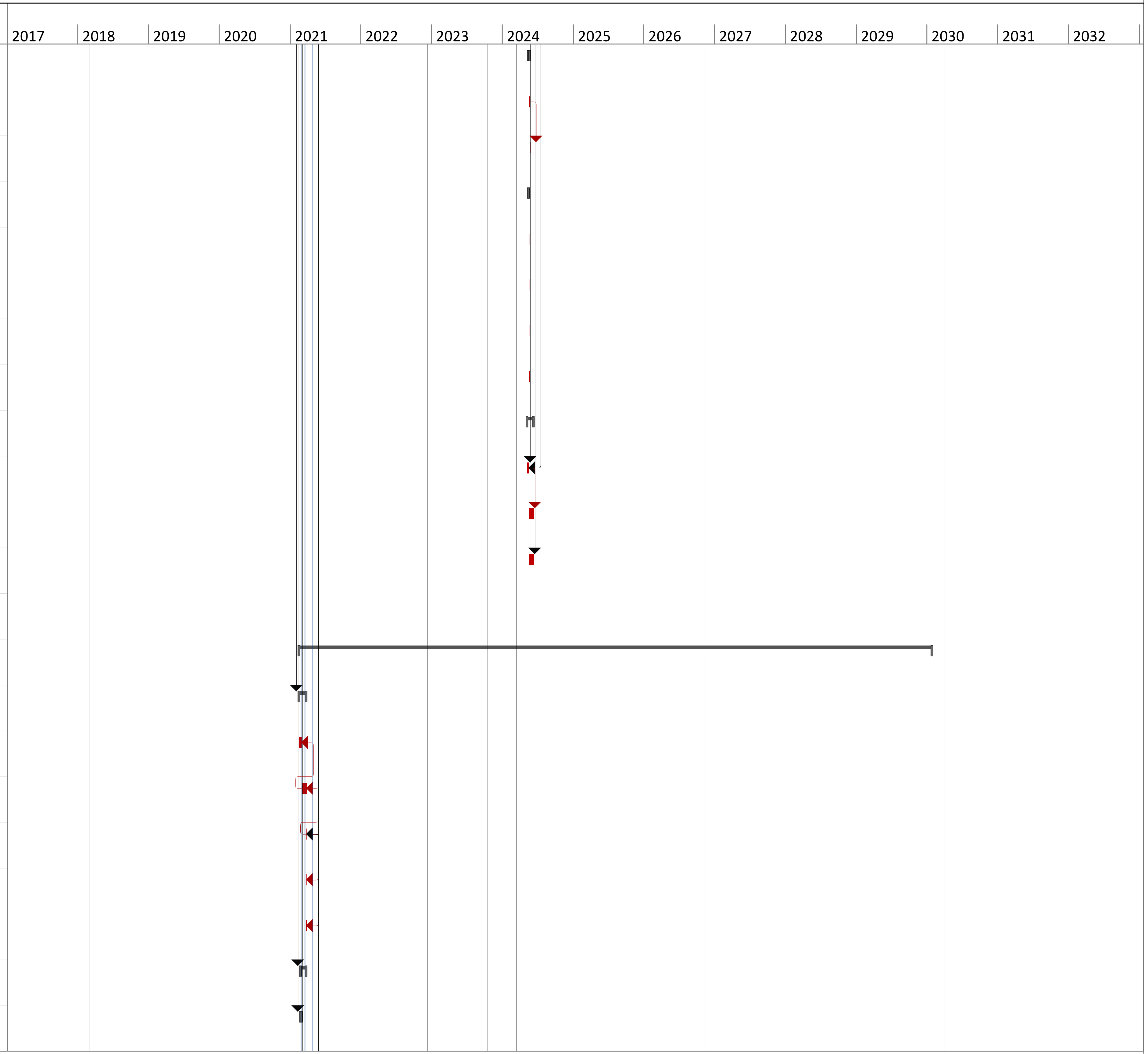
ID	Task Name	Estimated Duration	Start	Finish
89	Grade Stockpile	409 days	Mon 9/24/18	Tue 5/12/20
90	Final Radiological Survey	7 days	Wed 3/17/21	Fri 3/26/21
91	**Waste Backfill and Regrading**	**724 days**	**Fri 3/26/21**	**Mon 2/12/24**
92	Dewater backfill construction after rain events (budgeted weather delays)	32 days	Fri 3/26/21	Tue 5/11/21
93	**C&D Rubble Stockpiles**	**10 days**	**Tue 5/11/21**	**Tue 5/25/21**
94	Relocate Stockpiled Material on-site - E	10 days	Tue 5/11/21	Tue 5/25/21
95	Relocate Stockpiled Material on-site - Haul and Dump	5 days	Tue 5/11/21	Mon 5/17/21
96	Bury Stockpiled Material	2 days	Tue 5/11/21	Thu 5/13/21
97	**Backfill Overburden from Area 2 SW Exca**	**132 days**	**Mon 4/4/22**	**Mon 10/10/22**
98	Spread backfilled material	132 days	Mon 4/4/22	Mon 10/10/22
99	Apply daily cover to backfilled material	44 days	Mon 8/8/22	Mon 10/10/22
100	Compact backfilled material	56 days	Thu 7/21/22	Mon 10/10/22
101	**Backfill to Drainage Grades with Overburden from Area 2 NE Stockpile**	**234 days**	**Mon 10/10/22**	**Fri 9/15/23**
102	Apply daily cover to remaining stockpile excavation	50 days	Tue 1/3/23	Mon 3/13/23
103	**Excavate Overburden**	**158 days**	**Mon 10/10/22**	**Mon 5/29/23**
104	Excavate	137 days	Mon 10/10/22	Thu 4/27/23
105	Load	21 days	Thu 4/27/23	Mon 5/29/23
106	Transport Overburden to back Area 1	234 days	Mon 10/10/22	Fri 9/15/23
107	Spread backfilled material	164 days	Mon 10/10/22	Tue 6/6/23
108	Apply daily cover to backfilled material	55 days	Mon 10/10/22	Tue 1/3/23
109	Compact backfilled material	69 days	Mon 10/10/22	Tue 1/24/23
110	**Slope Correction Cuts**	**101 days**	**Fri 9/15/23**	**Mon 2/12/24**



ID	Task Name	Estimated Duration	Start	Finish
111	Apply daily cover to remaining excavati	3 days	Wed 2/7/24	Mon 2/12/24
112	**Excavate Non-RIM waste to correct slc**	**10 days**	**Fri 9/15/23**	**Fri 9/29/23**
113	Excavate	9 days	Fri 9/15/23	Thu 9/28/23
114	Load	1 day	Thu 9/28/23	Fri 9/29/23
115	Relocated excavated material	15 days	Fri 9/15/23	Fri 10/6/23
116	Spread backfilled material	11 days	Fri 9/15/23	Mon 10/2/23
117	Apply daily cover to backfilled material	4 days	Fri 2/2/24	Wed 2/7/24
118	Compact backfilled material	5 days	Fri 9/15/23	Thu 9/21/23
119	**Leachate Handling**	**316 days**	**Wed 8/8/18**	**Fri 11/8/19**
120	Pumping	4 days	Wed 8/8/18	Tue 8/14/18
121	Tank Transportation on Site	40 days	Wed 8/8/18	Wed 10/3/18
122	Sampling	5 days	Wed 8/8/18	Tue 8/14/18
123	Hauling & Disposal	316 days	Wed 8/8/18	Fri 11/8/19
124	**Final Cover**	**67 days**	**Mon 2/12/24**	**Thu 5/16/24**
125	**Clay**	**51 days**	**Mon 2/12/24**	**Tue 4/23/24**
126	Purchase and deliver clay material	51 days	Mon 2/12/24	Tue 4/23/24
127	Spread loose lift before compaction	10 days	Mon 2/12/24	Tue 2/27/24
128	Compact Clay	34 days	Mon 2/12/24	Fri 3/29/24
129	**Top Soil**	**16 days**	**Tue 4/23/24**	**Thu 5/16/24**
130	Purchase and place Topsoil	6 days	Tue 4/23/24	Wed 5/1/24
131	Addition for Topsoil Delivery	11 days	Wed 5/1/24	Thu 5/16/24
132	**Post-Construction Stormwater Controls**	**5 days**	**Thu 5/16/24**	**Thu 5/23/24**

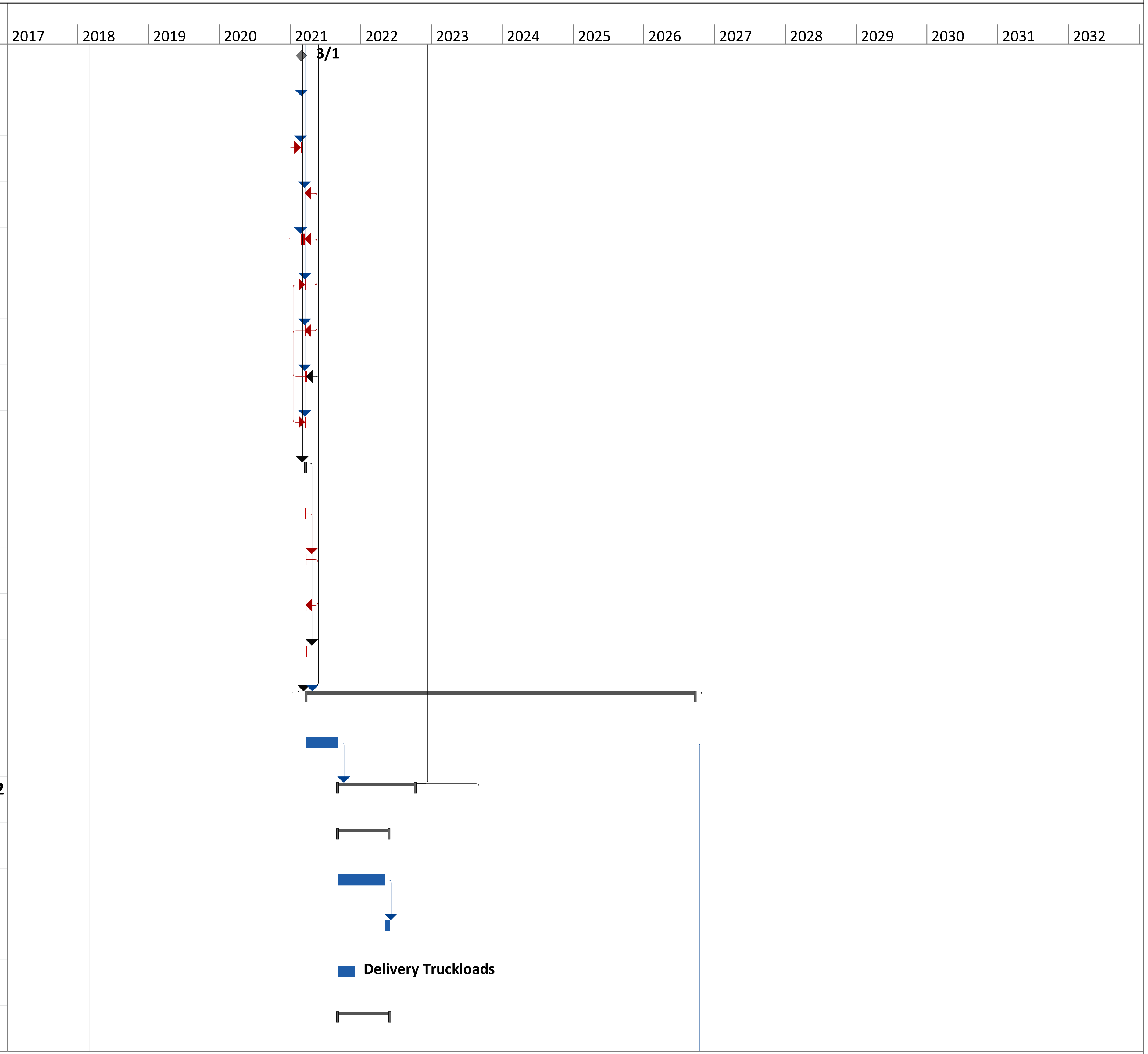


ID	Task Name	Estimated Duration	Start	Finish
133	**Install Terraces**	**4 days**	**Fri 5/17/24**	**Thu 5/23/24**
134	Purchase and place Topsoil	3 days	Fri 5/17/24	Wed 5/22/24
135	Addition for Delivery Distance	1 day	Wed 5/22/24	Thu 5/23/24
136	**Diversion Berms**	**1 day**	**Thu 5/16/24**	**Thu 5/16/24**
137	Purchase and deliver clay material	1 day	Thu 5/16/24	Thu 5/16/24
138	Spread loose lift before compaction	1 day	Thu 5/16/24	Thu 5/16/24
139	Compact berms	0 days	Thu 5/16/24	Thu 5/16/24
140	Final Stormwater Controls	4 days	Thu 5/16/24	Tue 5/21/24
141	**Site Completion**	**22 days**	**Wed 5/8/24**	**Mon 6/10/24**
142	Install temporary irrigation system	5 days	Wed 5/8/24	Thu 5/16/24
143	Apply seeding to cover	16 days	Thu 5/16/24	Mon 6/10/24
144	Install Fencing	16 days	Thu 5/16/24	Mon 6/10/24
145				
146	**Area 2**	**2251 days**	**Tue 2/16/21**	**Tue 1/29/30**
147	**Temporary Stormwater Infrastructure**	**29 days**	**Tue 2/16/21**	**Fri 3/26/21**
148	Deliver Frac Tanks	10 days	Tue 2/16/21	Mon 3/1/21
149	Install forcemain from Excavation to Tank	18 days	Mon 3/1/21	Thu 3/25/21
150	Install forcemain from Tank Area to Treatment Facility	1 day	Thu 3/25/21	Fri 3/26/21
151	Install forcemain valves	0 days	Fri 3/26/21	Fri 3/26/21
152	Prepare area with Stormwater BMPS	3 days	Tue 3/23/21	Fri 3/26/21
153	**Site Preparation**	**22 days**	**Wed 2/24/21**	**Fri 3/26/21**
154	**Decontamination Area**	**3 days**	**Wed 2/24/21**	**Mon 3/1/21**

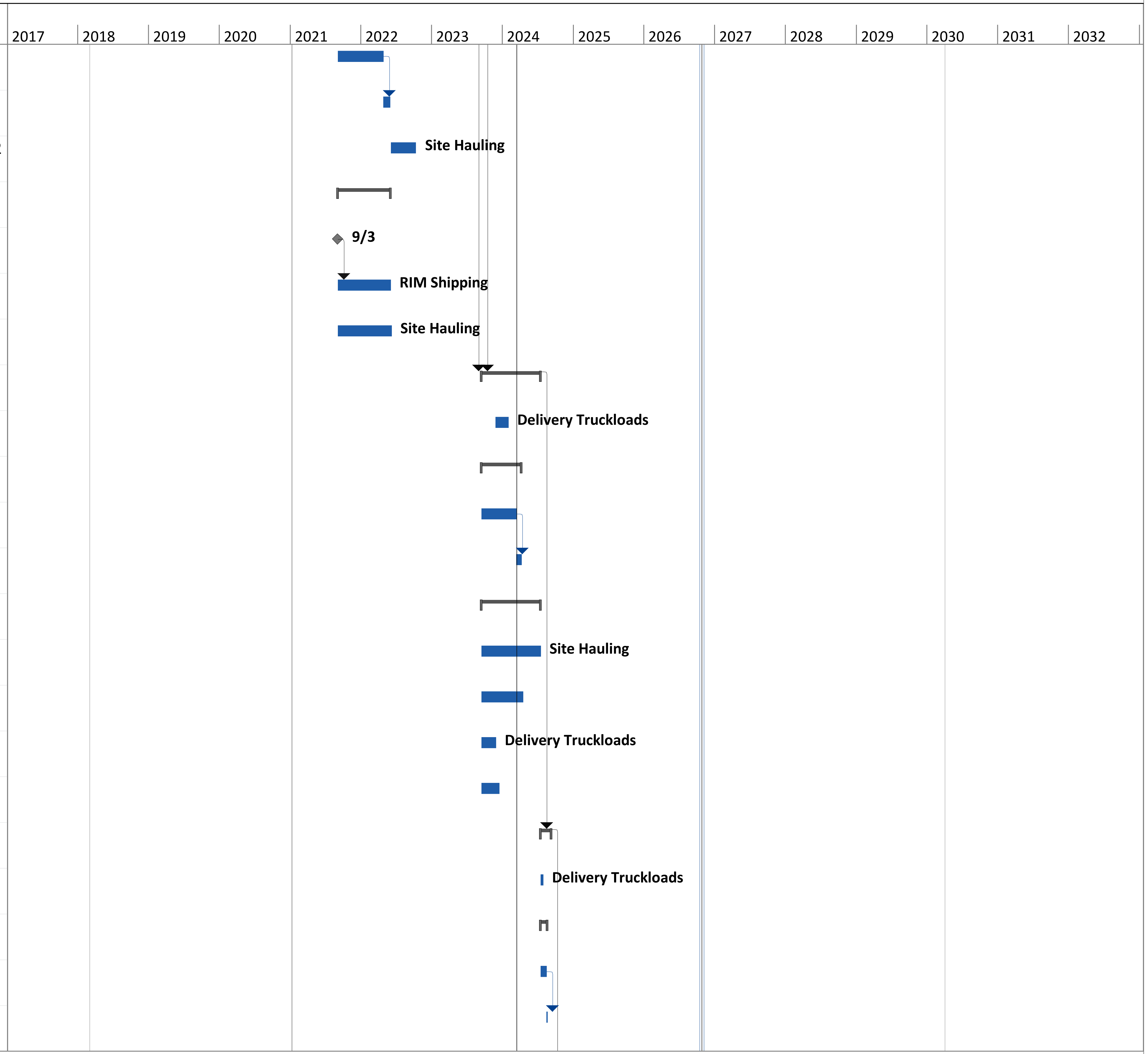


Note: All dates are for planning purposes only - not actual dates.

ID	Task Name	Estimated Duration	Start	Finish
155	Materials	0 days	Mon 3/1/21	Mon 3/1/21
156	Installation	0 days	Mon 3/1/21	Mon 3/1/21
157	Building Construction	3 days	Wed 2/24/21	Mon 3/1/21
158	Clear Vegetation (Light)	1 day	Tue 3/16/21	Wed 3/17/21
159	Clear Vegetation (Heavy)	15 days	Wed 2/24/21	Wed 3/17/21
160	Clear Small Trees	1 day	Wed 3/17/21	Wed 3/17/21
161	Clear Large Trees	1 day	Wed 3/17/21	Wed 3/17/21
162	Clear Small Stumps	7 days	Wed 3/17/21	Fri 3/26/21
163	Clear Large Stumps	3 days	Wed 3/17/21	Mon 3/22/21
164	**Secondary Containment for Frac Tanks**	**2 days**	**Fri 3/19/21**	**Tue 3/23/21**
165	Purchase and deliver liner/berm mater	1 day	Fri 3/19/21	Mon 3/22/21
166	Spread material	1 day	Mon 3/22/21	Tue 3/23/21
167	Compact liner/berms	1 day	Mon 3/22/21	Tue 3/23/21
168	Leachate Frac Tanks Delivery	3 days	Tue 3/23/21	Fri 3/26/21
169	**Waste Excavation**	**1385 days**	**Fri 3/26/21**	**Fri 9/25/26**
170	Dewater excavation construction after rain events (budgeted weather delays)	113 days	Fri 3/26/21	Fri 9/3/21
171	**Excavate SW Area 2**	**276 days**	**Fri 9/3/21**	**Mon 10/10/22**
172	**Excavate and Sort RIM and Overburde**	**182 days**	**Fri 9/3/21**	**Fri 5/27/22**
173	Excavate Waste & Stockpile RIM	165 days	Fri 9/3/21	Tue 5/3/22
174	Load Overburden into Haul Trucks	17 days	Wed 5/4/22	Fri 5/27/22
175	Apply daily cover to remaining excavati	58 days	Fri 9/3/21	Tue 11/30/21
176	**Load RIM from local stockpiles onto H**	**184 days**	**Fri 9/3/21**	**Tue 5/31/22**



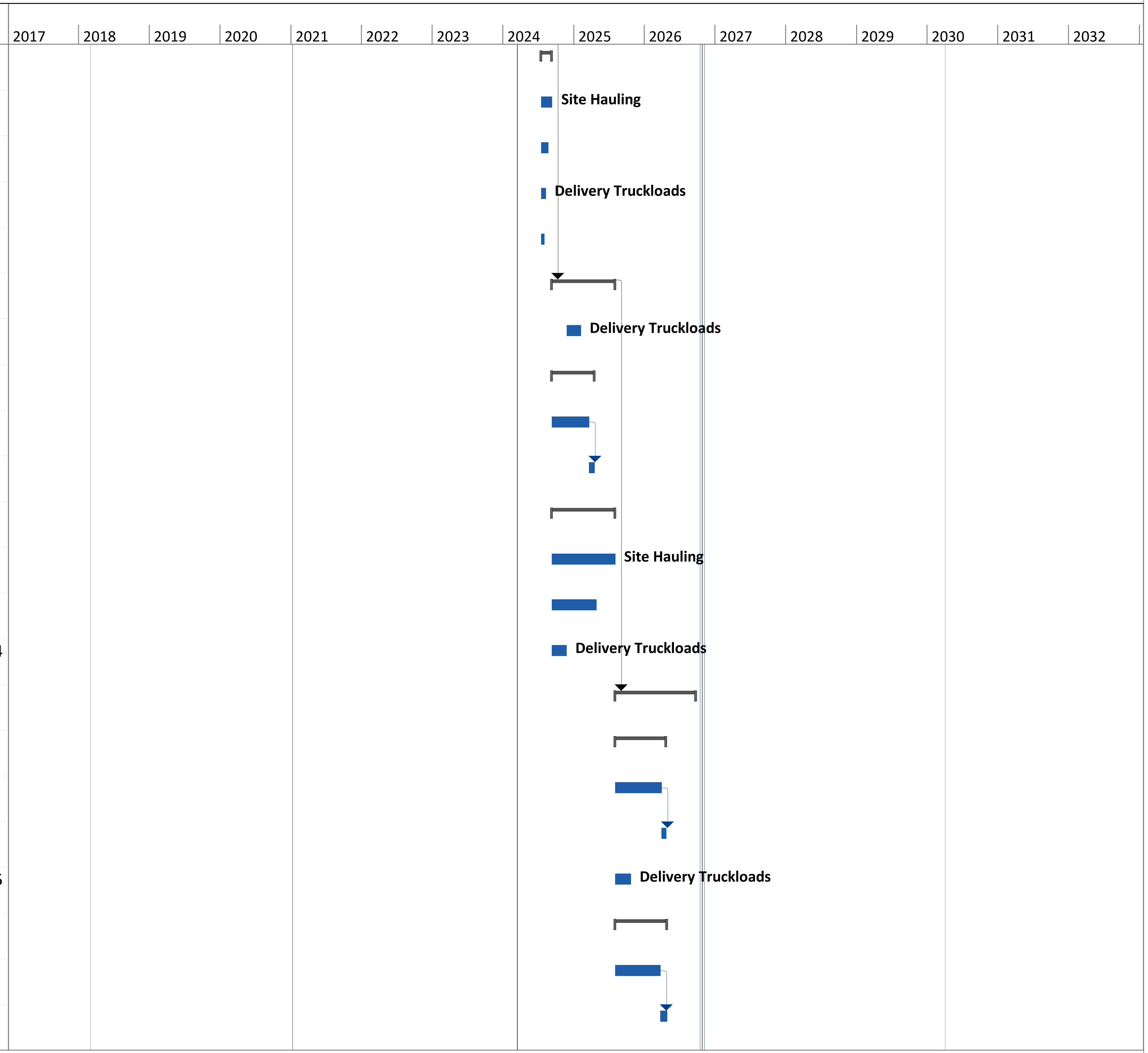
ID	Task Name	Estimated Duration	Start	Finish
177	Excavate	160 days	Fri 9/3/21	Tue 4/26/22
178	Load	24 days	Tue 4/26/22	Tue 5/31/22
179	Haul RIM to Loading Station	89 days	Mon 6/6/22	Mon 10/10/22
180	**RIM Loading & Shipping**	**187 days**	**Fri 9/3/21**	**Fri 6/3/22**
181	Startup Rate	0 days	Fri 9/3/21	Fri 9/3/21
182	Full Production Rate	187 days	Fri 9/3/21	Fri 6/3/22
183	Haul Overburden to Area 1	189 days	Fri 9/3/21	Tue 6/7/22
184	**Excavate NE Area 2 Stockpile for SW Area 2 Drainage Grades**	**210 days**	**Fri 9/15/23**	**Wed 7/17/24**
185	Apply daily cover to remaining stockpil	45 days	Mon 11/27/2:	Wed 1/31/24
186	**Excavate Overburden Stockpile**	**141 days**	**Fri 9/15/23**	**Tue 4/9/24**
187	Excavate Overburden	123 days	Fri 9/15/23	Wed 3/13/24
188	Load Overburden into Haul Trucks	19 days	Thu 3/14/24	Tue 4/9/24
189	**Transport Overburden to SW Area 2**	**210 days**	**Fri 9/15/23**	**Wed 7/17/24**
190	Haul to SW Area 2	210 days	Fri 9/15/23	Wed 7/17/24
191	Grade Backfill/Stockpile	147 days	Fri 9/15/23	Wed 4/17/24
192	Apply daily cover to backfilled/stockpiled material	49 days	Fri 9/15/23	Tue 11/28/23
193	Compact backfilled material	62 days	Fri 9/15/23	Fri 12/15/23
194	**Excavate NE Area 2 Stockpile for SW Area 2 Final Grades**	**37 days**	**Wed 7/17/24**	**Mon 9/9/24**
195	Apply daily cover to remaining stockpil	8 days	Wed 7/17/24	Mon 7/29/24
196	**Excavate Overburden Stockpile**	**25 days**	**Wed 7/17/24**	**Wed 8/21/24**
197	Excavate Overburden	22 days	Wed 7/17/24	Fri 8/16/24
198	Load Overburden into Haul Trucks	3 days	Fri 8/16/24	Wed 8/21/24



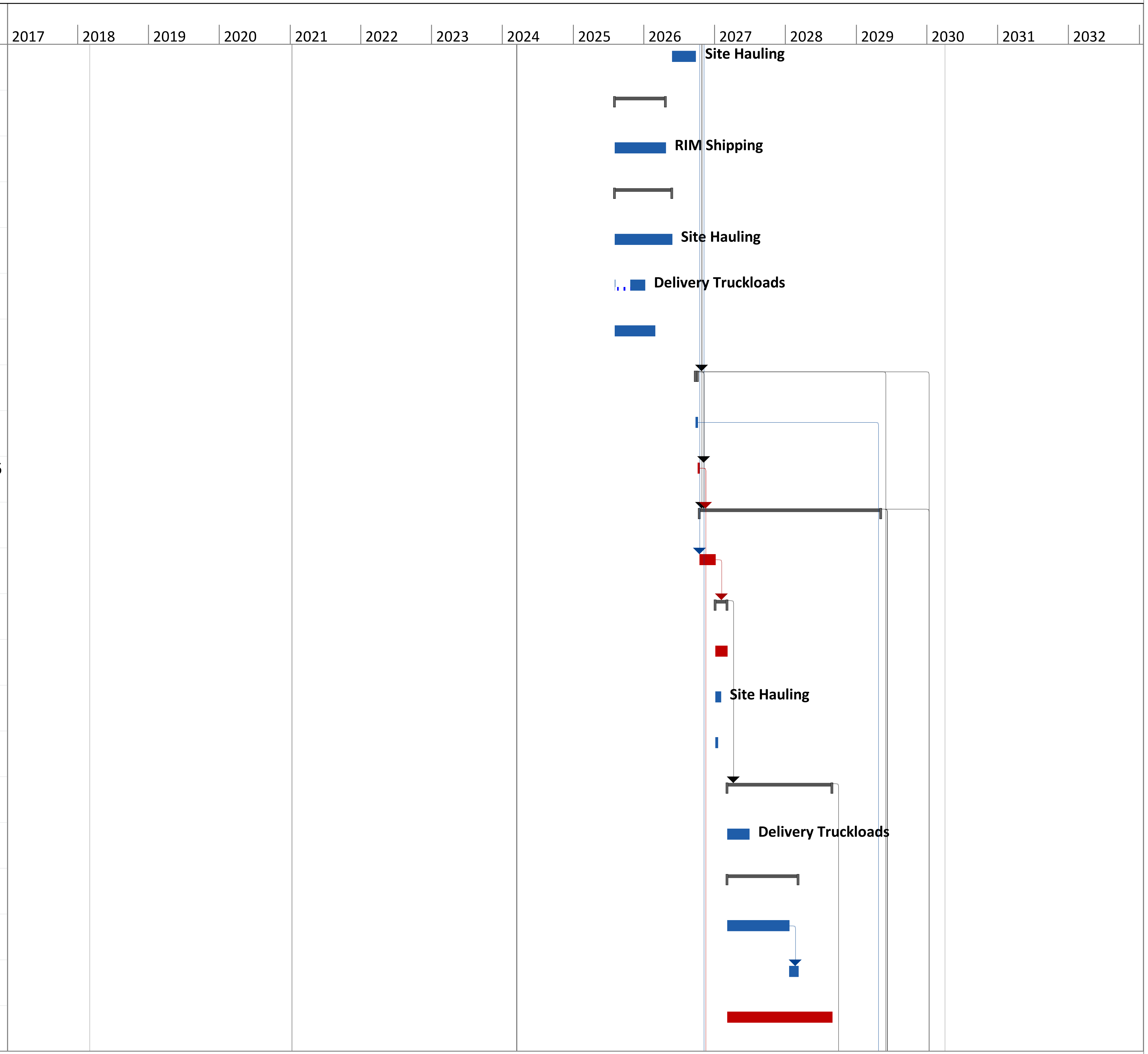
West Lake FFS - Complete Rad Removal

DRAFT - Subject to Revision

ID	Task Name	Estimated Duration	Start	Finish
199	**Transport Overburden to SW Area 2**	**37 days**	**Wed 7/17/24**	**Mon 9/9/24**
200	Haul to SW Area 2	37 days	Wed 7/17/24	Mon 9/9/24
201	Grade Backfill/Stockpile	26 days	Wed 7/17/24	Thu 8/22/24
202	Apply daily cover to backfilled/stockpiled material	9 days	Wed 7/17/24	Fri 8/9/24
203	Compact backfilled material	11 days	Wed 7/17/24	Thu 8/1/24
204	**Move remaining NE Area 2 Stockpile to SW Area 2 stockpile**	**226 days**	**Mon 9/9/24**	**Mon 8/4/25**
205	Apply daily cover to remaining stockpil	48 days	Tue 11/26/24	Thu 2/6/25
206	**Excavate Overburden Stockpile**	**152 days**	**Mon 9/9/24**	**Fri 4/18/25**
207	Excavate Overburden	132 days	Mon 9/9/24	Fri 3/21/25
208	Load Overburden into Haul Trucks	20 days	Fri 3/21/25	Fri 4/18/25
209	**Transport Overburden to SW Area 2**	**226 days**	**Mon 9/9/24**	**Mon 8/4/25**
210	Haul to SW Area 2	226 days	Mon 9/9/24	Mon 8/4/25
211	Grade Backfill/Stockpile	158 days	Mon 9/9/24	Mon 4/28/25
212	Apply daily cover to backfilled/stockpiled material	53 days	Mon 9/9/24	Mon 11/25/24
213	**Excavate NE Area 2**	**288 days**	**Mon 8/4/25**	**Fri 9/25/26**
214	**Excavate and Sort RIM and Overburde**	**180 days**	**Mon 8/4/25**	**Thu 4/23/26**
215	Excavate Waste & Stockpile RIM	162 days	Mon 8/4/25	Mon 3/30/26
216	Load Overburden into Haul Trucks	18 days	Mon 3/30/26	Thu 4/23/26
217	Apply daily cover to remaining excavati	56 days	Mon 8/4/25	Wed 10/22/25
218	**Load RIM from local stockpiles onto H**	**183 days**	**Mon 8/4/25**	**Mon 4/27/26**
219	Excavate	159 days	Mon 8/4/25	Tue 3/24/26
220	Load	24 days	Wed 3/25/26	Mon 4/27/26

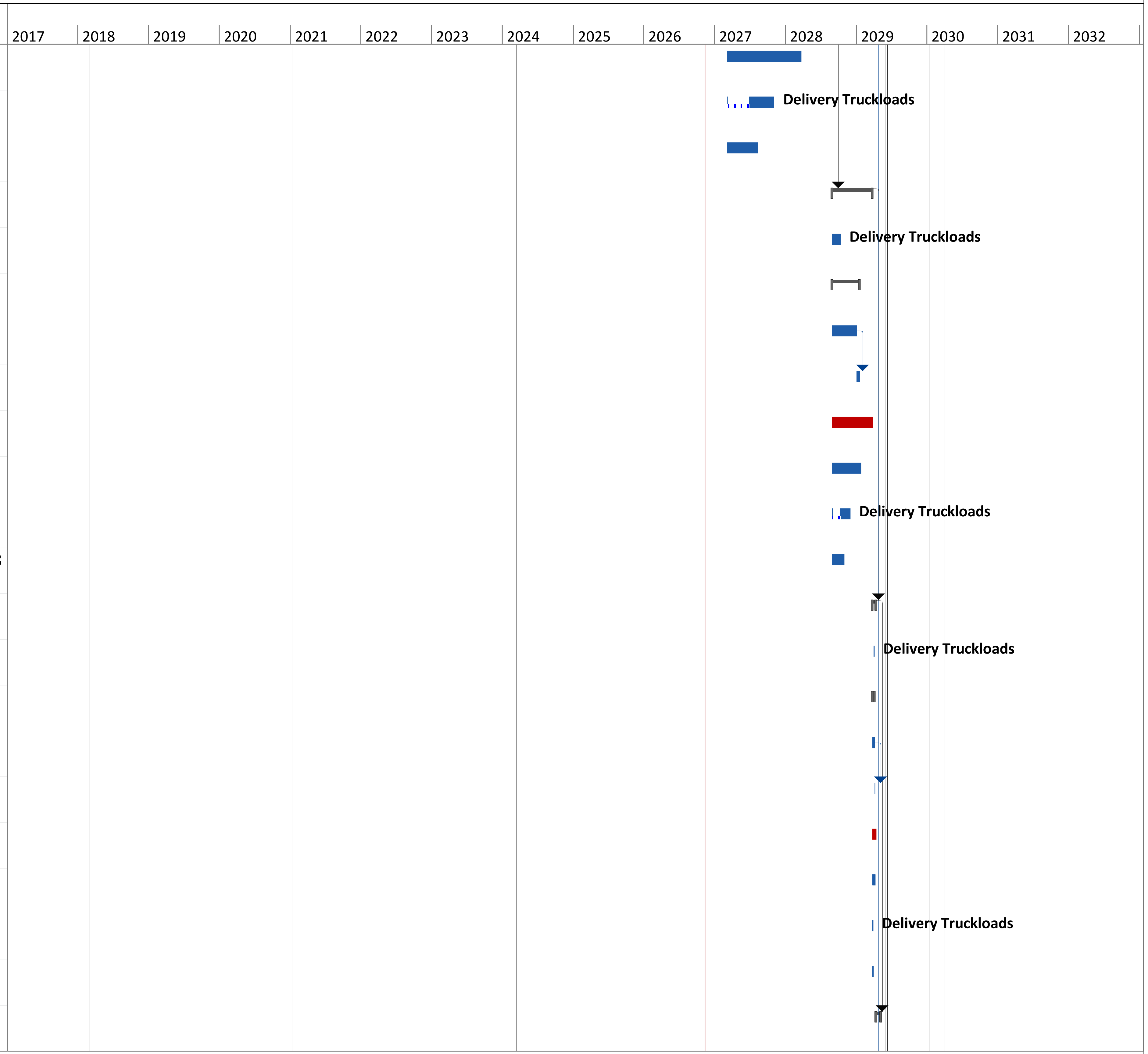


ID	Task Name	Estimated Duration	Start	Finish
221	Haul RIM to Loading Station	86 days	Tue 5/26/26	Fri 9/25/26
222	**RIM Loading & Shipping**	**181 days**	**Mon 8/4/25**	**Fri 4/24/26**
223	Full Production Rate	181 days	Mon 8/4/25	Fri 4/24/26
224	**Transport Overburden to SW Area 2 St**	**202 days**	**Mon 8/4/25**	**Tue 5/26/26**
225	Haul to SW Area 2	202 days	Mon 8/4/25	Tue 5/26/26
226	Apply daily cover to stockpiled mate	47 days	Mon 8/4/25	Tue 1/6/26
227	Grade Stockpile	141 days	Mon 8/4/25	Fri 2/27/26
228	**Buffer Zone**	**6 days**	**Fri 9/25/26**	**Mon 10/5/26**
229	Buffer Zone Activity	6 days	Fri 9/25/26	Mon 10/5/26
230	Final Radiological Survey	7 days	Tue 10/6/26	Wed 10/14/26
231	**Waste Backfill and Regrading**	**646 days**	**Thu 10/15/26**	**Wed 5/9/29**
232	Dewater backfill construction after rain events (budgeted weather delays)	52 days	Thu 10/15/26	Tue 1/5/27
233	**C&D Rubble Stockpiles**	**44 days**	**Tue 1/5/27**	**Mon 3/8/27**
234	Relocate Stockpiled Material on-site - E	44 days	Tue 1/5/27	Mon 3/8/27
235	Relocate Stockpiled Material on-site - Haul and Dump	20 days	Tue 1/5/27	Tue 2/2/27
236	Bury Stockpiled Material	9 days	Tue 1/5/27	Mon 1/18/27
237	**Backfill NE Area 2 Drainage Grades with Overburden from SW Area 2 Stockpile**	**377 days**	**Mon 3/8/27**	**Wed 8/30/28**
238	Apply daily cover to remaining stockpile excavation	80 days	Mon 3/8/27	Mon 6/28/27
239	**Excavate Overburden**	**253 days**	**Mon 3/8/27**	**Wed 3/8/28**
240	Excavate	220 days	Mon 3/8/27	Thu 1/20/28
241	Load	33 days	Thu 1/20/28	Wed 3/8/28
242	Transport Overburden back to NE Area	377 days	Mon 3/8/27	Wed 8/30/28



West Lake FFS - Complete Rad Removal

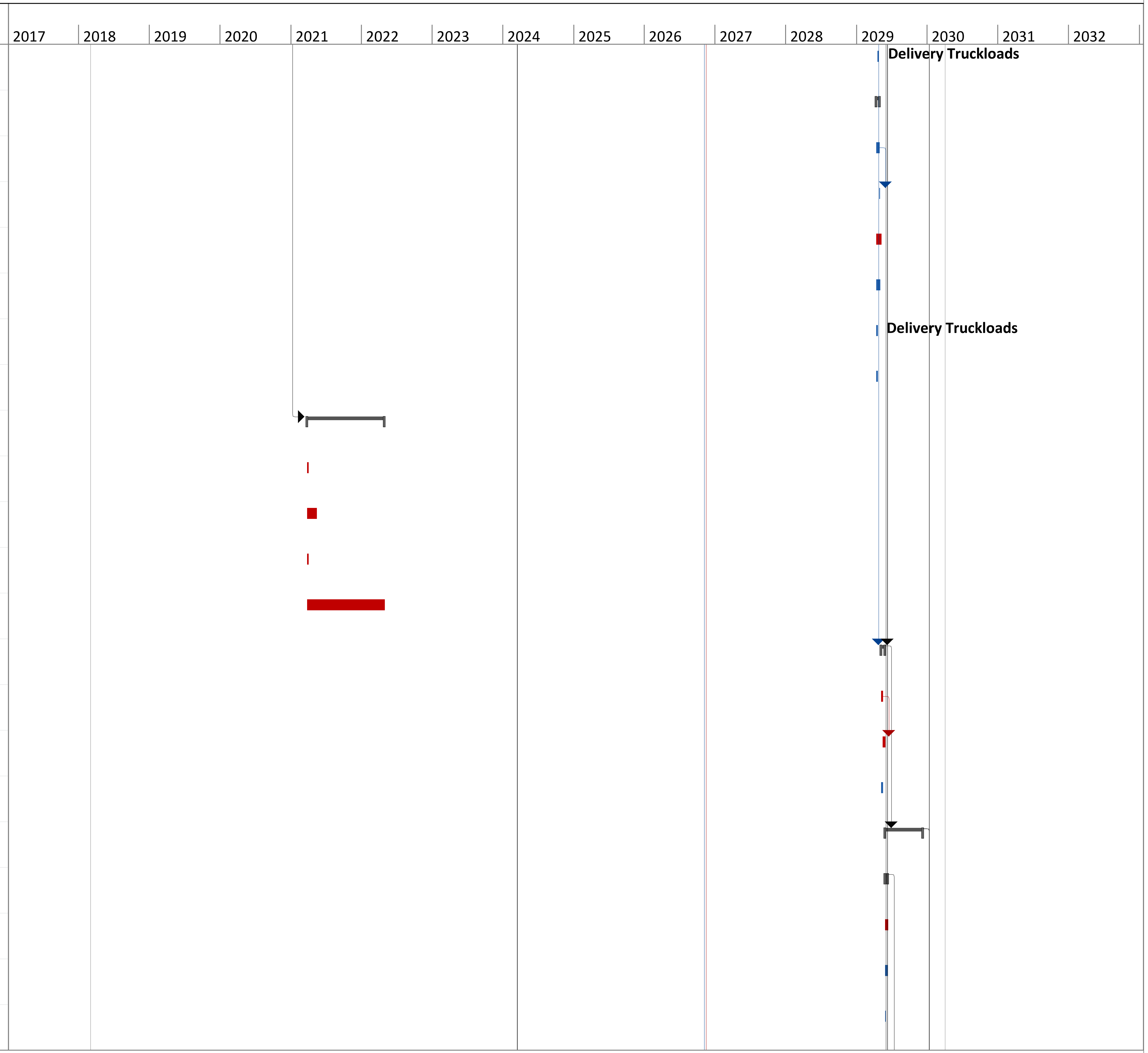
ID	Task Name	Estimated Duration	Start	Finish
243	Spread backfilled material	264 days	Mon 3/8/27	Wed 3/22/28
244	Apply daily cover to backfilled material	88 days	Mon 3/8/27	Mon 11/1/27
245	Compact backfilled material	112 days	Mon 3/8/27	Thu 8/12/27
246	**Backfill NE Area 2 Final Grades with Overburden from SW Area 2 Stockpile**	**141 days**	**Wed 8/30/28**	**Mon 3/26/29**
247	Apply daily cover to remaining stockpile excavation	30 days	Wed 8/30/28	Thu 10/12/28
248	**Excavate Overburden**	**94 days**	**Wed 8/30/28**	**Fri 1/19/29**
249	Excavate	82 days	Wed 8/30/28	Tue 1/2/29
250	Load	13 days	Tue 1/2/29	Fri 1/19/29
251	Transport Overburden back to NE Area	141 days	Wed 8/30/28	Mon 3/26/29
252	Spread backfilled material	98 days	Wed 8/30/28	Thu 1/25/29
253	Apply daily cover to backfilled material	33 days	Wed 8/30/28	Thu 11/30/28
254	Compact backfilled material	42 days	Wed 8/30/28	Mon 10/30/28
255	**Slope Correction Cuts in Area 2 SW**	**14 days**	**Mon 3/26/29**	**Fri 4/13/29**
256	Apply daily cover to remaining excavati	3 days	Mon 4/2/29	Wed 4/4/29
257	**Excavate Non-RIM waste to correct slc**	**10 days**	**Mon 3/26/29**	**Fri 4/6/29**
258	Excavate	8 days	Mon 3/26/29	Thu 4/5/29
259	Load	1 day	Thu 4/5/29	Fri 4/6/29
260	Relocated excavated material	14 days	Mon 3/26/29	Fri 4/13/29
261	Spread backfilled material	10 days	Mon 3/26/29	Mon 4/9/29
262	Apply daily cover to backfilled material	3 days	Mon 3/26/29	Thu 3/29/29
263	Compact backfilled material	4 days	Mon 3/26/29	Fri 3/30/29
264	**Slope Correction Cuts in Area 2 NE**	**18 days**	**Fri 4/13/29**	**Wed 5/9/29**



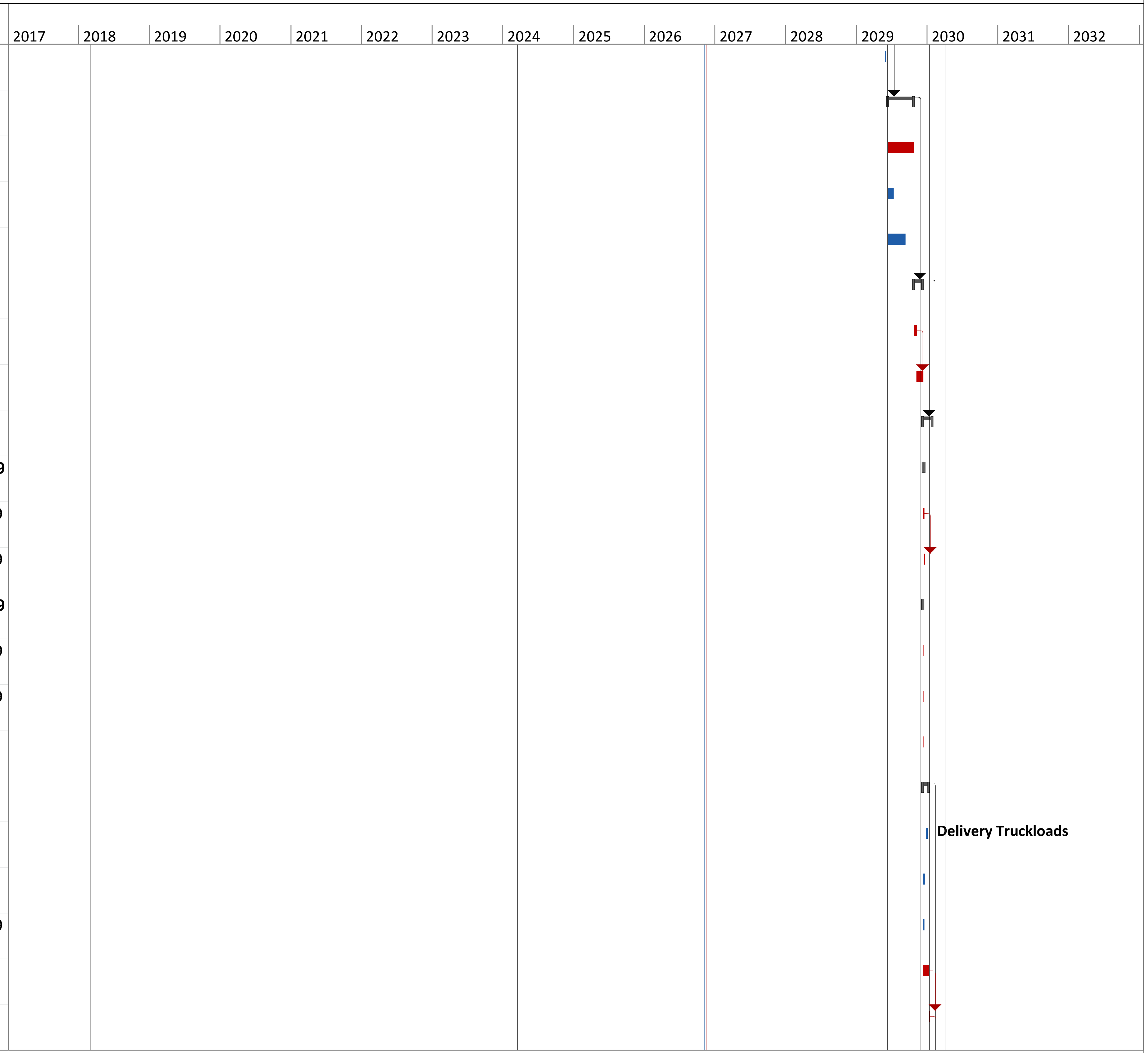
Note: All dates are for planning purposes only - not actual dates.

Feezor Engineering, Inc.

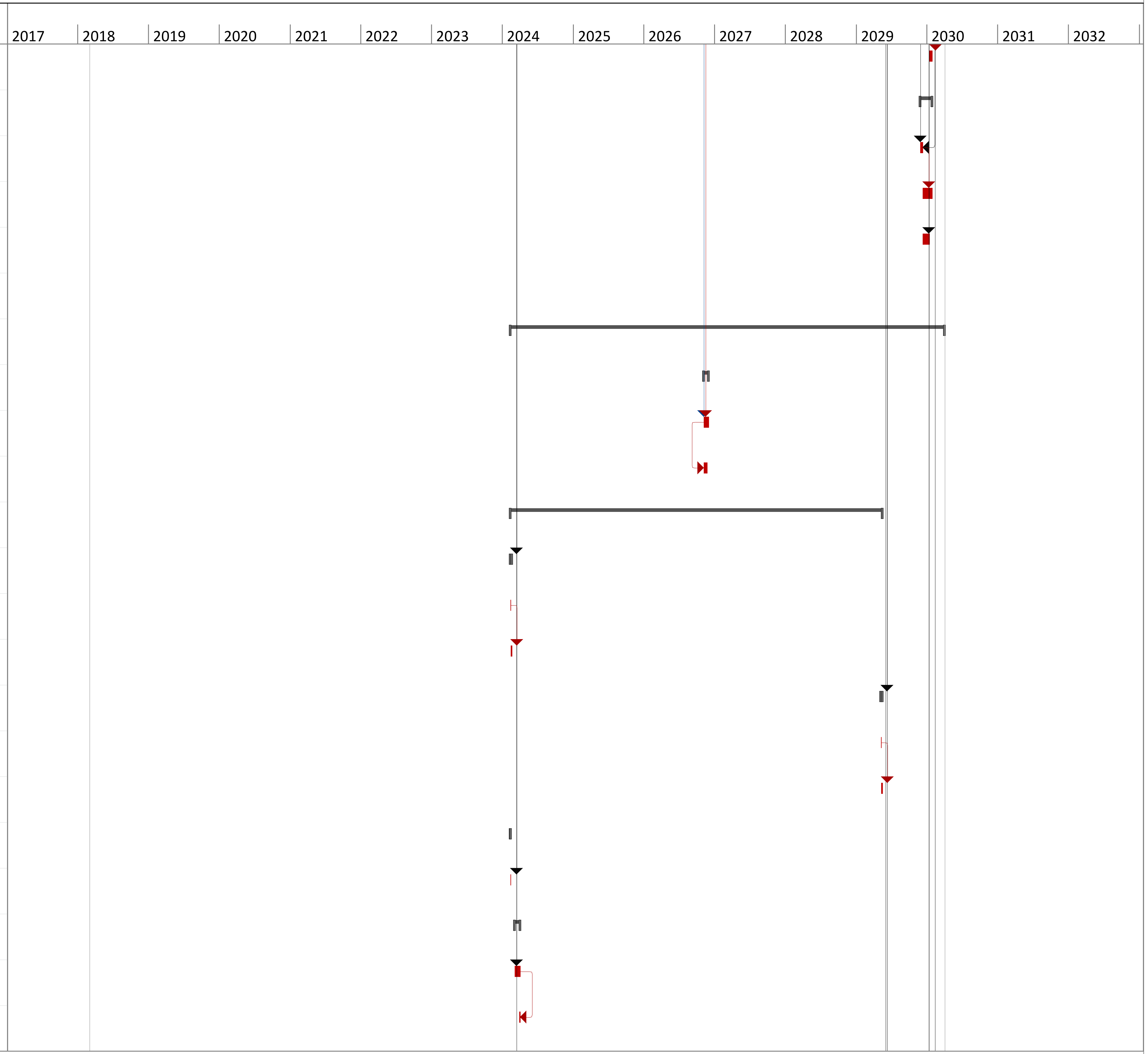
ID	Task Name	Estimated Duration	Start	Finish
265	Apply daily cover to remaining excavati	4 days	Thu 4/19/29	Wed 4/25/29
266	**Excavate Non-RIM waste to correct slc**	**12 days**	**Fri 4/13/29**	**Tue 5/1/29**
267	Excavate	11 days	Fri 4/13/29	Mon 4/30/29
268	Load	2 days	Mon 4/30/29	Tue 5/1/29
269	Relocated excavated material	18 days	Fri 4/13/29	Wed 5/9/29
270	Spread backfilled material	13 days	Fri 4/13/29	Wed 5/2/29
271	Apply daily cover to backfilled material	4 days	Fri 4/13/29	Thu 4/19/29
272	Compact backfilled material	5 days	Fri 4/13/29	Fri 4/20/29
273	**Leachate Handling**	**276 days**	**Fri 3/26/21**	**Fri 4/29/22**
274	Pumping	4 days	Fri 3/26/21	Thu 4/1/21
275	Tank Transportation on Site	35 days	Fri 3/26/21	Thu 5/13/21
276	Sampling	4 days	Fri 3/26/21	Thu 4/1/21
277	Hauling & Disposal	276 days	Fri 3/26/21	Fri 4/29/22
278	**Additional Fill**	**13 days**	**Wed 5/9/29**	**Tue 5/29/29**
279	Purchase material and spread	4 days	Wed 5/9/29	Wed 5/16/29
280	Additional delivery distance	9 days	Wed 5/16/29	Tue 5/29/29
281	Compact material	6 days	Wed 5/9/29	Thu 5/17/29
282	**Final Cover**	**135 days**	**Tue 5/29/29**	**Tue 12/11/29**
283	**Starter Berms**	**10 days**	**Tue 5/29/29**	**Tue 6/12/29**
284	Purchase and deliver material	10 days	Tue 5/29/29	Tue 6/12/29
285	Spread loose lift before compaction	8 days	Tue 5/29/29	Mon 6/11/29
286	Special grading for steep slopes	2 days	Tue 5/29/29	Thu 5/31/29



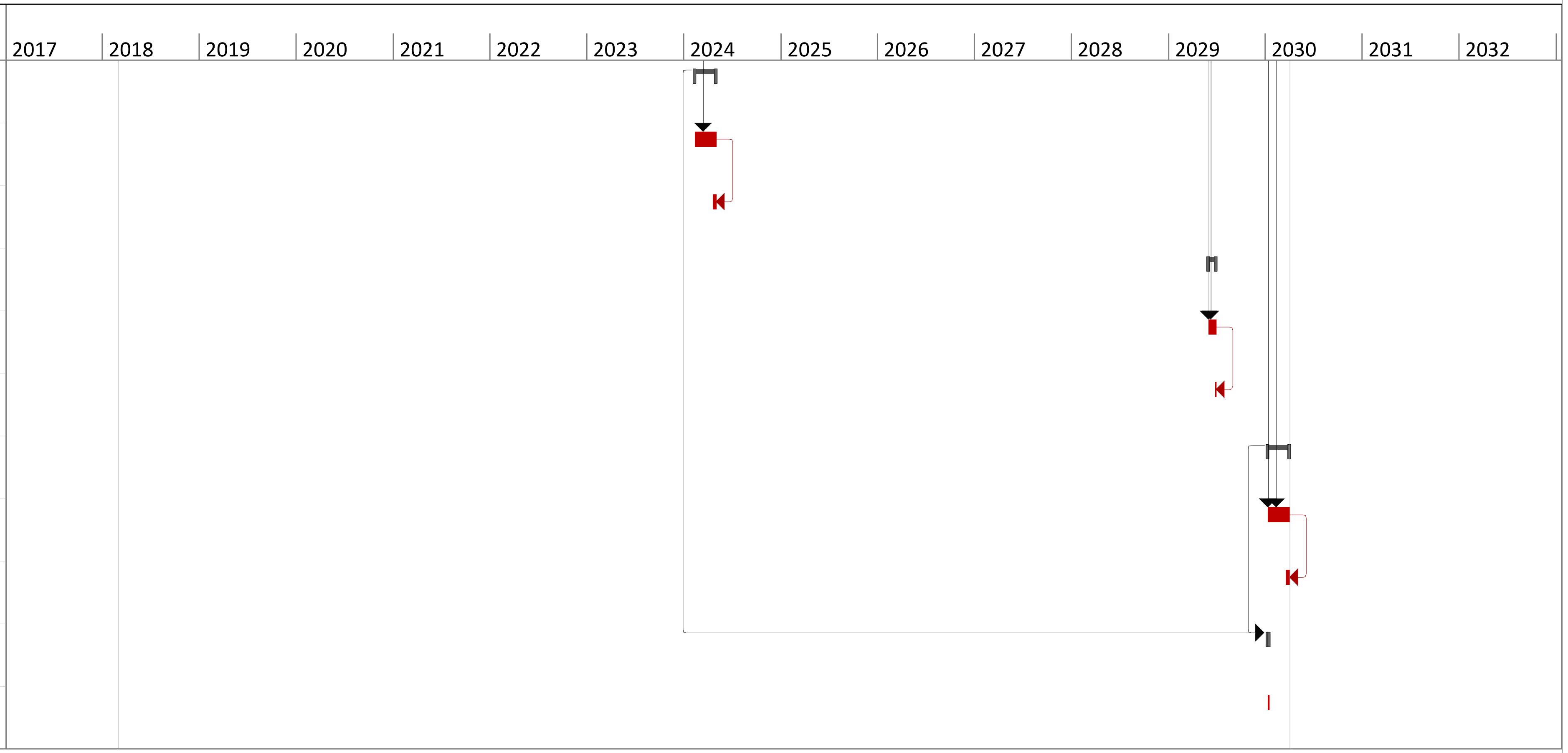
ID	Task Name	Estimated Duration	Start	Finish
287	Compact starter berms	3 days	Tue 5/29/29	Fri 6/1/29
288	**Clay**	**95 days**	**Tue 6/12/29**	**Thu 10/25/29**
289	Purchase and deliver clay material	95 days	Tue 6/12/29	Thu 10/25/29
290	Spread loose lift before compaction	19 days	Tue 6/12/29	Tue 7/10/29
291	Compact Clay (Final Cover)	62 days	Tue 6/12/29	Tue 9/11/29
292	**Top Soil**	**31 days**	**Thu 10/25/29**	**Tue 12/11/29**
293	Purchase and place Topsoil	10 days	Thu 10/25/29	Thu 11/8/29
294	Addition for Delivery Distance	20 days	Thu 11/8/29	Tue 12/11/29
295	**Post-Construction Stormwater Controls**	**31 days**	**Tue 12/11/29**	**Tue 1/29/30**
296	**Install Terraces**	**5 days**	**Wed 12/12/2!**	**Wed 12/19/29**
297	Purchase and place Topsoil	4 days	Wed 12/12/2!	Mon 12/17/29
298	Addition for Delivery Distance	1 day	Mon 12/17/2!	Wed 12/19/29
299	**Diversion Berms**	**0 days**	**Tue 12/11/29**	**Wed 12/12/29**
300	Purchase and deliver clay material	0 days	Tue 12/11/29	Wed 12/12/29
301	Spread loose lift before compaction	0 days	Tue 12/11/29	Wed 12/12/29
302	Compact berms	0 days	Tue 12/11/29	Tue 12/11/29
303	**Pond**	**18 days**	**Tue 12/11/29**	**Thu 1/10/30**
304	Purchase and deliver liner & berm mat	6 days	Wed 12/26/2!	Thu 1/3/30
305	Spread loose lift before compaction	7 days	Tue 12/11/29	Thu 12/20/29
306	Compact Liner & Berm	4 days	Tue 12/11/29	Mon 12/17/29
307	Perimeter Berm Structural Rock	18 days	Tue 12/11/29	Thu 1/10/30
308	Perimeter Road Stormwater Crossings	2 days	Fri 1/11/30	Mon 1/14/30



ID	Task Name	Estimated Duration	Start	Finish
309	Final Stormwater Controls	10 days	Tue 1/15/30	Tue 1/29/30
310	**Site Completion**	**40 days**	**Tue 11/27/29**	**Mon 1/28/30**
311	Install temporary irrigation system	10 days	Tue 11/27/29	Tue 12/11/29
312	Apply seeding to cover	30 days	Tue 12/11/29	Mon 1/28/30
313	Install Fencing	19 days	Tue 12/11/29	Mon 1/14/30
314				
315	**Clean-up and Demolition**	**1544 days**	**Mon 2/12/24**	**Tue 4/2/30**
316	**RIM Loading Station**	**15 days**	**Fri 11/6/26**	**Tue 12/1/26**
317	Demolition	15 days	Fri 11/6/26	Tue 12/1/26
318	Air Treatment Demobilization	12 days	Fri 11/6/26	Tue 11/24/26
319	**Haul Road between Areas and Loading Stat**	**1324 days**	**Mon 2/12/24**	**Wed 5/16/29**
320	**Area 1**	**5 days**	**Mon 2/12/24**	**Mon 2/19/24**
321	Remove potential contamination	1 day	Mon 2/12/24	Tue 2/13/24
322	Repairs for use during Capping Phase	4 days	Tue 2/13/24	Mon 2/19/24
323	**Area 2**	**5 days**	**Wed 5/9/29**	**Wed 5/16/29**
324	Remove potential contamination	1 day	Wed 5/9/29	Thu 5/10/29
325	Repairs for use during Capping Phase	4 days	Thu 5/10/29	Wed 5/16/29
326	**Bridge**	**1 day**	**Mon 2/12/24**	**Tue 2/13/24**
327	Demolition	1 day	Mon 2/12/24	Tue 2/13/24
328	**Area 1 Leachate Frac Tanks**	**20 days**	**Tue 3/5/24**	**Tue 4/2/24**
329	Clean Leachate Frac Tanks	20 days	Tue 3/5/24	Tue 4/2/24
330	Remove Leachate Frac Tanks	3 days	Thu 3/28/24	Tue 4/2/24



ID	Task Name	Estimated Duration	Start	Finish
331	**Area 1 Stormwater Frac Tanks**	**58 days**	**Mon 2/12/24**	**Thu 5/2/24**
332	Clean Frac Tanks	58 days	Mon 2/12/24	Thu 5/2/24
333	Remove Frac Tanks	10 days	Fri 4/19/24	Thu 5/2/24
334	**Area 2 Leachate Frac Tanks**	**20 days**	**Fri 6/1/29**	**Fri 6/29/29**
335	Clean Leachate Frac Tanks	20 days	Fri 6/1/29	Fri 6/29/29
336	Remove Leachate Frac Tanks	3 days	Tue 6/26/29	Fri 6/29/29
337	**Area 2 Stormwater Frac Tanks**	**58 days**	**Fri 1/11/30**	**Tue 4/2/30**
338	Clean Frac Tanks	58 days	Fri 1/11/30	Tue 4/2/30
339	Remove Frac Tanks	10 days	Wed 3/20/30	Tue 4/2/30
340	**Stormwater Treatment Facility**	**2 days**	**Fri 1/11/30**	**Tue 1/15/30**
341	Demolition	2 days	Fri 1/11/30	Tue 1/15/30



Estimated Schedule

“Partial Rad Removal, >52.9 pCi/g and <16 ft.” with Off-Site Disposal Alternative

OVERVIEW OF PARTIAL EXCAVATION >52.9 PCI/G AND <16 FT. CONSTRUCTION SCHEDULE

Final Feasibility Study, West Lake Landfill

OVERALL PROJECT: *MARCH 2018 – SEPTEMBER 2022 (4.6 YEARS)*

Site-wide Preparations – *MARCH - AUGUST 2018*

- Mobilization, Construction Trailers, Project Infrastructure, RIM Loading Station

Area 1 – *MARCH 2018 – JUNE 2020*

- Site Preparations – *MARCH - APRIL 2018*
- Waste Excavation – *AUGUST - DECEMBER 2018*
  - Ship RIM offsite, stockpile overburden
- Waste Backfilling and Regrading – *DECEMBER 2018 - OCTOBER 2019*
  - Backfill excavation, regrade other waste as necessary
- Final Cover – *OCTOBER 2019 – MAY 2020*
- Stormwater Controls and Site Completion – *MAY – JUNE 2020*

Partially overlapping:

Area 2 – *NOVEMBER 2018 – JULY 2022*

- Site Preparations – *NOVEMBER - DECEMBER 2018*
- Waste Excavation – *DECEMBER 2018 - APRIL 2020*
  - Ship RIM offsite, stockpile overburden, backfill where possible
  - Including Buffer Zone
- Remaining Waste Backfilling and Regrading – *MAY 2020 - FEBRUARY 2021*
  - Backfill excavation, regrade other waste as necessary
- Additional Fill – *FEBRUARY - JULY 2021*
- Final Cover – *JULY 2021 - JUNE 2022*
- Stormwater Controls and Site Completion – *THROUGH JULY 2022*

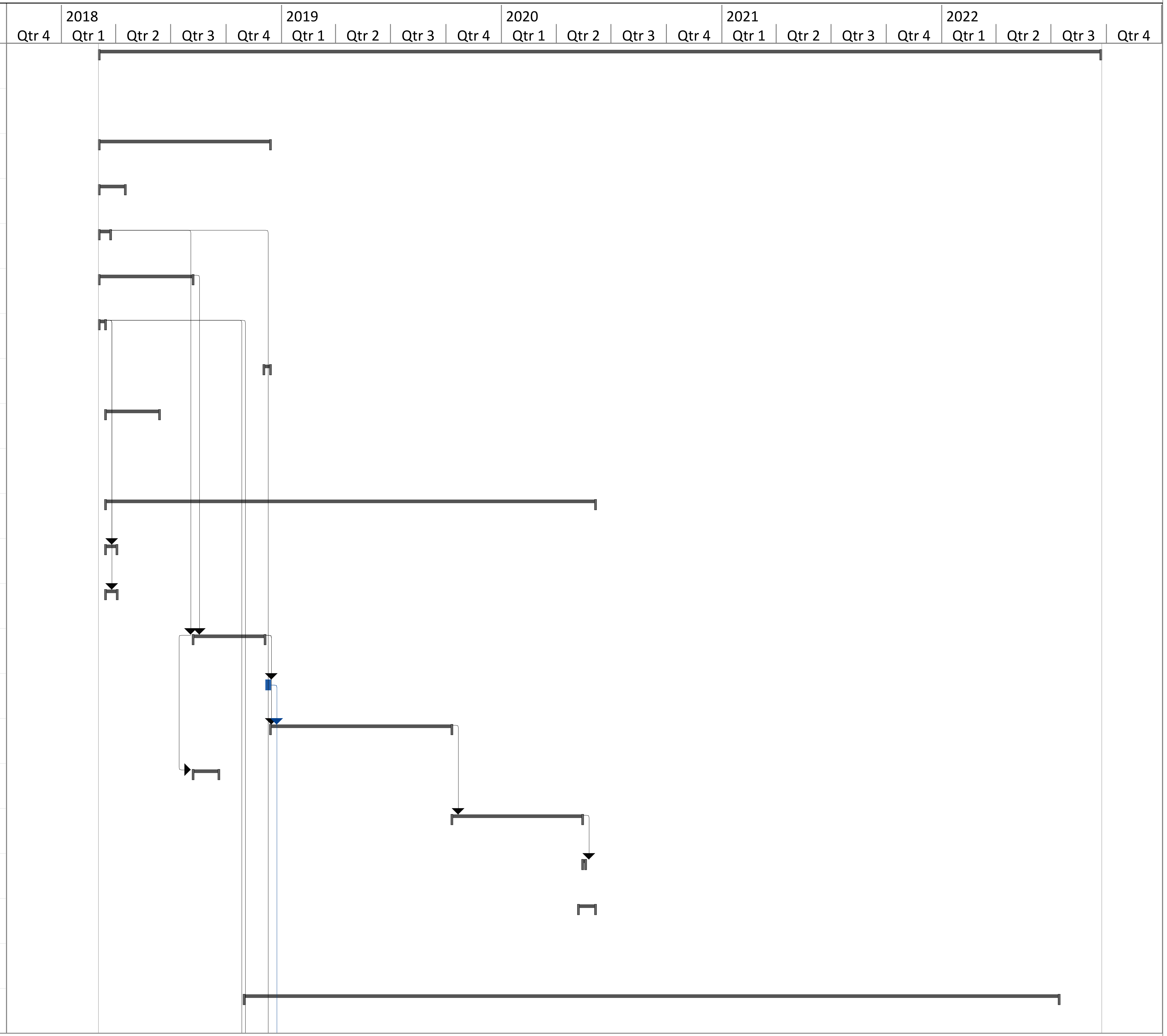
Clean-up and Demolition – *ENDING SEPTEMBER 2022*

- Takes place as appropriate throughout project

West Lake FFS - Partial Excavation 52.9/16'

DRAFT - Subject to Revision

ID	Task Name	Estimated Duration	Start	Finish
1	**Partial Excavation 52.9/16' Schedule**	**1148 days**	**Mon 3/5/18**	**Thu 9/22/22**
2				
3	**Site-wide Preparation**	**198 days**	**Mon 3/5/18**	**Fri 12/14/18**
4	**Temporary Construction Facilities / U**	**31 days**	**Mon 3/5/18**	**Tue 4/17/18**
7	**Stormwater Treatment Facility**	**15 days**	**Mon 3/5/18**	**Fri 3/23/18**
9	**RIM Loading Station**	**110 days**	**Mon 3/5/18**	**Tue 8/7/18**
12	**Mobilization**	**9 days**	**Mon 3/5/18**	**Thu 3/15/18**
23	**Supplemental Mobilization**	**9 days**	**Mon 12/3/18**	**Fri 12/14/18**
34	**Road & Traffic Improvements**	**62 days**	**Thu 3/15/18**	**Tue 6/12/18**
50				
51	**Area 1**	**560 days**	**Thu 3/15/18**	**Fri 6/5/20**
52	**Temporary Stormwater Infrastructure**	**13 days**	**Thu 3/15/18**	**Tue 4/3/18**
58	**Site Preparation**	**13 days**	**Thu 3/15/18**	**Tue 4/3/18**
74	**Waste Excavation**	**81 days**	**Wed 8/8/18**	**Wed 12/5/18**
91	Final Radiological Survey	7 days	Wed 12/5/18	Fri 12/14/18
92	**Waste Backfill and Regrading**	**208 days**	**Fri 12/14/18**	**Fri 10/11/19**
120	**Leachate Handling**	**30 days**	**Wed 8/8/18**	**Wed 9/19/18**
125	**Final Cover**	**149 days**	**Fri 10/11/19**	**Fri 5/15/20**
137	**Post-Construction Stormwater Contro**	**3 days**	**Fri 5/15/20**	**Wed 5/20/20**
146	**Site Completion**	**19 days**	**Fri 5/8/20**	**Fri 6/5/20**
150				
151	**Area 2**	**930 days**	**Wed 10/31/1**	**Fri 7/15/22**

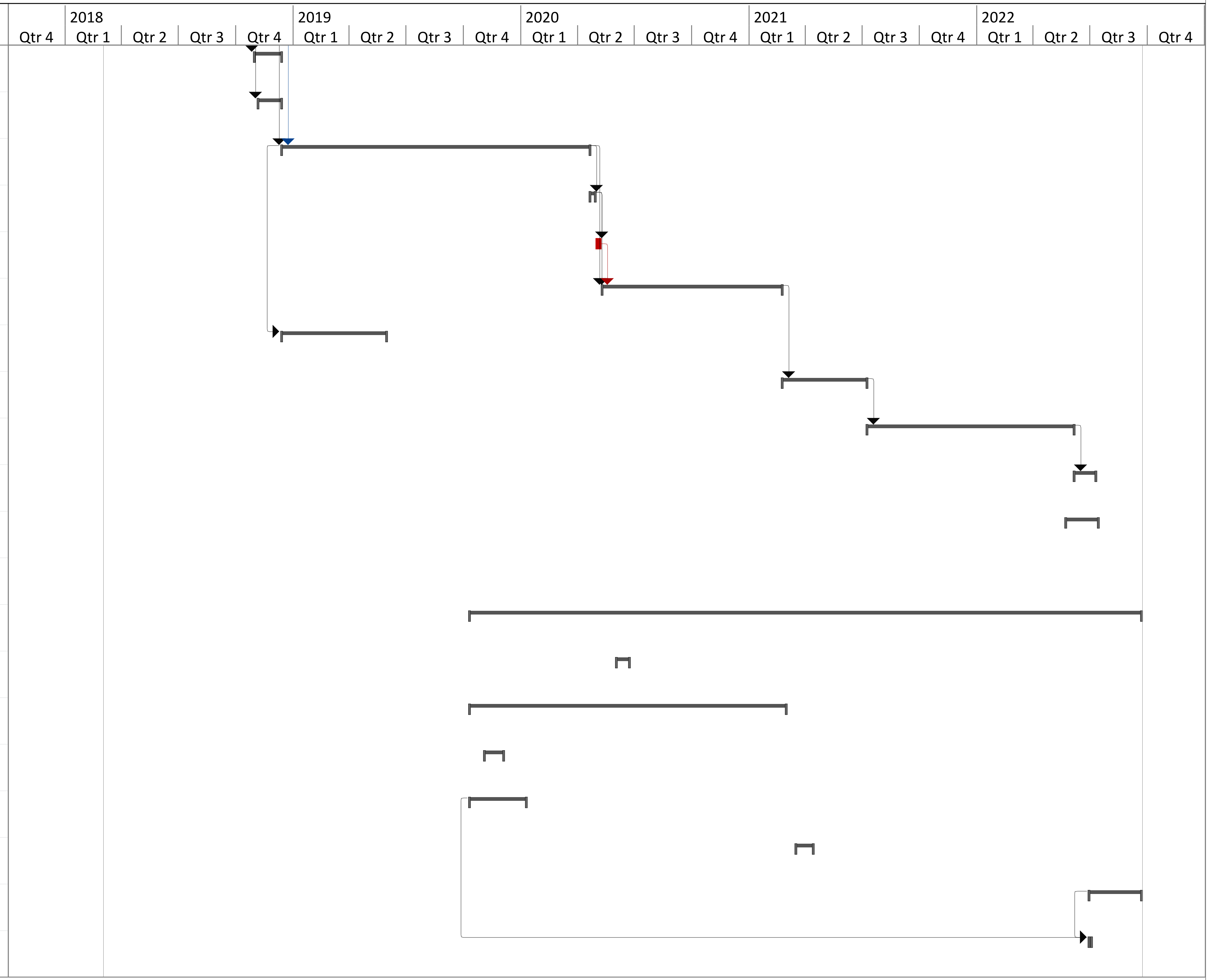


Note: All dates are for planning purposes only - not actual dates.

West Lake FFS - Partial Excavation 52.9/16'

DRAFT - Subject to Revision

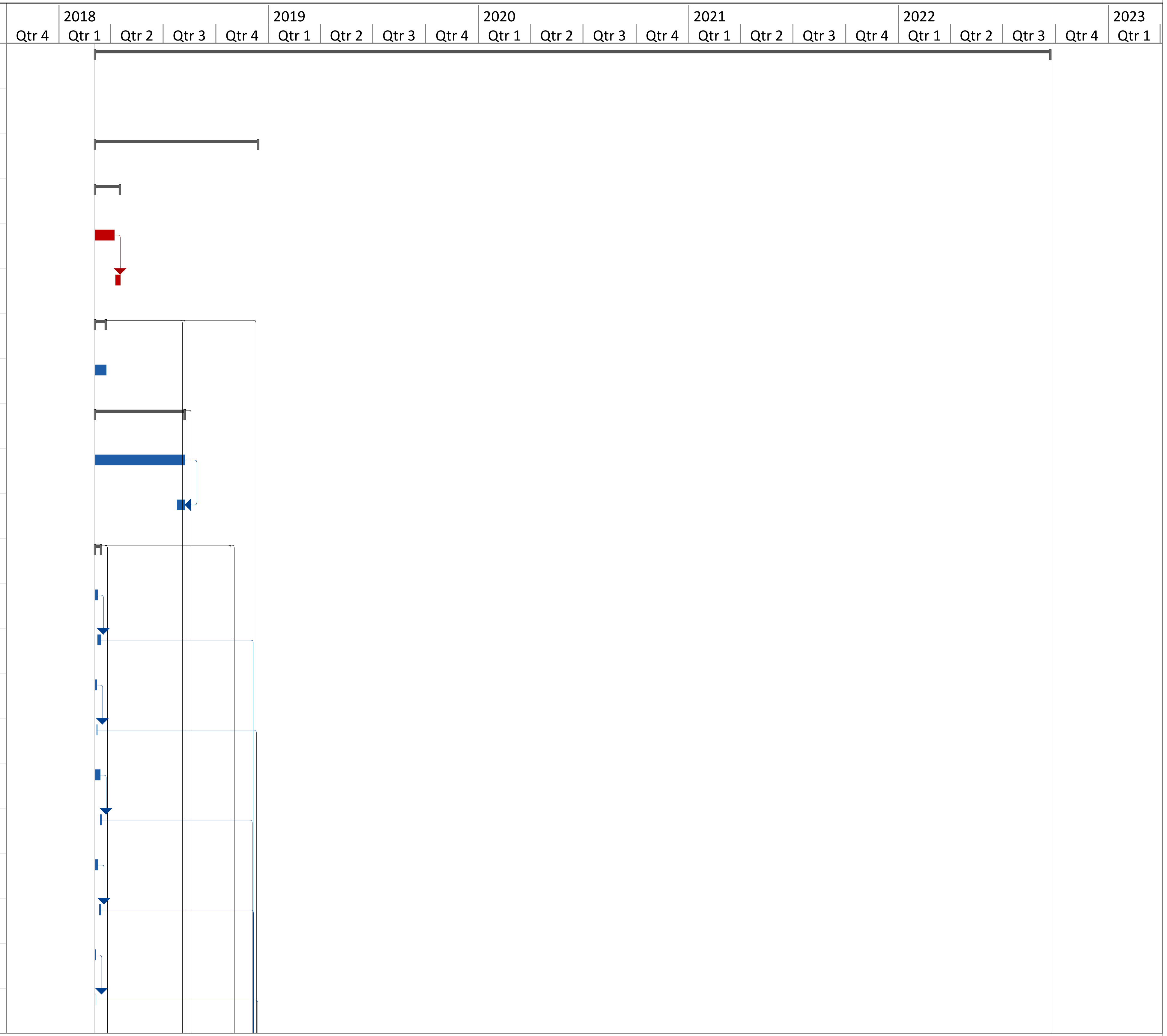
ID	Task Name	Estimated Duration	Start	Finish
152	**Temporary Stormwater Infrastructure**	**29 days**	**Wed 10/31/1**	**Fri 12/14/18**
158	**Site Preparation**	**25 days**	**Tue 11/6/18**	**Fri 12/14/18**
174	**Waste Excavation**	**339 days**	**Fri 12/14/18**	**Tue 4/21/20**
214	**Buffer Zone**	**6 days**	**Tue 4/21/20**	**Wed 4/29/20**
216	Final Radiological Survey	7 days	Thu 4/30/20	Fri 5/8/20
217	**Waste Backfill and Regrading**	**198 days**	**Mon 5/11/20**	**Tue 2/23/21**
250	**Leachate Handling**	**115 days**	**Fri 12/14/18**	**Fri 5/31/19**
255	**Additional Fill**	**96 days**	**Tue 2/23/21**	**Fri 7/9/21**
259	**Final Cover**	**228 days**	**Fri 7/9/21**	**Mon 6/6/22**
276	**Post-Construction Stormwater Contro**	**24 days**	**Mon 6/6/22**	**Mon 7/11/22**
291	**Site Completion**	**38 days**	**Tue 5/24/22**	**Fri 7/15/22**
295				
296	**Clean-up and Demolition**	**742 days**	**Fri 10/11/19**	**Thu 9/22/22**
297	**RIM Loading Station**	**15 days**	**Wed 6/3/20**	**Tue 6/23/20**
300	**Haul Road between Areas and Loadin**	**346 days**	**Fri 10/11/19**	**Tue 3/2/21**
309	**Area 1 Leachate Frac Tanks**	**20 days**	**Mon 11/4/19**	**Thu 12/5/19**
312	**Area 1 Stormwater Frac Tanks**	**58 days**	**Fri 10/11/19**	**Fri 1/10/20**
315	**Area 2 Leachate Frac Tanks**	**20 days**	**Wed 3/17/21**	**Wed 4/14/21**
318	**Area 2 Stormwater Frac Tanks**	**58 days**	**Thu 6/30/22**	**Thu 9/22/22**
321	**Stormwater Treatment Facility**	**2 days**	**Thu 6/30/22**	**Mon 7/4/22**



West Lake FFS - Partial Excavation 52.9/16'

DRAFT - Subject to Revision

ID	Task Name	Estimated Duration	Start	Finish
1	**Partial Excavation 52.9/16' Schedule**	**1148 days**	**Mon 3/5/18**	**Thu 9/22/22**
2				
3	**Site-wide Preparation**	**198 days**	**Mon 3/5/18**	**Fri 12/14/18**
4	**Temporary Construction Facilities / U**	**31 days**	**Mon 3/5/18**	**Tue 4/17/18**
5	Construction Trailers	25 days	Mon 3/5/18	Fri 4/6/18
6	Parking Area	6 days	Mon 4/9/18	Tue 4/17/18
7	**Stormwater Treatment Facility**	**15 days**	**Mon 3/5/18**	**Fri 3/23/18**
8	Construction	15 days	Mon 3/5/18	Fri 3/23/18
9	**RIM Loading Station**	**110 days**	**Mon 3/5/18**	**Tue 8/7/18**
10	Construction	110 days	Mon 3/5/18	Tue 8/7/18
11	Air Treatment System	10 days	Wed 7/25/18	Tue 8/7/18
12	**Mobilization**	**9 days**	**Mon 3/5/18**	**Thu 3/15/18**
13	Mobilize and Demobilize Equipment	4 days	Mon 3/5/18	Thu 3/8/18
14	Extra Mileage for Mobilizations	3 days	Fri 3/9/18	Wed 3/14/18
15	Mobilize and Demobilize Equipment by 3-ton Trailer	2 days	Mon 3/5/18	Wed 3/7/18
16	Extra Mileage for Mobilizations	1 day	Wed 3/7/18	Thu 3/8/18
17	Mobilize and Demobilize Equipment by 20-ton Trailer	6 days	Mon 3/5/18	Tue 3/13/18
18	Extra Mileage for Mobilizations	3 days	Tue 3/13/18	Thu 3/15/18
19	Mobilize and Demobilize Equipment by 40-ton Trailer	5 days	Mon 3/5/18	Fri 3/9/18
20	Extra Mileage for Mobilizations	2 days	Mon 3/12/18	Wed 3/14/18
21	Mobilize and Demobilize Crane Equipment (75+ tons)	1 day	Mon 3/5/18	Mon 3/5/18
22	Extra Mileage for Mobilizations	0 days	Mon 3/5/18	Tue 3/6/18



Note: All dates are for planning purposes only - not actual dates.

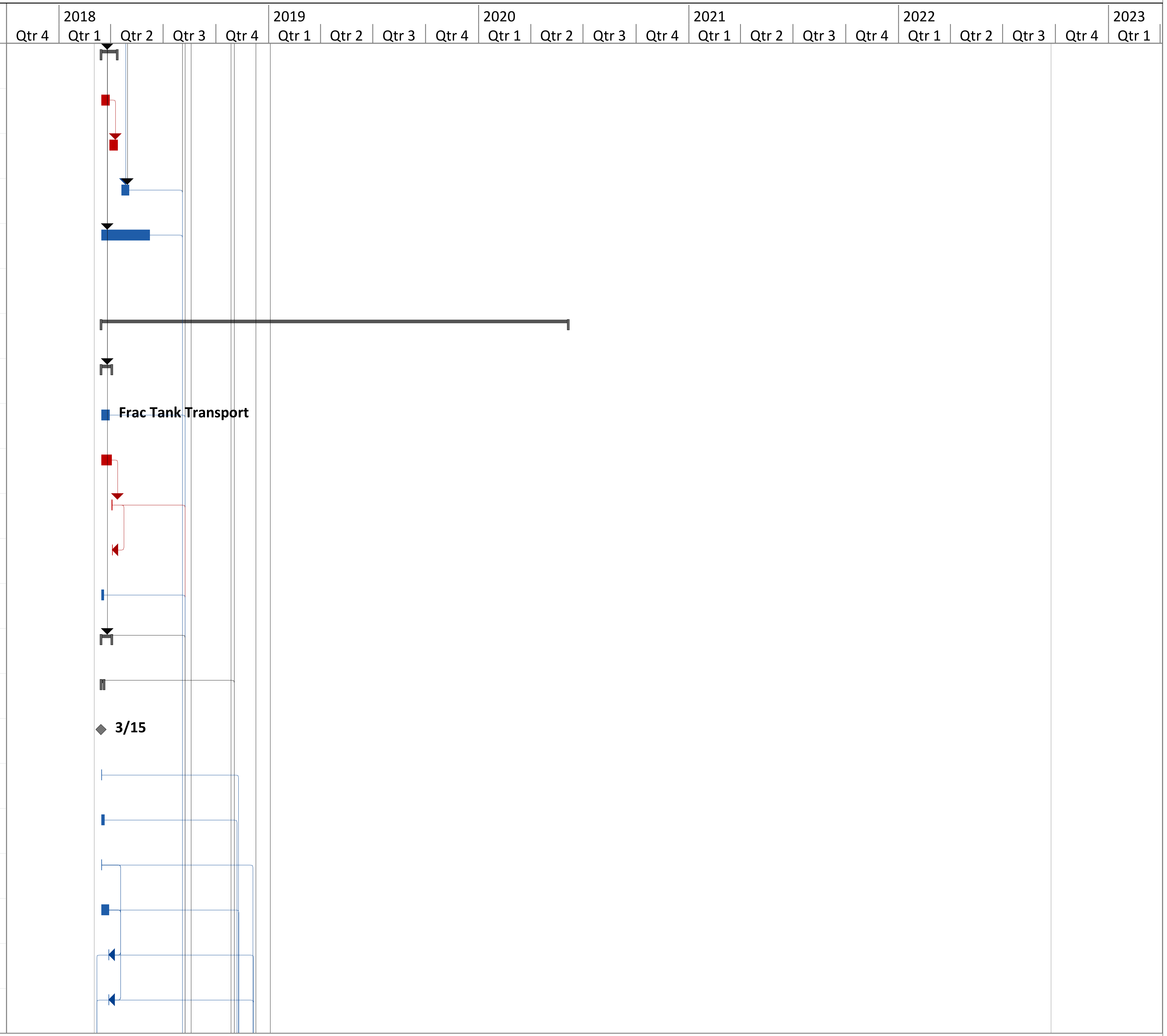
West Lake FFS - Partial Excavation 52.9/16'

DRAFT - Subject to Revision

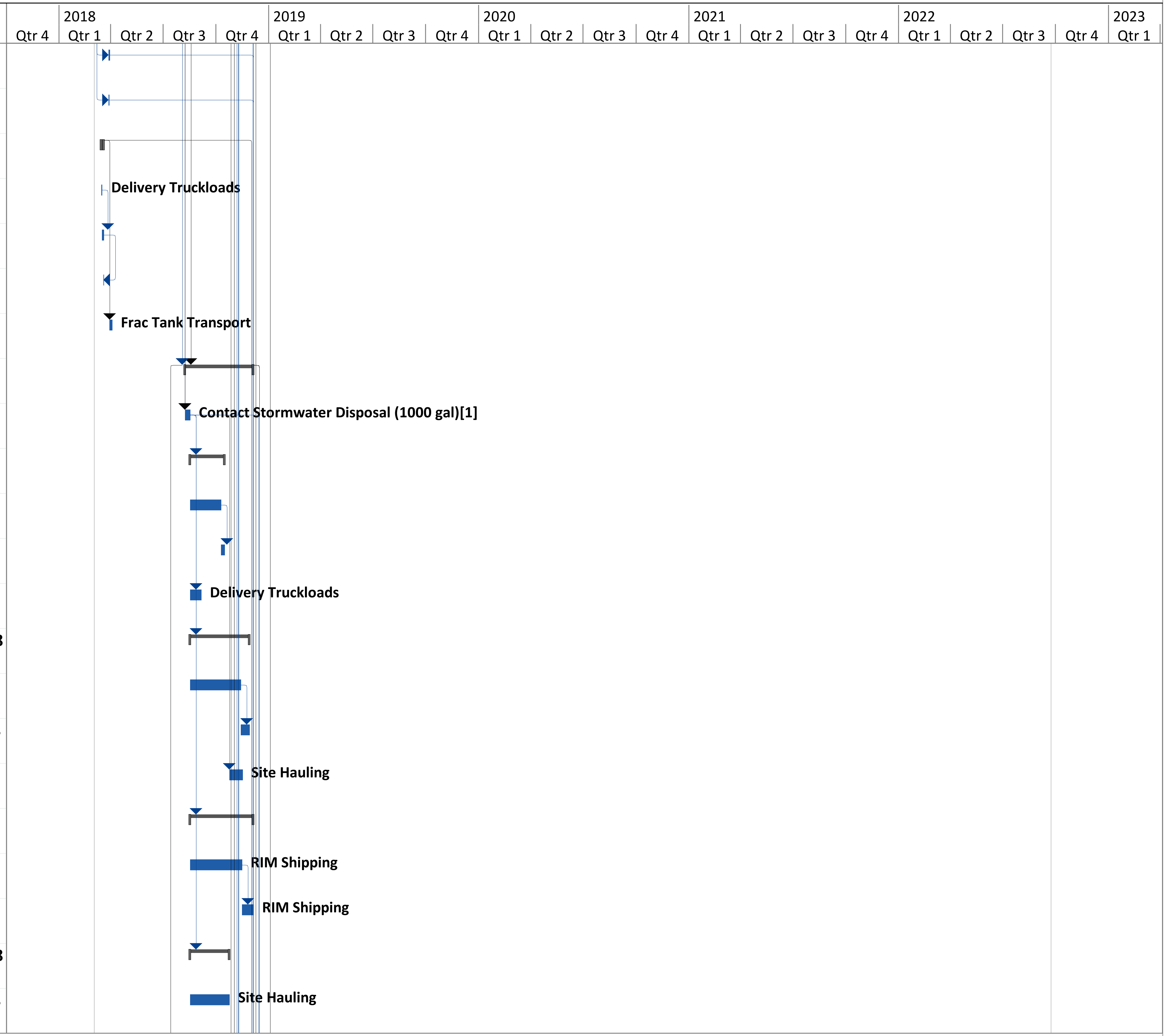
ID	Task Name	Estimated Duration	Start	Finish
23	**Supplemental Mobilization**	**9 days**	**Mon 12/3/18**	**Fri 12/14/18**
24	Mobilize and Demobilize Equipment	4 days	Tue 12/4/18	Mon 12/10/18
25	Extra Mileage for Mobilizations	3 days	Mon 12/10/18	Fri 12/14/18
26	Mobilize and Demobilize Equipment by 3-ton Trailer	2 days	Mon 12/10/18	Wed 12/12/18
27	Extra Mileage for Mobilizations	1 day	Wed 12/12/18	Fri 12/14/18
28	Mobilize and Demobilize Equipment by 20-ton Trailer	6 days	Mon 12/3/18	Tue 12/11/18
29	Extra Mileage for Mobilizations	3 days	Tue 12/11/18	Fri 12/14/18
30	Mobilize and Demobilize Equipment by 40-ton Trailer	5 days	Wed 12/5/18	Wed 12/12/18
31	Extra Mileage for Mobilizations	2 days	Wed 12/12/18	Fri 12/14/18
32	Mobilize and Demobilize Crane Equipment (75+ tons)	1 day	Wed 12/12/18	Thu 12/13/18
33	Extra Mileage for Mobilizations	0 days	Thu 12/13/18	Fri 12/14/18
34	**Road & Traffic Improvements**	**62 days**	**Thu 3/15/18**	**Tue 6/12/18**
35	**Temporary Roads**	**62 days**	**Thu 3/15/18**	**Tue 6/12/18**
36	Area 1	22 days	Thu 3/15/18	Mon 4/16/18
37	Area 2	37 days	Mon 4/16/18	Thu 6/7/18
38	**Upgrades to Road between Areas and RIM Loading Station**	**45 days**	**Tue 4/10/18**	**Tue 6/12/18**
39	**Area 1**	**8 days**	**Tue 4/10/18**	**Thu 4/19/18**
40	Fencing	3 days	Mon 4/16/18	Thu 4/19/18
41	Silt Fencing	5 days	Tue 4/10/18	Mon 4/16/18
42	**Area 2**	**12 days**	**Thu 5/24/18**	**Tue 6/12/18**
43	Fencing	3 days	Thu 6/7/18	Tue 6/12/18
44	Silt Fencing	9 days	Thu 5/24/18	Thu 6/7/18

Note: All dates are for planning purposes only - not actual dates.

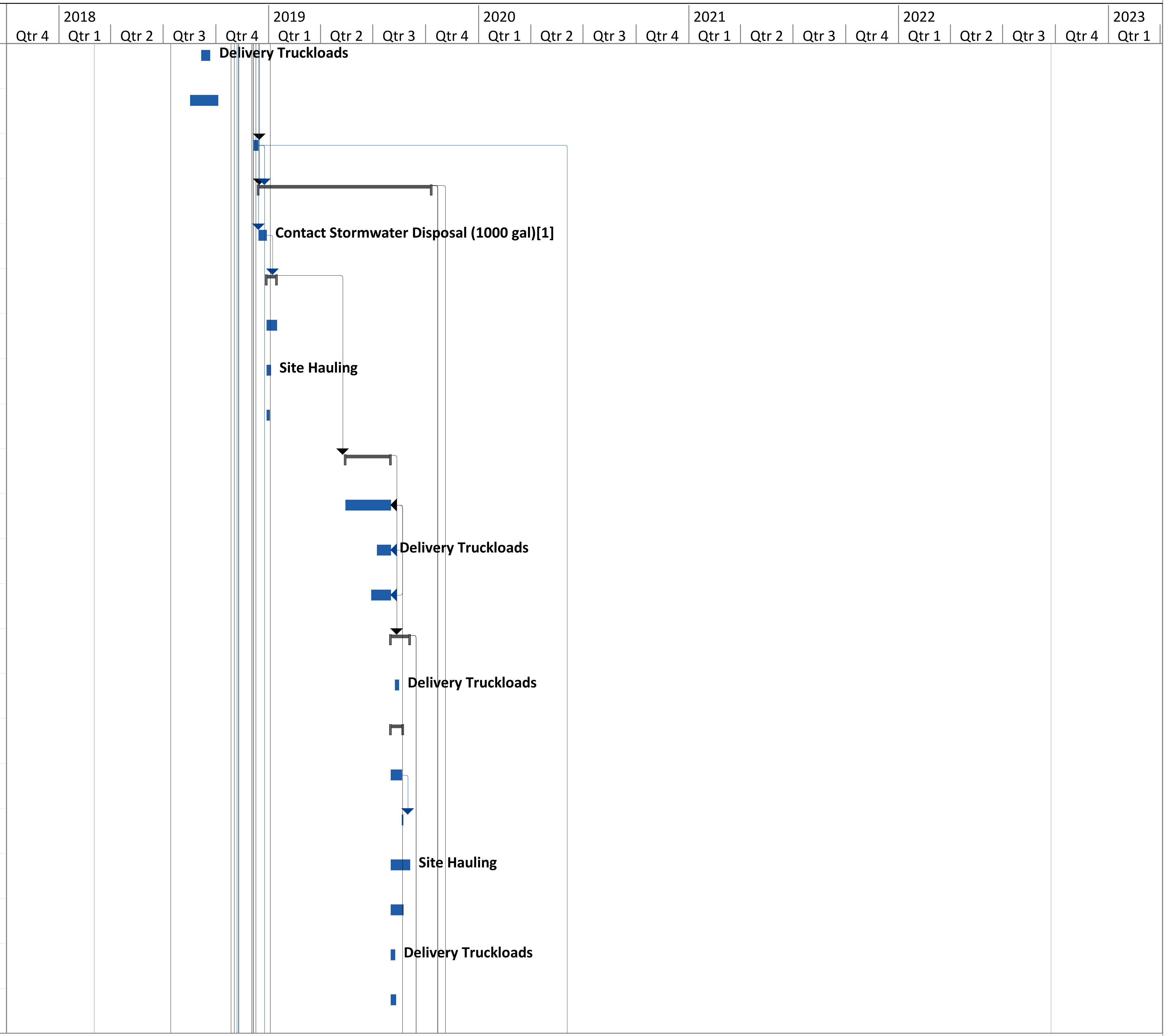
ID	Task Name	Estimated Duration	Start	Finish
45	**Install TBD Traffic Improvements**	**20 days**	**Thu 3/15/18**	**Thu 4/12/18**
46	Area 1	10 days	Thu 3/15/18	Thu 3/29/18
47	Area 2	10 days	Thu 3/29/18	Thu 4/12/18
48	Bridge over Entrance Road	9 days	Thu 4/19/18	Wed 5/2/18
49	Extend Permanent Road to new Transfer Station	59 days	Thu 3/15/18	Thu 6/7/18
50				
51	**Area 1**	**560 days**	**Thu 3/15/18**	**Fri 6/5/20**
52	**Temporary Stormwater Infrastructure**	**13 days**	**Thu 3/15/18**	**Tue 4/3/18**
53	Deliver Frac Tanks	10 days	Thu 3/15/18	Thu 3/29/18
54	Install forcemain from Excavation to Tank Area	11 days	Thu 3/15/18	Mon 4/2/18
55	Install forcemain from Tank Area to Treatment Facility	1 day	Mon 4/2/18	Tue 4/3/18
56	Install forcemain valves	0 days	Tue 4/3/18	Tue 4/3/18
57	Prepare area with Stormwater BMPs	2 days	Thu 3/15/18	Mon 3/19/18
58	**Site Preparation**	**13 days**	**Thu 3/15/18**	**Tue 4/3/18**
59	**Decontamination Area**	**3 days**	**Thu 3/15/18**	**Tue 3/20/18**
60	Materials	0 days	Thu 3/15/18	Thu 3/15/18
61	Installation	0 days	Thu 3/15/18	Fri 3/16/18
62	Building Construction	3 days	Thu 3/15/18	Tue 3/20/18
63	Clear Vegetation (Light)	0 days	Thu 3/15/18	Thu 3/15/18
64	Clear Vegetation (Heavy)	9 days	Thu 3/15/18	Wed 3/28/18
65	Clear Small Trees	0 days	Wed 3/28/18	Wed 3/28/18
66	Clear Large Trees	0 days	Wed 3/28/18	Wed 3/28/18



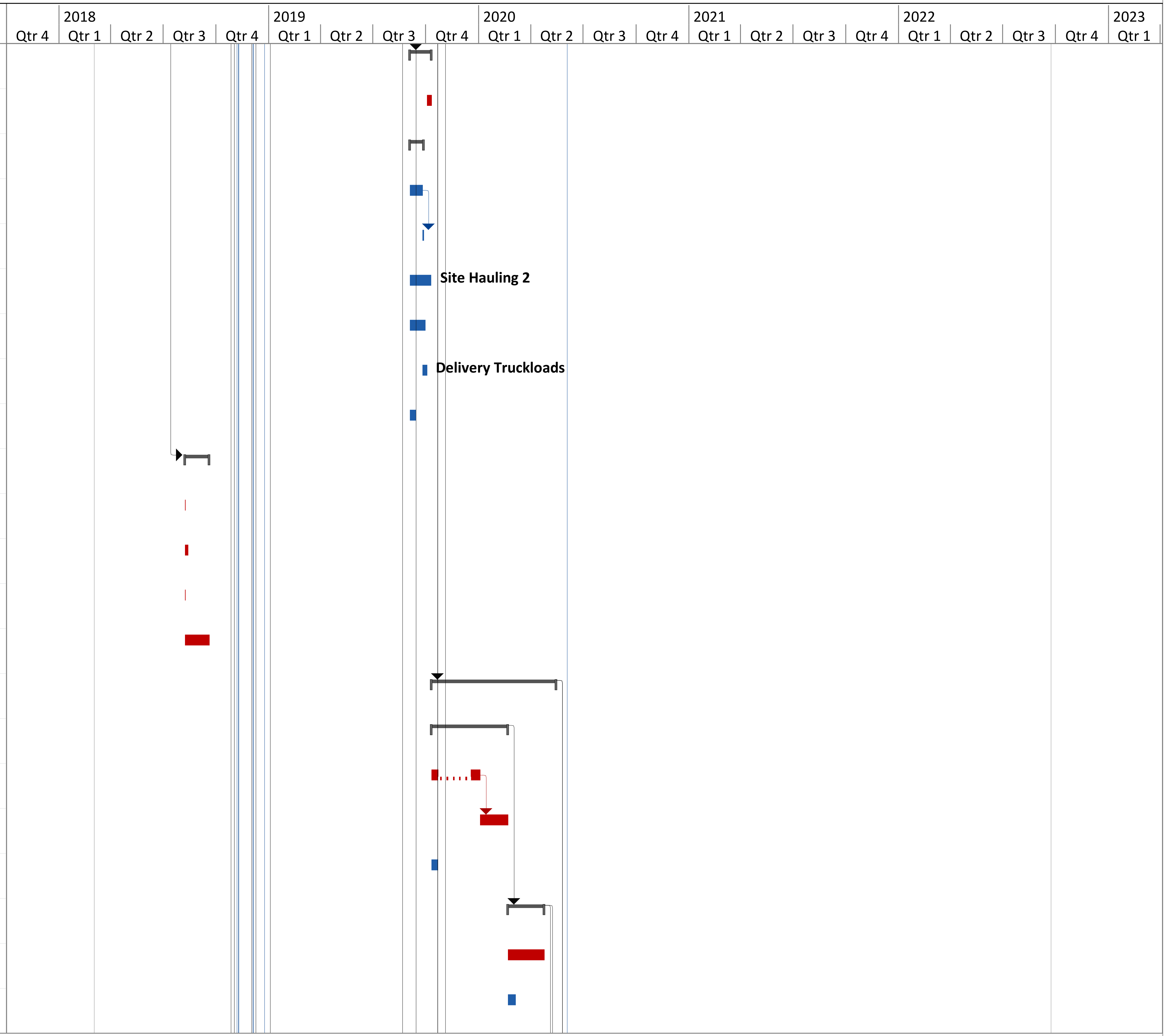
ID	Task Name	Estimated Duration	Start	Finish
67	Clear Small Stumps	2 days	Wed 3/28/18	Fri 3/30/18
68	Clear Large Stumps	1 day	Wed 3/28/18	Thu 3/29/18
69	**Secondary Containment for Frac Ta**	**2 days**	**Thu 3/15/18**	**Mon 3/19/18**
70	Purchase and deliver liner/berm r	1 day	Thu 3/15/18	Fri 3/16/18
71	Spread material	1 day	Fri 3/16/18	Mon 3/19/18
72	Compact liner/berms	1 day	Mon 3/19/18	Mon 3/19/18
73	Leachate Frac Tanks Delivery	3 days	Thu 3/29/18	Tue 4/3/18
74	**Waste Excavation**	**81 days**	**Wed 8/8/18**	**Wed 12/5/18**
75	Dewater excavation construction after rain events (budgeted	7 days	Wed 8/8/18	Thu 8/16/18
76	**Excavate and Sort RIM and Overbu**	**41 days**	**Fri 8/17/18**	**Tue 10/16/18**
77	Excavate Waste & Stockpile RIM	37 days	Fri 8/17/18	Tue 10/9/18
78	Load Overburden into Haul Truck	4 days	Wed 10/10/18	Tue 10/16/18
79	Apply daily cover to remaining exca	12 days	Fri 8/17/18	Wed 9/5/18
80	**Load RIM from local stockpiles onto Haul Trucks**	**69 days**	**Fri 8/17/18**	**Wed 11/28/18**
81	Excavate	60 days	Fri 8/17/18	Tue 11/13/18
82	Load	9 days	Tue 11/13/18	Wed 11/28/18
83	Haul RIM to Loading Station	16 days	Wed 10/24/18	Fri 11/16/18
84	**RIM Loading & Shipping**	**74 days**	**Fri 8/17/18**	**Wed 12/5/18**
85	Startup Rate	63 days	Fri 8/17/18	Thu 11/15/18
86	Full Production Rate	12 days	Thu 11/15/18	Wed 12/5/18
87	**Transport Overburden to Area 2 NE Stockpile**	**48 days**	**Fri 8/17/18**	**Wed 10/24/18**
88	Haul to Stockpile	48 days	Fri 8/17/18	Wed 10/24/18



ID	Task Name	Estimated Duration	Start	Finish
89	Apply daily cover to stockpile	11 days	Wed 9/5/18	Thu 9/20/18
90	Grade Stockpile	33 days	Fri 8/17/18	Thu 10/4/18
91	Final Radiological Survey	7 days	Wed 12/5/18	Fri 12/14/18
92	**Waste Backfill and Regrading**	**208 days**	**Fri 12/14/18**	**Fri 10/11/19**
93	Dewater backfill construction after rain events (budgeted weather	8 days	Fri 12/14/18	Fri 12/28/18
94	**C&D Rubble Stockpiles**	**10 days**	**Fri 12/28/18**	**Mon 1/14/19**
95	Relocate Stockpiled Material on-site - Excavate	10 days	Fri 12/28/18	Mon 1/14/19
96	Relocate Stockpiled Material on-site - Haul and Dump	5 days	Fri 12/28/18	Fri 1/4/19
97	Bury Stockpiled Material	2 days	Fri 12/28/18	Wed 1/2/19
98	**Backfill Overburden from Area 2 SW Excavation**	**55 days**	**Tue 5/14/19**	**Thu 8/1/19**
99	Spread backfilled material	55 days	Tue 5/14/19	Thu 8/1/19
100	Apply daily cover to backfilled ma	18 days	Mon 7/8/19	Thu 8/1/19
101	Compact backfilled material	23 days	Fri 6/28/19	Thu 8/1/19
102	**Backfill to Drainage Grades with Overburden from Area 2 NE**	**22 days**	**Thu 8/1/19**	**Tue 9/3/19**
103	Apply daily cover to remaining stockpile excavation	5 days	Thu 8/8/19	Thu 8/15/19
104	**Excavate Overburden**	**15 days**	**Thu 8/1/19**	**Thu 8/22/19**
105	Excavate	13 days	Thu 8/1/19	Tue 8/20/19
106	Load	2 days	Tue 8/20/19	Thu 8/22/19
107	Transport Overburden to back Ar	22 days	Thu 8/1/19	Tue 9/3/19
108	Spread backfilled material	16 days	Thu 8/1/19	Fri 8/23/19
109	Apply daily cover to backfilled ma	5 days	Thu 8/1/19	Thu 8/8/19
110	Compact backfilled material	7 days	Thu 8/1/19	Fri 8/9/19

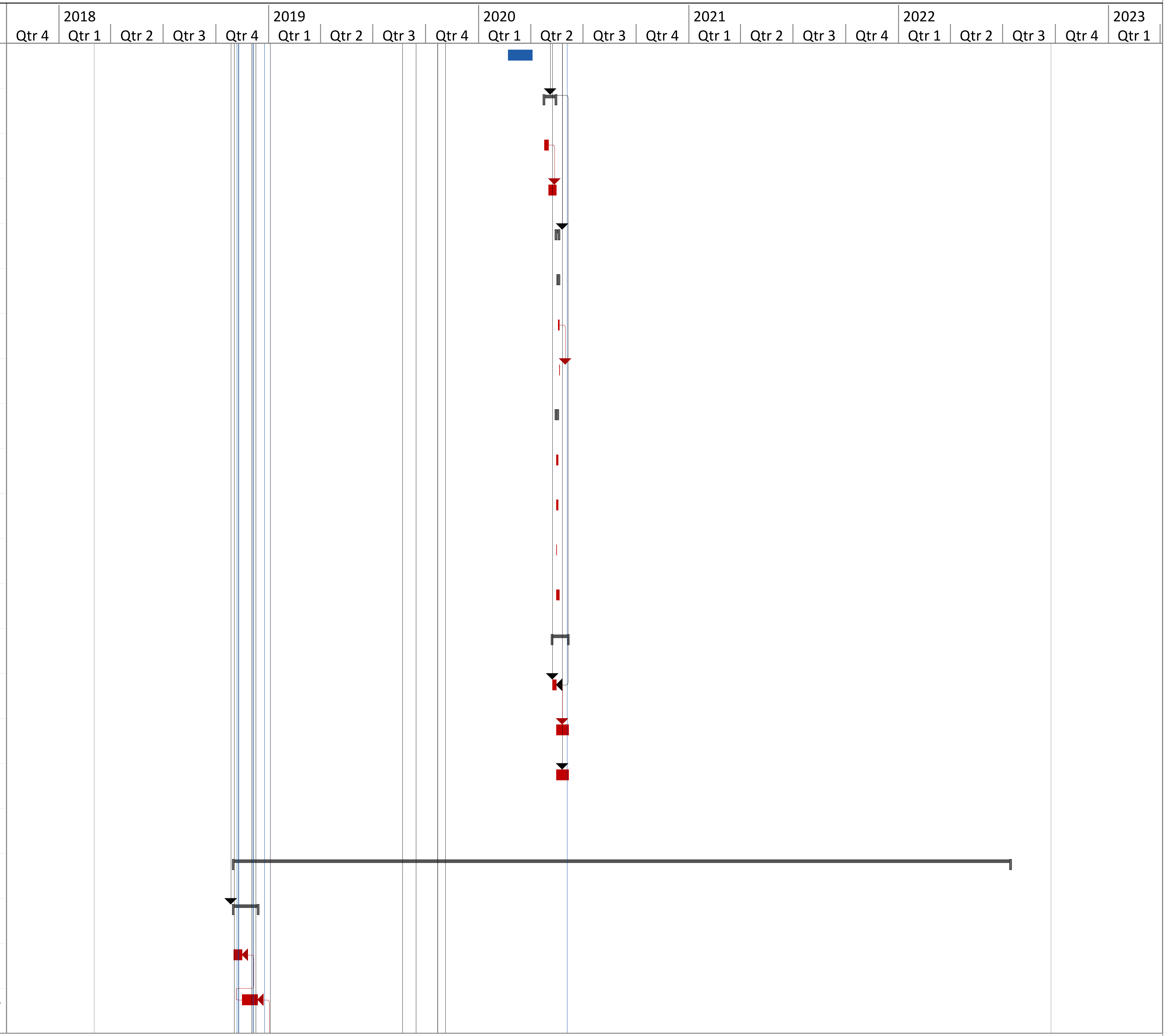


ID	Task Name	Estimated Duration	Start	Finish
111	**Slope Correction Cuts**	**27 days**	**Tue 9/3/19**	**Fri 10/11/19**
112	Apply daily cover to remaining ex	6 days	Thu 10/3/19	Fri 10/11/19
113	**Excavate Non-RIM waste to corr**	**18 days**	**Tue 9/3/19**	**Fri 9/27/19**
114	Excavate	16 days	Tue 9/3/19	Wed 9/25/19
115	Load	2 days	Wed 9/25/19	Fri 9/27/19
116	Relocated excavated material	27 days	Tue 9/3/19	Thu 10/10/19
117	Spread backfilled material	19 days	Tue 9/3/19	Mon 9/30/19
118	Apply daily cover to backfilled ma	6 days	Wed 9/25/19	Thu 10/3/19
119	Compact backfilled material	8 days	Tue 9/3/19	Fri 9/13/19
120	**Leachate Handling**	**30 days**	**Wed 8/8/18**	**Wed 9/19/18**
121	Pumping	0 days	Wed 8/8/18	Wed 8/8/18
122	Tank Transportation on Site	4 days	Wed 8/8/18	Mon 8/13/18
123	Sampling	1 day	Wed 8/8/18	Wed 8/8/18
124	Hauling & Disposal	30 days	Wed 8/8/18	Wed 9/19/18
125	**Final Cover**	**149 days**	**Fri 10/11/19**	**Fri 5/15/20**
126	**Bio-Intrusion**	**88 days**	**Fri 10/11/19**	**Fri 2/21/20**
127	Purchase and Spread Bio-Intrusion Layer Material	17 days	Fri 10/11/19	Fri 1/3/20
128	Deliver Bio-Intrusion Layer Mater	34 days	Fri 1/3/20	Fri 2/21/20
129	Compact Bio-Intrusion Layer Mat	7 days	Fri 10/11/19	Tue 10/22/19
130	**Clay**	**45 days**	**Fri 2/21/20**	**Fri 4/24/20**
131	Purchase and deliver clay materia	45 days	Fri 2/21/20	Fri 4/24/20
132	Spread loose lift before compacti	9 days	Fri 2/21/20	Thu 3/5/20

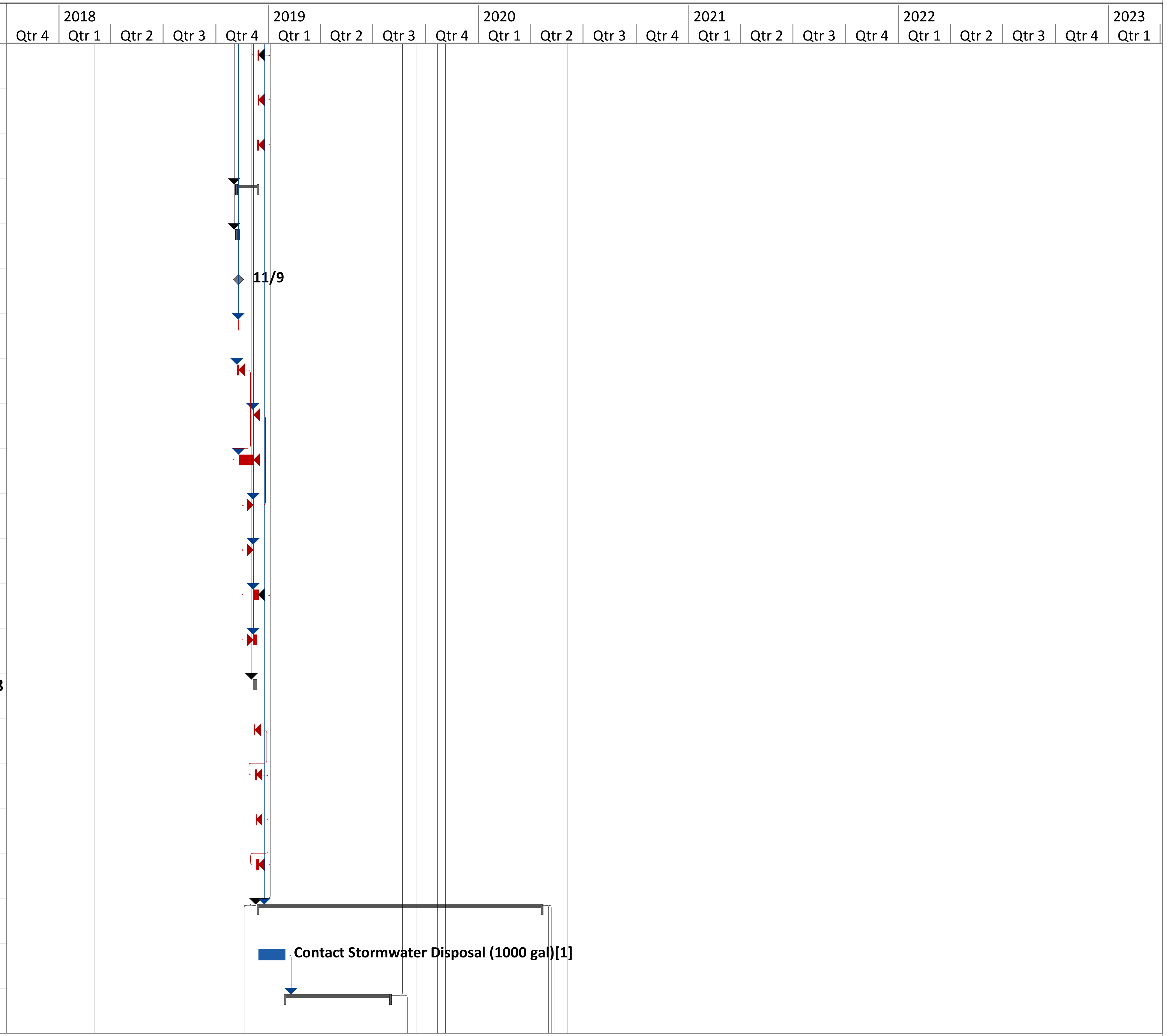


Note: All dates are for planning purposes only - not actual dates.

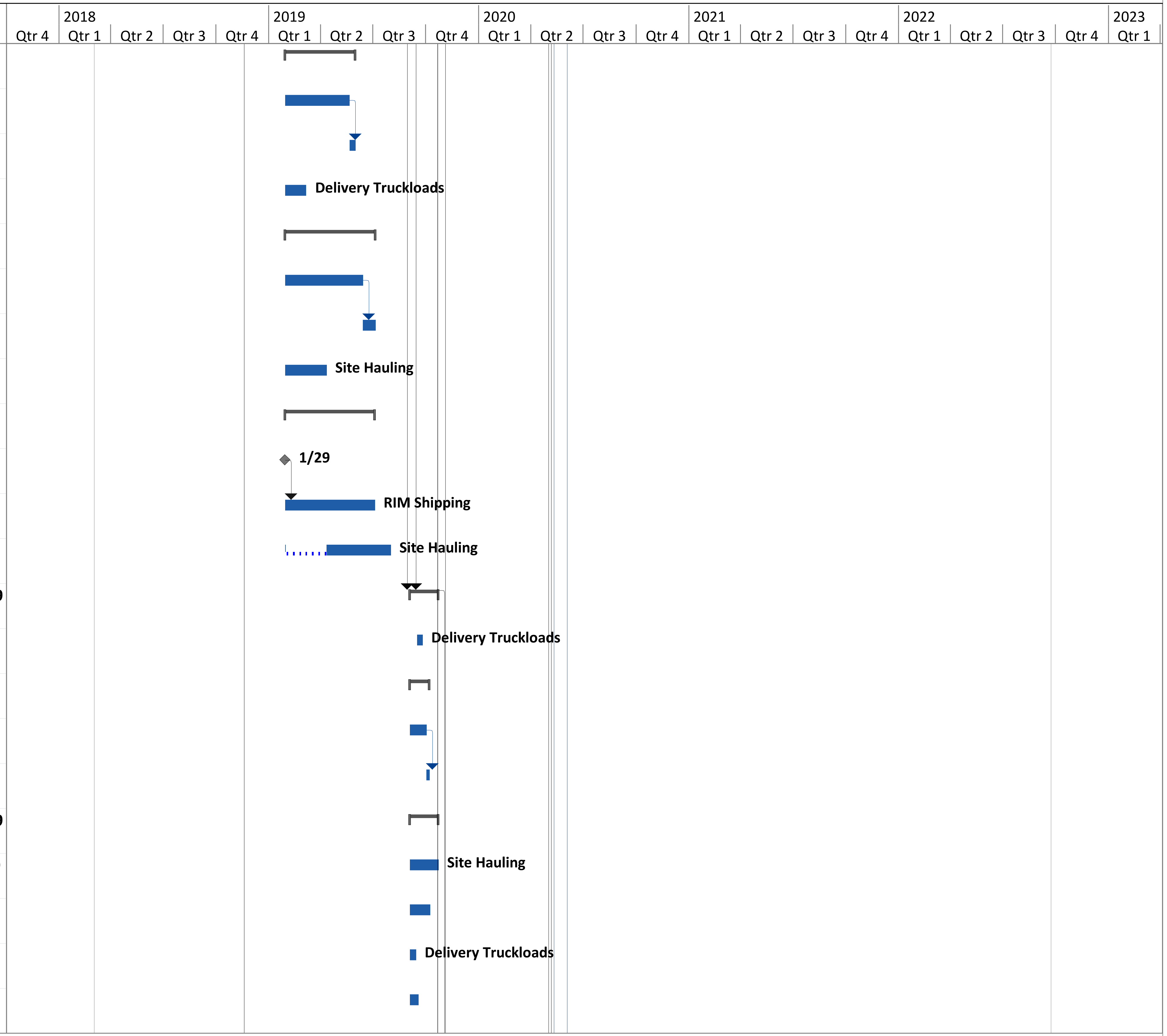
ID	Task Name	Estimated Duration	Start	Finish
133	Compact Clay	30 days	Fri 2/21/20	Fri 4/3/20
134	**Top Soil**	**15 days**	**Fri 4/24/20**	**Fri 5/15/20**
135	Purchase and place Topsoil	5 days	Fri 4/24/20	Fri 5/1/20
136	Addition for Topsoil Delivery	10 days	Fri 5/1/20	Fri 5/15/20
137	**Post-Construction Stormwater Contro**	**3 days**	**Fri 5/15/20**	**Wed 5/20/20**
138	**Install Terraces**	**2 days**	**Mon 5/18/20**	**Wed 5/20/20**
139	Purchase and place Topsoil	1 day	Mon 5/18/20	Wed 5/20/20
140	Addition for Delivery Distance	1 day	Wed 5/20/20	Wed 5/20/20
141	**Diversion Berms**	**1 day**	**Fri 5/15/20**	**Mon 5/18/20**
142	Purchase and deliver clay materia	1 day	Fri 5/15/20	Mon 5/18/20
143	Spread loose lift before compacti	1 day	Fri 5/15/20	Mon 5/18/20
144	Compact berms	0 days	Fri 5/15/20	Fri 5/15/20
145	Final Stormwater Controls	3 days	Fri 5/15/20	Wed 5/20/20
146	**Site Completion**	**19 days**	**Fri 5/8/20**	**Fri 6/5/20**
147	Install temporary irrigation system	5 days	Fri 5/8/20	Fri 5/15/20
148	Apply seeding to cover	14 days	Fri 5/15/20	Fri 6/5/20
149	Install Fencing	14 days	Fri 5/15/20	Fri 6/5/20
150				
151	**Area 2**	**930 days**	**Wed 10/31/1**	**Fri 7/15/22**
152	**Temporary Stormwater Infrastructure**	**29 days**	**Wed 10/31/1**	**Fri 12/14/18**
153	Deliver Frac Tanks	10 days	Wed 10/31/18	Thu 11/15/18
154	Install forcemain from Excavation to Tank Area	18 days	Thu 11/15/18	Wed 12/12/18



ID	Task Name	Estimated Duration	Start	Finish
155	Install forcemain from Tank Area to Treatment Facility	1 day	Wed 12/12/18	Fri 12/14/18
156	Install forcemain valves	0 days	Thu 12/13/18	Fri 12/14/18
157	Prepare area with Stormwater BMP:	3 days	Tue 12/11/18	Fri 12/14/18
158	**Site Preparation**	**25 days**	**Tue 11/6/18**	**Fri 12/14/18**
159	**Decontamination Area**	**3 days**	**Tue 11/6/18**	**Fri 11/9/18**
160	Materials	0 days	Fri 11/9/18	Fri 11/9/18
161	Installation	0 days	Fri 11/9/18	Fri 11/9/18
162	Building Construction	3 days	Tue 11/6/18	Fri 11/9/18
163	Clear Vegetation (Light)	1 day	Tue 12/4/18	Wed 12/5/18
164	Clear Vegetation (Heavy)	15 days	Fri 11/9/18	Wed 12/5/18
165	Clear Small Trees	1 day	Wed 12/5/18	Wed 12/5/18
166	Clear Large Trees	1 day	Wed 12/5/18	Wed 12/5/18
167	Clear Small Stumps	7 days	Wed 12/5/18	Fri 12/14/18
168	Clear Large Stumps	3 days	Wed 12/5/18	Mon 12/10/18
169	**Secondary Containment for Frac Ta**	**2 days**	**Thu 12/6/18**	**Mon 12/10/18**
170	Purchase and deliver liner/berm r	1 day	Thu 12/6/18	Fri 12/7/18
171	Spread material	1 day	Fri 12/7/18	Mon 12/10/18
172	Compact liner/berms	1 day	Mon 12/10/18	Mon 12/10/18
173	Leachate Frac Tanks Delivery	3 days	Mon 12/10/18	Fri 12/14/18
174	**Waste Excavation**	**339 days**	**Fri 12/14/18**	**Tue 4/21/20**
175	Dewater excavation construction after rain events (budgeted	28 days	Fri 12/14/18	Tue 1/29/19
176	**Excavate SW Area 2**	**130 days**	**Tue 1/29/19**	**Thu 8/1/19**

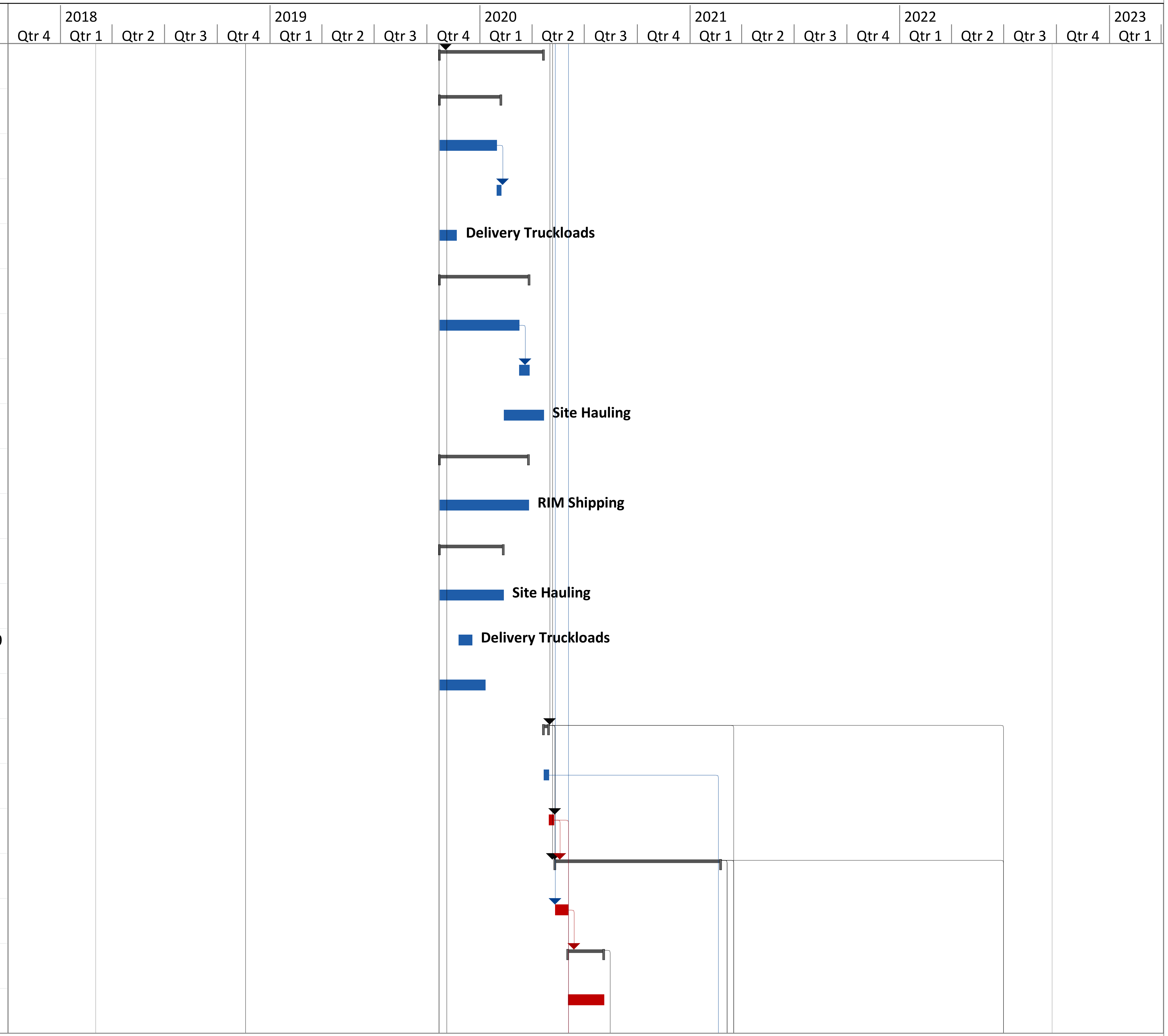


ID	Task Name	Estimated Duration	Start	Finish
177	**Excavate and Sort RIM and Overl**	**87 days**	**Tue 1/29/19**	**Fri 5/31/19**
178	Excavate Waste & Stockpile RII	80 days	Tue 1/29/19	Tue 5/21/19
179	Load Overburden into Haul Tru	7 days	Tue 5/21/19	Fri 5/31/19
180	Apply daily cover to remaining ex	26 days	Tue 1/29/19	Wed 3/6/19
181	**Load RIM from local stockpiles onto Haul Trucks**	**111 days**	**Tue 1/29/19**	**Fri 7/5/19**
182	Excavate	97 days	Tue 1/29/19	Thu 6/13/19
183	Load	15 days	Thu 6/13/19	Fri 7/5/19
184	Haul RIM to Loading Station	52 days	Tue 1/29/19	Thu 4/11/19
185	**RIM Loading & Shipping**	**110 days**	**Tue 1/29/19**	**Thu 7/4/19**
186	Startup Rate	0 days	Tue 1/29/19	Tue 1/29/19
187	Full Production Rate	110 days	Tue 1/29/19	Thu 7/4/19
188	Haul Overburden to Area 1	78 days	Tue 1/29/19	Thu 8/1/19
189	**Excavate NE Area 2 Stockpile for SW Area 2 Drainage Grades**	**35 days**	**Tue 9/3/19**	**Wed 10/23/19**
190	Apply daily cover to remaining st	8 days	Mon 9/16/19	Wed 9/25/19
191	**Excavate Overburden Stockpile**	**24 days**	**Tue 9/3/19**	**Mon 10/7/19**
192	Excavate Overburden	21 days	Tue 9/3/19	Wed 10/2/19
193	Load Overburden into Haul Tru	3 days	Wed 10/2/19	Mon 10/7/19
194	**Transport Remaining Overburden to SW Area 2**	**35 days**	**Tue 9/3/19**	**Wed 10/23/19**
195	Haul to SW Area 2	35 days	Tue 9/3/19	Wed 10/23/19
196	Grade Backfill/Stockpile	25 days	Tue 9/3/19	Tue 10/8/19
197	Apply daily cover to backfilled/stockpiled material	8 days	Tue 9/3/19	Fri 9/13/19
198	Compact backfilled material	10 days	Tue 9/3/19	Wed 9/18/19

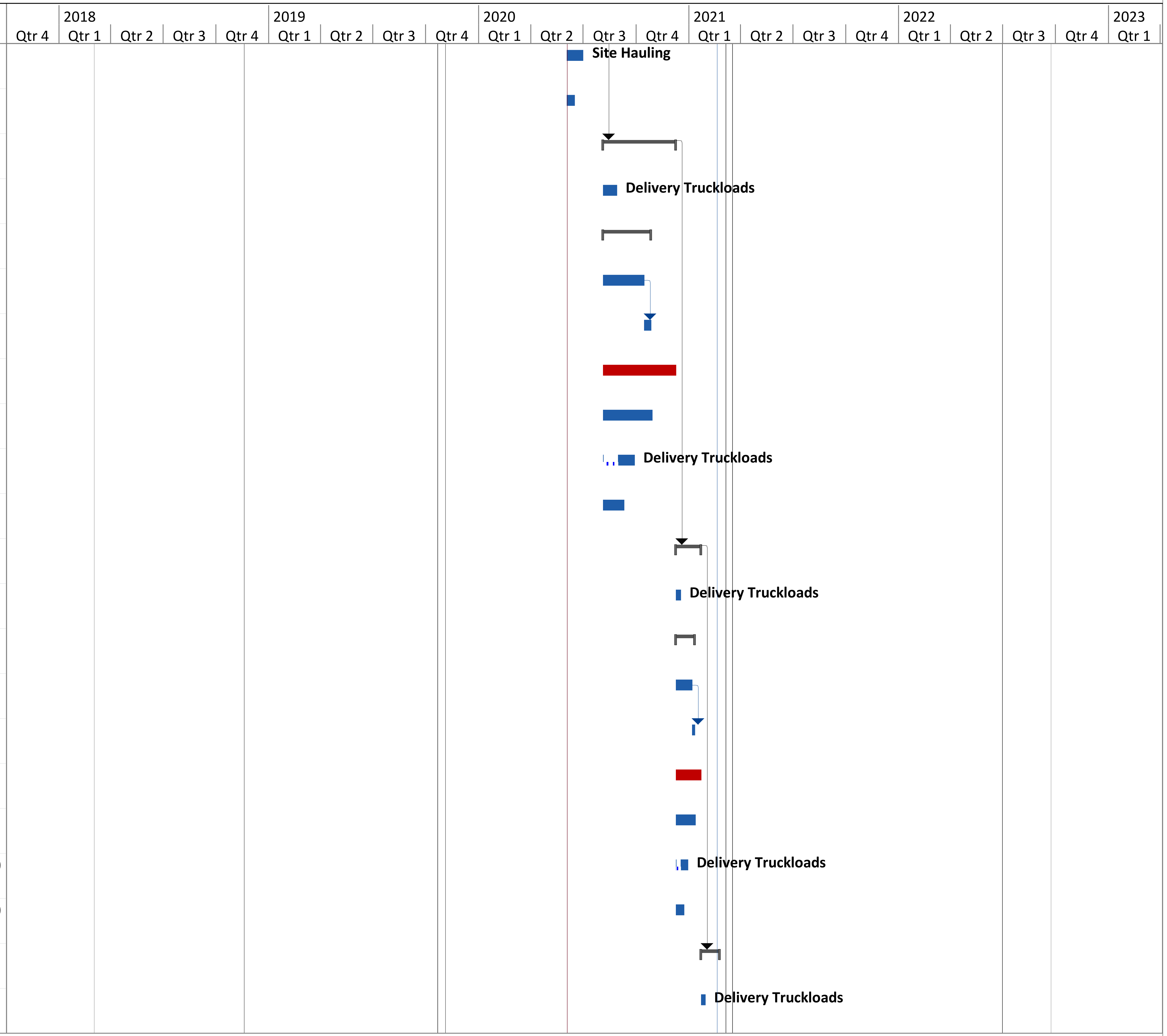


Note: All dates are for planning purposes only - not actual dates.

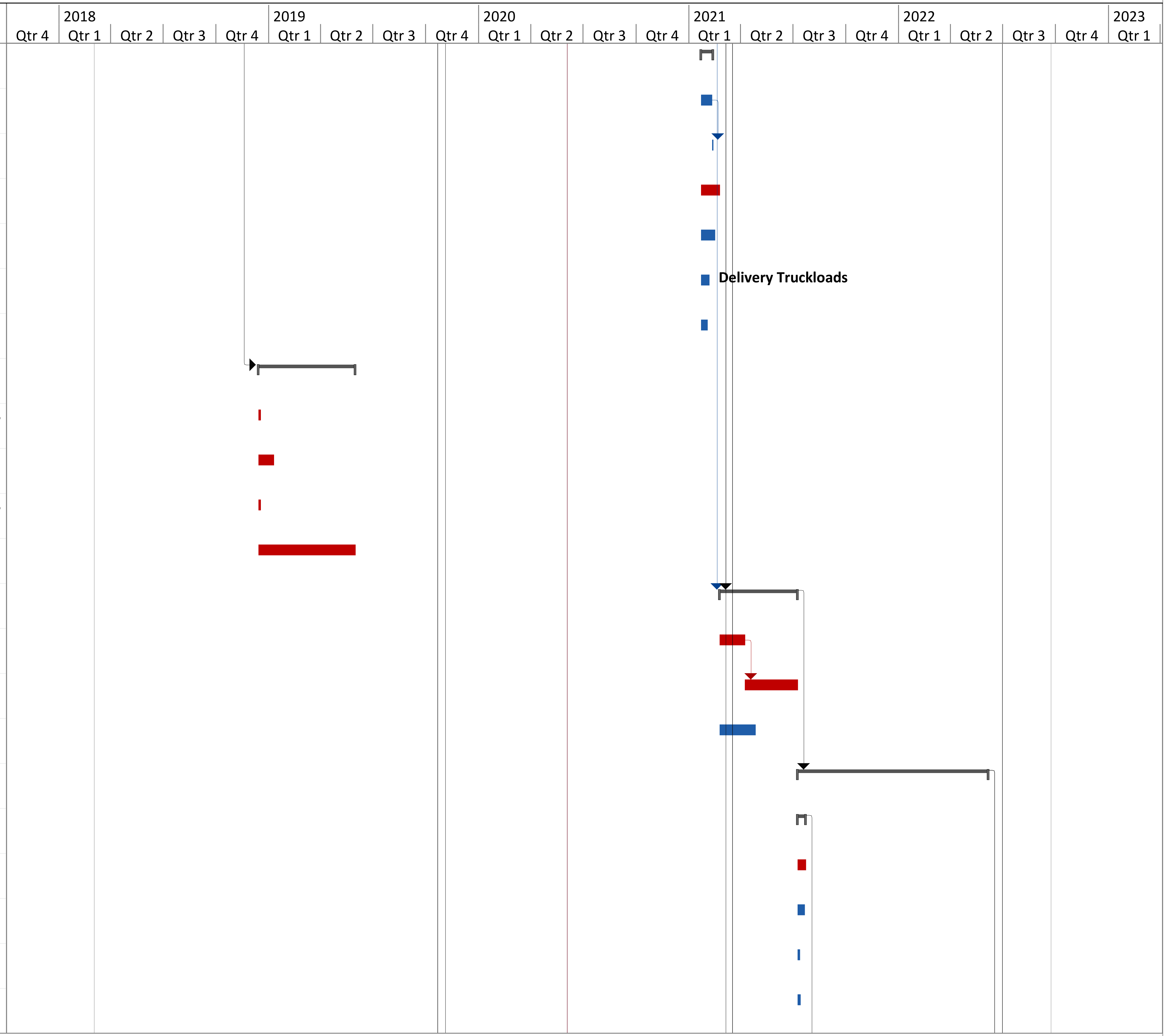
ID	Task Name	Estimated Duration	Start	Finish
199	**Excavate NE Area 2**	**123 days**	**Wed 10/23/1**	**Tue 4/21/20**
200	**Excavate and Sort RIM and Overl**	**70 days**	**Wed 10/23/1**	**Fri 2/7/20**
201	Excavate Waste & Stockpile RIN	64 days	Wed 10/23/19	Thu 1/30/20
202	Load Overburden into Haul Tru	6 days	Thu 1/30/20	Fri 2/7/20
203	Apply daily cover to remaining ex	21 days	Wed 10/23/19	Thu 11/21/19
204	**Load RIM from local stockpiles onto Haul Trucks**	**105 days**	**Wed 10/23/19**	**Fri 3/27/20**
205	Excavate	91 days	Wed 10/23/19	Mon 3/9/20
206	Load	14 days	Mon 3/9/20	Fri 3/27/20
207	Haul RIM to Loading Station	50 days	Wed 2/12/20	Tue 4/21/20
208	**RIM Loading & Shipping**	**104 days**	**Wed 10/23/1**	**Thu 3/26/20**
209	Full Production Rate	104 days	Wed 10/23/19	Thu 3/26/20
210	**Transport Overburden to SW Area 2 Stockpile**	**72 days**	**Wed 10/23/19**	**Tue 2/11/20**
211	Haul to SW Area 2	72 days	Wed 10/23/19	Tue 2/11/20
212	Apply daily cover to stockpiled	17 days	Mon 11/25/19	Wed 12/18/19
213	Grade Stockpile	51 days	Wed 10/23/19	Fri 1/10/20
214	**Buffer Zone**	**6 days**	**Tue 4/21/20**	**Wed 4/29/20**
215	Buffer Zone Activity	6 days	Tue 4/21/20	Wed 4/29/20
216	Final Radiological Survey	7 days	Thu 4/30/20	Fri 5/8/20
217	**Waste Backfill and Regrading**	**198 days**	**Mon 5/11/20**	**Tue 2/23/21**
218	Dewater backfill construction after rain events (budgeted weather	16 days	Mon 5/11/20	Tue 6/2/20
219	**C&D Rubble Stockpiles**	**44 days**	**Tue 6/2/20**	**Tue 8/4/20**
220	Relocate Stockpiled Material on-site - Excavate	44 days	Tue 6/2/20	Tue 8/4/20



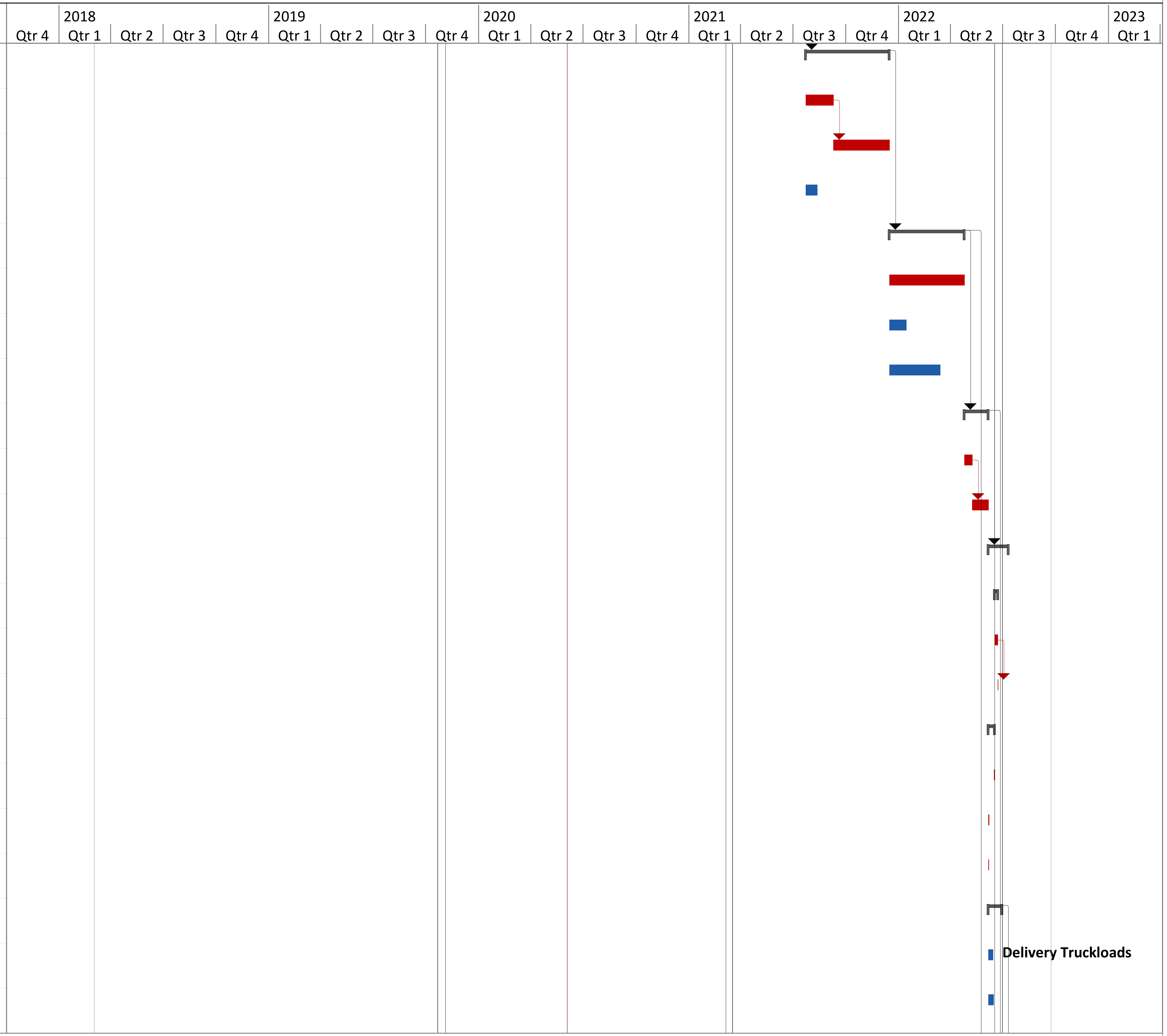
ID	Task Name	Estimated Duration	Start	Finish
221	Relocate Stockpiled Material on-site - Haul and Dump	20 days	Tue 6/2/20	Tue 6/30/20
222	Bury Stockpiled Material	9 days	Tue 6/2/20	Tue 6/16/20
223	**Backfill NE Area 2 with Overburden from SW Area 2**	**87 days**	**Tue 8/4/20**	**Wed 12/9/20**
224	Apply daily cover to remaining stockpile excavation	19 days	Tue 8/4/20	Fri 8/28/20
225	**Excavate Overburden**	**59 days**	**Tue 8/4/20**	**Tue 10/27/20**
226	Excavate	51 days	Tue 8/4/20	Thu 10/15/20
227	Load	8 days	Thu 10/15/20	Tue 10/27/20
228	Transport Overburden back to NE	87 days	Tue 8/4/20	Wed 12/9/20
229	Spread backfilled material	61 days	Tue 8/4/20	Thu 10/29/20
230	Apply daily cover to backfilled ma	20 days	Tue 8/4/20	Mon 9/28/20
231	Compact backfilled material	26 days	Tue 8/4/20	Thu 9/10/20
232	**Slope Correction Cuts in Area 2 SW**	**29 days**	**Wed 12/9/20**	**Fri 1/22/21**
233	Apply daily cover to remaining ex	6 days	Wed 12/9/20	Thu 12/17/20
234	**Excavate Non-RIM waste to corr**	**20 days**	**Wed 12/9/20**	**Mon 1/11/21**
235	Excavate	17 days	Wed 12/9/20	Wed 1/6/21
236	Load	3 days	Wed 1/6/21	Mon 1/11/21
237	Relocate excavated material	29 days	Wed 12/9/20	Fri 1/22/21
238	Spread backfilled material	20 days	Wed 12/9/20	Tue 1/12/21
239	Apply daily cover to backfilled ma	7 days	Wed 12/9/20	Wed 12/30/20
240	Compact backfilled material	9 days	Wed 12/9/20	Wed 12/23/20
241	**Slope Correction Cuts in Area 2 NE**	**22 days**	**Fri 1/22/21**	**Tue 2/23/21**
242	Apply daily cover to remaining ex	5 days	Fri 1/22/21	Fri 1/29/21



ID	Task Name	Estimated Duration	Start	Finish
243	**Excavate Non-RIM waste to corr**	**15 days**	**Fri 1/22/21**	**Fri 2/12/21**
244	Excavate	13 days	Fri 1/22/21	Wed 2/10/21
245	Load	2 days	Wed 2/10/21	Fri 2/12/21
246	Relocated excavated material	22 days	Fri 1/22/21	Tue 2/23/21
247	Spread backfilled material	15 days	Fri 1/22/21	Mon 2/15/21
248	Apply daily cover to backfilled ma	5 days	Fri 1/22/21	Fri 2/5/21
249	Compact backfilled material	6 days	Fri 1/22/21	Tue 2/2/21
250	**Leachate Handling**	**115 days**	**Fri 12/14/18**	**Fri 5/31/19**
251	Pumping	2 days	Fri 12/14/18	Mon 12/17/18
252	Tank Transportation on Site	15 days	Fri 12/14/18	Wed 1/9/19
253	Sampling	2 days	Fri 12/14/18	Mon 12/17/18
254	Hauling & Disposal	115 days	Fri 12/14/18	Fri 5/31/19
255	**Additional Fill**	**96 days**	**Tue 2/23/21**	**Fri 7/9/21**
256	Purchase material and spread	32 days	Tue 2/23/21	Thu 4/8/21
257	Additional delivery distance	64 days	Thu 4/8/21	Fri 7/9/21
258	Compact material	44 days	Tue 2/23/21	Mon 4/26/21
259	**Final Cover**	**228 days**	**Fri 7/9/21**	**Mon 6/6/22**
260	**Starter Berms**	**10 days**	**Fri 7/9/21**	**Fri 7/23/21**
261	Purchase and deliver material	10 days	Fri 7/9/21	Fri 7/23/21
262	Spread loose lift before compacti	8 days	Fri 7/9/21	Wed 7/21/21
263	Special grading for steep slopes	2 days	Fri 7/9/21	Tue 7/13/21
264	Compact starter berms	3 days	Fri 7/9/21	Wed 7/14/21



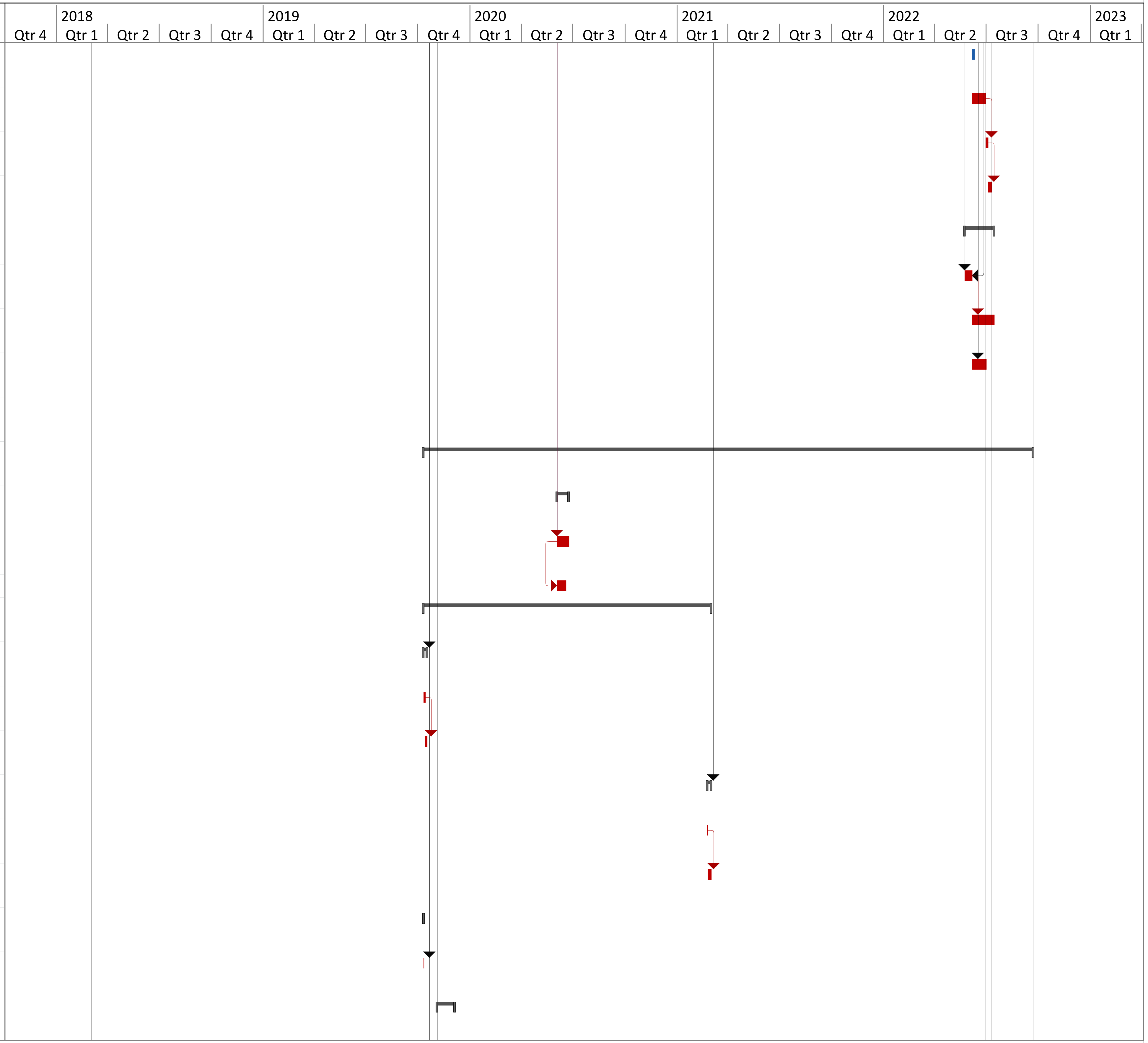
ID	Task Name	Estimated Duration	Start	Finish
265	**Bio-Intrusion**	**100 days**	**Fri 7/23/21**	**Thu 12/16/21**
266	Purchase and Spread Bio-Intrusion Layer Material	34 days	Fri 7/23/21	Thu 9/9/21
267	Deliver Bio-Intrusion Layer Mater	67 days	Thu 9/9/21	Thu 12/16/21
268	Compact Bio-Intrusion Layer Mat	14 days	Fri 7/23/21	Thu 8/12/21
269	**Clay**	**89 days**	**Thu 12/16/21**	**Mon 4/25/22**
270	Purchase and deliver clay materia	89 days	Thu 12/16/21	Mon 4/25/22
271	Spread loose lift before compacti	18 days	Thu 12/16/21	Fri 1/14/22
272	Compact Clay (Final Cover)	59 days	Thu 12/16/21	Mon 3/14/22
273	**Top Soil**	**29 days**	**Mon 4/25/22**	**Mon 6/6/22**
274	Purchase and place Topsoil	10 days	Mon 4/25/22	Mon 5/9/22
275	Addition for Delivery Distance	19 days	Mon 5/9/22	Mon 6/6/22
276	**Post-Construction Stormwater Contro**	**24 days**	**Mon 6/6/22**	**Mon 7/11/22**
277	**Install Terraces**	**4 days**	**Fri 6/17/22**	**Thu 6/23/22**
278	Purchase and place Topsoil	3 days	Fri 6/17/22	Wed 6/22/22
279	Addition for Delivery Distance	1 day	Wed 6/22/22	Thu 6/23/22
280	**Diversion Berms**	**9 days**	**Mon 6/6/22**	**Fri 6/17/22**
281	Purchase and deliver clay materia	1 day	Thu 6/16/22	Fri 6/17/22
282	Spread loose lift before compacti	1 day	Mon 6/6/22	Tue 6/7/22
283	Compact berms	0 days	Mon 6/6/22	Mon 6/6/22
284	**Pond**	**18 days**	**Mon 6/6/22**	**Thu 6/30/22**
285	Purchase and deliver liner & berm	6 days	Mon 6/6/22	Tue 6/14/22
286	Spread loose lift before compacti	7 days	Mon 6/6/22	Wed 6/15/22



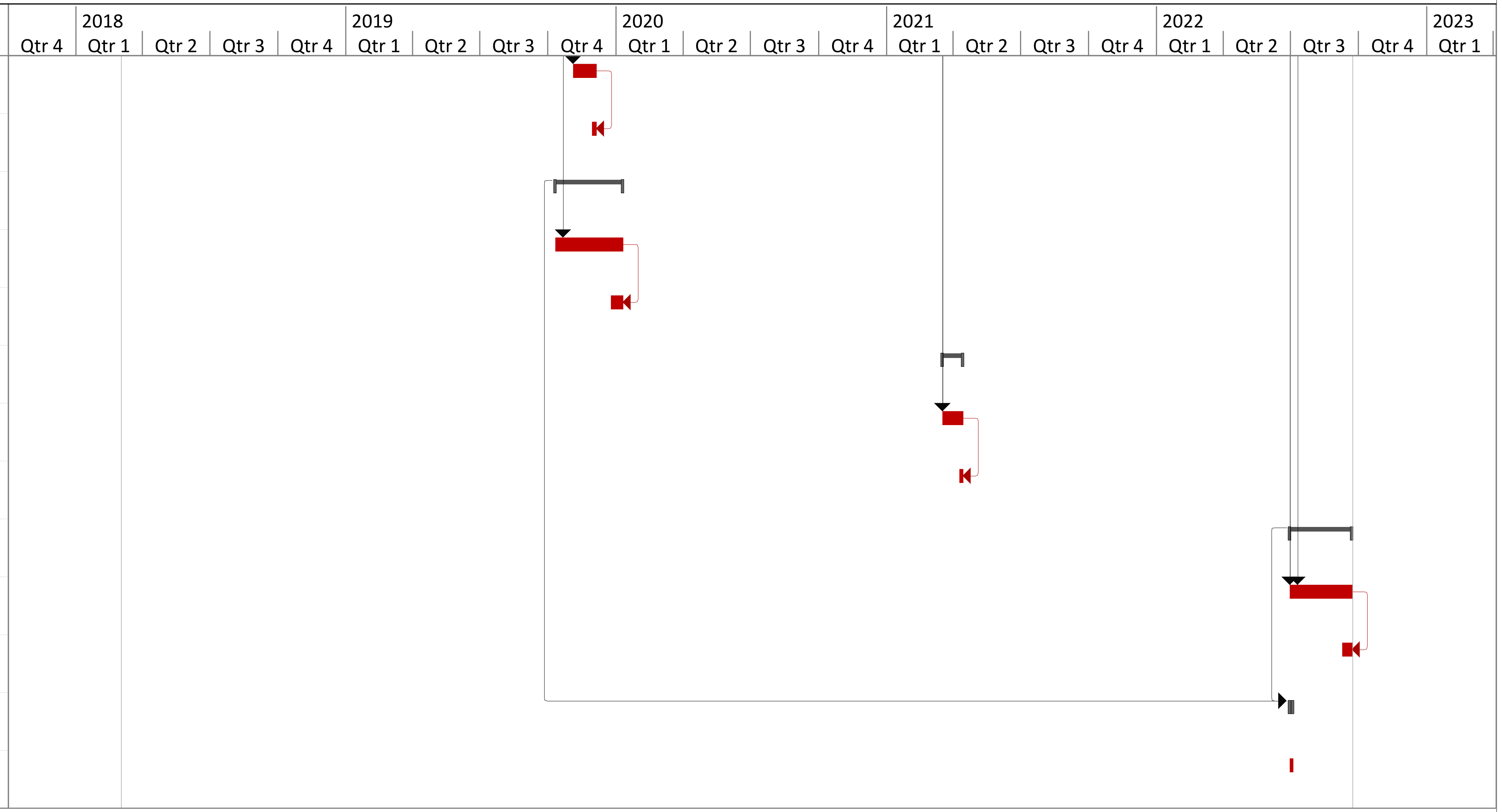
West Lake FFS - Partial Excavation 52.9/16'

DRAFT - Subject to Revision

ID	Task Name	Estimated Duration	Start	Finish
287	Compact Liner & Berm	4 days	Mon 6/6/22	Fri 6/10/22
288	Perimeter Berm Structural Rock	18 days	Mon 6/6/22	Thu 6/30/22
289	Perimeter Road Stormwater Crossin	2 days	Thu 6/30/22	Mon 7/4/22
290	Final Stormwater Controls	4 days	Mon 7/4/22	Mon 7/11/22
291	**Site Completion**	**38 days**	**Tue 5/24/22**	**Fri 7/15/22**
292	Install temporary irrigation system	9 days	Tue 5/24/22	Mon 6/6/22
293	Apply seeding to cover	28 days	Mon 6/6/22	Fri 7/15/22
294	Install Fencing	19 days	Mon 6/6/22	Fri 7/1/22
295				
296	**Clean-up and Demolition**	**742 days**	**Fri 10/11/19**	**Thu 9/22/22**
297	**RIM Loading Station**	**15 days**	**Wed 6/3/20**	**Tue 6/23/20**
298	Demolition	15 days	Wed 6/3/20	Tue 6/23/20
299	Air Treatment Demobilization	12 days	Wed 6/3/20	Thu 6/18/20
300	**Haul Road between Areas and Loadin**	**346 days**	**Fri 10/11/19**	**Tue 3/2/21**
301	**Area 1**	**5 days**	**Fri 10/11/19**	**Thu 10/17/19**
302	Remove potential contamination	1 day	Fri 10/11/19	Mon 10/14/19
303	Repairs for use during Capping Ph	4 days	Mon 10/14/19	Thu 10/17/19
304	**Area 2**	**5 days**	**Tue 2/23/21**	**Tue 3/2/21**
305	Remove potential contamination	1 day	Tue 2/23/21	Wed 2/24/21
306	Repairs for use during Capping Ph	4 days	Wed 2/24/21	Tue 3/2/21
307	**Bridge**	**1 day**	**Fri 10/11/19**	**Fri 10/11/19**
308	Demolition	1 day	Fri 10/11/19	Fri 10/11/19
309	**Area 1 Leachate Frac Tanks**	**20 days**	**Mon 11/4/19**	**Thu 12/5/19**



ID	Task Name	Estimated Duration	Start	Finish
310	Clean Leachate Frac Tanks	20 days	Mon 11/4/19	Thu 12/5/19
311	Remove Leachate Frac Tanks	3 days	Fri 11/29/19	Thu 12/5/19
312	**Area 1 Stormwater Frac Tanks**	**58 days**	**Fri 10/11/19**	**Fri 1/10/20**
313	Clean Frac Tanks	58 days	Fri 10/11/19	Fri 1/10/20
314	Remove Frac Tanks	10 days	Wed 12/25/19	Fri 1/10/20
315	**Area 2 Leachate Frac Tanks**	**20 days**	**Wed 3/17/21**	**Wed 4/14/21**
316	Clean Leachate Frac Tanks	20 days	Wed 3/17/21	Wed 4/14/21
317	Remove Leachate Frac Tanks	3 days	Fri 4/9/21	Wed 4/14/21
318	**Area 2 Stormwater Frac Tanks**	**58 days**	**Thu 6/30/22**	**Thu 9/22/22**
319	Clean Frac Tanks	58 days	Thu 6/30/22	Thu 9/22/22
320	Remove Frac Tanks	10 days	Fri 9/9/22	Thu 9/22/22
321	**Stormwater Treatment Facility**	**2 days**	**Thu 6/30/22**	**Mon 7/4/22**
322	Demolition	2 days	Thu 6/30/22	Mon 7/4/22



Estimated Schedule

“Partial Rad Removal, >1000 pCi/g” with Off-Site Disposal Alternative

Overview of Partial Excavation >1000 pCi/g Construction Schedule

Final Feasibility Study, West Lake Landfill

Overall Project: *March 2018 – November 2025 (7.7 years)*

Site-wide Preparations – *March - August 2018*

- Mobilization, Construction Trailers, Project Infrastructure, RIM Loading Station

Area 1 – *March 2018 – April 2022*

- Site Preparations – *March - April 2018*
- Waste Excavation – *August 2018 - January 2020*
  - Ship RIM offsite, stockpile overburden
- Waste Backfilling and Regrading – *February 2020 - April 2021*
  - Backfill excavation, regrade other waste as necessary
- Final Cover – *April 2021 – March 2022*
- Stormwater Controls and Site Completion – *March – April 2022*

Partially overlapping:

Area 2 – *December 2019 – September 2025*

- Site Preparations – *December 2019 - February 2020*
- Waste Excavation – *February 2020 - October 2022*
  - Ship RIM offsite, stockpile overburden, backfill where possible
  - Including Buffer Zone
- Remaining Waste Backfilling and Regrading – *October 2022 - August 2024*
  - Backfill excavation, regrade other waste as necessary
- Final Cover – *August 2024 - July 2025*
- Stormwater Controls and Site Completion – *through September 2025*

Clean-up and Demolition – *Ending November 2025*

- Takes place as appropriate throughout project

West Lake FFS - Partial Excavation 1000

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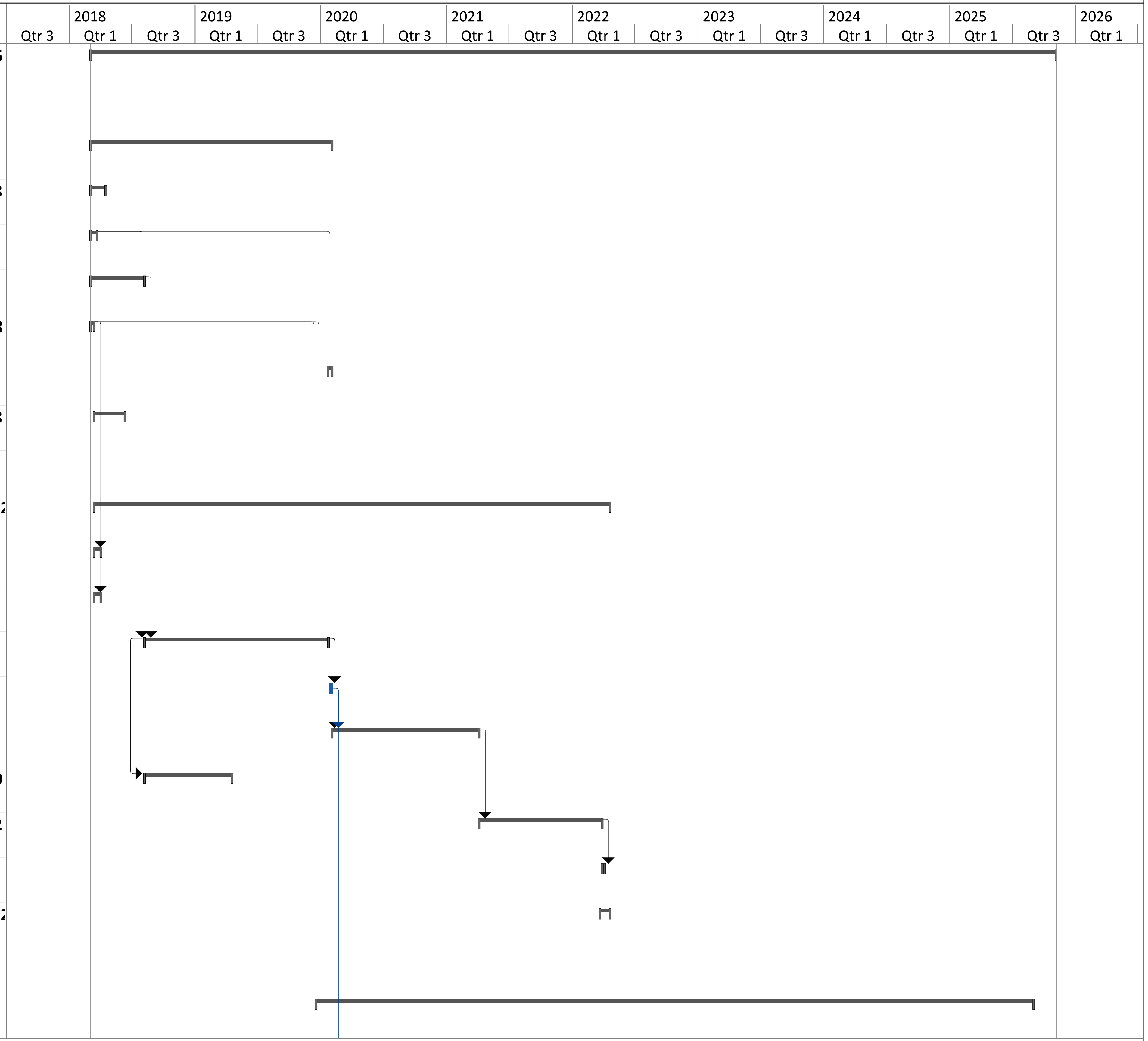
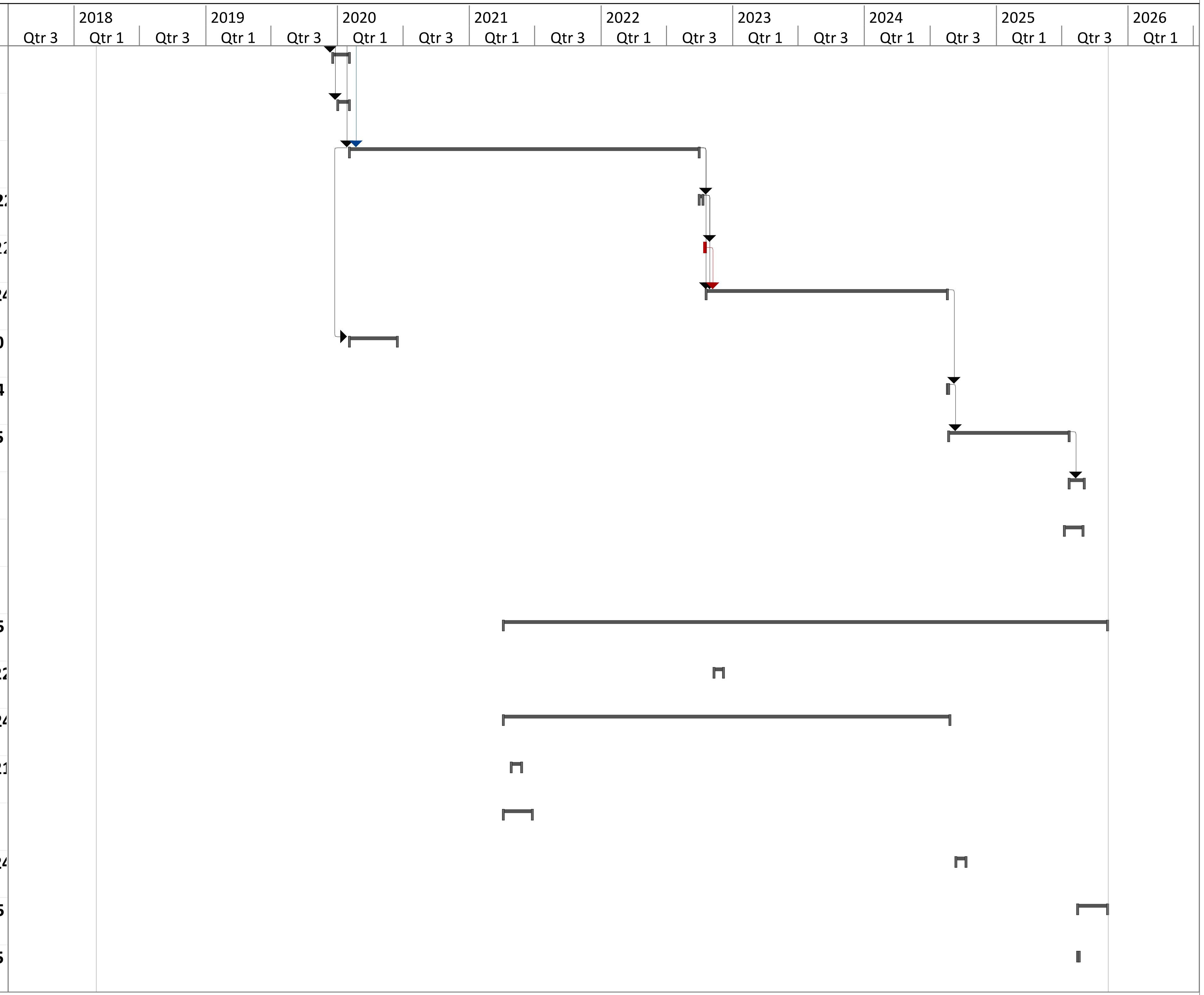
ID	Task Name	Estimated Duration	Start	Finish
1	**Partial Excavation 1000 Schedule**	**1935 days**	**Mon 3/5/18**	**Thu 11/6/25**
2				
3	**Site-wide Preparation**	**481 days**	**Mon 3/5/18**	**Tue 2/4/20**
4	**Temporary Construction Facilities / Utilities / Personnel**	**31 days**	**Mon 3/5/18**	**Tue 4/17/18**
7	**Stormwater Treatment Facility**	**15 days**	**Mon 3/5/18**	**Fri 3/23/18**
9	**RIM Loading Station**	**110 days**	**Mon 3/5/18**	**Tue 8/7/18**
12	**Mobilization**	**9 days**	**Mon 3/5/18**	**Thu 3/15/18**
23	**Supplemental Mobilization**	**9 days**	**Wed 1/22/20**	**Tue 2/4/20**
34	**Road & Traffic Improvements**	**62 days**	**Thu 3/15/18**	**Tue 6/12/18**
50				
51	**Area 1**	**1032 days**	**Thu 3/15/18**	**Wed 4/20/22**
52	**Temporary Stormwater Infrastructure**	**13 days**	**Thu 3/15/18**	**Tue 4/3/18**
58	**Site Preparation**	**13 days**	**Thu 3/15/18**	**Tue 4/3/18**
74	**Waste Excavation**	**364 days**	**Wed 8/8/18**	**Fri 1/24/20**
91	Final Radiological Survey	7 days	Fri 1/24/20	Tue 2/4/20
92	**Waste Backfill and Regrading**	**295 days**	**Tue 2/4/20**	**Mon 4/5/21**
120	**Leachate Handling**	**174 days**	**Wed 8/8/18**	**Thu 4/18/19**
125	**Final Cover**	**247 days**	**Mon 4/5/21**	**Tue 3/29/22**
137	**Post-Construction Stormwater Controls**	**5 days**	**Tue 3/29/22**	**Tue 4/5/22**
146	**Site Completion**	**22 days**	**Tue 3/22/22**	**Wed 4/20/22**
150				
151	**Area 2**	**1435 days**	**Thu 12/19/19**	**Tue 9/2/25**

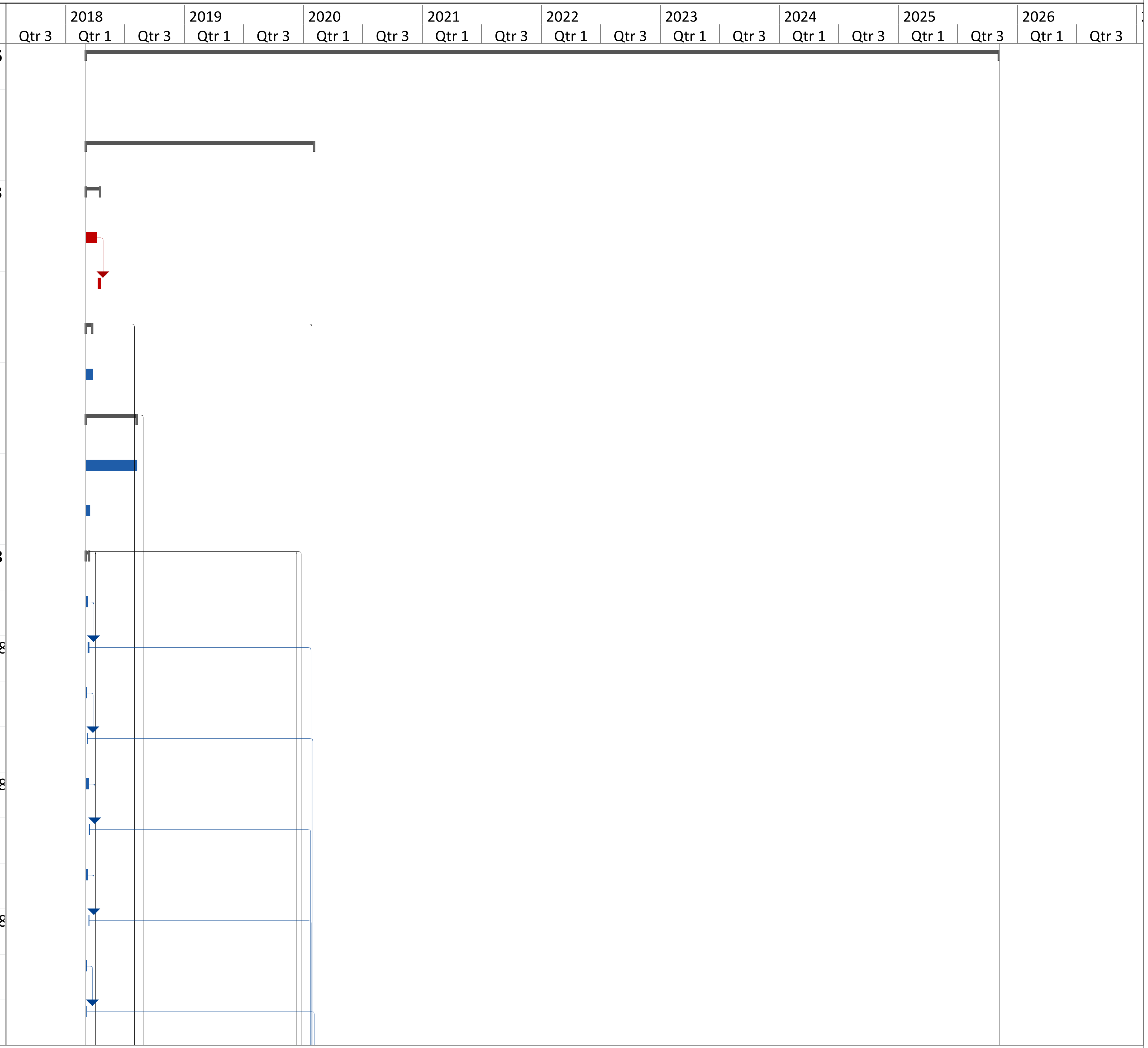


ID	Task Name	Estimated Duration	Start	Finish
152	**Temporary Stormwater Infrastructure**	**29 days**	**Thu 12/19/19**	**Tue 2/4/20**
158	**Site Preparation**	**22 days**	**Thu 1/2/20**	**Tue 2/4/20**
174	**Waste Excavation**	**673 days**	**Tue 2/4/20**	**Fri 9/30/22**
233	**Buffer Zone**	**6 days**	**Fri 9/30/22**	**Tue 10/11/2**
235	Final Radiological Survey	7 days	Tue 10/11/22	Thu 10/20/2
236	**Waste Backfill and Regrading**	**461 days**	**Thu 10/20/22**	**Mon 8/19/2**
278	**Leachate Handling**	**94 days**	**Tue 2/4/20**	**Tue 6/16/20**
283	**Additional Fill**	**2 days**	**Mon 8/19/24**	**Thu 8/22/24**
287	**Final Cover**	**229 days**	**Thu 8/22/24**	**Tue 7/22/25**
304	**Post-Construction Stormwater Controls**	**29 days**	**Tue 7/22/25**	**Tue 9/2/25**
319	**Site Completion**	**38 days**	**Wed 7/9/25**	**Fri 8/29/25**
323				
324	**Clean-up and Demolition**	**1158 days**	**Mon 4/5/21**	**Thu 11/6/25**
325	**RIM Loading Station**	**15 days**	**Fri 11/11/22**	**Wed 12/7/2**
328	**Haul Road between Areas and Loading Stat**	**856 days**	**Mon 4/5/21**	**Mon 8/26/2**
337	**Area 1 Leachate Frac Tanks**	**20 days**	**Tue 4/27/21**	**Wed 5/26/2**
340	**Area 1 Stormwater Frac Tanks**	**58 days**	**Mon 4/5/21**	**Fri 6/25/21**
343	**Area 2 Leachate Frac Tanks**	**20 days**	**Wed 9/11/24**	**Wed 10/9/2**
346	**Area 2 Stormwater Frac Tanks**	**58 days**	**Fri 8/15/25**	**Thu 11/6/25**
349	**Stormwater Treatment Facility**	**2 days**	**Fri 8/15/25**	**Tue 8/19/25**



Note: All dates are for planning purposes only - not actual dates.

ID	Task Name	Estimated Duration	Start	Finish
1	**Partial Excavation 1000 Schedule**	**1935 days**	**Mon 3/5/18**	**Thu 11/6/25**
2				
3	**Site-wide Preparation**	**481 days**	**Mon 3/5/18**	**Tue 2/4/20**
4	**Temporary Construction Facilities / Utilities / Personnel**	**31 days**	**Mon 3/5/18**	**Tue 4/17/18**
5	Construction Trailers	25 days	Mon 3/5/18	Fri 4/6/18
6	Parking Area	6 days	Mon 4/9/18	Tue 4/17/18
7	**Stormwater Treatment Facility**	**15 days**	**Mon 3/5/18**	**Fri 3/23/18**
8	Construction	15 days	Mon 3/5/18	Fri 3/23/18
9	**RIM Loading Station**	**110 days**	**Mon 3/5/18**	**Tue 8/7/18**
10	Construction	110 days	Mon 3/5/18	Tue 8/7/18
11	Air Treatment System	10 days	Mon 3/5/18	Fri 3/16/18
12	**Mobilization**	**9 days**	**Mon 3/5/18**	**Thu 3/15/18**
13	Mobilize and Demobilize Equipment by Pic	4 days	Mon 3/5/18	Thu 3/8/18
14	Extra Mileage for Mobilizations	3 days	Fri 3/9/18	Wed 3/14/18
15	Mobilize and Demobilize Equipment by 3-t	2 days	Mon 3/5/18	Wed 3/7/18
16	Extra Mileage for Mobilizations	1 day	Wed 3/7/18	Thu 3/8/18
17	Mobilize and Demobilize Equipment by 20-	6 days	Mon 3/5/18	Mon 3/12/18
18	Extra Mileage for Mobilizations	3 days	Tue 3/13/18	Thu 3/15/18
19	Mobilize and Demobilize Equipment by 40-	5 days	Mon 3/5/18	Fri 3/9/18
20	Extra Mileage for Mobilizations	2 days	Mon 3/12/18	Wed 3/14/18
21	Mobilize and Demobilize Crane Equipment	1 day	Mon 3/5/18	Mon 3/5/18
22	Extra Mileage for Mobilizations	0 days	Mon 3/5/18	Tue 3/6/18



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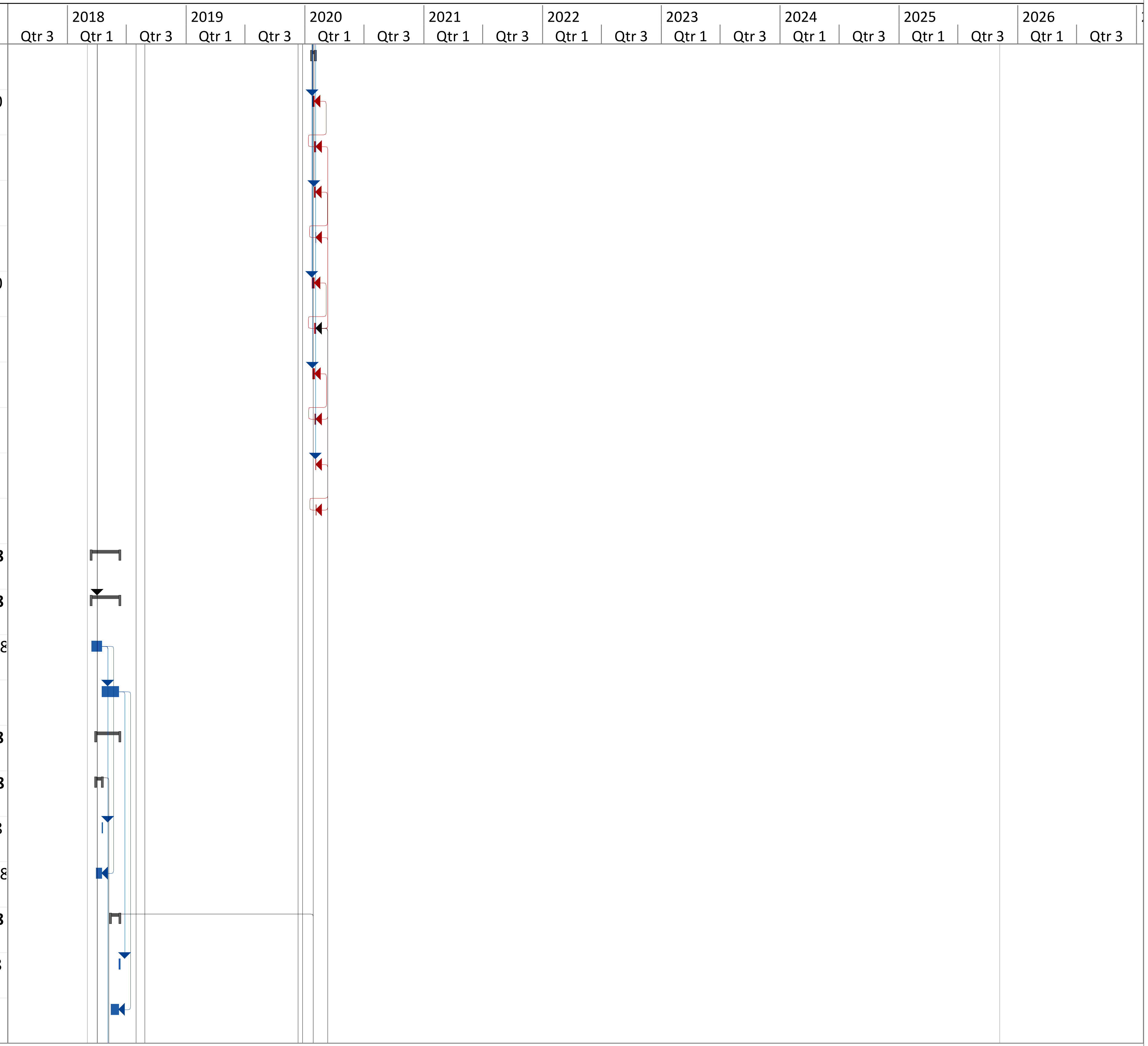
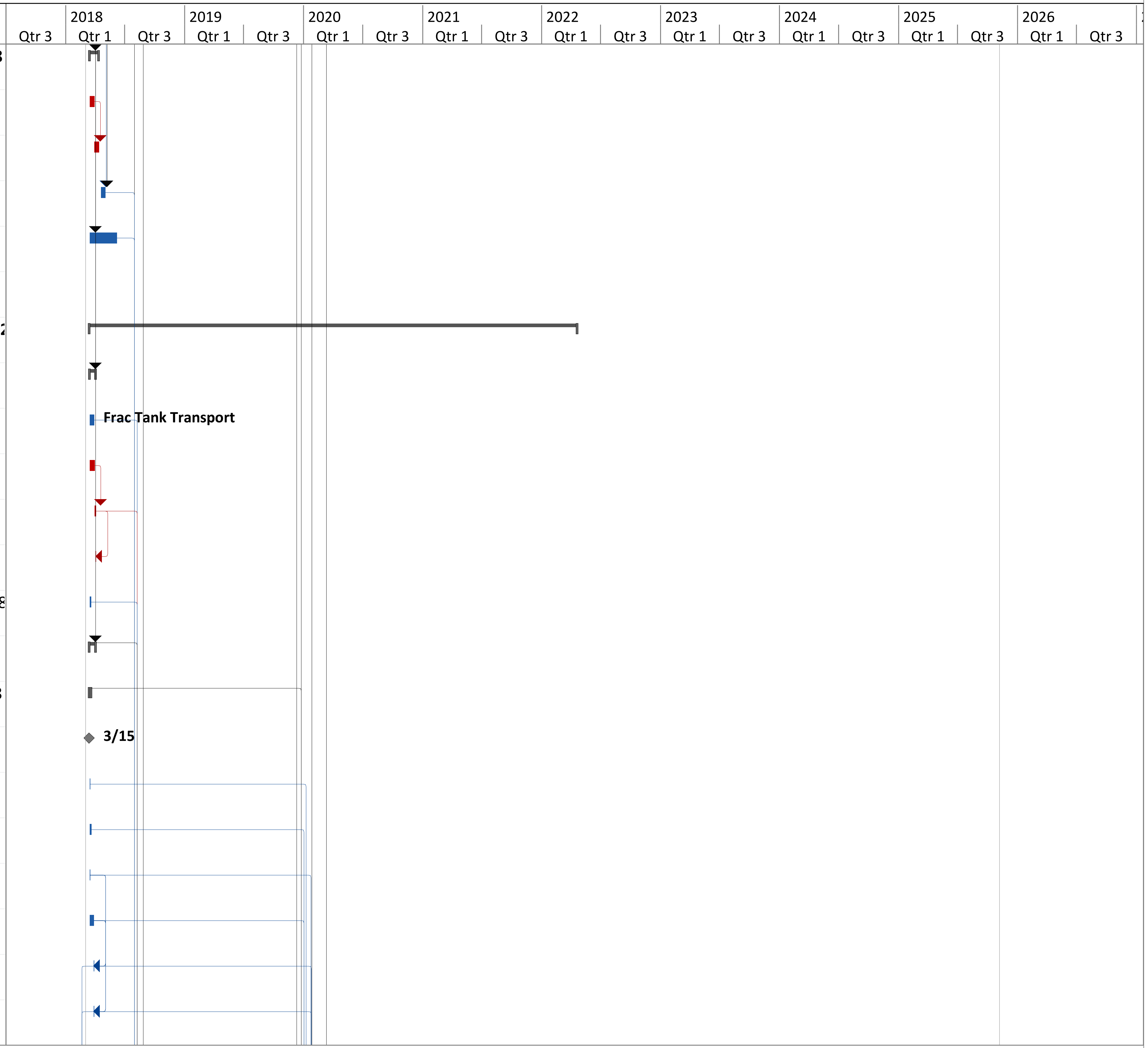
ID	Task Name	Estimated Duration	Start	Finish
23	**Supplemental Mobilization**	**9 days**	**Wed 1/22/20**	**Tue 2/4/20**
24	Mobilize and Demobilize Equipment by Pic	4 days	Fri 1/24/20	Thu 1/30/20
25	Extra Mileage for Mobilizations	3 days	Thu 1/30/20	Tue 2/4/20
26	Mobilize and Demobilize Equipment by 3-t	2 days	Wed 1/29/20	Mon 2/3/20
27	Extra Mileage for Mobilizations	1 day	Mon 2/3/20	Tue 2/4/20
28	Mobilize and Demobilize Equipment by 20-	6 days	Wed 1/22/20	Thu 1/30/20
29	Extra Mileage for Mobilizations	3 days	Thu 1/30/20	Tue 2/4/20
30	Mobilize and Demobilize Equipment by 40-	5 days	Fri 1/24/20	Fri 1/31/20
31	Extra Mileage for Mobilizations	2 days	Fri 1/31/20	Tue 2/4/20
32	Mobilize and Demobilize Crane Equipment	1 day	Mon 2/3/20	Mon 2/3/20
33	Extra Mileage for Mobilizations	0 days	Mon 2/3/20	Tue 2/4/20
34	**Road & Traffic Improvements**	**62 days**	**Thu 3/15/18**	**Tue 6/12/18**
35	**Temporary Roads**	**62 days**	**Thu 3/15/18**	**Tue 6/12/18**
36	Area 1	22 days	Thu 3/15/18	Mon 4/16/18
37	Area 2	37 days	Mon 4/16/18	Thu 6/7/18
38	**Upgrades to Road between Areas and RIM Loading Station**	**52 days**	**Thu 3/29/18**	**Tue 6/12/18**
39	**Area 1**	**15 days**	**Thu 3/29/18**	**Thu 4/19/18**
40	Fencing	3 days	Mon 4/16/18	Thu 4/19/18
41	Silt Fencing	12 days	Thu 3/29/18	Mon 4/16/18
42	**Area 2**	**20 days**	**Mon 5/14/18**	**Tue 6/12/18**
43	Fencing	3 days	Thu 6/7/18	Tue 6/12/18
44	Silt Fencing	17 days	Mon 5/14/18	Thu 6/7/18



ID	Task Name	Estimated Duration	Start	Finish
45	**Install TBD Traffic Improvements**	**20 days**	**Thu 3/15/18**	**Thu 4/12/18**
46	Area 1	10 days	Thu 3/15/18	Thu 3/29/18
47	Area 2	10 days	Thu 3/29/18	Thu 4/12/18
48	Bridge over Entrance Road	9 days	Thu 4/19/18	Wed 5/2/18
49	Extend Permanent Road to new Transfer S	59 days	Thu 3/15/18	Wed 6/6/18
50				
51	**Area 1**	**1032 days**	**Thu 3/15/18**	**Wed 4/20/2**
52	**Temporary Stormwater Infrastructure**	**13 days**	**Thu 3/15/18**	**Tue 4/3/18**
53	Deliver Frac Tanks	10 days	Thu 3/15/18	Thu 3/29/18
54	Install forcemain from Excavation to Tank /	11 days	Thu 3/15/18	Fri 3/30/18
55	Install forcemain from Tank Area to Treatment Facility	1 day	Fri 3/30/18	Tue 4/3/18
56	Install forcemain valves	0 days	Mon 4/2/18	Tue 4/3/18
57	Prepare area with Stormwater BMPS	2 days	Thu 3/15/18	Mon 3/19/18
58	**Site Preparation**	**13 days**	**Thu 3/15/18**	**Tue 4/3/18**
59	**Decontamination Area**	**3 days**	**Thu 3/15/18**	**Tue 3/20/18**
60	Materials	0 days	Thu 3/15/18	Thu 3/15/18
61	Installation	0 days	Thu 3/15/18	Thu 3/15/18
62	Building Construction	3 days	Thu 3/15/18	Tue 3/20/18
63	Clear Vegetation (Light)	0 days	Thu 3/15/18	Thu 3/15/18
64	Clear Vegetation (Heavy)	9 days	Thu 3/15/18	Tue 3/27/18
65	Clear Small Trees	0 days	Tue 3/27/18	Tue 3/27/18
66	Clear Large Trees	0 days	Tue 3/27/18	Tue 3/27/18



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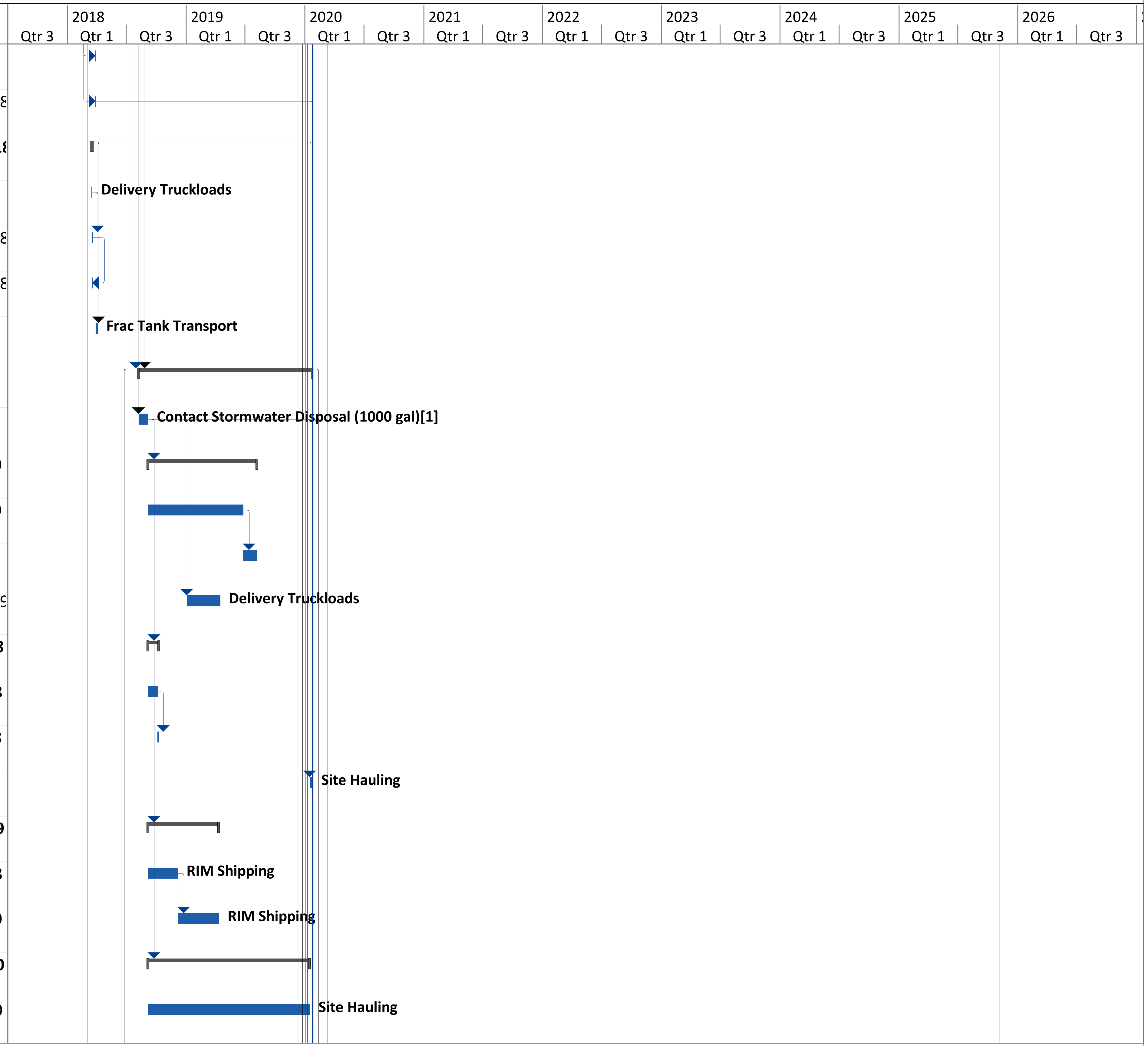
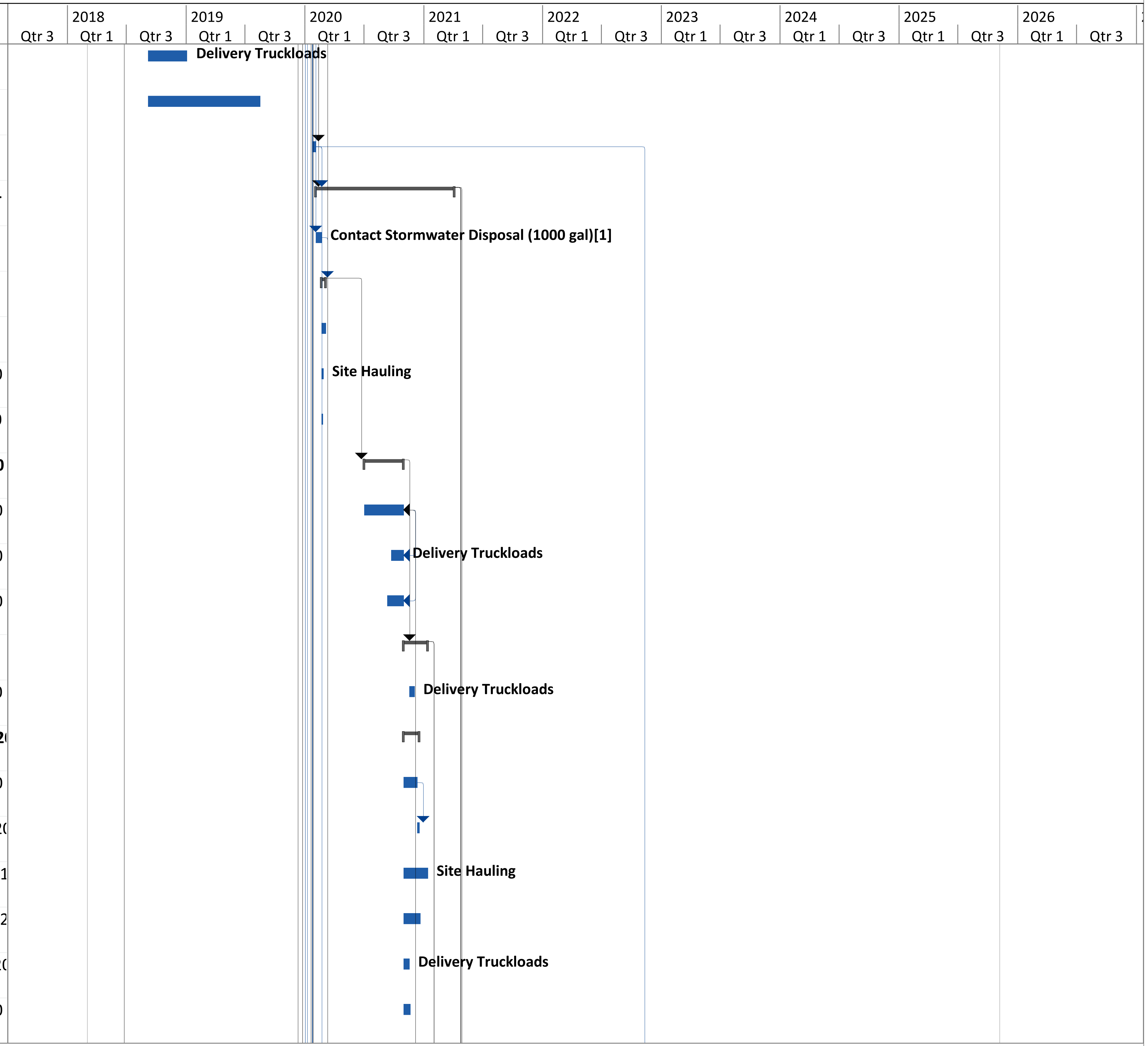
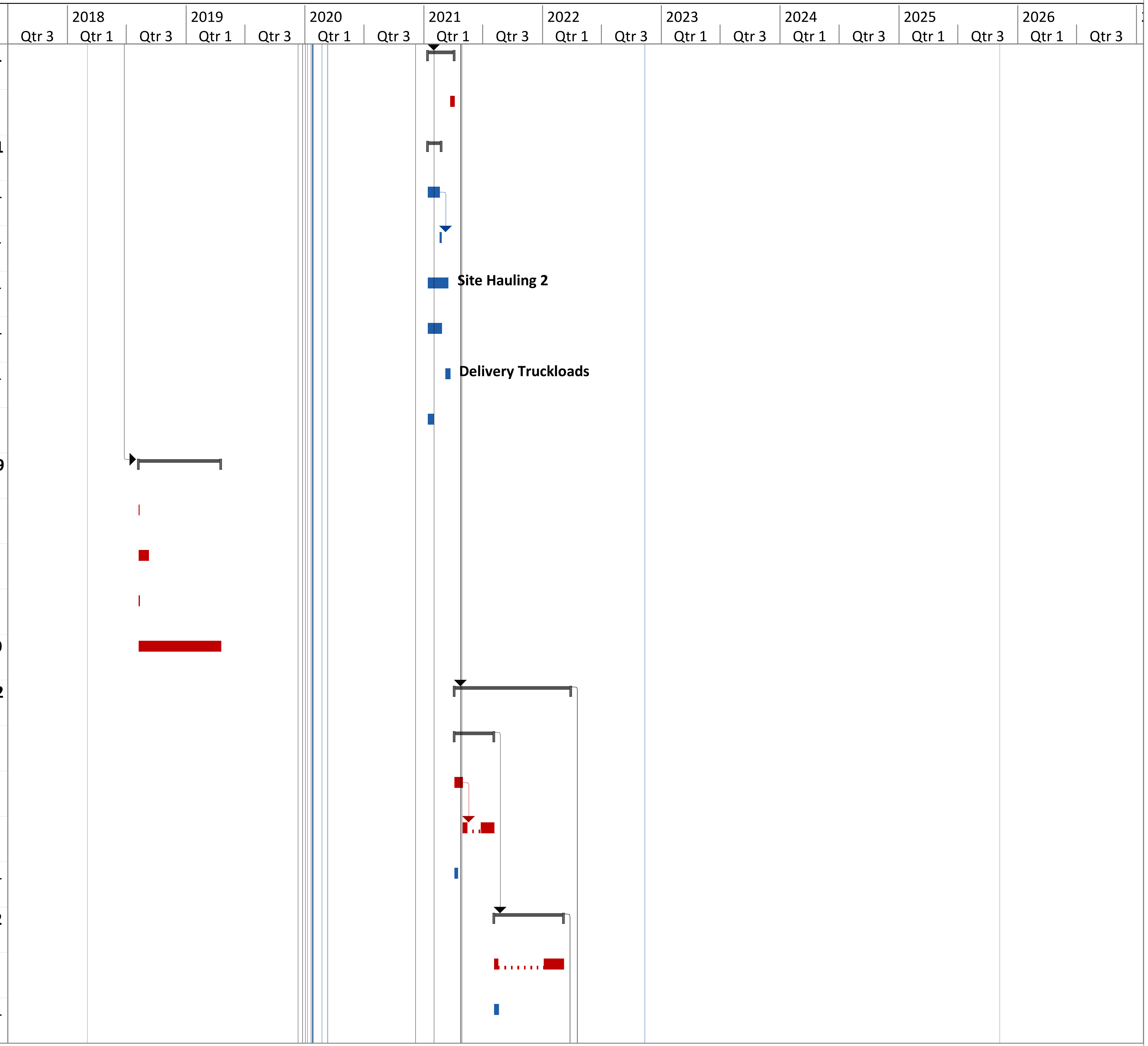
ID	Task Name	Estimated Duration	Start	Finish
67	Clear Small Stumps	2 days	Tue 3/27/18	Fri 3/30/18
68	Clear Large Stumps	1 day	Tue 3/27/18	Wed 3/28/18
69	**Secondary Containment for Frac Tanks**	**2 days**	**Thu 3/15/18**	**Mon 3/19/18**
70	Purchase and deliver liner/berm materi	1 day	Thu 3/15/18	Fri 3/16/18
71	Spread material	1 day	Fri 3/16/18	Mon 3/19/18
72	Compact liner/berms	1 day	Fri 3/16/18	Mon 3/19/18
73	Leachate Frac Tanks Delivery	3 days	Thu 3/29/18	Tue 4/3/18
74	**Waste Excavation**	**364 days**	**Wed 8/8/18**	**Fri 1/24/20**
75	Dewater excavation construction after rain events (budgeted weather delays)	20 days	Wed 8/8/18	Thu 9/6/18
76	**Excavate and Sort RIM and Overburden**	**230 days**	**Thu 9/6/18**	**Wed 8/7/19**
77	Excavate Waste & Stockpile RIM	200 days	Thu 9/6/18	Tue 6/25/19
78	Load Overburden into Haul Trucks	30 days	Tue 6/25/19	Wed 8/7/19
79	Apply daily cover to remaining excavation	72 days	Thu 1/3/19	Mon 4/15/19
80	**Load RIM from local stockpiles onto Haul**	**24 days**	**Thu 9/6/18**	**Tue 10/9/18**
81	Excavate	21 days	Thu 9/6/18	Thu 10/4/18
82	Load	3 days	Thu 10/4/18	Tue 10/9/18
83	Haul RIM to Loading Station	6 days	Thu 1/16/20	Fri 1/24/20
84	**RIM Loading & Shipping**	**149 days**	**Thu 9/6/18**	**Thu 4/11/19**
85	Startup Rate	63 days	Thu 9/6/18	Thu 12/6/18
86	Full Production Rate	86 days	Thu 12/6/18	Thu 4/11/19
87	**Transport Overburden to Area 2 NE Stock**	**338 days**	**Thu 9/6/18**	**Thu 1/16/20**
88	Haul to Stockpile	338 days	Thu 9/6/18	Thu 1/16/20



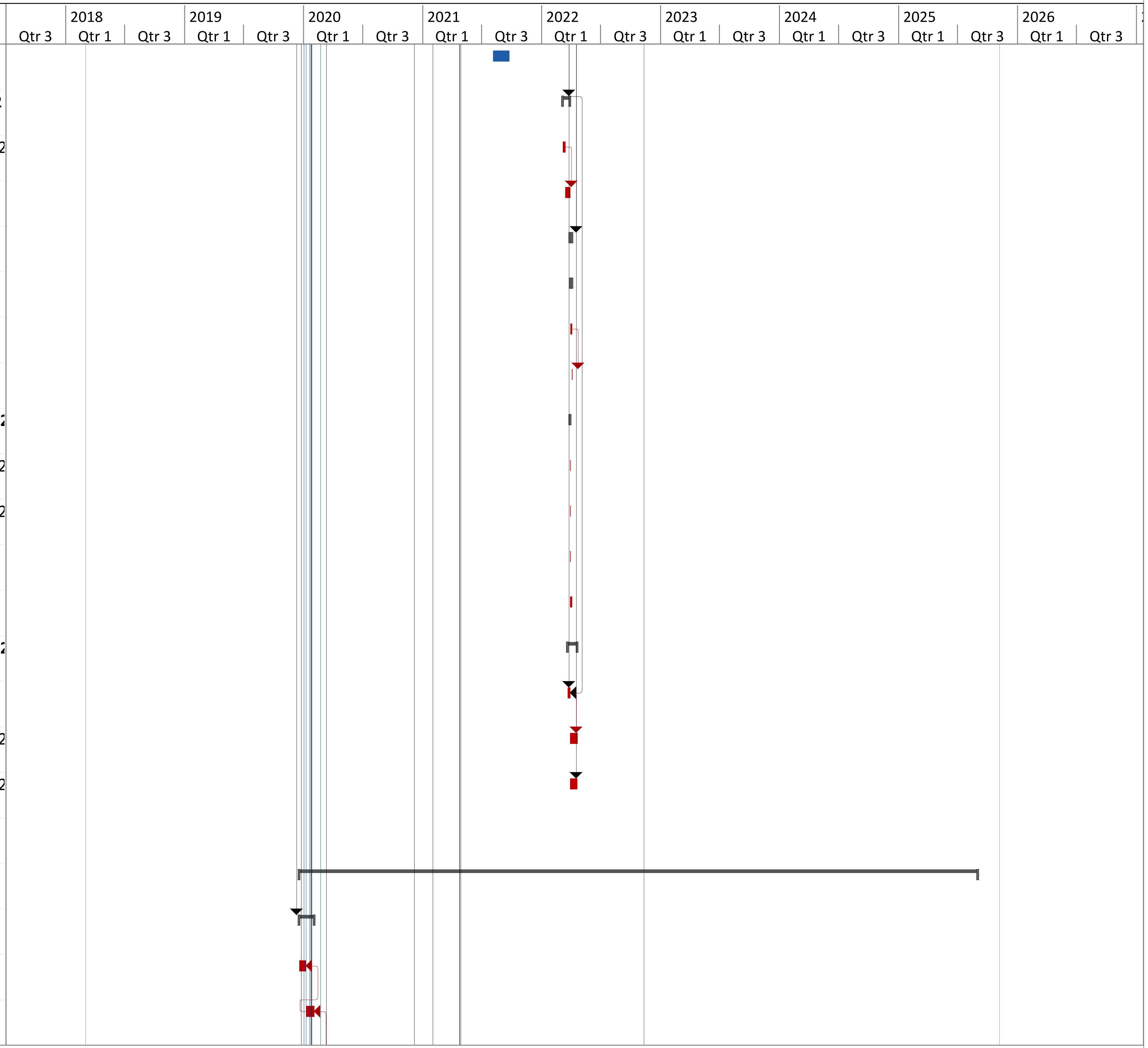
ID	Task Name	Estimated Duration	Start	Finish
89	Apply daily cover to stockpile	79 days	Thu 9/6/18	Thu 1/3/19
90	Grade Stockpile	237 days	Thu 9/6/18	Fri 8/16/19
91	Final Radiological Survey	7 days	Fri 1/24/20	Tue 2/4/20
92	**Waste Backfill and Regrading**	**295 days**	**Tue 2/4/20**	**Mon 4/5/21**
93	Dewater backfill construction after rain events (budgeted weather delays)	13 days	Tue 2/4/20	Fri 2/21/20
94	**C&D Rubble Stockpiles**	**10 days**	**Fri 2/21/20**	**Thu 3/5/20**
95	Relocate Stockpiled Material on-site - Ex	10 days	Fri 2/21/20	Thu 3/5/20
96	Relocate Stockpiled Material on-site - Haul and Dump	5 days	Fri 2/21/20	Thu 2/27/20
97	Bury Stockpiled Material	2 days	Fri 2/21/20	Tue 2/25/20
98	**Backfill Overburden from Area 2 SW Exca**	**86 days**	**Thu 7/2/20**	**Fri 10/30/20**
99	Spread backfilled material	86 days	Thu 7/2/20	Fri 10/30/20
100	Apply daily cover to backfilled material	29 days	Tue 9/22/20	Fri 10/30/20
101	Compact backfilled material	36 days	Thu 9/10/20	Fri 10/30/20
102	**Backfill to Drainage Grades with Overburden from Area 2 NE Stockpile**	**46 days**	**Fri 10/30/20**	**Wed 1/13/21**
103	Apply daily cover to remaining stockpile excavation	10 days	Tue 11/17/20	Thu 12/3/20
104	**Excavate Overburden**	**31 days**	**Fri 10/30/20**	**Thu 12/17/2(**
105	Excavate	27 days	Fri 10/30/20	Fri 12/11/20
106	Load	4 days	Fri 12/11/20	Thu 12/17/2(
107	Transport Overburden to back Area 1	46 days	Fri 10/30/20	Wed 1/13/21
108	Spread backfilled material	33 days	Fri 10/30/20	Mon 12/21/2
109	Apply daily cover to backfilled material	11 days	Fri 10/30/20	Tue 11/17/2(
110	Compact backfilled material	14 days	Fri 10/30/20	Fri 11/20/20



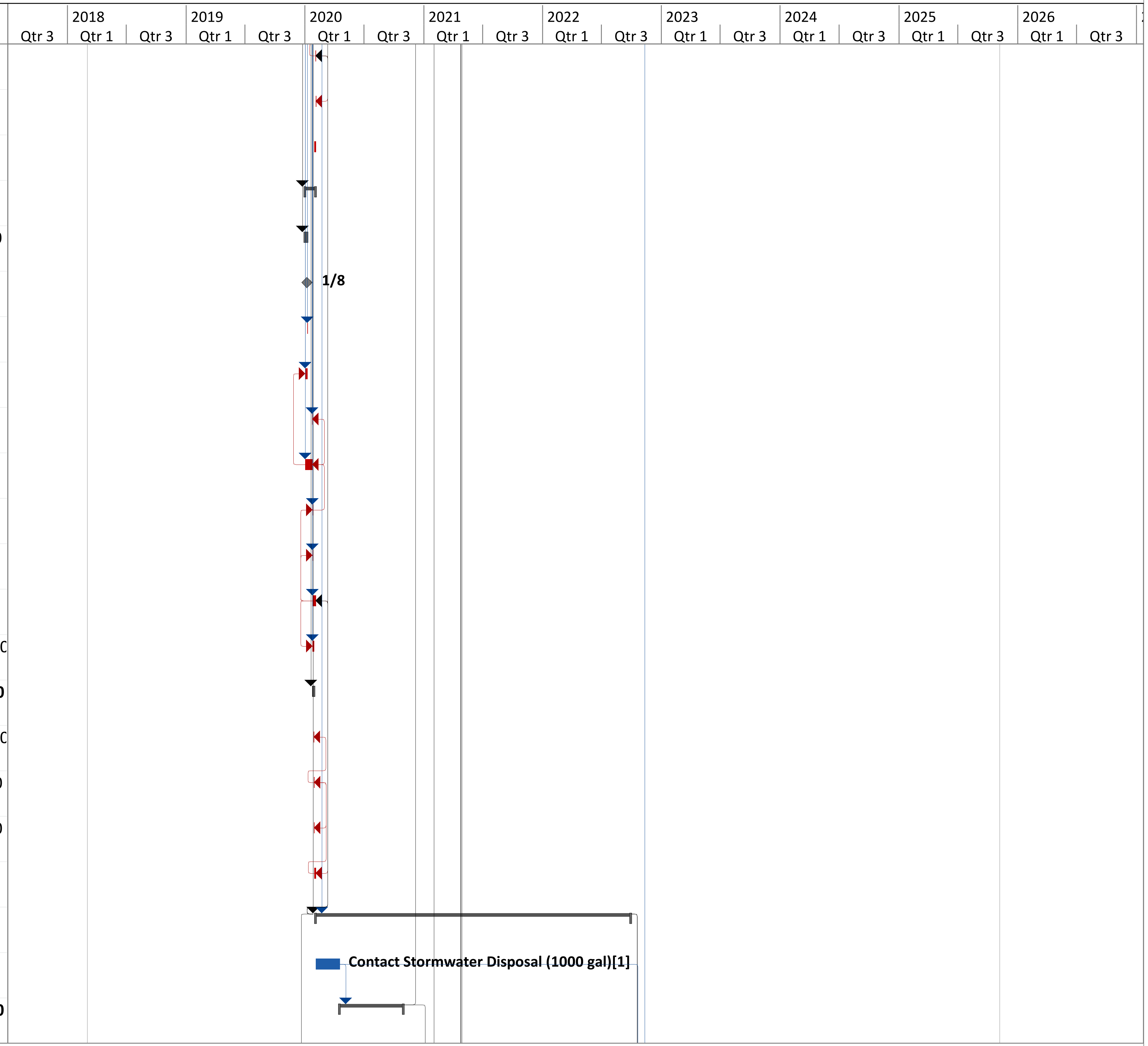
ID	Task Name	Estimated Duration	Start	Finish
111	**Slope Correction Cuts**	**58 days**	**Wed 1/13/21**	**Mon 4/5/21**
112	Apply daily cover to remaining excavatic	9 days	Tue 3/23/21	Mon 4/5/21
113	**Excavate Non-RIM waste to correct slo**	**30 days**	**Wed 1/13/21**	**Tue 2/23/21**
114	Excavate	26 days	Wed 1/13/21	Thu 2/18/21
115	Load	4 days	Thu 2/18/21	Tue 2/23/21
116	Relocated excavated material	44 days	Wed 1/13/21	Tue 3/16/21
117	Spread backfilled material	31 days	Wed 1/13/21	Thu 2/25/21
118	Apply daily cover to backfilled material	10 days	Mon 3/8/21	Tue 3/23/21
119	Compact backfilled material	13 days	Wed 1/13/21	Mon 2/1/21
120	**Leachate Handling**	**174 days**	**Wed 8/8/18**	**Thu 4/18/19**
121	Pumping	2 days	Wed 8/8/18	Fri 8/10/18
122	Tank Transportation on Site	22 days	Wed 8/8/18	Fri 9/7/18
123	Sampling	3 days	Wed 8/8/18	Fri 8/10/18
124	Hauling & Disposal	174 days	Wed 8/8/18	Thu 4/18/19
125	**Final Cover**	**247 days**	**Mon 4/5/21**	**Tue 3/29/22**
126	**Bio-Intrusion**	**86 days**	**Mon 4/5/21**	**Thu 8/5/21**
127	Purchase and Spread Bio-Intrusion Layei	19 days	Mon 4/5/21	Fri 4/30/21
128	Deliver Bio-Intrusion Layer Material	38 days	Fri 4/30/21	Thu 8/5/21
129	Compact Bio-Intrusion Layer Material	8 days	Mon 4/5/21	Thu 4/15/21
130	**Clay**	**145 days**	**Thu 8/5/21**	**Mon 3/7/22**
131	Purchase and deliver clay material	51 days	Thu 8/5/21	Mon 3/7/22
132	Spread loose lift before compaction	10 days	Thu 8/5/21	Thu 8/19/21



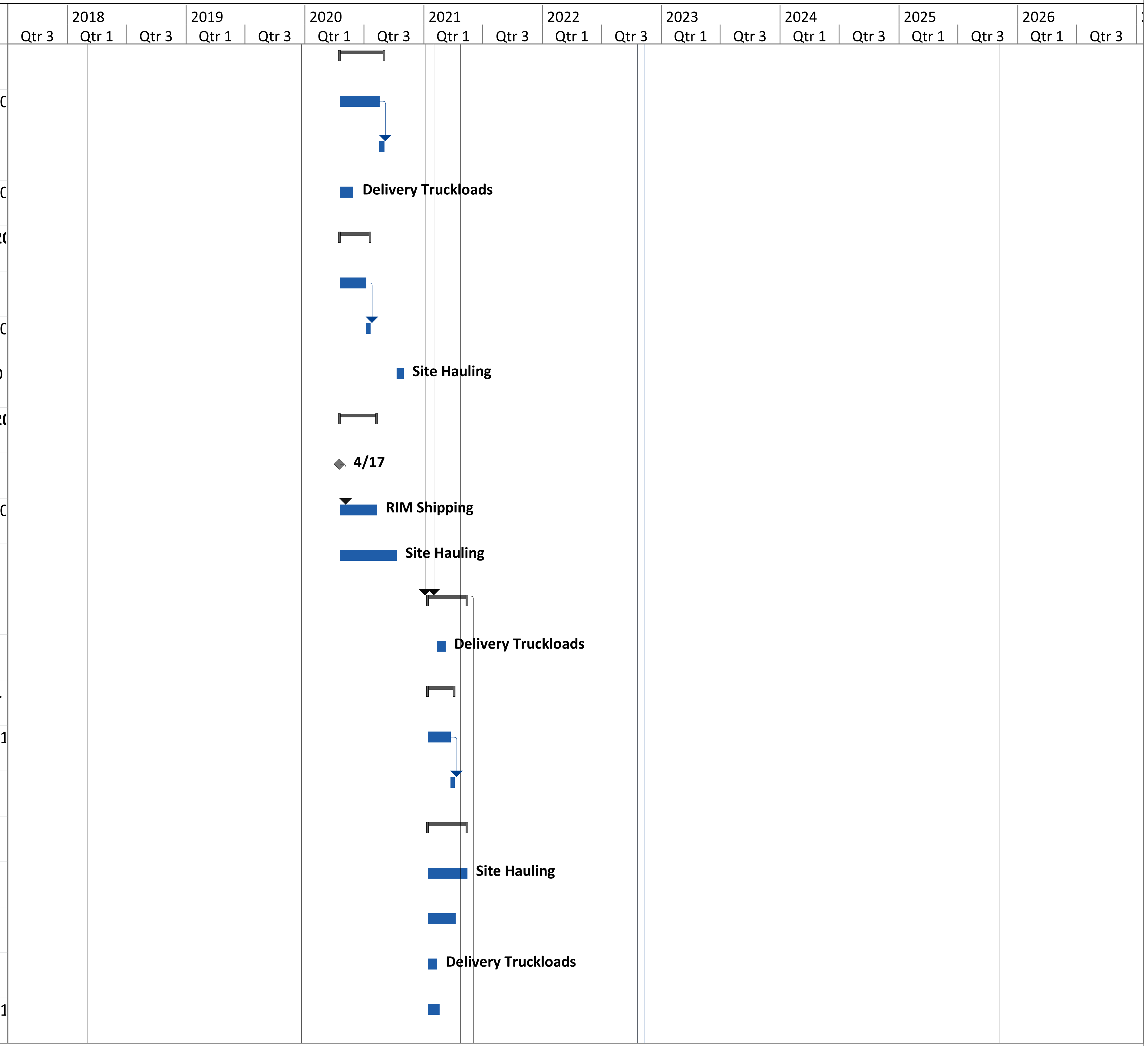
ID	Task Name	Estimated Duration	Start	Finish
133	Compact Clay (Final Cover)	34 days	Thu 8/5/21	Thu 9/23/21
134	**Top Soil**	**16 days**	**Mon 3/7/22**	**Tue 3/29/22**
135	Purchase and place Topsoil	6 days	Mon 3/7/22	Mon 3/14/22
136	Addition for Topsoil Delivery	11 days	Tue 3/15/22	Tue 3/29/22
137	**Post-Construction Stormwater Controls**	**5 days**	**Tue 3/29/22**	**Tue 4/5/22**
138	**Install Terraces**	**4 days**	**Wed 3/30/22**	**Tue 4/5/22**
139	Purchase and place Topsoil	3 days	Wed 3/30/22	Mon 4/4/22
140	Addition for Delivery Distance	1 day	Mon 4/4/22	Tue 4/5/22
141	**Diversion Berms**	**1 day**	**Tue 3/29/22**	**Wed 3/30/2**
142	Purchase and deliver clay material	1 day	Tue 3/29/22	Wed 3/30/22
143	Spread loose lift before compaction	1 day	Tue 3/29/22	Wed 3/30/22
144	Compact berms	0 days	Tue 3/29/22	Tue 3/29/22
145	Final Stormwater Controls	4 days	Tue 3/29/22	Mon 4/4/22
146	**Site Completion**	**22 days**	**Tue 3/22/22**	**Wed 4/20/2**
147	Install temporary irrigation system	5 days	Tue 3/22/22	Tue 3/29/22
148	Apply seeding to cover	16 days	Tue 3/29/22	Wed 4/20/22
149	Install Fencing	16 days	Tue 3/29/22	Wed 4/20/22
150				
151	**Area 2**	**1435 days**	**Thu 12/19/19**	**Tue 9/2/25**
152	**Temporary Stormwater Infrastructure**	**29 days**	**Thu 12/19/19**	**Tue 2/4/20**
153	Deliver Frac Tanks	10 days	Thu 12/19/19	Wed 1/8/20
154	Install forcemain from Excavation to Tank	18 days	Wed 1/8/20	Mon 2/3/20



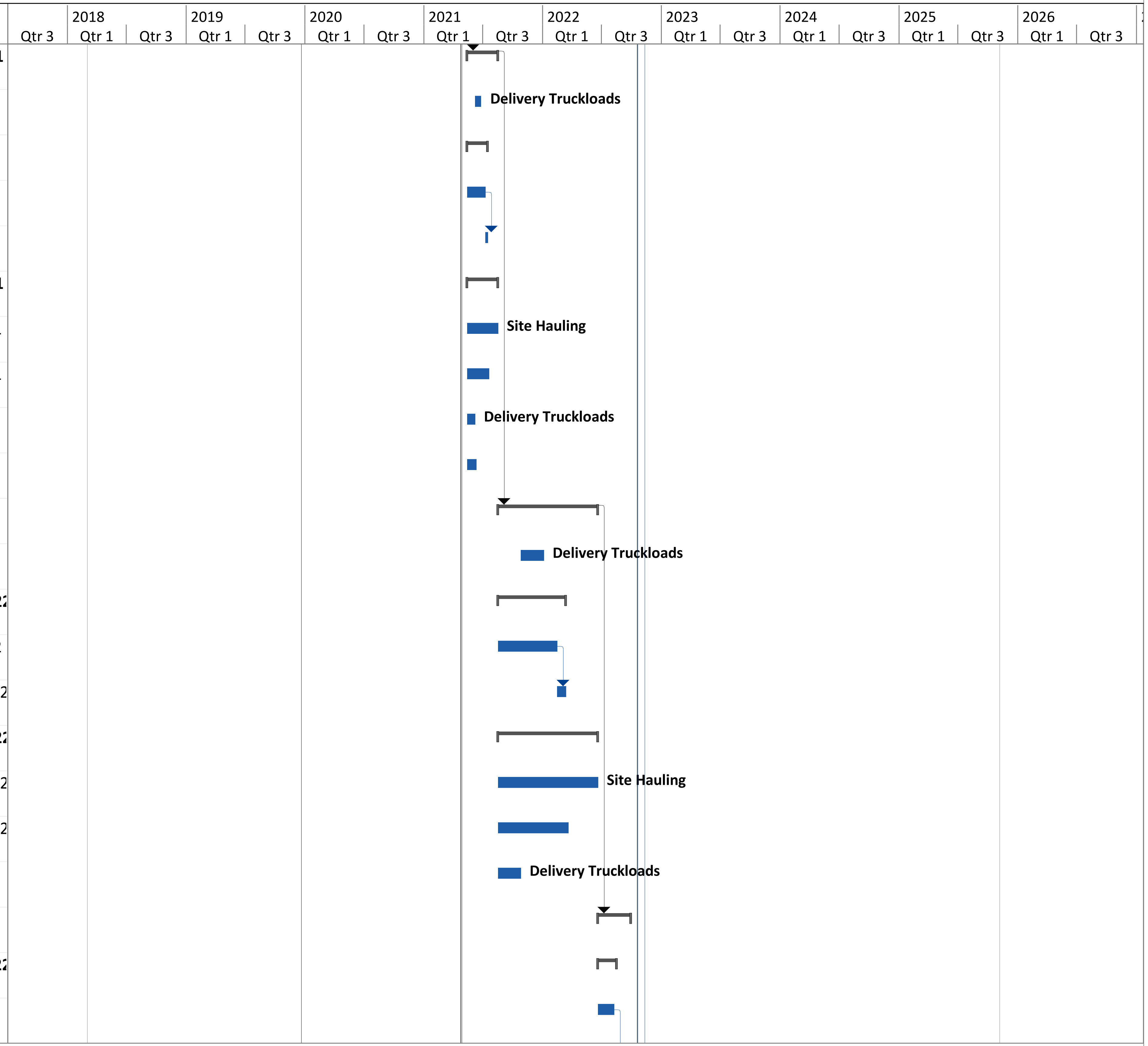
ID	Task Name	Estimated Duration	Start	Finish
155	Install forcemain from Tank Area to Treatment Facility	1 day	Mon 2/3/20	Tue 2/4/20
156	Install forcemain valves	0 days	Mon 2/3/20	Tue 2/4/20
157	Prepare area with Stormwater BMPS	3 days	Thu 1/30/20	Tue 2/4/20
158	**Site Preparation**	**22 days**	**Thu 1/2/20**	**Tue 2/4/20**
159	**Decontamination Area**	**3 days**	**Thu 1/2/20**	**Wed 1/8/20**
160	Materials	0 days	Wed 1/8/20	Wed 1/8/20
161	Installation	0 days	Wed 1/8/20	Wed 1/8/20
162	Building Construction	3 days	Thu 1/2/20	Wed 1/8/20
163	Clear Vegetation (Light)	1 day	Thu 1/23/20	Fri 1/24/20
164	Clear Vegetation (Heavy)	15 days	Thu 1/2/20	Fri 1/24/20
165	Clear Small Trees	1 day	Fri 1/24/20	Fri 1/24/20
166	Clear Large Trees	1 day	Fri 1/24/20	Fri 1/24/20
167	Clear Small Stumps	7 days	Fri 1/24/20	Tue 2/4/20
168	Clear Large Stumps	3 days	Fri 1/24/20	Wed 1/29/2C
169	**Secondary Containment for Frac Tanks**	**2 days**	**Tue 1/28/20**	**Thu 1/30/20**
170	Purchase and deliver liner/berm materi:	1 day	Tue 1/28/20	Wed 1/29/2C
171	Spread material	1 day	Wed 1/29/20	Thu 1/30/20
172	Compact liner/berms	1 day	Wed 1/29/20	Thu 1/30/20
173	Leachate Frac Tanks Delivery	3 days	Thu 1/30/20	Tue 2/4/20
174	**Waste Excavation**	**673 days**	**Tue 2/4/20**	**Fri 9/30/22**
175	Dewater excavation construction after rain events (budgeted weather delays)	53 days	Tue 2/4/20	Fri 4/17/20
176	**Excavate SW Area 2**	**138 days**	**Fri 4/17/20**	**Fri 10/30/20**



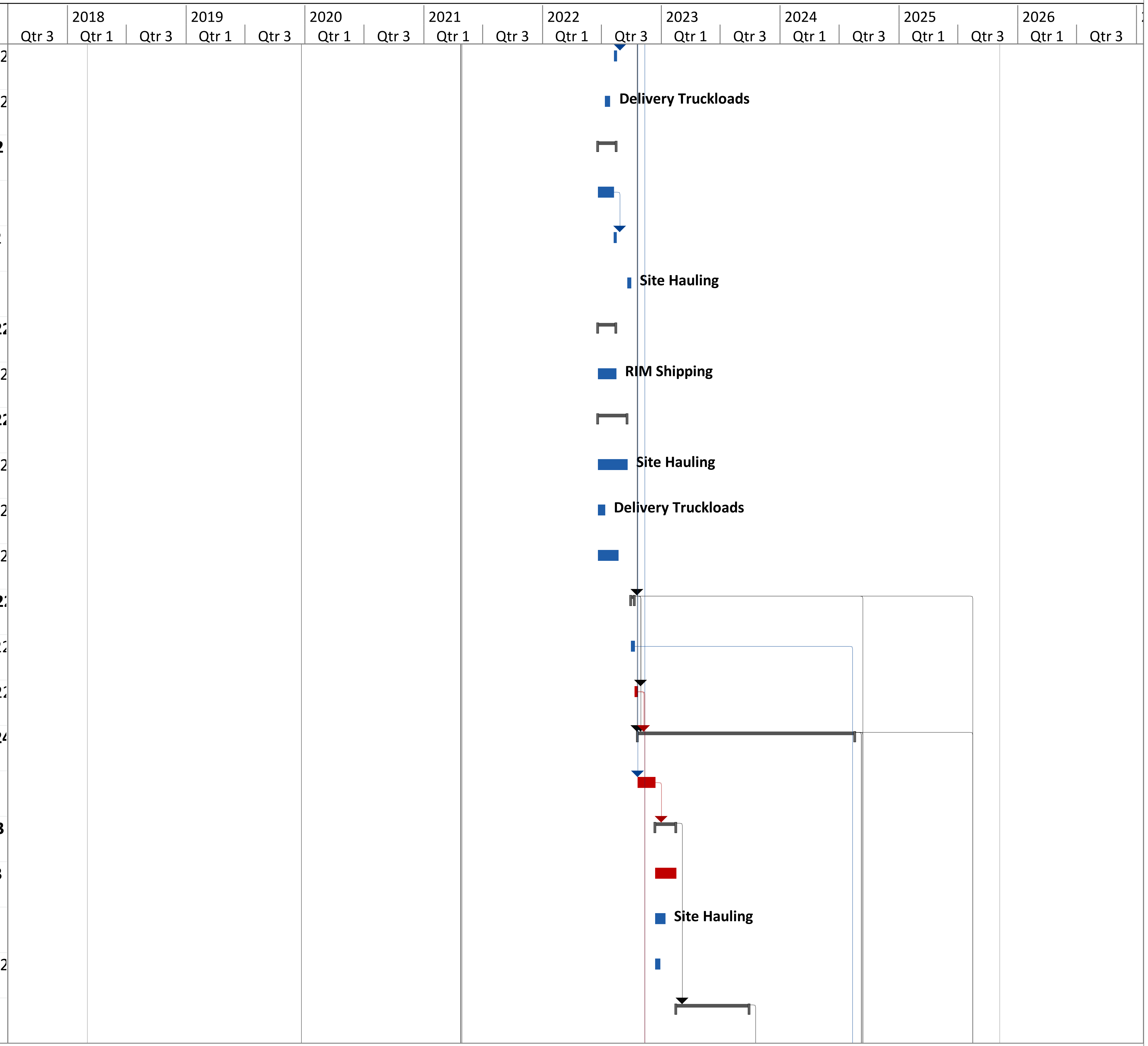
ID	Task Name	Estimated Duration	Start	Finish
177	**Excavate and Sort RIM and Overburden**	**95 days**	**Fri 4/17/20**	**Tue 9/1/20**
178	Excavate Waste & Stockpile RIM	84 days	Fri 4/17/20	Mon 8/17/20
179	Load Overburden into Haul Trucks	11 days	Mon 8/17/20	Tue 9/1/20
180	Apply daily cover to remaining excavatio	27 days	Fri 4/17/20	Wed 5/27/20
181	**Load RIM from local stockpiles onto Ha**	**64 days**	**Fri 4/17/20**	**Mon 7/20/20**
182	Excavate	56 days	Fri 4/17/20	Tue 7/7/20
183	Load	8 days	Tue 7/7/20	Mon 7/20/20
184	Haul RIM to Loading Station	15 days	Fri 10/9/20	Fri 10/30/20
185	**RIM Loading & Shipping**	**79 days**	**Fri 4/17/20**	**Mon 8/10/20**
186	Startup Rate	0 days	Fri 4/17/20	Fri 4/17/20
187	Full Production Rate	79 days	Fri 4/17/20	Mon 8/10/20
188	Haul Overburden to Area 1	122 days	Fri 4/17/20	Fri 10/9/20
189	**Excavate NE Area 2 Stockpile for SW Area 2 Drainage Grades**	**87 days**	**Wed 1/13/21**	**Fri 5/14/21**
190	Apply daily cover to remaining stockpile	18 days	Wed 2/10/21	Mon 3/8/21
191	**Excavate Overburden Stockpile**	**58 days**	**Wed 1/13/21**	**Mon 4/5/21**
192	Excavate Overburden	51 days	Wed 1/13/21	Wed 3/24/21
193	Load Overburden into Haul Trucks	8 days	Wed 3/24/21	Mon 4/5/21
194	**Transport Remaining Overburden to SV**	**87 days**	**Wed 1/13/21**	**Fri 5/14/21**
195	Haul to SW Area 2	87 days	Wed 1/13/21	Fri 5/14/21
196	Grade Backfill/Stockpile	61 days	Wed 1/13/21	Wed 4/7/21
197	Apply daily cover to backfilled/stockpiled material	20 days	Wed 1/13/21	Wed 2/10/21
198	Compact backfilled material	26 days	Wed 1/13/21	Wed 2/17/21



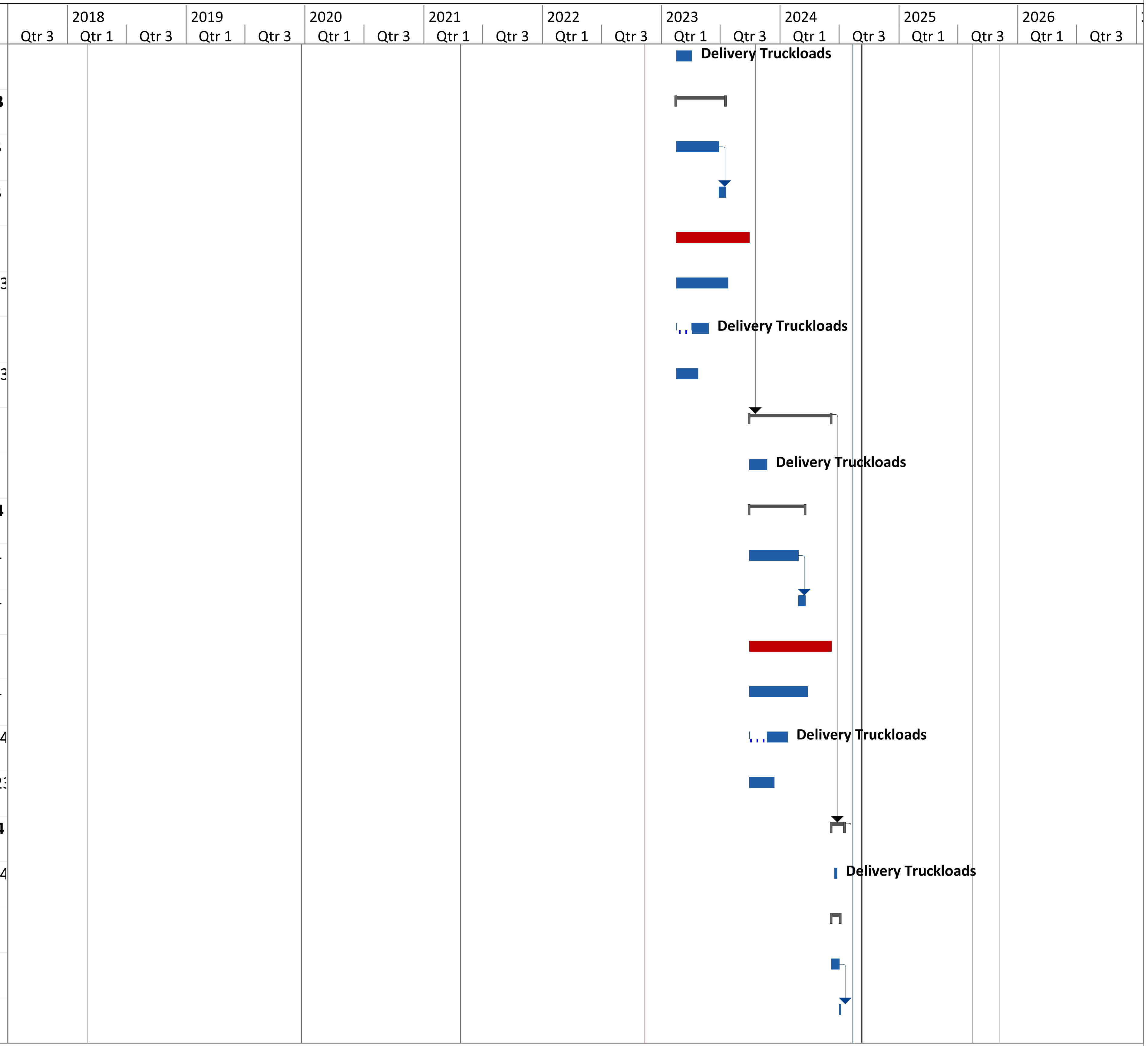
ID	Task Name	Estimated Duration	Start	Finish
199	**Excavate NE Area 2 Stockpile for SW Area 2 Final Grades**	**65 days**	**Fri 5/14/21**	**Tue 8/17/21**
200	Apply daily cover to remaining stockpile	14 days	Mon 6/7/21	Fri 6/25/21
201	**Excavate Overburden Stockpile**	**44 days**	**Fri 5/14/21**	**Fri 7/16/21**
202	Excavate Overburden	38 days	Fri 5/14/21	Fri 7/9/21
203	Load Overburden into Haul Trucks	6 days	Fri 7/9/21	Fri 7/16/21
204	**Transport Remaining Overburden to SV**	**65 days**	**Fri 5/14/21**	**Tue 8/17/21**
205	Haul to SW Area 2	65 days	Fri 5/14/21	Tue 8/17/21
206	Grade Backfill/Stockpile	46 days	Fri 5/14/21	Tue 7/20/21
207	Apply daily cover to backfilled/stockpiled material	15 days	Fri 5/14/21	Mon 6/7/21
208	Compact backfilled material	19 days	Fri 5/14/21	Fri 6/11/21
209	**Move remaining NE Area 2 Stockpile to SW Area 2 stockpile**	**211 days**	**Tue 8/17/21**	**Mon 6/20/22**
210	Apply daily cover to remaining stockpile	45 days	Tue 10/26/21	Wed 1/5/22
211	**Excavate Overburden Stockpile**	**142 days**	**Tue 8/17/21**	**Mon 3/14/2**
212	Excavate Overburden	123 days	Tue 8/17/21	Tue 2/15/22
213	Load Overburden into Haul Trucks	19 days	Tue 2/15/22	Mon 3/14/22
214	**Transport Remaining Overburden to SV**	**211 days**	**Tue 8/17/21**	**Mon 6/20/2**
215	Haul to SW Area 2	211 days	Tue 8/17/21	Mon 6/20/22
216	Grade Backfill/Stockpile	148 days	Tue 8/17/21	Mon 3/21/22
217	Apply daily cover to backfilled/stockpiled material	49 days	Tue 8/17/21	Tue 10/26/21
218	**Excavate NE Area 2**	**73 days**	**Mon 6/20/22**	**Fri 9/30/22**
219	**Excavate and Sort RIM and Overburden**	**41 days**	**Mon 6/20/22**	**Wed 8/17/2**
220	Excavate Waste & Stockpile RIM	35 days	Mon 6/20/22	Tue 8/9/22



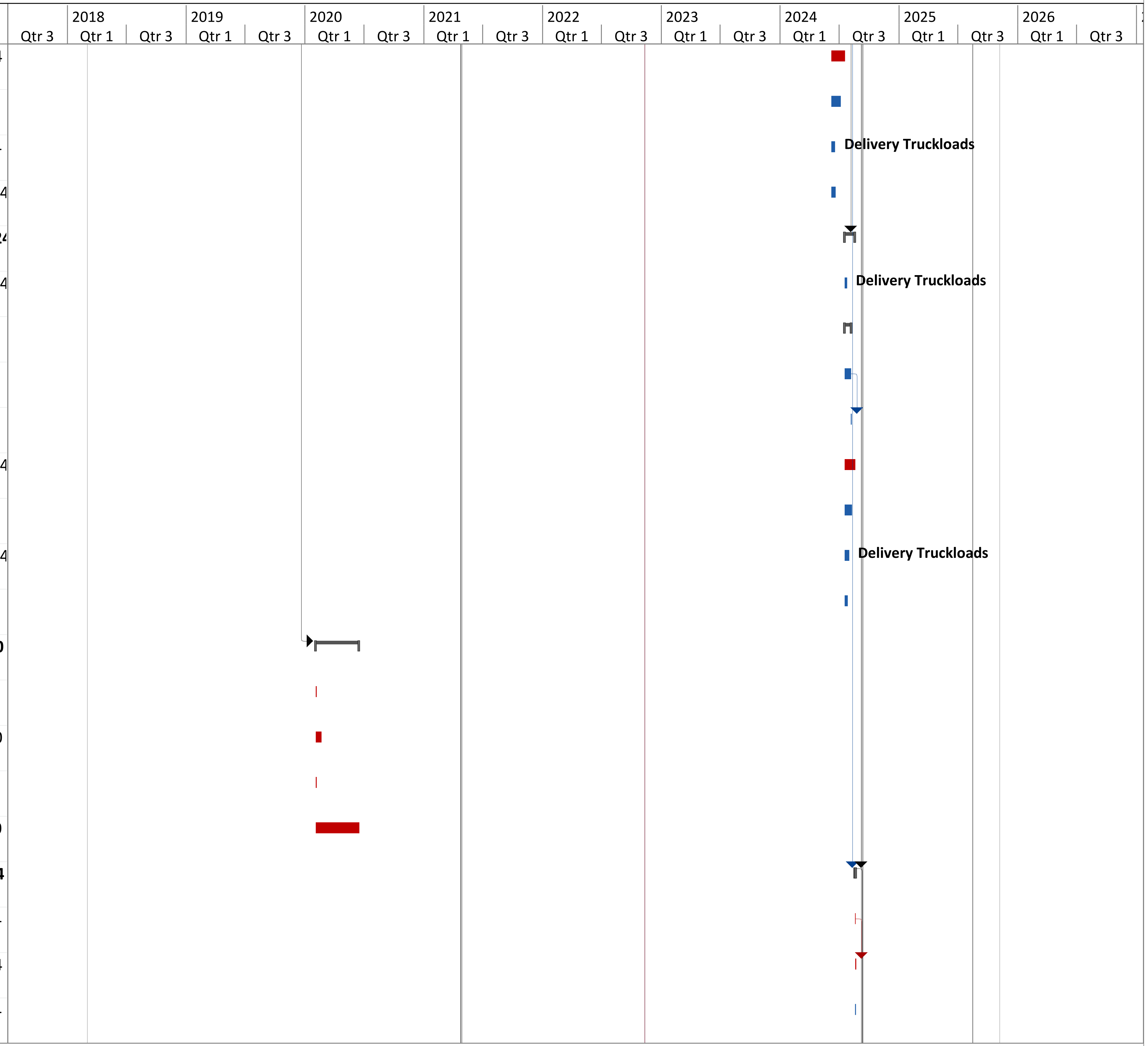
ID	Task Name	Estimated Duration	Start	Finish
221	Load Overburden into Haul Trucks	6 days	Tue 8/9/22	Wed 8/17/22
222	Apply daily cover to remaining excavatic	11 days	Tue 7/12/22	Wed 7/27/22
223	**Load RIM from local stockpiles onto Ha**	**40 days**	**Mon 6/20/22**	**Tue 8/16/22**
224	Excavate	35 days	Mon 6/20/22	Mon 8/8/22
225	Load	5 days	Mon 8/8/22	Tue 8/16/22
226	Haul RIM to Loading Station	9 days	Mon 9/19/22	Fri 9/30/22
227	**RIM Loading & Shipping**	**39 days**	**Mon 6/20/22**	**Mon 8/15/2**
228	Full Production Rate	39 days	Mon 6/20/22	Mon 8/15/22
229	**Transport Overburden to SW Area 2 St**	**63 days**	**Mon 6/20/22**	**Mon 9/19/2**
230	Haul to SW Area 2	63 days	Mon 6/20/22	Mon 9/19/22
231	Apply daily cover to stockpiled materi	15 days	Mon 6/20/22	Mon 7/11/22
232	Grade Stockpile	44 days	Mon 6/20/22	Mon 8/22/22
233	**Buffer Zone**	**6 days**	**Fri 9/30/22**	**Tue 10/11/2**
234	Buffer Zone Activity	6 days	Fri 9/30/22	Tue 10/11/22
235	Final Radiological Survey	7 days	Tue 10/11/22	Thu 10/20/2
236	**Waste Backfill and Regrading**	**461 days**	**Thu 10/20/22**	**Mon 8/19/2**
237	Dewater backfill construction after rain events (budgeted weather delays)	35 days	Thu 10/20/22	Tue 12/13/22
238	**C&D Rubble Stockpiles**	**44 days**	**Tue 12/13/22**	**Thu 2/16/23**
239	Relocate Stockpiled Material on-site - Ex	44 days	Tue 12/13/22	Thu 2/16/23
240	Relocate Stockpiled Material on-site - Haul and Dump	20 days	Tue 12/13/22	Fri 1/13/23
241	Bury Stockpiled Material	9 days	Tue 12/13/22	Wed 12/28/2
242	**Backfill NE Area 2 (drainage grades) with Overburden from SW Area 2 Stockpile**	**158 days**	**Thu 2/16/23**	**Fri 9/29/23**



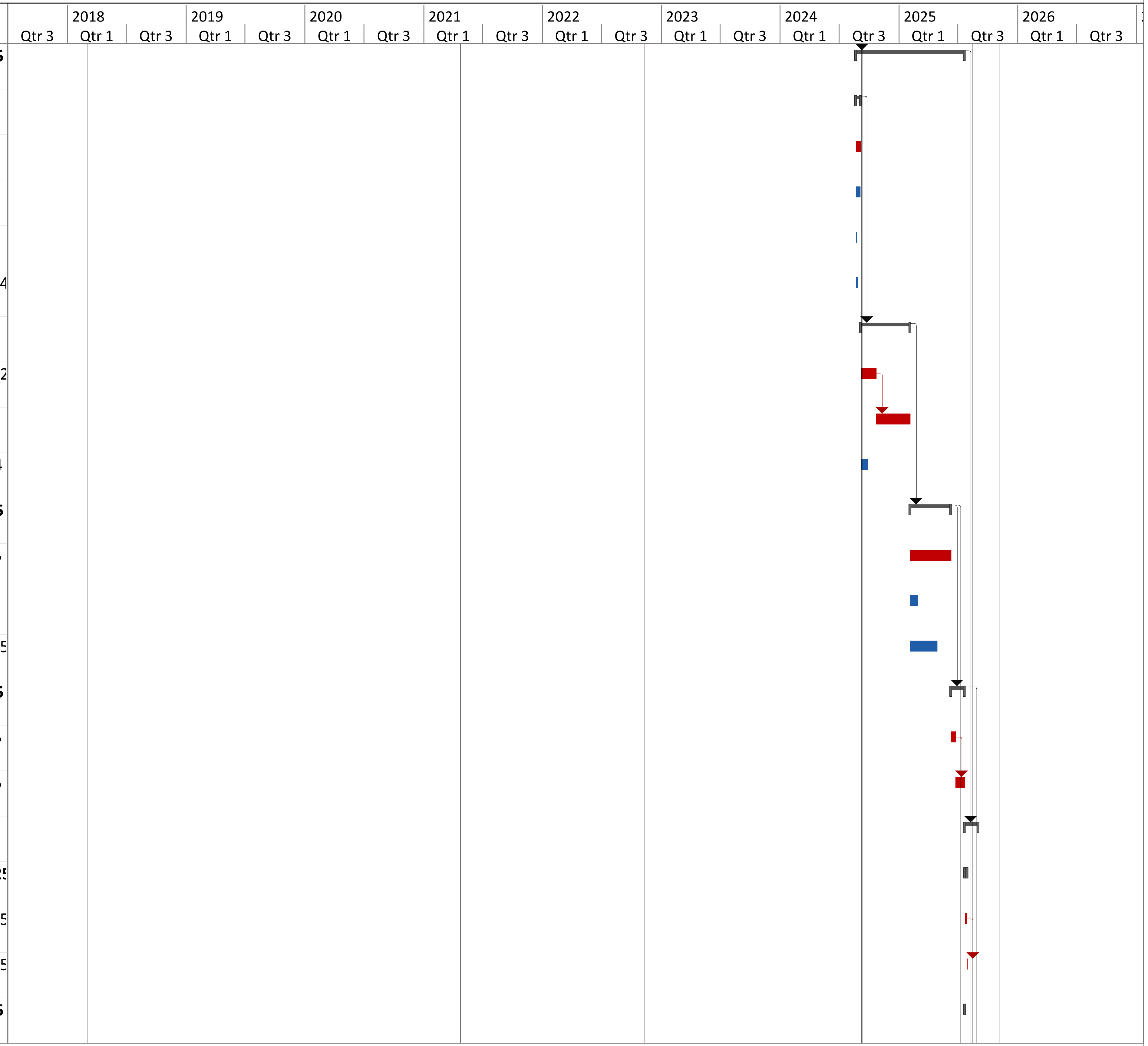
ID	Task Name	Estimated Duration	Start	Finish
243	Apply daily cover to remaining stockpile excavation	34 days	Thu 2/16/23	Tue 4/4/23
244	**Excavate Overburden**	**106 days**	**Thu 2/16/23**	**Tue 7/18/23**
245	Excavate	92 days	Thu 2/16/23	Tue 6/27/23
246	Load	14 days	Tue 6/27/23	Tue 7/18/23
247	Transport Overburden back to NE Area 2	158 days	Thu 2/16/23	Fri 9/29/23
248	Spread backfilled material	111 days	Thu 2/16/23	Mon 7/24/23
249	Apply daily cover to backfilled material	37 days	Thu 2/16/23	Fri 5/26/23
250	Compact backfilled material	47 days	Thu 2/16/23	Mon 4/24/23
251	**Backfill NE Area 2 (final grades) with Overburden from SW Area 2 Stockpile**	**174 days**	**Fri 9/29/23**	**Fri 6/7/24**
252	Apply daily cover to remaining stockpile excavation	37 days	Fri 9/29/23	Wed 11/22/23
253	**Excavate Overburden**	**117 days**	**Fri 9/29/23**	**Tue 3/19/24**
254	Excavate	101 days	Fri 9/29/23	Tue 2/27/24
255	Load	15 days	Tue 2/27/24	Tue 3/19/24
256	Transport Overburden back to NE Area 2	174 days	Fri 9/29/23	Fri 6/7/24
257	Spread backfilled material	121 days	Fri 9/29/23	Tue 3/26/24
258	Apply daily cover to backfilled material	41 days	Fri 9/29/23	Wed 1/24/24
259	Compact backfilled material	51 days	Fri 9/29/23	Thu 12/14/23
260	**Slope Correction Cuts in Area 2 SW**	**27 days**	**Fri 6/7/24**	**Thu 7/18/24**
261	Apply daily cover to remaining excavation	6 days	Mon 6/17/24	Mon 6/24/24
262	**Excavate Non-RIM waste to correct slope**	**18 days**	**Fri 6/7/24**	**Fri 7/5/24**
263	Excavate	16 days	Fri 6/7/24	Mon 7/1/24
264	Load	2 days	Mon 7/1/24	Fri 7/5/24



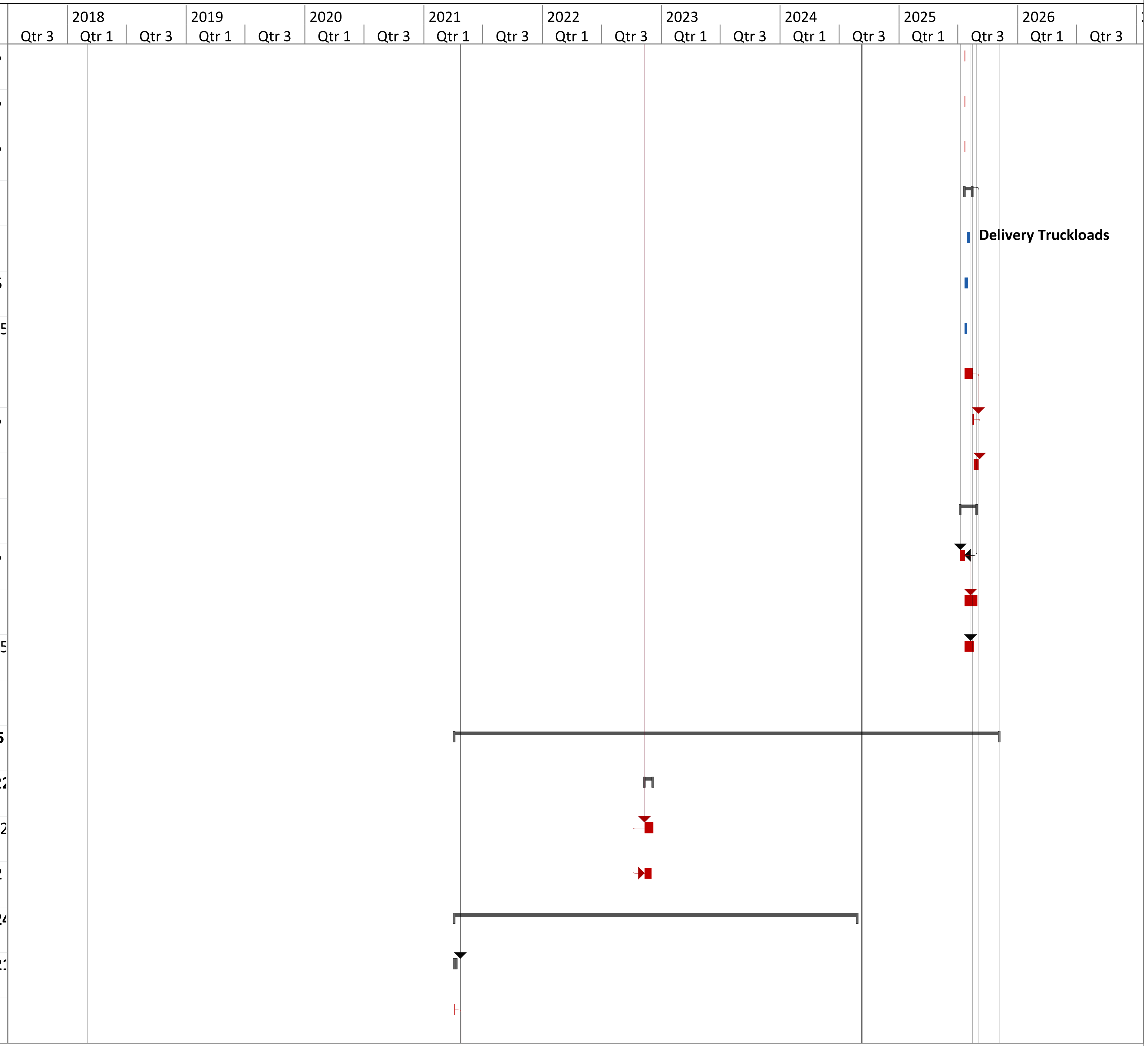
ID	Task Name	Estimated Duration	Start	Finish
265	Relocate excavated material	27 days	Fri 6/7/24	Thu 7/18/24
266	Spread backfilled material	19 days	Fri 6/7/24	Fri 7/5/24
267	Apply daily cover to backfilled material	6 days	Fri 6/7/24	Tue 6/18/24
268	Compact backfilled material	8 days	Fri 6/7/24	Wed 6/19/24
269	**Slope Correction Cuts in Area 2 NE**	**23 days**	**Thu 7/18/24**	**Mon 8/19/24**
270	Apply daily cover to remaining excavatic	5 days	Thu 7/18/24	Wed 7/24/24
271	**Excavate Non-RIM waste to correct slo**	**15 days**	**Thu 7/18/24**	**Thu 8/8/24**
272	Excavate	13 days	Thu 7/18/24	Tue 8/6/24
273	Load	2 days	Tue 8/6/24	Thu 8/8/24
274	Relocated excavated material	23 days	Thu 7/18/24	Mon 8/19/24
275	Spread backfilled material	16 days	Thu 7/18/24	Fri 8/9/24
276	Apply daily cover to backfilled material	5 days	Thu 7/18/24	Wed 7/31/24
277	Compact backfilled material	7 days	Thu 7/18/24	Fri 7/26/24
278	**Leachate Handling**	**94 days**	**Tue 2/4/20**	**Tue 6/16/20**
279	Pumping	1 day	Tue 2/4/20	Wed 2/5/20
280	Tank Transportation on Site	12 days	Tue 2/4/20	Thu 2/20/20
281	Sampling	2 days	Tue 2/4/20	Wed 2/5/20
282	Hauling & Disposal	94 days	Tue 2/4/20	Tue 6/16/20
283	**Additional Fill**	**2 days**	**Mon 8/19/24**	**Thu 8/22/24**
284	Purchase material and spread	1 day	Mon 8/19/24	Tue 8/20/24
285	Additional delivery distance	2 days	Tue 8/20/24	Thu 8/22/24
286	Compact material	1 day	Mon 8/19/24	Tue 8/20/24



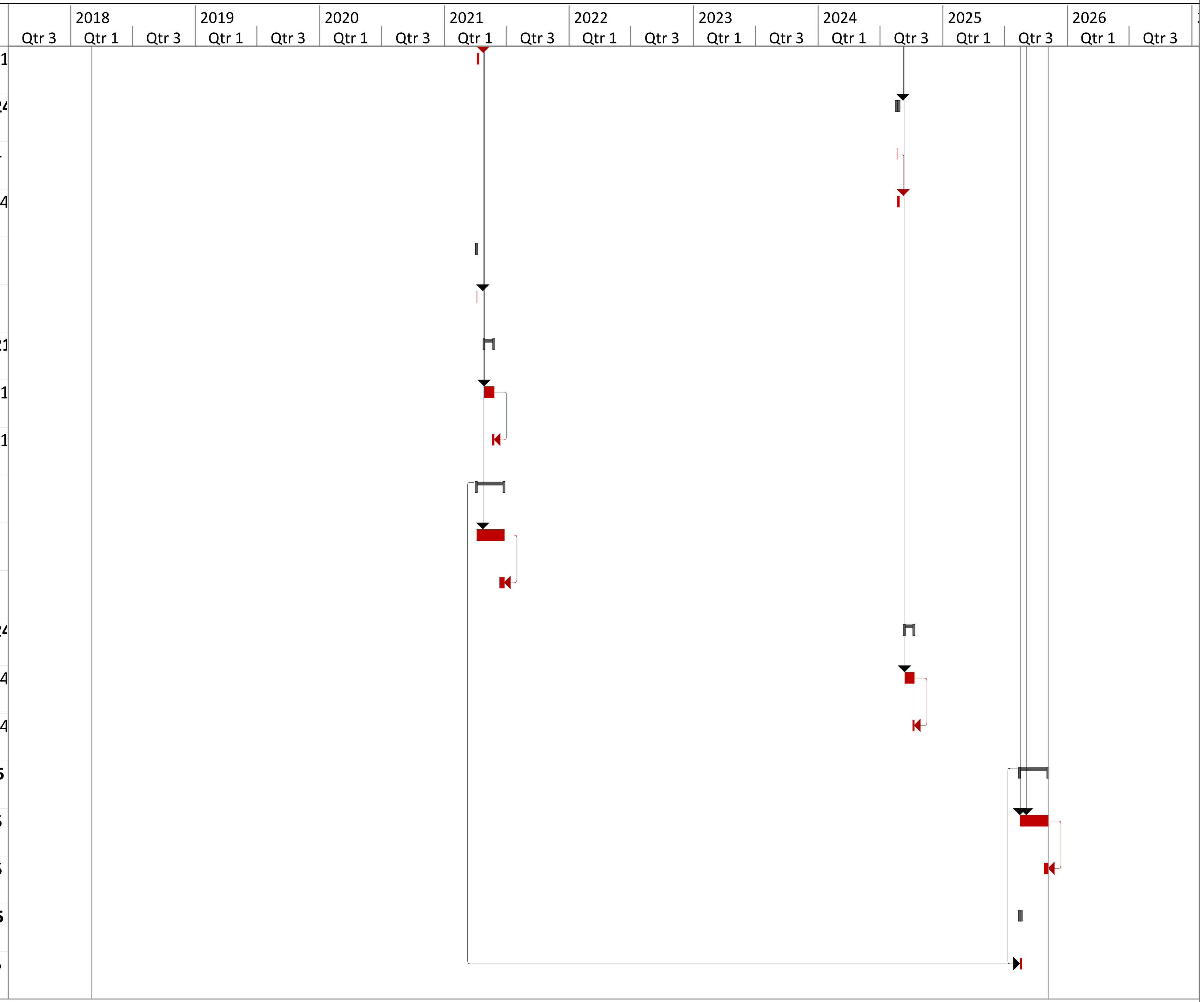
ID	Task Name	Estimated Duration	Start	Finish
287	**Final Cover**	**229 days**	**Thu 8/22/24**	**Tue 7/22/25**
288	**Starter Berms**	**10 days**	**Thu 8/22/24**	**Fri 9/6/24**
289	Purchase and deliver material	10 days	Thu 8/22/24	Fri 9/6/24
290	Spread loose lift before compaction	8 days	Thu 8/22/24	Wed 9/4/24
291	Special grading for steep slopes	2 days	Thu 8/22/24	Fri 8/23/24
292	Compact starter berms	3 days	Thu 8/22/24	Mon 8/26/24
293	**Bio-Intrusion**	**100 days**	**Fri 9/6/24**	**Tue 2/4/25**
294	Purchase and Spread Bio-Intrusion Layer	34 days	Fri 9/6/24	Wed 10/23/2
295	Deliver Bio-Intrusion Layer Material	67 days	Wed 10/23/24	Tue 2/4/25
296	Compact Bio-Intrusion Layer Material	14 days	Fri 9/6/24	Thu 9/26/24
297	**Clay**	**90 days**	**Tue 2/4/25**	**Tue 6/10/25**
298	Purchase and deliver clay material	90 days	Tue 2/4/25	Tue 6/10/25
299	Spread loose lift before compaction	18 days	Tue 2/4/25	Fri 2/28/25
300	Compact Clay (Final Cover)	59 days	Tue 2/4/25	Mon 4/28/25
301	**Top Soil**	**29 days**	**Tue 6/10/25**	**Tue 7/22/25**
302	Purchase and place Topsoil	10 days	Tue 6/10/25	Tue 6/24/25
303	Addition for Delivery Distance	19 days	Tue 6/24/25	Tue 7/22/25
304	**Post-Construction Stormwater Controls**	**29 days**	**Tue 7/22/25**	**Tue 9/2/25**
305	**Install Terraces**	**5 days**	**Wed 7/23/25**	**Wed 7/30/25**
306	Purchase and place Topsoil	4 days	Wed 7/23/25	Mon 7/28/25
307	Addition for Delivery Distance	1 day	Mon 7/28/25	Wed 7/30/25
308	**Diversion Berms**	**0 days**	**Tue 7/22/25**	**Tue 7/22/25**



ID	Task Name	Estimated Duration	Start	Finish
309	Purchase and deliver clay material	0 days	Tue 7/22/25	Tue 7/22/25
310	Spread loose lift before compaction	0 days	Tue 7/22/25	Tue 7/22/25
311	Compact berms	0 days	Tue 7/22/25	Tue 7/22/25
312	**Pond**	**18 days**	**Tue 7/22/25**	**Fri 8/15/25**
313	Purchase and deliver liner & berm mate	6 days	Wed 7/30/25	Wed 8/6/25
314	Spread loose lift before compaction	7 days	Tue 7/22/25	Thu 7/31/25
315	Compact Liner & Berm	4 days	Tue 7/22/25	Mon 7/28/25
316	Perimeter Berm Structural Rock	18 days	Tue 7/22/25	Fri 8/15/25
317	Perimeter Road Stormwater Crossings	2 days	Fri 8/15/25	Tue 8/19/25
318	Final Stormwater Controls	9 days	Tue 8/19/25	Tue 9/2/25
319	**Site Completion**	**38 days**	**Wed 7/9/25**	**Fri 8/29/25**
320	Install temporary irrigation system	9 days	Wed 7/9/25	Tue 7/22/25
321	Apply seeding to cover	28 days	Tue 7/22/25	Fri 8/29/25
322	Install Fencing	19 days	Tue 7/22/25	Mon 8/18/25
323				
324	**Clean-up and Demolition**	**1158 days**	**Mon 4/5/21**	**Thu 11/6/25**
325	**RIM Loading Station**	**15 days**	**Fri 11/11/22**	**Wed 12/7/22**
326	Demolition	15 days	Fri 11/11/22	Wed 12/7/22
327	Air Treatment Demobilization	12 days	Fri 11/11/22	Thu 12/1/22
328	**Haul Road between Areas and Loading Stati**	**856 days**	**Mon 4/5/21**	**Mon 8/26/24**
329	**Area 1**	**5 days**	**Mon 4/5/21**	**Mon 4/12/21**
330	Remove potential contamination	1 day	Mon 4/5/21	Tue 4/6/21



ID	Task Name	Estimated Duration	Start	Finish
331	Repairs for use during Capping Phase	4 days	Tue 4/6/21	Mon 4/12/21
332	**Area 2**	**5 days**	**Mon 8/19/24**	**Mon 8/26/2**
333	Remove potential contamination	1 day	Mon 8/19/24	Tue 8/20/24
334	Repairs for use during Capping Phase	4 days	Tue 8/20/24	Mon 8/26/24
335	**Bridge**	**1 day**	**Mon 4/5/21**	**Tue 4/6/21**
336	Demolition	1 day	Mon 4/5/21	Tue 4/6/21
337	**Area 1 Leachate Frac Tanks**	**20 days**	**Tue 4/27/21**	**Wed 5/26/21**
338	Clean Leachate Frac Tanks	20 days	Tue 4/27/21	Wed 5/26/21
339	Remove Leachate Frac Tanks	3 days	Thu 5/20/21	Wed 5/26/21
340	**Area 1 Stormwater Frac Tanks**	**58 days**	**Mon 4/5/21**	**Fri 6/25/21**
341	Clean Frac Tanks	58 days	Mon 4/5/21	Fri 6/25/21
342	Remove Frac Tanks	10 days	Fri 6/11/21	Fri 6/25/21
343	**Area 2 Leachate Frac Tanks**	**20 days**	**Wed 9/11/24**	**Wed 10/9/2**
344	Clean Leachate Frac Tanks	20 days	Wed 9/11/24	Wed 10/9/24
345	Remove Leachate Frac Tanks	3 days	Fri 10/4/24	Wed 10/9/24
346	**Area 2 Stormwater Frac Tanks**	**58 days**	**Fri 8/15/25**	**Thu 11/6/25**
347	Clean Frac Tanks	58 days	Fri 8/15/25	Thu 11/6/25
348	Remove Frac Tanks	10 days	Fri 10/24/25	Thu 11/6/25
349	**Stormwater Treatment Facility**	**2 days**	**Fri 8/15/25**	**Tue 8/19/25**
350	Demolition	2 days	Fri 8/15/25	Tue 8/19/25



Appendix K

Estimated Costs for the Remedial Alternatives

Prepared by:

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Appendix K-1

Costing Assumptions

Swell and Recompaction Factors	Swell (Load Factor =1/[1+Swell])		Recompaction (over 100% means higher compaction in new location)	
Material	Factor	Units	Factor	Units
Clay	140%	lcy/bcy	110%	bcy/ccy
Bio-Intrusion Rock	165%	lcy/bcy	105%	bcy/ccy
Top Soil	125%	lcy/bcy	NA	bcy/ccy
General Fill Material	165%	lcy/bcy	105%	bcy/ccy
Starter Berm Riprap	120%	lcy/bcy	105%	bcy/ccy
General Refuse	150%	lcy/bcy	110%	bcy/ccy
C&D Stockpiled Refuse	120%	lcy/bcy	110%	bcy/ccy

Material Densities (placed)	Value	Units
Density Clay	125	pcf
Density Bio-Intrusion Rock	135	pcf
Density Top Soil	105	pcf
Density Daily Cover	110	pcf
Density Starter Berm Riprap	2.0	ton/bcy

Delivery Distances (Round Trips)	Distance	Units	Basis	Calculation of Additional Delivery Distance Factor		
				Hauling Increment	*Increment Basis*	*Hauling Increment Multiplier*
Clay Delivery Round Trip	40	miles	RS Means 354113200040 (max haul is 20 mi [40 RT])	NA		
Topsoil Round Trip	15	miles	Radius for possible sites is intermediate between Fred Weber (8.5 mi RT) and Central Stone (33 mi RT). Assumption is based on the "average load", if there were multiple sources.	10	RS Means 310513100900 (assume 5 mi haul = 10 round trip)	1.3
Bio-Intrusion Rock, Round Trip	15	miles		10	RS Means 310513100900 (assume 5 mi haul = 10 round trip)	1.3
Daily Cover, Round Trip	15	miles		10	RS Means 310513100900 (assume 5 mi haul = 10 round trip)	1.3
General Fill, Round Trip	15	miles		10	RS Means 310513100900 (assume 5 mi haul = 10 round trip)	1.3
Round Trip Miles to Rail Spur	20	miles	US Ecology estimate	NA		NA
Miscellaneous Deliveries Distance Round Trip	20	miles		NA		NA

Delivery Truck Traffic	Value	Units
Maximum Daily Delivery Truckloads to Site	200	truckloads
Assume no constraints on material availability		

Daily Cover

Assuming that daily cover material will be purchased, and delivered to the location needed just a few days in advance

Operation	RS Means Item	Description	Units	Crew	Source	Production Rate	Crew Size	Unit Costs: Ext. Mat, O&P	Unit Costs: Ext. Labor, O&P	Unit Costs: Ext. Equip, O&P	Unit Costs: Ext. Total, O&P
Purchase material and spread	310513100200	Soils for earthwork, common borrow, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	C.Y.	B15	RS Means, Year 2016 Quarter 1	600	3.5	$ 12.63	$ 3.02	$ 5.76	$ 21.41
Additional delivery distance	310513100900	Soils for earthwork, borrow, spread with 200 HP dozer, includes load at pit and haul, round trip, excludes compaction, for 5 mile haul, add	C.Y.	B34B	RS Means, Year 2016 Quarter 1	200	1	$ -	$ 2.50	$ 4.29	$ 6.79
Total per unit for additional delivery	Multiplier (add'l mileage increments needed) = 1.3					154	1	$ -	$ 3.25	$ 5.58	$ 8.83
What size haul crew is needed to match the production rate of material spreading?		*Production Rate to match:*		600	*Calculated Crew Size:*		3.9				
Total		**Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)**	**B.C.Y.**	**B15/B34B**	**RS Means, Year 2016 Quarter 1**	**600**	**7.4**	**$ 12.63**	**$ 6.27**	**$ 11.34**	**$ 30.24**
						Total number of truck drivers in crew:	**5.9**				

Dust Control	Quantity	Units	Notes
Water Truck Capital Expense	$ 55,000	each	Assumed depreciation between purchase and resale. (Based on SFS, plus inflation)
Average Days per Month Requiring Dust Control	30.4	days/month	Work days plus holidays and weekends
Water Truck Average Hours per Day	12	hours/day	Average hours of daylight
Water Truck Operation	$ 19,800	per month	Estimate of operator, fuel, maintenance. (Based on SFS, plus inflation)
Water Use (per water truck)	1,250	gallons/hour	
which is	*457,000*	*gallons/month per truck*	
Water Cost	$ 0.0034	per gallon	Missouri American Water Company, 7/19/2016
Water Truck Crew Size	1	workers per truck	

Bird Mitigation	Quantity	Units
Estimate of Annual Cost	$ 400,000	
Estimated Monthly Cost	$ 33,000	
Crew Size	2	workers
Estimate of Crew Labor	$ 18,300	per month

Based on conversation with LGL Limited, 9/19/2016

Tree Removal

Estimating the number of trees to be removed in OU-1, based upon site experience with the 2016 Non-Combustible Cover (NCC) project.

- *Assuming that tree density in early NCC construction (Area 2) is representative of the rest of Area 2*
- *Assuming that tree density in early NCC construction (Area 2) is representative of Area 1*

Item	Quantity	Units
Preliminary NCC coverage (Area 2)	15.22	acres
NCC buttress area	1.75	acres
Total initial NCC cleared Area 2 area (partial project)	*16.97*	*acres*
Trees with diameter 12-24 inches, within initial NCC progress	174	trees
Average Trees (12-24 inches) per acre	***10.3***	***trees/acre***
Trees with diameter >24 inches, within initial NCC progress	48	trees
Average Trees (>24 inches) per acre	***2.8***	***trees/acre***

Construction Trailers

Capital Costs	**RS Means Reference #**	**Description**	**Cost**	**Source**	**Crew Type**	**Crew Size**	**Daily Rate**	**Days**	**Man-days**
Trailer Purchase	015213200300	Office trailer, furnished, buy, 32' x 8', excl. hookups	$ 19,571	RS Means, Year 2016 Quarter 1	2 Skwk	2	0.7	1.4	2.9
Trailer Delivery, per mile	015213200800	Office trailer, delivery, add per mile	$ 12	RS Means, Year 2016 Quarter 1			0		
Delivery Distance (Round Trip)		Delivery Distance (miles)	20	Estimate					
Trailer Delivery (each)			*$ 244*						
Electrical Connection	015113500890	Temporary electrical power equipment (pro-rated per job), connections, office trailer, 200 amp	$ 711	RS Means, Year 2016 Quarter 1	1 Elec	1	2	0.5	0.5
Total per Trailer			*$ 20,526*					*1.9*	*3.4*
Number of Site Trailers		Contractor, Engineering, Reg. Oversight, Decon building, Lab	5						
Electrical Feed to Trailer Area	015113500160	Temporary electrical power equipment (pro-rated per job), underground feed, 3 uses, 1000 amp	$ 4,070	RS Means, Year 2016 Quarter 1	1 Elec	1	0.35	2.9	2.9
Grand Total			***$ 107,000***					***13***	***20***
Total Delivery Miles			*100*						

Operating Costs	**RS Means Reference #**	**Description**	**Cost per Trailer**	**Contractor**	**Engineering**	**Reg. Oversight**	**Lab**	**Decon**	**Source**
Office Equipment Rental	015213400100	Field office expense, office equipment rental, average	$ 222	$ 222	$ 222				RS Means, Year 2016 Quarter 1
Office Supplies	015213400120	Field office expense, office supplies, average	$ 89	$ 89	$ 89				RS Means, Year 2016 Quarter 1
Telephone	015213400140	Field office expense, telephone bill; average bill/month, incl. long distance	$ 94	$ 94	$ 94	$ 94	$ 94		RS Means, Year 2016 Quarter 1
Electrical Usage	015213400160	Field office expense, field office lights & HVAC	$ 177	$ 177	$ 177	$ 177	$ 177	$ 177	RS Means, Year 2016 Quarter 1
Air Conditioning	015213200700	Office trailer, excl. hookups, air conditioning, rent per month, add	$ 54	$ 54	$ 54	$ 54	$ 54	$ 54	RS Means, Year 2016 Quarter 1
Portable Toilets for Trailer Areas	015433406420	Rent portable toilet chemical, recycle, flush type, Incl. Hourly Oper. Cost.	$ 317	$ 317			$ 317		RS Means, Year 2016 Quarter 1
Total Monthly, each Trailer				***$ 952***	***$ 635***	***$ 325***	***$ 642***	***$ 231***	
Grand Total (Monthly)								***$ 2,800***	

Leachate Handling				
Assume that a portion of excavated waste will be saturated, and that pockets of this leachate will be encountered occassionally				
	Quantity	**Units**	**Source**	**Notes**
Percentage of Waste with Leachate Saturation	10%			
Drainability Factor	20%			
Average Leachate Production Rate	*28*	*cy/day*		
which is	*5,655*	*gal/day*		
Safety Factor (accounts for continuous pockets of leachate)	3.0			Safety factor on volume within the time window
Frac Tank Capacity	20,000	gal		Assume 21k tanks are useable to 20k
Leachate Storage Days for Testing	14	days		Test by on-site lab, turn around could be shorter depending on priority
Leachate Storage Days to Coordinate Hauling	2	days		
Leachate Storage Days for Upcoming Excavation	7	days		
Days of Leachate Storage Needed	*23*	*days*		
Volume of Storage Needed	*390,000*	*gal*		Volume (with safety factor) that could be encountered in the time window
Frac Tanks Needed for Leachate Storage (time-based)	*20*	*tanks*		This many tanks needed for the specified time window
Leachate Hauling and Disposal Cost	$ 0.57	per gallon	Heritage Environmental estimate, 8/3/2016	
Disposal Distance (round trip)	600	miles (round trip)		
Tank Truck Capacity	5,000	gal	Heritage Environmental estimate, 8/3/2016	
Disposal Truck Crew (approximation)	B34B			

Leachate Tank Costs			
	Quantity	**Units**	**Source**
Rent	$ 28	per day	Rain for Rent, 7/22/2016
Purchase	$ 30,000	per tank	
Delivery	$ 200	per tank	Rain for Rent, 7/22/2016
Pickup	$ 200	per tank	Rain for Rent, 7/22/2016
Reposition Onsite (both directions)	$ 140	per tank	Based on Delivery cost and distance
Cleaning	$ 1,500	per tank	Estimated by Rain for Rent, 7/22/2016
Delivery distance	60	miles (round trip)	
Budget for prevention (or remediation) of stormwater contamination	$ 10,000	per month	

Secondary Containment			
Assume that tanks are lined up side to side, placed on clay liner and surrounded by berms			
	Quantity	**Units**	**Notes**
Liner Area qty per frac tank	700	sf	Assume 102" wide x 560" long, with 60" between tanks
Liner Thickness	2	ft	
Berm length per frac tank	27	lf	Assume 102" wide + 60" between x 2 sides
Additional berm length for 1st tank	103	lf	Assume 560" long + 60" x 2 sides
Berm Cross-section	16	sf	Triangular berm, 2' tall, 2:1 sides. 2' floor beneath.
Clay per additional Frac Tank	*68*	*cy*	
Clay for initial berm	*61*	*cy*	

Assumptions:

Perched Leachate is encountered in proportion to excavation

Leachate is held for lab testing, then hauled offsite for disposal

Leachate is Non-Hazardous

Assume one tank to be located near excavation, then moved to tank farm

Gas System for Overburden Stockpile

Based on system estimate by Environmental Information Logistics, July 2016

			Material		Installation			
Installation Costs	**Units**	**Qty**	**Unit Cost**	**Extended**	**Unit Cost**	**Extended**	**Total**	**Note**
4 inch perforated channel flow single wall ADS w/ 3 holes in 120 degrees	lf	20550	$ 1.50	$ 30,825	$ 10.00	$ 205,500	$ 236,000	
Misc. Fittings for 4 inch pipe				$ 3,083		$ 20,550	$ 24,000	10% of pipe costs
6" HDPE SDR 17 manifold system	lf	1000	$ 6.00	$ 6,000	$ 10.00	$ 10,000	$ 16,000	
Misc. Fittings for 6 inch pipe				$ 1,200		$ 2,000	$ 3,000	20% of pipe costs
Installation Totals				$ 41,108		$ 238,050	**$ 279,000**	
Est. Labor (at $80/hr)							**2,980**	**man-hours**

Monthly Costs	**Units**	**Qty**	**Unit Cost**	**Extended**	**Monthly**
Vacuum System rental	per month	1	$3,000.00	$ 3,000	$ 3,000
Carbon Treatment System rental	per month	1	$2,600.00	$ 2,600	$ 2,600
Power	per year	1	$3,500.00	$ 3,500	$ 290
Condensate Disposal	gallons/day	13	$ 0.14	$ 1.82	$ 55
Operational Labor	hours/week	2	$ 80.00	$ 160	$ 700
Monthly Total					**$ 6,600**
Monthly Labor Hours					9

Road Extension to New Transfer Station

Estimate of unit cost for road extension	$ 1,000,000	per mile
Estimated unit cost per foot	*$ 190*	per foot
Estimate distance of Road Extension	2,000	feet
Budget for Road Extension to New Transfer Station	*$ 380,000*	
RS Means Crew Estimate	B25	*Asphalt paver, tandem roller, pneumatic wheel loader, foreman, 3 equipment operators, 7 laborers*
Daily Cost	$ 6,500	
Production Estimate	*34*	ft/day

Calculated values shown in italics

RIM Loading Station		
Based on estimates from two companies, a projected budget was determined for a clear-span fabric structure for managing and loading RIM for transportation off-site.		
	Budget	
Structure and Other Non-Itemized Construction*	$ 2,300,000	
Sitework	$ 330,000	
Slab on Grade (6" concrete)	$ 480,000	
HVAC	$ 400,000	
Fire Suppression (and needed water/sewer)	$ 250,000	
Misting System	$ 180,000	
Internal Furnishings (Jersery Barriers, Scaffolding, etc.)	$ 80,000	
Truck Scale	$ 120,000	
Contractor's Construction Management	$ 300,000	
Overhead, Profit, Insurance	$ 320,000	
**Air treatment (carbon filtering, odor mitigation) are estimated separately*		
Total Construction Budget (rounded)	**$ 4,800,000**	
Demolition Budget	**$ 160,000**	
Construction Duration	22	weeks
Demolition Duration	3	weeks
Estimated Construction Crew (average workers per day)	30	workers

Estimated Costs for Internal Furnishings

Item	Qty	Cost	Total	Note	RS Means Item	RS Means Description
Jersey Barriers	36	$ 887	$ 31,920	3 bays x 2 row x 6 per row	347113171900	Security vehicle barriers, concrete barrier, jersey, 20' L x 2' by 6" W x 32" H, 10 or more same site
Scaffolding Sections	32	$ 174	$ 5,575	Need qty 4, each 25' x 15' tall total	015423701350	Scaffolding, steel tubular, regular, frame, buy, 7'-6" high x 6' wide
Scaffolding Stairs	8	$ 317	$ 2,538	2 per assembly	015423701900	Scaffolding, steel tubular, regular, accessory, stairway section, buy
Misc Furnishings			$ 40,000	Allotment for various smaller items		
Total			**$ 80,000**			

Air Treatment System

Based on information from Carbonair to EMSI (July 2016), with additional assumptions for sitework

System would use (9) 22,000 cfm contactors (3 in parallel at 3 locations somewhere around the bldg), each loaded with 10,000 lb of Darco H2S media and 10,000 lb of vapor phase granular activated carbon (VPGAC). Vessels would be rented. Carbonair would supply 480v/3 ph blower packages (w/ controls) at each location.

Capital Expenses

Project Startup	Cost	Est. Taxable	Man-Days	Notes
Installation	$ 332,800	$ 332,800	5	Initial media, installation labor, initialization
Vessel and Media Mobilization	$ 40,000	$ 40,000	23.4	Each vessel requires a dedicated semi (1040 miles RT)
Startup Capital Subtotal	$ 372,800	$ 372,800	28	
Sitework	$ 136,000	$ 13,400	43	*See Site Work Details*
Total	**$ 508,800**	**$ 386,200**	**71**	
Average Crew Size	7.1			
Project Wrapup	Cost	Est. Taxable	Man-Days	Notes
Media Disposal	$ 45,000	$ 45,000	5	
Vessel and Media Demobilization	$ 40,000	$ 40,000	23.4	
Wrapup Capital Subtotal	$ 85,000	$ 85,000	28	
Sitework (Demolition)	$ 36,000	$ -	13	*See Site Work Details*
Total	**$ 121,000**	**$ 85,000**	**41**	
Average Crew Size	3.5			

Recurring Costs

Media Replacement & Change-out	7.9	52.9	1000
Total Excavation (months, active excavation only)	61.1	16.7	26.3
Number of Media Cycles	5.1	1.4	2.2
Estimated Number of Media Change-outs	5	1	2
Media Replacement Cost	**$ 2,160,000**	**$ 432,000**	**$ 864,000**
Media Replacement Man-days	150	30	60
Rental Fees			
Expected Excavation Duration (months, including breaks)	96	23	50
Vessel Rental costs over expected duration	$ 3,168,000	$ 956,000	$ 1,768,000
Blower Rental Costs, capped by Purchase Cost	$ 975,000	$ 709,000	$ 975,000
Average Monthly System (given expected duration)	**$ 43,000**	**$ 73,600**	**$ 55,200**

Summary

	Estimated Cost (after taxes)		
Remediation Alternative	**7.9**	**52.9**	**1000**
Startup Capital Expenses	$ 541,000	$ 541,000	$ 541,000
Rental Costs (Project Total)	$ 4,492,000	$ 1,805,000	$ 2,973,000
Media Replacement (Project Total)	$ 2,341,000	$ 468,000	$ 936,000
Wrapup & Demobilization	$ 128,000	$ 128,000	$ 128,000
Total	**$ 7,500,000**	**$ 2,940,000**	**$ 4,580,000**

Assumption Details for Air Treatment System

Rental Fees	First 12 months	Next 6	>18 months	Purchase Outright
Vessels (3 groups of 3)	$ 48,600	$ 38,880	$ 30,000	N/A
Blower Packages (3)	$ 36,745	$ 27,600	$ 22,000	$ 975,000
Subtotal	**$ 85,345**	**$ 66,480**	**$ 52,000**	

Media Replacement Costs	Quantity	Notes
Replacement Cost	$ 432,000	For all 9 vessesls
Assumed Average Frequency	12	months
Crew Man-Days	30	4 workers x 2.5 days per 3 vessels
Crew Size	4	

Site Work Details				**Installation**		**Demolition**		
Item	Unit Cost	Units	Qty	Cost	Man-Days	Cost	Man-Days	Notes
Concrete slabs for vessels	$ 7,067	each	3	$ 21,200	12.75	$ 21,200	12.75	Based on RS Means Data. Assume demolition is similar to construction.
Crane for unloading, positioning vessels	$ 1,304	per day	9	$ 11,737	-	$ 11,737	-	Operator provided by Carbonair. Assume 1 day per vessel. Based on RS Means Data.
Crane mob/demob	$ 167	each	1	$ 167	0.25	$ 167	0.25	Based on RS Means Data. Assume demolition is similar to construction.
Electrical	$ 100,000	each	1	$ 100,000	30			Power to each slab location and connect power to box on blower package. Estimated budget and man-days.
Fork Truck to unload media	$ 334	per day	9	$ 3,006	-	$ 3,006	-	Operator provided by Carbonair. Assume 1 day/vessel. Based on RS Means 2016 for a 5000 lb forklift.
			Subtotal	**$ 136,000**	**43**	**$ 36,000**	**13**	

Sitework Assumptions	RS Means Reference #	RS Means Description	Quantity	Units	Unit Cost	Extended	Material Cost	Source	Crew Type	Crew Size	Man-days
Concrete pad (each, 40' x 48' x 6")	033053404700	Structural concrete, in place, slab on grade (3500 psi), 6" thick, includes forms(4 uses), Grade 60 rebar, concrete (Portland cement Type I), and placing, excludes finishing	36	C.Y.	$ 199	$ 7,067	$ 4,476	RS Means, Year 2016 Quarter 1	C14E	11	4.25
Crane	015419500200	Crane crew, daily use for small jobs, 25-ton truck-mounted hydraulic crane, portal to portal	1	Day	$ 1,304	$ 1,304	$ -	RS Means, Year 2016 Quarter 1	A3I	1	-
Crane Mob/Demob	015436501700	Mobilization or demobilization, crane, truck-mounted, up to 75 ton, (driver only)	1	Ea.	$ 167	$ 167	$ -	RS Means, Year 2016 Quarter 1	1 Eqhv	1	0.25

Vessel Mobilization	Quantity	Notes
Est. Distance (Roseville, MN to Bridgeton, MO)	1040	RT miles
Est. Avg Speed	50	mph
Duration	2.6	days (8-hr)

Duration Assumptions	Quantity	Units
Project Startup	10	days
Media Replacement	7.5	days
Wrapup	11.6	days

Bridge over Entrance Road

Quantities	Value	Units	Notes
Bridge Length	22	ft	Allows roadway underneath to be 16 ft wide, stop signs assumed for traffic below
Bridge Width	16	ft	Assumes single-lane use over bridge
Vertical Clearance for underpassing vehicles	15	ft	
Sidewall Height	30	in	
Total Bridge Height	*17.5*	*ft*	*Also determines ramp height*
Ramp Slope (X:1)	4	ft/ft	
Ramp Length	*70*	*ft*	
Ramp Width	32	ft	Assumes two-lane traffic
Ramp Sideslope (X:1)	2.5	ft/ft	
Estimated Ramp Volume	*4,100*	*bcy*	
Top Soil Depth on Sideslopes	1	ft	
Sideslope Area	*1693*	*sf*	
Top Soil Volume (4 total sideslopes)	*260*	*bcy*	
Clay Swell Factor (during delivery)	140%	lcy/bcy	Used elsewhere in FFS estimate
Clay Compaction Factor	110%	bcy/ecy	Used elsewhere in FFS estimate
Clay volume for purchase	*6,314*	*lcy*	*After swell/compaction factors*

Bridge Components	Material Cost	Installation Cost	Total Cost	Installation (days)	Notes
Steel Modular Bridge	$ 40,000	$ 4,700	*$ 44,700*	1	22x16 Weathering Steel Modular Bridge with Timber Running Planks (4x12 Treated) and HL-93 Loading
Precast Sills	$ 5,500	$ -	*$ 5,500*	0	Assumes single-lane use over bridge. Installed with bridge.
MSE Wire Wall	$ 7,200	$ 7,200	*$ 14,400*	3	Non-galvanized, 600 sf
Subtotals	*$ 52,700*	*$ 11,900*	*$ 64,600*	*4*	
Estimated Installation Crew (average daily total)		4			
					Material Cost Source: Big R Bridge (June 2016)

Bridge Placement Estimate		
Duration	1 day	
Crew B12D	$ 3,784	3.5 CY Excav. w/ operator and laborer
2 additional laborers	$ 930	
Total	**$ 4,700**	

Installation Estimate	RS Means Reference #	RS Means Description	Quantity	Units	Unit Cost	Extended Cost	Material Cost	Source	Crew Type	Daily Rate	Crew Size	Truck Drivers/Crew	Number of Crews	Efficiency Factor	Days	Man-days	Truck Driver Man-days	Delivery Truckloads	Delivery Miles
Purchase and Deliver Ramp Soil	354113200040	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	6,314	L.C.Y.	$ 26.69	$ 168,521	$ 168,521	RS Means, Year 2016 Quarter 1	B34B	58	1	1	41	100%	2.7	108.9	108.9	527	21,080
Spread Ramp Soil	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	6,314	L.C.Y.	$ 2.54	$ 16,038	$ -	RS Means, Year 2016 Quarter 1	B10B	1000	1.5	0	2.1	100%	3.0	9.5	-		
Compact Ramp Soil	312323235060	Compaction, riding, vibrating roller, 2 passes, 12" lifts	4,100	E.C.Y.	$ 0.29	$ 1,189	$ -	RS Means, Year 2016 Quarter 1	B10Y	5200	1.5	0	1	100%	0.8	1.2	-		
Purchase and Place Topsoil on Sideslopes	310513100800	Soils for earthwork, topsoil borrow, weed free, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	260	C.Y.	$ 33.76	$ 8,778	$ 6,495	RS Means, Year 2016 Quarter 1	B15	600	3.5	2	5	100%	0.1	1.5	0.9	22	330
Addition for Topsoil Delivery	310513100900	Soils for earthwork, borrow, spread with 200 HP dozer, includes load at pit and haul, round trip, excludes compaction, for 5 mile haul, add	338	C.Y., per add'l hauling increment	$ 6.79	$ 2,295	$ -	RS Means, Year 2016 Quarter 1	B34B	200	1	1	5	100%	0.3	1.7	1.7		
Apply Seeding to Sideslopes	329219142400	Seeding athletic fields, seeding fescue, tall with mulch and fertilizer, 5.5 lb. per M.S.F., hydro/air seeding	6.8	M.S.F.	$ 56.09	$ 380	$ 178	RS Means, Year 2016 Quarter 1	B81	80	3	1	1	100%	0.1	0.3	0.1		
Construct Gravel Road on Ramps	015523500050	Temporary, roads, gravel fill, 4" gravel depth, excl surfacing	498	S.Y.	$ 9.08	$ 4,520	$ 2,041	RS Means, Year 2016 Quarter 1	B14	715	6	0	1	100%	0.7	4.2	-		
Install Bridge Components	See above assumptions		1	Each	$ 64,600	$ 64,600	$ 52,700	Based on Big R Bridge estimate, June 2016			4	0	1	100%	4.0	16.0	-		
Totals						**$ 266,000**	**$ 230,000**								**9.0**	**143**	**112**	**549**	**21,400**
Schedule assumes ramp soil delivery and spreading will be concurrent																			

Demolition Estimate	Cost	Days	Note	Man-days
Remove Bridge	$ 2,350	0.5	Same crew as installation, assume 50% of installation time	2
Scrap Bridge	$ -	-	Assume scrapping company will pick up bridge	-
Remediate Top Portion of Road	$ -	-	Costed with RIM Loading Station	-
Remove Ramp Soil	$ -	-	Assume soil can be used in landfill cap and will offset purchased material	-
Totals	**$ 2,350**	**0.5**		**2**

Stormwater Handling			
Primary Storm	**Quantity**	**Units**	**Source**
Design Storm	25-yr 24-hr		
Design Storm Rainfall	5.6	inches	National Weather Service Technical Paper No. 40
Exposed Area	4	acres	FFS Team Estimate
Storm Volume	*81,300*	*cf*	
which is	*608,000*	*gal*	
Frac Tank Capacity	20,000	gal	Assume 21k tanks are useable to 20k
Frac Tanks per Storm	*30.4*	*tanks*	
Secondary Storm (while plant is processing)			
Design Storm	10-yr 24-hr		
Design Storm Rainfall	5	inches	National Weather Service Technical Paper No. 40
Storm Volume	*72,600*	*cf*	
which is	*543,000*	*gal*	
Frac Tanks per Storm	*27.2*	*tanks*	
Total Frac Tanks	***58***	***tanks***	
Disposal cost (after treatment)	$ 0.14	per gallon	

Silt Fence					*Determine Unit Costs considering Maintenance and Replacement*			
	RS Means Reference #	**RS Means Description**	**Quantity**	**Units**	**Unit Cost**	**Extended Cost**	**Material Cost**	**Source**
1) Installation and Removal	312514161000	Synthetic erosion control, silt fence, install and maintain, remove, 3' high	1	L.F.	$ 1.54	$ 1.54	$ 0.26	RS Means, Year 2016 Quarter 1
2) Maintenance, per month (up to 6 months)	312514161100	Synthetic erosion control, silt fence, polypropylene, allow 25% per month maintenance; 6 month max life	1		$ 0.39	$ 0.39	$ 0.07	RS Means, Year 2016 Quarter 1
Total Cost for 6 months					$ 3.85	$ 3.85	$ 0.65	
Average Monthly cost (for durations >> 6 months)			*1*	*L.F.*	*$ 0.64*	*$ 0.64*	*$ 0.11*	

Stormwater Treatment Plant

Based on information from Carbonair to EMSI (August 2016), with additional assumptions for sitework

System would include 2 treatment trains, each handling 120 gpm. (Second train is for redundancy, or for extra capacity in an emergency.) Consist of duplex bag filter skid, LPGAC adsorbers, transfer pump, interconnecting piping, flow meter, pressure gauges. To be housed in pre-engineered slab on grade metal building.

Capital Expenses

Project Startup	Cost	Est. Taxable	Man-Days	Notes
System shipping & installation, initial media	$ 10,267	$ 10,267	3.6	Initial media, installation labor, initialization
Transfer Pumps	$ 54,254	$ 54,254	1	2 pumps, delivered & installed
Startup Capital Subtotal	$ 64,521	$ 64,521	5	
Sitework	$ 37,000	$ 6,700	25	*See Site Work Details*
Total	**$ 102,000**	**$ 71,000**	**30**	
Average Crew Size	*2*			
Project Wrapup	**Cost**	**Est. Taxable**	**Man-Days**	**Notes**
Dispose of spent carbon, return systems	$ 4,617	$ 3,567	3.6	
Sitework (Demolition)	$ 22,000	$ -	15	*See Site Work Details. Assumes forcemain can remain in place.*
Total	**$ 27,000**	**$ 4,000**	**19**	
Average Crew Size	*9.2*			

Recurring Costs for Stormwater Treatment System

Recurring Costs (amortized to an "average month")

Rental Fees	**ROD**	**7.9**	**52.9**	**1000**
Average Monthly Rental (given expected duration)	**$ 2,800**	**$ 1,630**	**$ 1,970**	**$ 1,720**
Media Replacement Cost per month	**$ 1,268**			
Media Replacement Man-hours per month	10			
Bag filters per month	62			
Bag filters cost per month	**$ 620**			
Operational Hours per month	31			
Operational Labor Cost per month	**$ 2,382**			
Total Monthly Cost (excl. Rent)	**$ 4,271**			
Total Monthly Man-days	5			

Recurring Cost Details

Rental Fees	First 10 months	Next 8	>18 months	
Filter bag skid & adsorber (2 systems)	$ 2,800	$ 2,000	$ 1,500	
Media Replacement Costs	Quantity	Notes		
Replacement Cost	$ 7,610	For all 4 vessels		
Assumed Average Frequency	6	months		
Crew Man-Days	7.2	2 workers x 1 days plus mobilization		
Bag Filters	Quantity	Notes		
Cost	$ 10	each		
Frequency	2	per day		
Operations Personnel	Quantity	Notes		
Skilled Worker	$ 76.85	per hour, w/ O&P (RS Means 2016)		
Labor	1	hr/day		

Assumption Details for Stormwater Treatment System

Site Work Details				Installation		Demolition		
Item	Unit Cost	Units	Qty	Cost	Man-Days	Cost	Man-Days	Notes
Steel Building	$ 20,531	each	1	$ 20,531	14	$ 20,531	14	Based on RS Means Data. Assume demolition is similar to construction.
Slab on Grade for Building	$ 1,178	each	1	$ 1,178	0.7	$ 1,178	0.7	Based on RS Means Data. Assume demolition is similar to construction.
Electrical	$ 5,000	each	1	$ 5,000	3.5			Estimated budget and man-days at quarter of building cost.
Plumbing, Lighting, Heating	$ 10,000	each	1	$ 10,000	7			Estimated budget and man-days at half of building cost.
Fork Truck to unload media	$ 334	per day	1	$ 334	0	$ 334	0	Operator provided by Carbonair. Assume 1 day. Based on RS Means 2016 for a 5000 lb forklift.
			Subtotal	**$ 37,000**	**25**	**$ 22,000**	**15**	

Sitework Assumptions	RS Means Reference #	RS Means Description	Quantity	Units	Unit Cost	Extended Cost	Material Cost	Source	Crew Type	Crew Size	Days	Man-days
Pre-Engineered Steel Building (20' x 16', add 2x multiplier for small size)	133419500170	Pre-engineered steel building, clear span rigid frame, 30 psf roof and 20 psf wind load, 20' to 29' W x 16' eave H, incl. 26 ga. colored ribbed roofing & siding, excl. footings, slab, anchor bolts	640	SF Flr.	$ 32	$ 20,531	$ 6,746	RS Means, Year 2016 Quarter 1	E2	7	2.0	14.0
Slab on Grade (20' x 16' x 6")	033053404700	Structural concrete, in place, slab on grade (3500 psi), 6" thick, includes forms(4 uses), Grade 60 rebar, concrete (Portland cement Type I), and placing, excludes finishing	5.9	C.Y.	$ 199	$ 1,178	$ 746	RS Means, Year 2016 Quarter 1	C14E	11	0.1	0.7

System Mobilization	Quantity	Notes
Est. Distance (Roseville, MN to Bridgeton, MO)	1,040	RT miles
Est. Avg Speed	50	mph
Duration	2.6	days (8-hr)

Duration Assumptions	Quantity	Units	Notes
Project Startup	15	days	Assume 10 days to construct building & add utilities. Allow 5 day window for system install. Lead times (vessels 3-6 wks, pumps 6-10 wks) but could begin before site work.
Media Replacement	1	days	Assume these can be staged or otherwise coordinated to avoid shutdown of RIM Loading Station
Wrapup	2.1	days	Assume longest task sequence is building demo, based on building construction

Buffer Zone / Crossroad Property

Inputs	Value	Units	Source
Length of Access Fence	850	lf	
Length of Silt Fence	850	lf	
Area to address	1.78	ac	ROD, Section 5.2
Depth of soil to replace	1.0	ft	

	RS Means Reference #	RS Means Description	Quantity	Units	Unit Cost	Extended Cost	Material Cost	Source	Crew Type	Daily Rate	Crew Size	Number of Crews	Efficiency Factor	Days	Man-days
1) Surveying	022113090020	Topographical survey, conventional, minimum	1.78	Acre	$ 656.35	$ 1,168	$ 39	RS Means, Year 2016 Quarter 1	A7	3.3	3	1	100%	0.5	1.6
2) Silt Fence	312514161000	Synthetic erosion control, silt fence, install and maintain, remove, 3' high	850	L.F.	$ 1.54	$ 1,309	$ 221	RS Means, Year 2016 Quarter 1	B62	1300	3	1	100%	0.7	2.0
3) Clearing and grubbing (light)	311313101020	Selective tree and shrub removal, selective clearing brush mowing, light density, tractor with rotary mower, excludes	1.78	Acre	$ 525.75	$ 936	$ -	RS Means, Year 2016 Quarter 1	B84	2	1	1	100%	0.9	0.9
4) Excavate top layer of soil and haul to Area 2															
Excavate top layer of soil	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 160 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding	2,872	B.C.Y.	$ 1.71	$ 4,911	$ -	RS Means, Year 2016 Quarter 1	B12D	2,400	2	2	50%	1.2	4.8
Load soil onto haul trucks	312316420305A	Excavating, bulk bank measure, for loading onto trucks, add	2,872	B.C.Y.	$ 0.26	$ 747	$ -	RS Means, Year 2016 Quarter 1	B12D	15,785	2	2	50%	0.2	0.7
Haul soil to Area 2	312323205060	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15	4,020	L.C.Y.	$ 4.03	$ 16,202	$ -	RS Means, Year 2016 Quarter 1	B34F	594	1	3.5	100%	1.9	6.8
Spread soil in Area 2	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	4,020	L.C.Y.	$ 2.54	$ 10,212	$ -	RS Means, Year 2016 Quarter 1	B10B	1,000	1.5	3	100%	1.3	6.0
Compact soil in Area 2	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	2,611	E.C.Y.	$ 0.89	$ 2,323	$ -	RS Means, Year 2016 Quarter 1	B10G	2,600	1.5	1	100%	1.0	1.5
Apply daily cover to relocated soil	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	287	B.C.Y.	$ 30.24	$ 8,683	$ 3,627	RS Means, Year 2016 Quarter 1	B15/B34B	600	7.4	1	100%	0.5	3.5
													Duration for this step (some activities in parallel):	1.9	
5) Chain Link Fence for Access Restriction	323113200920	Fence, chain link industrial, galvanized steel, 6 ga. wire, 2-1/2" posts @ 10' OC, 8' high, includes excavation, in	*850*	L.F.	$ 46.83	$ 39,806	$ 31,450	RS Means, Year 2016 Quarter 1	B80C	180	3	2	100%	2.4	14.2
Total						**$ 86,297**	**$ 35,337**							**6.4**	**42.0**

Other Note and Assumptions

Clearing

- Any existing geomembrane liner requiring demolition is assumed to be added to the overburden waste, consuming an insignificant volume.
- Tree density of the early Non-Combustible Cover construction (Area 2) is assumed to be representative of the rest of Area 2, and of Area 1.
- Disposal of stumps is assumed to be as normal waste (RS Means rate), not as a special waste. Stumps are not included in the truckload estimate.

C&D Rubble Stockpiles

- It is assumed that all construction & demolition material can be used without crushing or other means of processing for size reduction.

Air Treatment System (RIM Loading Station)

- Media replacement frequency for the Air Treatment System is a significant risk item. In addition to being a sizeable expense, its effectiveness is not yet known.
  -- The media replacement frequency could be significantly shorter than assumed, perhaps prohibitively so.
- Depending on the final project scheduling, it may be advantageous to demobilize and remobilize the Air Treatment System components rather than maintain continuous rental for long gaps between RIM excavation phases.

Stormwater and Leachate

- Stormwater design is conceptual in nature.
- It is assumed that solids from stormwater retention can be returned to the landfill.
- Preliminary locations for frac tanks have been identified and it assumed that the design phase will either confirm these locations or identify alternates within a reasonable distance.

Landfill Gas System

- A longer-term gas system may be required in Area 2 if a significant volume of waste is permanently relocated from the North Quarry.

Material Delivery

- No traffic study has been conducted as a part of this feasibility-level estimate.
- Final cover materials, daily cover, and clean fill are assumed to be delivered to the locations needed, 3 days in advance. Thus double-handling will be minimized but a buffer of material will still be available in case of disruption.

Schedule Estimates

- Construction schedules assume that replacement of the existing Transfer Station is completed before excavation begins. This includes design, permitting, construction of the new, and demolition of the old.
- Schedules account for weather delays, but not any seasonal stoppages.
- Schedules do not relect any delays (or costs) of work stoppages or standby time due to odor issues, regulatory requests, etc.
- The construction rate is assumed to be limited by the on-site hauling rate, with the contractor furnishing equipment for other operations as needed to meet this rate.
- Inefficiency factors due to radiological materials are applied primarily to excavation and loading operations. It is assumed that space will allow assigning additional crews to these operations so that the on-site hauling rate is maintained.

Additional Assumptions	**Quantity**	**Units**	**Notes**
On-site Transportation Rate (per each Contractor's Operation)	2,100	lcy/day	
Work Days per Year	250	days	
Traffic Improvements (TBD), Area 1	10	days	
Traffic Improvements (TBD), Area 2	10	days	
Radiological Survey following final excavation in an area	7	days	
Taxes for Bridgeton, MO	8.363%		http://dor.mo.gov/pdf/rates/2016/jul2016.pdf
Construction Inflation Rate			
RS Means Historical Cost Index for 2011	191.2		
RS Means Historical Cost Index for 2016	207.2		For January 2016, estimated
Construction Inflation Multiplier from SFS to FFS	*1.084*		

Construction Assumptions for ROD Remedy

Site Preparations				
	Units	**Area 1**	**Area 2**	**Notes**
Clearing Perimeter	ft	4,900	7,500	
Silt Fence Length	ft	4,900	7,500	
Number of Decontamination Pads		1	1	
Total Clearing Area (final cover footprint)	acres	21	44	
Area to Clear and Grub Light or No Trees	acres	0.2	2.6	*Includes some area outside final cover footprint*
Area to Clear and Grub Heavy Trees	acres	8.5	15	*Includes some area outside final cover footprint*
Area to Remove Trees Felled during Non-Combustible Cover Project	acres	2.7	17	*Includes some area outside final cover footprint*
Area not requiring Clearing	acres	11	11	
Trees to Remove, Small	trees	120	360	*Tree density is extrapolated from NCC project*
Trees to Remove, Large	trees	30	100	*Tree density is extrapolated from NCC project*
Temporary Road Length	feet	2,500	5,000	*SFS*
Temporary Road Width	feet	24	24	
Site Traffic TBD Improvements Cost	budget	$ 108,000	$ 108,000	*SFS + inflation*

Decontamination Structures	For both Areas	
Length of Pad	50	ft
Width of Pad	20	ft
Area of Pad	*1,000*	*sq ft*
Volume of 18 inch Pad	*56*	cy

Parking Areas	For both Areas	
Parking Area Length	100	ft
Parking Area Width	200	ft
Parking Area Total	*2,200*	*sy*

Construction Assumptions for ROD Remedy

Leachate and Stormwater	Quantity	Units	Notes
Contact Stormwater Force Main Distance Area 1	4,500	ft	Assume storage and treatment center are located north of existing leachate treatment plant
Contact Stormwater Force Main Distance Area 2	7,000	ft	
Force Main from StorageArea to Treatment Facility Area 1	500	ft	
Force Main from StorageArea to Treatment Facility Area 2	500	ft	Assume distance from Treatment Facility to Discharge Point is included here
Force Main Valves Area 1	6	each	
Force Main Valves Area 2	8	each	
Contact Stormwater Treatment Systems	1		
Rainfall	50	in/yr	
Pump Volume per Day	25,700	cf/day	(400 gpm/7.481 gal/cf) * 60 min/hr * 8 hr/day
Contact Stormwater Generated During Area 1 Construction	*110,000*	*gal*	SFS Estimate: one 50k event per month for Areas 1 & 2
Contact Stormwater Generated During Area 2 Construction	*320,000*	*gal*	
Frac Tanks for Leachate:	**Area 1**	**Area 2**	
Frac Tanks Estimated (volume based, unless reduced by time)	16	20	Quantity of individual tanks needed; use the quantity for the hold & test time window, unless the project is shorter than the time window

Waste Relocation			
	Units	**Area 1**	**Area 2**
Waste Relocation Volume (Total)	bcy	33,300	78,600
C&D Rubble Stockpiles	bcy	7,800	33,500
General Waste Relocation Volume (excluding stockpiles)	*bcy*	*25,600*	*45,200*
Ditch Excavation to be included as Waste	bcy	-	-
Pond Excavation to be included as Waste	bcy	-	11,100
Buffer Zone material relocated as Waste	bcy	-	2,900
Waste Relocation including Ponds, Ditches, & Buffer Zone	*bcy*	*25,600*	*59,100*
Volume for Daily Cover During Excavation (General Waste)	%	10%	10%
Volume for Daily Cover During Excavation (C&D Rubble)	%	0%	0%
Fill Needed for Design Grades	ccy	31,100	80,800
Extra Fill to include with Final Grades	ccy	3,900	14,100

Construction Assumptions for ROD Remedy

Starter Berms

Riprap Type	Units	Area 1	Area 2
Starter Berm Length, Type I	ft	500	3,900
Starter Berm Cross-sectional Area, Type I	sf	65	190
Starter Berm Cross-sectional Surface, Type I	ft	12	29
Starter Berm Length, Type II	ft	1,200	-
Starter Berm Cross-sectional Area, Type II	sf	60	-
Starter Berm Cross-sectional Surface, Type II	ft	10	-

Final Cover

	Units	Area 1	Area 2
Area of Final Cover, 3D	sq ft	617,000	1,865,000
Thickness of Bio-Intrusion Layer	ft		2.0
Thickness of Clay Layer	ft		2.0
Thickness of Topsoil Layer	ft		1.0

Post-Construction Stormwater Controls

	Units	Area 1	Area 2
Terrace Type I			
Terrace length	lf	2,600	6,720
Cross Sectional area of terrace	sq ft	17	17
Terrace Type II			
Terrace length	lf	-	830
Cross Sectional area of terrace	sq ft	30	30
Length of Perimeter Ditch to construct	lf	-	-
Cross Sectional area of Perimeter Ditch	sq ft	-	-
Stormwater Pond Liner Thickness	lf	-	4
Area of Pond Liner	sq ft	-	60,300
Structural Rock for Pond Perimeter Berm	cy	-	1,100
Lengths of Diversion Berms	lf	2,100	15,000
Cross Sectional Area of Diversion Berms	sq ft	27	27
Lengths of Perimeter Road Crossings	lf	-	130
Cross Sectional Area of Perimeter Road Crossings	sq ft	-	21
Area of Riprap	sq ft	16,000	18,000

Construction Assumptions for ROD Remedy

Vegetation and Fencing Information			
	Units	**Area 1**	**Area 2**
Vegetation Area	sq ft	617,000	1,865,000
Additional Disturbed Area Factor	%	20%	20%
Seeding Area	*sq ft*	*740,000*	*2,238,000*
Fencing Length	lf	5,000	6,700
Irrigation Area Reduction Factor	%	90%	90%
Irrigation Areas	*sq ft*	*62,000*	*187,000*

Schedule				
	Units	**Area 1**	**Area 2**	
Project Duration	months	12.4	20	
Duration of Water Truck Dust Control	months	11.7	18	
		Whole Project	**Area 1**	**Area 2**
Duration of Construction Stormwater	months	6	2	6
		Area 1	**Area 2**	
Time Encountering Leachate	months	1.4	4.9	
		1st Unit	**2nd Unit**	**3rd Unit**
Project Duration for Construction Units	months	20	3.9	-
		Whole Project		
Project Duration for Construction Personnel (considering multiple crews)	months	24		
Project Duration for Construction Trailers (considering multiple crews)	months	24		

Construction Assumptions for Excavation Alternatives

Site Preparations		**FFS 7.9**		**FFS 52.9**		**FFS 1000**		
	Units	**Area 1**	**Area 2**	**Area 1**	**Area 2**	**Area 1**	**Area 2**	**Notes**
Clearing Perimeter	ft	5,400	7,800	4,900	7,500	5,400	7,500	
Silt Fence Length	ft	5,400	7,800	4,900	7,500	5,400	7,500	
Number of Decontamination Pads		1	1	1	1	1	1	
Total Clearing Area (final cover footprint)	acres	26	47	23	45	26	45	
Area to Clear and Grub Light or No Trees	acres	0.2	2.6	0.2	2.6	0.2	2.6	*Includes some area outside final cover footprint*
Area to Clear and Grub Heavy Trees	acres	8.5	15	8.5	15	8.5	15	*Includes some area outside final cover footprint*
Area to Remove Trees Felled during Non-Combustible Cover Project	acres	2.7	17	2.7	17	2.7	17	*Includes some area outside final cover footprint*
Area not requiring Clearing	acres	16	14	13	11	16	11	
Trees to Remove, Small	trees	120	360	120	360	120	360	*Tree density is extrapolated from NCC project*
Trees to Remove, Large	trees	30	100	30	100	30	100	*Tree density is extrapolated from NCC project*
Temporary Road Length	feet	5,000	10,000	5,000	10,000	5,000	10,000	*SFS*
Temporary Road Width	feet	24	24	24	24	24	24	*SFS*
Portion of Temporary Road to Secure for RIM Hauling (On-site)	feet	800	800	800	800	800	800	
Temporary RIM Loading Station Road Length (Offsite Trucks)	feet	800	-	800	-	800	-	
Site Traffic TBD Improvements Cost	budget	$ 108,000	$ 108,000	$ 108,000	$ 108,000	$ 108,000	$ 108,000	*SFS + inflation*

Decontamination Structures	**For both Areas**	
Length of Pad	50	ft
Width of Pad	20	ft
Area of Pad	*1,000*	*sq ft*
Volume of 18 inch Pad	*56*	*cy*

Parking Areas	**For both Areas**	
Parking Area Length	100	ft
Parking Area Width	200	ft
Parking Area Total	*2,200*	*sy*

Dust Control	**Units**	**FFS 7.9**	**FFS 52.9**	**FFS 1000**	**Notes**
Water Trucks per Area	trucks	1	2	2	For non-CRR alternatives, double the dust control

Construction Assumptions for Excavation Alternatives

Leachate and Stormwater	Units	FFS 7.9	FFS 52.9	FFS 1000	Notes
Contact Stormwater Force Main Distance Area 1	ft	4,500	4,500	4,500	Assume storage and treatment center are located north of existing leachate treatment plant
Contact Stormwater Force Main Distance Area 2	ft	7,000	7,000	7,000	
Force Main from StorageArea to Treatment Facility Area 1	ft	500	500	500	
Force Main from StorageArea to Treatment Facility Area 2	ft	500	500	500	Assume distance from Treatment Facility to Discharge Point is included here
Force Main Valves Area 1	each	6	6	6	
Force Main Valves Area 2	each	8	8	8	
Contact Stormwater Treatment Systems		1	1	1	
Rainfall	in/yr	50	50	50	
Pump Volume per Day	cf/day	25,700	25,700	25,700	(400 gpm/7.481 gal/cf) * 60 min/hr * 8 hr/day
Contact Stormwater Generated During Construction Area 1	*gal*	3,600,000	1,000,000	1,900,000	SFS Estimate: one 50k event per month for Areas 1 & 2
Contact Stormwater Generated During Construction Area 2	*gal*	5,000,000	1,400,000	2,800,000	
Frac Tanks for Leachate:					
Area 1	tanks	20	20	20	Quantity of individual tanks needed; use the quantity for the hold & test time window, unless the project is shorter than the time window
Area 2	tanks	20	20	20	

Construction Assumptions for Excavation Alternatives

Waste Relocation		**FFS 7.9**		**FFS 52.9**		**FFS 1000**	
	Units	**Area 1**	**Area 2**	**Area 1**	**Area 2**	**Area 1**	**Area 2**
RIM Volume from Areas 1 & 2	bcy	46,241	220,029	20,760	129,878	7,113	31,120
Total RIM from Other Sources (Buffer Zone)	bcy	-	2,898	-	-	-	-
Waste Excavation Volume	bcy	790,000	707,000	81,000	307,000	438,000	253,000
Additional Excavation (Ponds & Ditches, but Buffer Zone counted elsewhere)	bcy	-	11,000	-	11,000	-	11,000
Overburden (calculated)	*bcy*	*744,000*	*487,000*	*61,000*	*177,000*	*431,000*	*222,000*
C&D Rubble Stockpiles, demo from RIM Loading structure	bcy	8,000	35,000	8,000	35,000	8,000	35,000
General Overburden Volume (excluding stockpiles, RIM)	*bcy*	*736,000*	*451,000*	*53,000*	*142,000*	*423,000*	*187,000*
Ditch Excavation to be included as Overburden	bcy			-	-	-	-
Pond excavation to be included as Overburden	bcy	-	11,000	-	11,000	-	11,000
Buffer Zone material relocated as Overburden	bcy	-	-	-	2,898	-	2,898
Overburden Relocation including Ditch Material & Buffer Zone	*bcy*	*736,000*	*463,000*	*53,000*	*156,000*	*423,000*	*201,000*
Daily Cover	%	10%	10%	10%	10%	10%	10%
Fill Needed for Drainage Grades	ccy	614,000	867,000	178,000	463,000	298,000	413,000
Extra Waste Relocation	bcy	19,600	41,200	33,800	64,600	56,400	63,600
Extra Fill to include with Final Grades	ccy	-	279,000	-	-	-	339,400
Supplemental Fill Material Required	ccy	-	30,000	-	220,000	-	5,000

Starter Berms		**FFS 7.9**		**FFS 52.9**		**FFS 1000**	
Riprap Type	**Units**	**Area 1**	**Area 2**	**Area 1**	**Area 2**	**Area 1**	**Area 2**
Starter Berm Length, Type I	ft	-	3,900	-	3,900	-	3,900
Starter Berm Cross-sectional Area, Type I	sf	-	190	-	190	-	190
Starter Berm Cross-sectional Surface, Type I	ft	-	29	-	29	-	29
Starter Berm Length, Type II	ft	-	-	-	-	-	-
Starter Berm Cross-sectional Area, Type II	sf	-	-	-	-	-	-
Starter Berm Cross-sectional Surface, Type II	ft	-	-	-	-	-	-

Construction Assumptions for Excavation Alternatives

Final Cover		**FFS 7.9**		**FFS 52.9**		**FFS 1000**	
	Units	**Area 1**	**Area 2**	**Area 1**	**Area 2**	**Area 1**	**Area 2**
Area of Final Cover, 3D	sq ft	1,073,000	1,988,000	956,000	1,881,000	1,073,000	1,884,000
Thickness of Bio-Intrusion Layer	ft		-		2.0		2.0
Thickness of Clay Layer	ft		2.0		2.0		2.0
Thickness of Topsoil Layer	ft		1.0		1.0		1.0

Post-Construction Stormwater Controls		**FFS 7.9**		**FFS 52.9**		**FFS 1000**	
	Units	**Area 1**	**Area 2**	**Area 1**	**Area 2**	**Area 1**	**Area 2**
Terrace length	lf	6,200	7,500	2,700	5,300	6,200	7,400
Cross Sectional area of terrace	sq ft	17	17	17	17	17	17
Length of Perimeter Ditch to construct	lf	-	-	-	-	-	-
Cross Sectional area of Perimeter Ditch	sq ft	-	-	-	-	-	-
Stormwater Liner Thickness	lf	-	4	-	4	-	4
Area of Pond Liner	sq ft	-	60,300	-	60,300	-	60,300
Structural Rock for Pond Perimeter Berm	cy	-	1,100	-	1,100	-	1,100
Lengths of Diversion Berms	lf	900	500	1,600	1,700	900	500
Cross Sectional Area of Diversion Berms	sq ft	27	27	27	27	27	27
Lengths of Perimeter Road Crossings	lf	-	130	-	130	-	130
Cross Sectional Area of Perimeter Road Crossings	sq ft	-	21	-	21	-	21
Length of Letdown Riprap	lf	400	1,110	310	430	400	950
Width of Letdown Riprap	ft	20	20	20	20	20	20
Area of Letdown Riprap	sq ft	*8,000*	*22,200*	*6,200*	*8,600*	*8,000*	*19,000*

Vegetation and Fencing Information		**FFS 7.9**		**FFS 52.9**		**FFS 1000**	
	Units	**Area 1**	**Area 2**	**Area 1**	**Area 2**	**Area 1**	**Area 2**
Vegetation Area	sq ft	1,073,000	1,988,000	956,000	1,881,000	1,073,000	1,884,000
Additional Disturbed Area Factor	%	20%	20%	20%	20%	20%	20%
Seeding Area	*sq ft*	*1,288,000*	*2,386,000*	*1,147,000*	*2,257,000*	*1,288,000*	*2,261,000*
Fencing Length	lf	5,800	7,000	5,100	6,700	5,800	6,700
Irrigation Area Reduction Factor	%	90%	90%	90%	90%	90%	90%
Irrigation Areas	*sq ft*	*107,000*	*199,000*	*96,000*	*188,000*	*107,000*	*188,000*

Construction Assumptions for Excavation Alternatives

Schedule		FFS 7.9			FFS 52.9			FFS 1000		
	Units	**Area 1**	**Area 2**		**Area 1**	**Area 2**		**Area 1**	**Area 2**	
Project Duration	months	75	108		27	45		50	69	
Duration of Water Truck Dust Control	months	74	106		26	43		48	67	
		Whole Project	**Area 1**	**Area 2**	**Whole Project**	**Area 1**	**Area 2**	**Whole Project**	**Area 1**	**Area 2**
Duration of Construction Stormwater - Excavation	months	134 total	36	67	35 total	9	18	77 total	22	33
Duration of Construction Stormwater - Backfill	months		35	31		10	10		14	22
		Area 1	**Area 2 SW**	**Area 2 NE**	**Area 1**	**Area 2 SW**	**Area 2 NE**	**Area 1**	**Area 2 SW**	**Area 2 NE**
Duration of RIM Excavation (Workdays)	workdays	652	386	286	82	158	124	366	184	70
		Area 1	**Area 2**		**Area 1**	**Area 2**		**Area 1**	**Area 2**	
Time Encountering Leachate	months	66	97		14	26		32	54	
		1st Unit	**2nd Unit**	**3rd Unit**	**1st Unit**	**2nd Unit**	**3rd Unit**	**1st Unit**	**2nd Unit**	**3rd Unit**
Project Duration for Construction Units	months	145	39	-	55	18	-	92	26	-
		Whole Project			**Whole Project**			**Whole Project**		
Project Duration for Construction Personnel (considering multiple crews)	months	183			72			119		
Project Duration for Construction Trailers (considering multiple crews)	months	183			72			119		

RIM Loading Rate Assumptions

Values in italics are calculated from other assumptions

Potential Loading Rates

	RIM Rate 1	*RIM Rate 2*	*RIM Rate 3*	*RIM Rate 4*	*RIM Rate 5*	*RIM Rate 6*	
Shipping Rate	1000	800	500	400	150	100	LCY/day
which is	*33.3*	*26.7*	*16.7*	*13.3*	*5.0*	*3.3*	intermodals/day

Assumptions

Intermodal Capacity	30	cy
Distance to Rail Spur (Round Trip)	20	miles (RT)
Round Trips per Truck - Missouri	4	per day
Distance from Transloading Facility to Disposal Facility (Round Trip)	70	miles (RT)
Round Trips per Truck - Destination	3	per day
Distance by Rail (Round Trip)	3,200	miles (RT)
Transportation & Disposal, per intermodal	$ 6,500	each
Fuel Surcharge per intermodal (total, as of July 2016)	$ 12	each
Disposal Facility Transportation & Disposal	*$ 229*	per LCY
Disposal Facility's Onsite Coordinator	$ 1,100	per day

Crew Sizes

	1000 LCY/day	*800 LCY/day*	*500 LCY/day*	*400 LCY/day*	*150 LCY/day*	*100 LCY/day*	
Scalehouse Operator	1	1	0	0	0	0	
Liner Crew*	2	2	1	1	1	1	
Policing Loose RIM*	1	0	0	0	0	0	
Tarp Assistance*	1	1	1	1	0	0	
Front End Loader Operators*	2	2	1	1	1	1	
Sr. Shipping Technicians	2	2	1	1	1	1	
Shipping Technicians*	4	3	2	1	1	1	
Crew at Rail Spur	4	4	3	3	2	2	
Crew at Transloading Facility	5	4	3	3	2	2	
Loading Station Subtotal	***9***	***8***	***6***	***6***	***4***	***4***	
Loading Crew Daily Cost	*$10,100*	*$9,200*	*$4,800*	*$4,400*	*$3,900*	*$3,900*	
Flat-bed Drivers to Rail Spur	*9*	*7*	*5*	*4*	*2*	*1*	*Calculated to meet Shipping Capacity*
Flat-bed Drivers to Disposal Facility	*12*	*9*	*6*	*5*	*2*	*2*	*Calculated to meet Shipping Capacity*
			continued				

RIM Loading Rate Assumptions

	1000 LCY/day	800 LCY/day	500 LCY/day	400 LCY/day	150 LCY/day	100 LCY/day
Drivers Subtotal	***21***	***16***	***11***	***9***	***4***	***3***
Crew Total	***30***	***24***	***17***	***15***	***8***	***7***
Superintendent/Coordinator	1	1	1	1	1	1

Unrestrained RIM

	1000 LCY/day	800 LCY/day	500 LCY/day	400 LCY/day	150 LCY/day	100 LCY/day
Workers interacting with unrestrained RIM	*10*	*8*	*5*	*8*	*5*	*4*

Based on the marked (*) crew members. At low throughput rates, assuming the truck drivers assist the loading crew.

Crew Cost Approximations

Crew Type	RS Means	Description	Daily Cost
Laborer	013113200160	Field personnel, general purpose laborer, average	$465
Front End Loader	312316421300	Excavating, bulk bank measure, 3 C.Y. capacity = 130 C.Y./hour, front end loader, track mounted, excluding truck loading	$2,309
Sr. Tech	013113200260	Field personnel, superintendent, average	$670

Appendix K-2

Cost Estimates for the No Action Alternative

DRAFT

Present Worth Cost Estimate
FFS No Action Alternative

Year	*n*	P/F(*i* =7%)	Capital Costs ($): No Action Alternative	Capital Costs ($): Subtotal Capital Costs	Operation, Maintenance, Monitoring, and Periodic Costs ($/yr): Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000							0	0	0	0
2018	1	0.93458							0	0	0	0
2019	2	0.87344							0	0	0	0
2020	3	0.81630							0	0	0	0
2021	4	0.76290						35,000	35,000	35,000	27,000	27,000
2022	5	0.71299							0	0	0	27,000
2023	6	0.66634							0	0	0	27,000
2024	7	0.62275							0	0	0	27,000
2025	8	0.58201							0	0	0	27,000
2026	9	0.54393						35,000	35,000	35,000	19,000	46,000
2027	10	0.50835							0	0	0	46,000
2028	11	0.47509							0	0	0	46,000
2029	12	0.44401							0	0	0	46,000
2030	13	0.41496							0	0	0	46,000
2031	14	0.38782						35,000	35,000	35,000	14,000	60,000
2032	15	0.36245							0	0	0	60,000
2033	16	0.33873							0	0	0	60,000
2034	17	0.31657							0	0	0	60,000
2035	18	0.29586							0	0	0	60,000
2036	19	0.27651						35,000	35,000	35,000	10,000	70,000
2037	20	0.25842							0	0	0	70,000
2038	21	0.24151							0	0	0	70,000
2039	22	0.22571							0	0	0	70,000
2040	23	0.21095							0	0	0	70,000
2041	24	0.19715						35,000	35,000	35,000	7,000	77,000
2042	25	0.18425							0	0	0	77,000
2043	26	0.17220							0	0	0	77,000
2044	27	0.16093							0	0	0	77,000
2045	28	0.15040							0	0	0	77,000
2046	29	0.14056						35,000	35,000	35,000	5,000	82,000
2047	30	0.13137							0	0	0	82,000

Estimated Non-discounted Capital Costs: 0

Estimated Non-discounted Total Costs: 210,000

Estimated 30-year Present Worth Costs: 82,000

Note: For purposes of costing, it is assumed that the 5-year Review periodic costs would be the same as for the ROD-selected Remedy

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and da collected during the engineering design of the remedial alternative. In accordance with USEPA Guidance, this is a order-of-magnitude engineering estimate that is expected to be within -30 to +50 percent of the actual project cos

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Present Worth Cost Estimate
FFS No Action Alternative

			Capital Costs ($)		Operation, Maintenance, Monitoring, and Periodic Costs ($/yr)							
Year	*n*	P/F(*i* =1.5%)	No Action Alternative	Subtotal Capital Costs	Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000							0	0	0	0
2018	1	0.98522							0	0	0	0
2019	2	0.97066							0	0	0	0
2020	3	0.95632							0	0	0	0
2021	4	0.94218						35,000	35,000	35,000	33,000	33,000
2022	5	0.92826							0	0	0	33,000
2023	6	0.91454							0	0	0	33,000
2024	7	0.90103							0	0	0	33,000
2025	8	0.88771							0	0	0	33,000
2026	9	0.87459						35,000	35,000	35,000	31,000	64,000
2027	10	0.86167							0	0	0	64,000
2028	11	0.84893							0	0	0	64,000
2029	12	0.83639							0	0	0	64,000
2030	13	0.82403							0	0	0	64,000
2031	14	0.81185						35,000	35,000	35,000	28,000	92,000
2032	15	0.79985							0	0	0	92,000
2033	16	0.78803							0	0	0	92,000
2034	17	0.77639							0	0	0	92,000
2035	18	0.76491							0	0	0	92,000
2036	19	0.75361						35,000	35,000	35,000	26,000	118,000
2037	20	0.74247							0	0	0	118,000
2038	21	0.73150							0	0	0	118,000
2039	22	0.72069							0	0	0	118,000
2040	23	0.71004							0	0	0	118,000
2041	24	0.69954						35,000	35,000	35,000	24,000	142,000
2042	25	0.68921							0	0	0	142,000
2043	26	0.67902							0	0	0	142,000
2044	27	0.66899							0	0	0	142,000
2045	28	0.65910							0	0	0	142,000
2046	29	0.64936						35,000	35,000	35,000	23,000	165,000
2047	30	0.63976							0	0	0	165,000

Estimated Non-discounted Capital Costs: 0

Estimated Non-discounted Total Costs: 210,000

Estimated 30-year Present Worth Costs: 165,000

Note: For purposes of costing, it is assumed that the 5-year Review periodic costs would be the same as for the ROD-selected Remed

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Present Worth Cost Estimate
FFS No Action Alternative

Year	*n*	P/F(*i* =7%)	Capital Costs ($) No Action Alternative	Capital Costs ($) Subtotal Capital Costs	Operation, Maintenance, Monitoring, and Periodic Costs ($/yr) Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000							0	0	0	0
2018	1	0.93458							0	0	0	0
2019	2	0.87344							0	0	0	0
2020	3	0.81630							0	0	0	0
2021	4	0.76290						35,000	35,000	35,000	27,000	27,000
2022	5	0.71299							0	0	0	27,000
2023	6	0.66634							0	0	0	27,000
2024	7	0.62275							0	0	0	27,000
2025	8	0.58201							0	0	0	27,000
2026	9	0.54393						35,000	35,000	35,000	19,000	46,000
2027	10	0.50835							0	0	0	46,000
2028	11	0.47509							0	0	0	46,000
2029	12	0.44401							0	0	0	46,000
2030	13	0.41496							0	0	0	46,000
2031	14	0.38782						35,000	35,000	35,000	14,000	60,000
2032	15	0.36245							0	0	0	60,000
2033	16	0.33873							0	0	0	60,000
2034	17	0.31657							0	0	0	60,000
2035	18	0.29586							0	0	0	60,000
2036	19	0.27651						35,000	35,000	35,000	10,000	70,000
2037	20	0.25842							0	0	0	70,000
2038	21	0.24151							0	0	0	70,000
2039	22	0.22571							0	0	0	70,000
2040	23	0.21095							0	0	0	70,000
2041	24	0.19715						35,000	35,000	35,000	7,000	77,000
2042	25	0.18425							0	0	0	77,000
2043	26	0.17220							0	0	0	77,000
2044	27	0.16093							0	0	0	77,000
2045	28	0.15040							0	0	0	77,000
2046	29	0.14056						35,000	35,000	35,000	5,000	82,000
2047	30	0.13137							0	0	0	82,000
2216	199	0.0000014						35,000	35,000	35,000	0	94,000
2217	200	0.0000013							0	0	0	94,000

Estimated Non-discounted Capital Costs: 0

Estimated Non-discounted Total Costs: 1,400,000

Estimated 200-year Present Worth Costs: 94,000

Note: For purposes of costing, it is assumed that the 5-year Review periodic costs would be the same as for the ROD-selected Remedy.

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. In accordance with USEPA Guidance, this is an order-of-magnitude engineering estimate that is expected to be within -30 to +50 percent of the actual project cost.

Present Worth Cost Estimate
FFS No Action Alternative

			Capital Costs ($)		Operation, Maintenance, Monitoring, and Periodic Costs ($/yr)							
Year	*n*	P/F(*i* =1.5%)	No Action Alternative	Subtotal Capital Costs	Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000							0	0	0	0
2018	1	0.98522							0	0	0	0
2019	2	0.97066							0	0	0	0
2020	3	0.95632							0	0	0	0
2021	4	0.94218						35,000	35,000	35,000	33,000	33,000
2022	5	0.92826							0	0	0	33,000
2023	6	0.91454							0	0	0	33,000
2024	7	0.90103							0	0	0	33,000
2025	8	0.88771							0	0	0	33,000
2026	9	0.87459						35,000	35,000	35,000	31,000	64,000
2027	10	0.86167							0	0	0	64,000
2028	11	0.84893							0	0	0	64,000
2029	12	0.83639							0	0	0	64,000
2030	13	0.82403							0	0	0	64,000
2031	14	0.81185						35,000	35,000	35,000	28,000	92,000
2032	15	0.79985							0	0	0	92,000
2033	16	0.78803							0	0	0	92,000
2034	17	0.77639							0	0	0	92,000
2035	18	0.76491							0	0	0	92,000
2036	19	0.75361						35,000	35,000	35,000	26,000	118,000
2037	20	0.74247							0	0	0	118,000
2038	21	0.73150							0	0	0	118,000
2039	22	0.72069							0	0	0	118,000
2040	23	0.71004							0	0	0	118,000
2041	24	0.69954						35,000	35,000	35,000	24,000	142,000
2042	25	0.68921							0	0	0	142,000
2043	26	0.67902							0	0	0	142,000
2044	27	0.66899							0	0	0	142,000
2045	28	0.65910							0	0	0	142,000
2046	29	0.64936						35,000	35,000	35,000	23,000	165,000
2047	30	0.63976							0	0	0	165,000
2216	199	0.05167						35,000	35,000	35,000	2,000	437,000
2217	200	0.05091							0	0	0	437,000

Estimated Non-discounted Capital Costs: 0

Estimated Non-discounted Total Costs: 1,400,000

Estimated 200-year Present Worth Costs: 437,000

Note: For purposes of costing, it is assumed that the 5-year Review periodic costs would be the same as for the ROD-selected Remedy.

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Present Worth Cost Estimate
FFS No Action Alternative

			Capital Costs ($)		Operation, Maintenance, Monitoring, and Periodic Costs ($/yr)							
Year	*n*	P/F(*i* =7%)	No Action Alternative	Subtotal Capital Costs	Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000							0	0	0	0
2018	1	0.93458							0	0	0	0
2019	2	0.87344							0	0	0	0
2020	3	0.81630							0	0	0	0
2021	4	0.76290						35,000	35,000	35,000	27,000	27,000
2022	5	0.71299							0	0	0	27,000
2023	6	0.66634							0	0	0	27,000
2024	7	0.62275							0	0	0	27,000
2025	8	0.58201							0	0	0	27,000
2026	9	0.54393						35,000	35,000	35,000	19,000	46,000
2027	10	0.50835							0	0	0	46,000
2028	11	0.47509							0	0	0	46,000
2029	12	0.44401							0	0	0	46,000
2030	13	0.41496							0	0	0	46,000
2031	14	0.38782						35,000	35,000	35,000	14,000	60,000
2032	15	0.36245							0	0	0	60,000
2033	16	0.33873							0	0	0	60,000
2034	17	0.31657							0	0	0	60,000
2035	18	0.29586							0	0	0	60,000
2036	19	0.27651						35,000	35,000	35,000	10,000	70,000
2037	20	0.25842							0	0	0	70,000
2038	21	0.24151							0	0	0	70,000
2039	22	0.22571							0	0	0	70,000
2040	23	0.21095							0	0	0	70,000
2041	24	0.19715						35,000	35,000	35,000	7,000	77,000
2042	25	0.18425							0	0	0	77,000
2043	26	0.17220							0	0	0	77,000
2044	27	0.16093							0	0	0	77,000
2045	28	0.15040							0	0	0	77,000
2046	29	0.14056						35,000	35,000	35,000	5,000	82,000
2047	30	0.13137							0	0	0	82,000
3016	999	4.422E-30						35,000	35,000	35,000	0	94,000
3017	1000	4.133E-30							0	0	0	94,000

Estimated Non-discounted Capital Costs: 0

Estimated Non-discounted Total Costs: 7,000,000

Estimated 1,000-year Present Worth Costs: 94,000

Note: For purposes of costing, it is assumed that the 5-year Review periodic costs would be the same as for the ROD-selected Remedy.

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. In accordance with USEPA Guidance, this is an order-of-magnitude engineering estimate that is expected to be within -30 to +50 percent of the actual project cost.

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Present Worth Cost Estimate
FFS No Action Alternative

			Capital Costs ($)		Operation, Maintenance, Monitoring, and Periodic Costs ($/yr)							
Year	*n*	P/F(*i* =1.5%)	No Action Alternative	Subtotal Capital Costs	Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000							0	0	0	0
2018	1	0.98522							0	0	0	0
2019	2	0.97066							0	0	0	0
2020	3	0.95632							0	0	0	0
2021	4	0.94218						35,000	35,000	35,000	33,000	33,000
2022	5	0.92826							0	0	0	33,000
2023	6	0.91454							0	0	0	33,000
2024	7	0.90103							0	0	0	33,000
2025	8	0.88771							0	0	0	33,000
2026	9	0.87459						35,000	35,000	35,000	31,000	64,000
2027	10	0.86167							0	0	0	64,000
2028	11	0.84893							0	0	0	64,000
2029	12	0.83639							0	0	0	64,000
2030	13	0.82403							0	0	0	64,000
2031	14	0.81185						35,000	35,000	35,000	28,000	92,000
2032	15	0.79985							0	0	0	92,000
2033	16	0.78803							0	0	0	92,000
2034	17	0.77639							0	0	0	92,000
2035	18	0.76491							0	0	0	92,000
2036	19	0.75361						35,000	35,000	35,000	26,000	118,000
2037	20	0.74247							0	0	0	118,000
2038	21	0.73150							0	0	0	118,000
2039	22	0.72069							0	0	0	118,000
2040	23	0.71004							0	0	0	118,000
2041	24	0.69954						35,000	35,000	35,000	24,000	142,000
2042	25	0.68921							0	0	0	142,000
2043	26	0.67902							0	0	0	142,000
2044	27	0.66899							0	0	0	142,000
2045	28	0.65910							0	0	0	142,000
2046	29	0.64936						35,000	35,000	35,000	23,000	165,000
2047	30	0.63976							0	0	0	165,000
2048	31	0.63031							0	0	0	165,000
3016	999	3.471E-07						35,000	35,000	35,000	0	456,000
3017	1000	3.419E-07							0	0	0	456,000

Estimated Non-discounted Capital Costs: 0

Estimated Non-discounted Total Costs: 7,000,000

Estimated 1,000-year Present Worth Costs: 456,000

Note: For purposes of costing, it is assumed that the 5-year Review periodic costs would be the same as for the ROD-selected Remedy.

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. In accordance with USEPA Guidance, this is an order-of-magnitude engineering estimate that is expected to be within -30 to +50 percent of the actual project cost.

Appendix K-3

Cost Estimates for the ROD-Selected Remedy

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Preliminary Estimated Capital Costs
FFS ROD Remedy Alternative

Cost Item			Estimated Capital Costs
Construction Costs		$	41,600,000
Radiological Survey/H&S Support Costs		$	1,871,000
Long-Term Monitoring Facilities		$	211,000
Post Construction Radon Flux Monitoring		$	26,000
Stormwater Monitoring during Construction		$	84,000
Air Monitoring during Construction		$	315,000
Institutional Controls		$	50,000
Subtotal		$	44,160,000
Project Management	5%	$	2,208,000
Engineering Design	6%	$	2,650,000
Construction Management	6%	$	2,650,000
Subtotal Construction On-Site		$	51,670,000
Scope Contingency	10%	$	5,167,000
Bid Contingency	20%	$	10,334,000
Subtotal Contingency		$	15,500,000
Total: ROD Remedy		$	67,000,000

Estimated Length Construction	3/5/18	start
	10/31/19	end
	605	no. Days
	1.7	no. Years
	7	no. Quarters

Construction Cost Estimate - ROD Remedy

Step #	Category	Sub-Category	Task	Quantity Area 1	Quantity Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Construction Days Area 1	Construction Days Area 2	Crew Man-days Area 1	Crew Man-days Area 2	Unit Costs Ext. Mat. O&P	Ext. Labor, O&P	Ext. Labor, O&P Ineff.	Ext. Equip, O&P	Ext. Equip, O&P Ineff.	Ext. Total, O&P	Bridgeton Taxes Area 1	Bridgeton Taxes Area 2	Total Cost Area 1	Total Cost Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Delivery Miles Area 1	Total Delivery Miles Area 2
ROD 1	Temporary Construction Facilitities / Utilities / Personnel	Construction Trailers	Capital Expenses	2	-	Group of Trailers		See separate Assumptions sheet								25.0	-	39.2	-	$ -					$ 106,698.53	$ -	$ -	$ 213,397	$ -	10	-	200	-
ROD 2			Operating Expenses	24	-	Group of Trailers	Months	See separate Assumptions sheet												$ -					$ 2,786.52	$ -	$ -	$ 66,418	$ -				
ROD 3			Parking Area	4,444	-	Gravel Area	S.Y.	RS Means, Year 2016 Quarter 1	015523500050	Temporary, roads, gravel fill, 4" gravel depth, excl surfacing	B14	715	6.0	1.0	100%	6.2	-	37.3	-	$ 4.10	$ 4.35	$ -	$ 0.63	$ -	$ 9.08	$ 1,524	$ -	$ 41,879	$ -				
ROD 4			Portable Toilets in Construction Areas	12	20	Portable Toilets	Month	RS Means, Year 2016 Quarter 1	015433406420	Rent portable toilet chemical, recycle, flush type, Incl. Hourly Oper. Cost.					100%					$ -	$ -	$ -	$ 317.05	$ -	$ 317.05	$ -	$ -	$ 3,942	$ 6,285				
ROD 5		Contractor's Construction Management Personnel	Project Manager	86	-	Personnel	Week	RS Means, Year 2016 Quarter 1	013113200220	Field personnel, project manager, maximum		0	1.0	1.0	100%	414.4	-	414.4	-	$ -	$ 4,100.00	$ -	$ -	$ -	$ 4,100.00	$ -	$ -	$ 354,600	$ -				
ROD 6			Construction Superintendent(s)	104	-	Personnel	Week	RS Means, Year 2016 Quarter 1	013113200260	Field personnel, superintendent, average		0	1.0	1.0	100%	496.6	-	496.6	-	$ -	$ 3,350.00	$ -	$ -	$ -	$ 3,350.00	$ -	$ -	$ 347,202	$ -				
ROD 7			Clerk(s)	104	-	Personnel	Week	RS Means, Year 2016 Quarter 1	013113200020	Field personnel, clerk, average		0	1.0	1.0	100%	496.6	-	496.6	-	$ -	$ 710.00	$ -	$ -	$ -	$ 710.00	$ -	$ -	$ 73,586	$ -				
ROD 8			Field Engineer(s) / Safety Officer(s)	104	-	Personnel	Week	RS Means, Year 2016 Quarter 1	013113200120	Field personnel, field engineer, average		0	1.0	1.0	100%	496.6	-	496.6	-	$ -	$ 2,200.00	$ -	$ -	$ -	$ 2,200.00	$ -	$ -	$ 228,013	$ -				
ROD 9	Temporary Stormwater Infrastructure (for stormwater during construction)	Frac Tanks	Delivery	58	58	Frac Tanks	Ea.	See separate Assumptions sheet				3	2.0	2.0	100%	9.7	9.7	38.7	38.7	$ -	$ 200.00	$ -		$ -	$ 200.00	$ -	$ -	$ 11,600	$ 11,600	58	58	3,480	3,480
ROD 10			Monthly Rental	120	360	Frac Tanks	Month	See separate Assumptions sheet							100%					$ 852.25		$ -		$ -	$ 852.25	$ 8,562	$ 25,687	$ 110,944	$ 332,833				
ROD 11			Cleaning	58	58	Frac Tanks	Ea.	See separate Assumptions sheet				1	2.0	1.0	100%	58.0	58.0	116.0	116.0	$ -	$ 1,500.00	$ -		$ -	$ 1,500.00	$ -	$ -	$ 87,000	$ 87,000				
ROD 12			Removal	58	58	Frac Tanks	Ea.	See separate Assumptions sheet				3	2.0	2.0	100%	9.7	9.7	38.7	38.7	$ -	$ 200.00	$ -		$ -	$ 200.00	$ -	$ -	$ 11,600	$ 11,600	58	58	3,480	3,480
ROD 13		Forcemain	Install forcemain from Excavation Area to Tank Area	4,500	7,000	HDPE Pipe	L.F.	RS Means, Year 2016 Quarter 1	331113350100	Water supply distribution piping, piping HDPE, butt fusion joints, 40' lengths, 4" diameter, SDR 21	B22A	400	5.0	1.0	100%	11.3	17.5	56.3	87.5	$ 2.61	$ 7.12	$ -	$ 2.05	$ -	$ 11.78	$ 982	$ 1,528	$ 53,992	$ 83,988				
ROD 14			Install forcemain from Tank Area to Treatment Plant and Discharge Point	500	500	HDPE Pipe	L.F.	RS Means, Year 2016 Quarter 1	331113350100	Water supply distribution piping, piping HDPE, butt fusion joints, 40' lengths, 4" diameter, SDR 21	B22A	400	5.0	1.0	100%	1.3	1.3	6.3	6.3	$ 2.61	$ 7.12	$ -	$ 2.05	$ -	$ 11.78	$ 109	$ 109	$ 5,999	$ 5,999				
ROD 15			Install forcemain valves	6	8	Pipe Valves	Ea.	RS Means, Year 2016 Quarter 1	220523601310	Valves, plastic, PVC, ball, true union, socket or threaded, 4"	Q1	20	2.0	1.0	100%	0.3	0.4	0.6	0.8	$ 472.63	$ 68.18	$ -	$ -	$ -	$ 540.81	$ 237	$ 316	$ 3,482	$ 4,643				
ROD 16		Treatment Facility	Construct Treatment Facility	1	-	Treatment Facility	Each	See separate Assumptions sheet				0	2.0	1.0	100%	15.0	-	30.0	-	$ 71,000.00					$ 102,000.00	$ 5,938	$ -	$ 107,938	$ -				
ROD 17			Treatment Facility Demolition	1	-	Treatment Facility	Each	See separate Assumptions sheet				0	9.2	1.0	100%	2.1	-	19.0	-	$ 4,000.00					$ 27,000.00	$ 335	$ -	$ 27,335	$ -				
ROD 18			Monthly Rent	7	-	Treatment Facility Operation	Months	See separate Assumptions sheet							100%					$ 2,800.00					$ 2,800.00	$ 1,639	$ -	$ 21,239	$ -				
ROD 19			Monthly Operation during remediation	6	-	Treatment Facility Operation	Months	See separate Assumptions sheet				0	1.0	1.0	100%	31.6	-	31.6	-	$ 4,270.68					$ 4,270.68	$ 2,219	$ -	$ 28,756	$ -				
ROD 20		Stormwater events during construction	Dewater construction after rain events	17	157	Days of Pumping Construction Stormwater	Day	RS Means, Year 2016 Quarter 1	312319200650	Dewatering, pumping 8 hours, attended 2 hrs per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose	B10I	4	1.5	4.0	100%	1.1	9.8	6.5	58.8	$ -	$ 201.71	$ -	$ 38.99	$ -	$ 240.70	$ -	$ -	$ 4,159	$ 37,737				
ROD 21			Dispose of contact stormwater to MSD	110,000	320,000	Contact Stormwater	Gallons	St. Louis Sewer District, May 2011							100%					$ -					$ 0.14	$ -	$ -	$ 15,400	$ 44,800				
ROD 22	Leachate Handling	Frac Tanks	Delivery	16	20	Frac Tanks	Ea.	See separate Assumptions sheet				3	2.0	2.0	100%	2.7	3.3	10.7	13.3	$ -	$ 200.00	$ -		$ -	$ 200.00	$ -	$ -	$ 3,200	$ 4,000	16	20	960	1,200
ROD 23			Monthly Rental (or Purchase)	23	97	Frac Tanks	Month	See separate Assumptions sheet							100%					$ 852.25		$ -		$ -	$ 852.25	$ 1,650	$ 6,936	$ 21,375	$ 89,873				
ROD 24			Cleaning	16	20	Frac Tanks	Ea.	See separate Assumptions sheet				1	2.0	1.0	100%	16.0	20.0	32.0	40.0	$ -	$ 1,500.00	$ -		$ -	$ 1,500.00	$ -	$ -	$ 24,000	$ 30,000				
ROD 25			Removal	16	20	Frac Tanks	Ea.	See separate Assumptions sheet				3	2.0	2.0	100%	2.7	3.3	10.7	13.3	$ -	$ 200.00	$ -		$ -	$ 200.00	$ -	$ -	$ 3,200	$ 4,000	16	20	960	1,200
ROD 26		Secondary Containment for Frac Tanks	Purchase and deliver liner & berm material	1,762	2,178	Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	354113200040	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	41.4	100%	0.7	0.9	30.4	37.6	$ 26.69	$ -	$ -	$ -	$ -	$ 26.69	$ 3,932	$ 4,862	$ 50,949	$ 63,005	147	182	5,880	7,280
ROD 27			Spread loose lift before compaction	1,762	2,178	Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	2.1	100%	0.8	1.0	2.6	3.3	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ 4,474	$ 5,533				
ROD 28			Compact Liner & Berms	1,258	1,556	Clay	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235640	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	1,300	1.5	2.0	100%	0.5	0.6	1.5	1.8	$ -	$ 0.62	$ -	$ 1.15	$ -	$ 1.77	$ -	$ -	$ 2,227	$ 2,754				
ROD 29		Leachate Storage & Testing	Pumping from Excavation Site	1	1	Leachate	Day	RS Means, Year 2016 Quarter 1	312319200650	Dewatering, pumping 8 hours, attended 2 hrs per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose	B10I	4	1.5	1.0	100%	0.1	0.3	0.2	0.5	$ -	$ 201.71	$ -	$ 38.99	$ -	$ 240.70	$ -	$ -	$ 130	$ 299				
ROD 30			Move Tank from Tank Area to Excavation Site	6	12	Tanks	Ea.	See separate Assumptions sheet				4	2.0	1.0	100%	1.5	3.0	3.0	6.0	$ -	$ 70.00	$ -	$ 70.00	$ -	$ 140.00	$ -	$ -	$ 840	$ 1,680				
ROD 31			Leachate Sampling	6	12	Lab Tests	Ea.	RS Means, Year 2016 Quarter 1	029110100100	Field testing equipment, sampling & testing soil/sediment, sample collection, field samples, sludge	1 Skwk	32	1.0	1.0	100%	0.2	0.4	0.2	0.4	$ -	$ 20.28	$ -	$ -	$ -	$ 20.28	$ -	$ -	$ 122	$ 243				

Construction Cost Estimate - ROD Remedy

Step #	Category	Sub-Category	Task	Quantity Area 1	Quantity Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Construction Days Area 1	Construction Days Area 2	Crew Man-days Area 1	Crew Man-days Area 2	Unit Costs Ext. Mat. O&P	Ext. Labor, O&P	Ext. Labor, O&P Ineff.	Ext. Equip, O&P	Ext. Equip, O&P Ineff.	Ext. Total, O&P	Bridgeton Taxes Area 1	Bridgeton Taxes Area 2	Total Cost Area 1	Total Cost Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Delivery Miles Area 1	Total Delivery Miles Area 2
ROD 32			Leachate Testing - VOC's	6	12	Lab Tests	Ea.	RS Means, Year 2016 Quarter 1	029110100600	Laboratory analytical services, laboratory testing, volatile organics without GC/MS					100%					$ 173.20	$ -	$ -	$ -	$ -	$ 173.20	$ 87	$ 174	$ 1,126	$ 2,252				
ROD 33			Hauling and Disposal	103,306	238,865	Leachate	Gallons	See separate Assumptions sheet			B34B	5,000	1.0	2	100%	10.3	23.9	20.7	47.8	$ -	$ 0.28	$ -	$ 0.28	$ -	$ 0.57	$ -	$ -	$ 58,781	$ 135,914	21	48	12,600	28,800
ROD 34			Budget for Contaminated Stormwater Prevention or Disposal	1	5	Budget	Months	Budgeted Monthly Amount							100%					$ 10,000.00		$ -		$ -	$ 10,000.00	$ 1,210	$ 4,069	$ 15,676	$ 52,727				
ROD 35	Site-wide Preparation	Mobilization	Mobilize and Demobilize Equipment by Pickup Truck	16	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501200	Mobilization or demobilization, delivery charge for small equipment, placed in rear of, or towed by pickup truck	A3A	4	1.0	1.0	100%	4.0	-	4.0	-	$ -	$ 157.34	$ -	$ 48.59	$ -	$ 205.93	$ -	$ -	$ 3,295	$ -				
ROD 36			Extra Mileage for Mobilizations	240	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501200A	Mobilization or demobilization, each additional 5 miles haul distance, add	A3A	72	1.0	1.0	100%	3.3	-	3.3	-	$ -	$ 15.73	$ -	$ 4.86	$ -	$ 20.59	$ -	$ -	$ 4,942	$ -				
ROD 37			Mobilize and Demobilize Equipment by 3-Ton Trailer	6	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501300	Mobilization or demobilization, delivery charge for equipment, hauled on 3-ton capacity towed trailer	A3Q	3	1.0	1.0	100%	2.2	-	2.2	-	$ -	$ 235.49	$ -	$ 84.19	$ -	$ 319.68	$ -	$ -	$ 1,918	$ -				
ROD 38			Extra Mileage for Mobilizations	90	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501300A	Mobilization or demobilization, each additional 5 miles haul distance, add	A3Q	72	1.0	1.0	100%	1.3	-	1.3	-	$ -	$ 23.55	$ -	$ 8.42	$ -	$ 31.97	$ -	$ -	$ 2,877	$ -				
ROD 39			Mobilize and Demobilize Equipment by 20-Ton Trailer	32	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501400	Mobilization or demobilization, delivery charge for equipment, hauled on 20-ton capacity towed trailer	B34U	2	2.0	3.0	100%	5.3	-	32.0	-	$ -	$ 591.36	$ -	$ 293.80	$ -	$ 885.16	$ -	$ -	$ 28,325	$ -				
ROD 40		Mobilization (cont.)	Extra Mileage for Mobilizations	480	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501400A	Mobilization or demobilization, each additional 5 miles haul distance, add	B34U	72	2.0	3.0	100%	2.2	-	13.3	-	$ -	$ 59.14	$ -	$ 29.38	$ -	$ 88.52	$ -	$ -	$ 42,490	$ -				
ROD 41			Mobilize and Demobilize Equipment by 40-Ton Trailer	46	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501500	Mobilization or demobilization, delivery charge for equipment, hauled on 40-ton capacity towed trailer	B34N	2	2.0	4.0	100%	5.8	-	46.0	-	$ -	$ 601.92	$ -	$ 468.95	$ -	$ 1,070.87	$ -	$ -	$ 49,260	$ -				
ROD 42			Extra Mileage for Mobilizations	690	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501500A	Mobilization or demobilization, each additional 5 miles haul distance, add	B34N	72	2.0	4.0	100%	2.4	-	19.2	-	$ -	$ 60.19	$ -	$ 46.90	$ -	$ 107.09	$ -	$ -	$ 73,892	$ -				
ROD 43			Mobilize and Demobilize Crane Equipment (more than 75 tons)	2	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501800	Mobilization or demobilization, crane, truck-mounted, over 75 ton, (with chase vehicle)	A3E	3	2.0	1.0	100%	0.8	-	1.6	-	$ -	$ 485.76	$ -	$ 77.97	$ -	$ 563.73	$ -	$ -	$ 1,127	$ -				
ROD 44			Extra Mileage for Mobilizations	30	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501800A	Mobilization or demobilization, each additional 5 miles haul distance, add	A3E	72	2.0	1.0	100%	0.4	-	0.8	-	$ -	$ 48.58	$ -	$ 7.80	$ -	$ 56.38	$ -	$ -	$ 1,691	$ -				
ROD 45			Mobilize and Demobilize Equipment by Pickup Truck	16	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501200	Mobilization or demobilization, delivery charge for small equipment, placed in rear of, or towed by pickup truck	A3A	4	1.0	1.0	100%	4.0	-	4.0	-	$ -	$ 157.34	$ -	$ 48.59	$ -	$ 205.93	$ -	$ -	$ 3,295	$ -				
ROD 46			Extra Mileage for Mobilizations	240	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501200A	Mobilization or demobilization, each additional 5 miles haul distance, add	A3A	72	1.0	1.0	100%	3.3	-	3.3	-	$ -	$ 15.73	$ -	$ 4.86	$ -	$ 20.59	$ -	$ -	$ 4,942	$ -				
ROD 47	Site-wide Preparation (cont.)		Mobilize and Demobilize Equipment by 3-Ton Trailer	6	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501300	Mobilization or demobilization, delivery charge for equipment, hauled on 3-ton capacity towed trailer	A3Q	3	1.0	1.0	100%	2.2	-	2.2	-	$ -	$ 235.49	$ -	$ 84.19	$ -	$ 319.68	$ -	$ -	$ 1,918	$ -				
ROD 48			Extra Mileage for Mobilizations	90	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501300A	Mobilization or demobilization, each additional 5 miles haul distance, add	A3Q	72	1.0	1.0	100%	1.3	-	1.3	-	$ -	$ 23.55	$ -	$ 8.42	$ -	$ 31.97	$ -	$ -	$ 2,877	$ -				
ROD 49		Supplemental Mobilizations	Mobilize and Demobilize Equipment by 20-Ton Trailer	32	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501400	Mobilization or demobilization, delivery charge for equipment, hauled on 20-ton capacity towed trailer	B34U	2	2.0	3.0	100%	5.3	-	32.0	-	$ -	$ 591.36	$ -	$ 293.80	$ -	$ 885.16	$ -	$ -	$ 28,325	$ -				
ROD 50			Extra Mileage for Mobilizations	480	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501400A	Mobilization or demobilization, each additional 5 miles haul distance, add	B34U	72	2.0	3.0	100%	2.2	-	13.3	-	$ -	$ 59.14	$ -	$ 29.38	$ -	$ 88.52	$ -	$ -	$ 42,490	$ -				
ROD 51			Mobilize and Demobilize Equipment by 40-Ton Trailer	46	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501500	Mobilization or demobilization, delivery charge for equipment, hauled on 40-ton capacity towed trailer	B34N	2	2.0	4.0	100%	5.8	-	46.0	-	$ -	$ 601.92	$ -	$ 468.95	$ -	$ 1,070.87	$ -	$ -	$ 49,260	$ -				
ROD 52			Extra Mileage for Mobilizations	690	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501500A	Mobilization or demobilization, each additional 5 miles haul distance, add	B34N	72	2.0	4.0	100%	2.4	-	19.2	-	$ -	$ 60.19	$ -	$ 46.90	$ -	$ 107.09	$ -	$ -	$ 73,892	$ -				
ROD 53			Mobilize and Demobilize Crane Equipment (more than 75 tons)	2	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501800	Mobilization or demobilization, crane, truck-mounted, over 75 ton, (with chase vehicle)	A3E	3	2.0	1.0	100%	0.8	-	1.6	-	$ -	$ 485.76	$ -	$ 77.97	$ -	$ 563.73	$ -	$ -	$ 1,127	$ -				
ROD 54			Extra Mileage for Mobilizations	30	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501800A	Mobilization or demobilization, each additional 5 miles haul distance, add	A3E	72	2.0	1.0	100%	0.4	-	0.8	-	$ -	$ 48.58	$ -	$ 7.80	$ -	$ 56.38	$ -	$ -	$ 1,691	$ -				
ROD 55			Create Temporary Roads	6,667	13,333	Gravel Roads	S.Y.	RS Means, Year 2016 Quarter 1	015523500050	Temporary, roads, gravel fill, 4" gravel depth, excl surfacing	B14	715	6.0	1.0	100%	9.3	18.6	55.9	111.9	$ 4.10	$ 4.35	$ -	$ 0.63	$ -	$ 9.08	$ 2,286	$ 4,572	$ 62,819	$ 125,638				
ROD 56			Budget for Add'l Traffic Improvements	108,000	108,000	TBD (shown as budget estimate)	$	SFS budget (plus inflation)							100%	10.0	10.0	-	-	$ 1.00					$ 1.00	$ 9,032	$ 9,032	$ 117,032	$ 117,032				
ROD 57			Water Truck Depreciation	1	1	Water Trucks	Trucks	Estimate												$ 55,000.00					$ 55,000.00	$ 4,600	$ 4,600	$ 59,600	$ 59,600				
ROD 58			Water Truck Operation	12	18	Water Trucks	Months	Estimate				0	1.0	1.0	100%	357.2	557.4	357.2	557.4	$ -					$ 19,790.74	$ -	$ -	$ 232,284	$ 362,415				
ROD 59		Dust Control	Use Water to Control Dust	5,358,668	8,360,723	Water	Gallons	Missouri American Water Company, 7/19/2016							100%					$ -					$ 0.0034	$ -	$ -	$ 18,219	$ 28,426				
ROD 60			Prepare area with Stormwater BMPs	4,883	7,495	Erosion Control Measures	L.F.	RS Means, Year 2016 Quarter 1	312514161250	Synthetic erosion control, hay bales, staked	A2	2,500	3.0	1.0	100%	2.0	3.0	5.9	9.0	$ 3.56	$ 0.54	$ -	$ 0.12	$ -	$ 4.22	$ 1,454	$ 2,231	$ 22,060	$ 33,860				
ROD 61			Floor	56	56	Concrete	C.Y.	RS Means, Year 2016 Quarter 1	033113350300	Structural concrete, ready mix, heavyweight, 4000 psi, includes local aggregate, sand, Portland cement (Type I) and water, delivered, excludes all additives and treatments					100%					$ 113.96	$ -	$ -	$ -	$ -	$ 113.96	$ 529	$ 529	$ 6,861	$ 6,861				
ROD 62		Decontamination Area	Floor Installation	56	56	Concrete	C.Y.	RS Means, Year 2016 Quarter 1	033113704650	Structural concrete, placing, slab on grade, pumped, over 6" thick, includes leveling (strike off) & consolidation, excludes material	C20	185	8.0	1.0	100%	0.3	0.3	2.4	2.4	$ -	$ 22.40	$ -	$ 5.31	$ -	$ 27.71	$ -	$ -	$ 1,539	$ 1,539				

Construction Cost Estimate - ROD Remedy

Step #	Category	Sub-Category	Task	Quantity Area 1	Quantity Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor
ROD 63	Site Preparation		Building	1,000	1,000	Steel Building	SF Flr.	RS Means, Year 2016 Quarter 1	133419500170	Pre-engineered steel building, clear span rigid frame, 30 psf roof and 20 psf wind load, 20' to 29' W x 16' eave H, incl. 26 ga. colored ribbed roofing & siding, excl. footings, slab, anchor bolts	E2	320	7.0	1.0	100%
ROD 64		Clearing & Grubbing	Clear Vegetation (Light)	0	3	Vegetation	Acre	RS Means, Year 2016 Quarter 1	311313101020	Selective tree and shrub removal, selective clearing brush mowing, light density, tractor with rotary mower, excludes removal offsite	B84	2	1.0	1.0	100%
ROD 65			Clear Vegetation (Heavy)	8	15	Vegetation	Acre	RS Means, Year 2016 Quarter 1	311110100020	Clearing & grubbing, cut & chip light trees, to 6" diameter	B7	1	6.0	1.0	100%
ROD 66			Clear Small Trees	117	355	Trees	Ea.	RS Means, Year 2016 Quarter 1	311313201650	Selective felling trees and piling, large tract clearing & piling, firm level terrain, no boulders, hardwood, per tree, 300 H.P. dozer, 12" to 24" diameter	B10M	80	1.5	8.0	100%
ROD 67			Clear Large Trees	33	98	Trees	Ea.	RS Means, Year 2016 Quarter 1	311313201750	Selective felling trees and piling, large tract clearing & piling, firm level terrain, no boulders, hardwood, per tree, 300 H.P. dozer, 24" to 36" diameter	B10M	50	1.5	4.0	100%
ROD 68	Site Preparation (cont.)	Clearing & Grubbing (cont.)	Clear Small Stumps	117	355	Trees	Ea.	RS Means, Year 2016 Quarter 1	311313202100	Selective clearing and grubbing, 1-1/2 C.Y. excavator, 14" to 24" diameter, stump removal on site by hydraulic excavator	B30	25	3.0	1.0	100%
ROD 69			Clear Large Stumps	33	98	Trees	Ea.	RS Means, Year 2016 Quarter 1	311313202150	Selective clearing and grubbing, 1-1/2 C.Y. excavator, 26" to 36" diameter, stump removal on site by hydraulic excavator	B30	16	3.0	1.0	100%
ROD 70		Bird Mitigation	Average Monthly Expense	2	6	Months	Months	See separate Assumptions sheet			Bird Mitigation Crew	0.03	1.0	1.0	100%
ROD 71	Regrading	C&D Rubble Stockpiles	Relocate Stockpiled Material on-site - Excavate	7,794	33,469	C&D Rubble	B.C.Y.	RS Means, Year 2016 Quarter 1	312316305000	Drilling and blasting rock, less than 0.5 C.Y., excavate and load boulders	B10T	80	1.5	10.0	100%
ROD 72			Relocate Stockpiled Material on-site - Haul and Dump	7,794	33,469	C&D Rubble	B.C.Y.	RS Means, Year 2016 Quarter 1	312316305400	Drilling and blasting rock, 25 ton off-highway dump, 1 mile round trip, haul boulders	B34E	330	1.0	5.3	100%
ROD 73			Bury Stockpiled Material	7,794	33,469	C&D Rubble	B.C.Y.	RS Means, Year 2016 Quarter 1	312316305620	Drilling and blasting rock, 300 H.P. dozer, less than 0.5 C.Y., 150' haul, bury boulders on site	B10M	310	1.5	12.0	100%
ROD 74		General Waste	Apply daily cover to remaining excavation of Landfilled Material	2,557	5,913	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Soils for earthwork, common borrow, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15/B34B	600	7.4	1.0	100%
ROD 75			Relocate Landfilled Material on-site - Excavate	28,132	65,046	RAD Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%
ROD 76			(additional cost to previous line)	28,132	65,046	RAD Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%
ROD 77			Relocate Landfilled Material on-site - Haul and Dump	40,919	94,612	RAD Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205060	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2000 ft, 10 MPH, excludes loading equipment	B34F	594	1.0	3.5	100%
ROD 78			Apply daily cover to relocated Landfilled Material	2,557	5,913	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Soils for earthwork, common borrow, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15/B34B	600	7.4	1.0	100%
ROD 79			Spread Landfilled Material	43,476	100,526	RAD Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	10.0	100%
ROD 80			Compact Landfilled Material	30,689	70,959	RAD Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	1.0	100%
ROD 81	Buffer Zone		Buffer Zone Activity	-	1	See separate Assumptions sheet		See separate Assumptions sheet						1.0	100%
ROD 82		Starter Berms	Purchase and deliver material	7,503	55,519	Riprap	Ton	RS Means, Year 2016 Quarter 1	313713100350	Rip-rap and rock lining, random, broken stone, 100 lb. average, dumped	B11A	700	2.0	8.0	100%
ROD 83			Spread loose lift before compaction	4,502	33,311	Riprap	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	4.0	100%
ROD 84			Special grading for steep slopes	1,989	12,806	Riprap	S.Y.	RS Means, Year 2016 Quarter 1	312216103310	Fine grading, slopes, steep, finish grading	B11L	7,100	2.0	1.0	100%
ROD 85			Compact starter berms	3,751	27,759	Riprap	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235060	Compaction, riding, vibrating roller, 2 passes, 12" lifts	B10Y	5,200	1.5	2.0	100%
ROD 86			Purchase and Spread Bio-Intrusion Layer Material	79,145	239,357	4-in Minus Aggregate	L.C.Y.	RS Means, Year 2016 Quarter 1	310516100300	Aggregate for earthwork, crushed stone, 1.40 tons per C.Y., 1-1/2", spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	12.0	100%
ROD 87			Deliver Bio-Intrusion Layer Material	102,888	311,164	4-in Minus Aggregate (per Hauling Increment)	L.C.Y.	RS Means, Year 2016 Quarter 1	310516100900	Aggregate for earthwork, aggregate or sand, spread with 200 HP dozer, includes load at pit and haul, round trip, for 5 mile haul add	B34B	200	1.0	23.6	100%
ROD 88			Compact Bio-Intrusion Layer Material	47,966	145,065	4-in Minus Aggregate	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235060	Compaction, riding, vibrating roller, 2 passes, 12" lifts	B10Y	5,200	1.5	2.0	100%

Step #	Construction Days Area 1	Construction Days Area 2	Crew Man-days Area 1	Crew Man-days Area 2	Unit Costs: Ext. Mat, O&P	Ext. Labor, O&P	Ext. Labor, O&P Ineff.	Ext. Equip, O&P	Ext. Equip, O&P Ineff.	Ext. Total, O&P	Bridgeton Taxes Area 1	Bridgeton Taxes Area 2	Total Cost Area 1	Total Cost Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Delivery Miles Area 1	Total Delivery Miles Area 2
ROD 63	3.1	3.1	21.9	21.9	$ 10.54	$ 15.61	$ -	$ 5.93	$ -	$ 32.08	$ 881	$ 881	$ 32,961	$ 32,961				
ROD 64	0.1	1.3	0.1	1.3	$ -	$ 296.36	$ -	$ 229.39	$ -	$ 525.75	$ -	$ -	$ 110	$ 1,383				
ROD 65	8.5	15.3	50.9	91.7	$ -	$ 2,844.10	$ -	$ 2,090.50	$ -	$ 4,934.60	$ -	$ -	$ 41,895	$ 75,450				
ROD 66	0.2	0.6	2.2	6.7	$ -	$ 10.18	$ -	$ 29.38	$ -	$ 39.56	$ -	$ -	$ 4,629	$ 14,044				
ROD 67	0.2	0.5	1.0	2.9	$ -	$ 16.25	$ -	$ 46.90	$ -	$ 63.15	$ -	$ -	$ 2,084	$ 6,189				
ROD 68	4.7	14.2	14.0	42.6	$ -	$ 63.57	$ -	$ 119.78	$ -	$ 183.35	$ -	$ -	$ 21,452	$ 65,089				
ROD 69	2.1	6.1	6.2	18.4	$ -	$ 99.42	$ -	$ 187.58	$ -	$ 287.00	$ -	$ -	$ 9,471	$ 28,126				
ROD 70	63.0	189.1	63.0	189.1	$ 14,700.00	$ 9,150	$ -		$ -	$ 23,850.00	$ 2,546	$ 7,639	$ 51,945	$ 155,836				
ROD 71	9.7	41.8	146.1	627.5	$ -	$ 10.09	$ -	$ 8.02	$ -	$ 18.11	$ -	$ -	$ 141,150	$ 606,118				
ROD 72	4.5	19.1	23.6	101.4	$ -	$ 1.50	$ -	$ 5.16	$ -	$ 6.66	$ -	$ -	$ 51,908	$ 222,901				
ROD 73	2.1	9.0	37.7	161.9	$ -	$ 2.60	$ -	$ 7.57	$ -	$ 10.17	$ -	$ -	$ 79,265	$ 340,376				
ROD 74	4.3	9.9	31.5	72.9	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ 2,701	$ 6,246	$ 80,030	$ 185,045	352	814	5,280	12,210
ROD 75	11.7	27.1	46.9	108.4	$ -	$ 0.44	$0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ 96,210	$ 222,457				
ROD 76	1.8	4.1	7.1	16.5	$ -	$ 0.07	$0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ 14,628	$ 33,824				
ROD 77	19.5	45.1	68.9	159.3	$ -	$ 0.83	$ -	$ 3.20	$ -	$ 4.03	$ -	$ -	$ 164,902	$ 381,288				
ROD 78	4.3	9.9	31.5	72.9	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ 2,701	$ 6,246	$ 80,030	$ 185,045	352	814	5,280	12,210
ROD 79	4.3	10.1	65.2	150.8	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ 110,429	$ 255,335				
ROD 80	11.8	27.3	17.7	40.9	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ 27,313	$ 63,154				
ROD 81	-	6.4	-	42.0	$ 35,337					$ 86,296.91	$ -	$ 2,955	$ -	$ 89,252				
ROD 82	1.3	9.9	21.4	158.6	$ 27.87	$ 1.47	$ -	$ 2.49	$ -	$ 31.83	$ 17,487	$ 129,401	$ 256,296	$ 1,896,560	376	2,776	15,040	111,040
ROD 83	1.1	8.3	6.8	50.0	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ 11,434	$ 84,610				
ROD 84	0.3	1.8	0.6	3.6	$ -	$ 0.14	$ -	$ 0.12	$ -	$ 0.26	$ -	$ -	$ 517	$ 3,330				
ROD 85	0.4	2.7	1.1	8.0	$ -	$ 0.15	$ -	$ 0.14	$ -	$ 0.29	$ -	$ -	$ 1,088	$ 8,050				
ROD 86	11.0	33.2	461.7	1,396.2	$ 24.51	$ 3.02	$ -	$ 5.76	$ -	$ 33.29	$ 162,228	$ 490,627	$ 2,796,953	$ 8,458,825	6,596	19,947	98,940	299,205
ROD 87	21.8	65.9	514.4	1,555.8	$ -	$ 2.50	$ -	$ 4.29	$ -	$ 6.79	$ -	$ -	$ 698,610	$ 2,112,805				
ROD 88	4.6	13.9	13.8	41.8	$ -	$ 0.15	$ -	$ 0.14	$ -	$ 0.29	$ -	$ -	$ 13,910	$ 42,069				

Construction Cost Estimate - ROD Remedy

				Quantity												Construction Days		Crew Man-days		Unit Costs						Bridgeton Taxes		Total Cost		Delivery Truckloads		Total Delivery Miles	
Step #	Category	Sub-Category	Task	Area 1	Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Area 1	Area 2	Area 1	Area 2	Ext. Mat, O&P	Ext. Labor, O&P	Ext. Labor, O&P Ineff.	Ext. Equip, O&P	Ext. Equip, O&P Ineff.	Ext. Total, O&P	Area 1	Area 2	Area 1	Area 2	Area 1	Area 2	Area 1	Area 2
ROD 89		Clay	Purchase and deliver clay material	70,351	212,762	Clay Material	L.C.Y.	RS Means, Year 2016 Quarter 1	354113200040	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	41.4	100%	29.3	88.7	1,212.9	3,668.3	$ 26.69	$ -	$ -	$ -	$ -	$ 26.69	$ 157,029	$ 474,902	$ 2,034,691	$ 6,153,516	5,863	17,731	234,520	709,240
ROD 90			Spread loose lift before compaction	70,351	212,762	Clay Material	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	12.0	100%	5.9	17.7	105.5	319.1	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ 178,691	$ 540,415				
ROD 91			Compact Clay (Final Cover)	50,251	151,973	Clay Material	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235640	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	1,300	1.5	2.0	100%	19.3	58.5	58.0	175.4	$ -	$ 0.62	$ -	$ 1.15	$ -	$ 1.77	$ -	$ -	$ 88,943	$ 268,992				
ROD 92		Top Soil	Purchase and place Topsoil	22,841	69,079	Topsoil	C.Y.	RS Means, Year 2016 Quarter 1	310513100800	Soils for earthwork, topsoil borrow, weed free, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	12.0	100%	3.2	9.6	133.2	403.0	$ 24.98	$ 3.02	$ -	$ 5.76	$ -	$ 33.76	$ 47,717	$ 144,310	$ 818,835	$ 2,476,401	2,380	7,196	35,700	107,940
ROD 93			Addition for Topsoil Delivery	29,694	89,802	Topsoil (per Hauling Increment)	C.Y.	RS Means, Year 2016 Quarter 1	310513100900	Soils for earthwork, borrow, spread with 200 HP dozer, includes load at pit and haul, round trip, excludes compaction, for 5 mile haul, add	B34B	200	1.0	23.6	100%	6.3	19.0	148.5	449.0	$ -	$ 2.50	$ -	$ 4.29	$ -	$ 6.79	$ -	$ -	$ 201,619	$ 609,756				
ROD 94	Stormwater Controls (for stormwater after cover is constructed)	Terraces	Purchase and place Topsoil	1,637	5,153	Topsoil	C.Y.	RS Means, Year 2016 Quarter 1	310513100800	Soils for earthwork, topsoil borrow, weed free, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	2.0	100%	1.4	4.3	9.5	30.1	$ 24.98	$ 3.02	$ -	$ 5.76	$ -	$ 33.76	$ 3,420	$ 10,766	$ 58,686	$ 184,742	171	537	2,565	8,055
ROD 95			Addition for Topsoil Delivery	2,128	6,699	Topsoil (per Hauling Increment)	C.Y.	RS Means, Year 2016 Quarter 1	310513100900	Soils for earthwork, borrow, spread with 200 HP dozer, includes load at pit and haul, round trip, excludes compaction, for 5 mile haul, add	B34B	200	1.0	23.6	100%	0.5	1.4	10.6	33.5	$ -	$ 2.50	$ -	$ 4.29	$ -	$ 6.79	$ -	$ -	$ 14,450	$ 45,488				
ROD 96		Pond	Purchase and deliver liner & berm material	-	13,760	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	354113200040	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	41.4	100%	-	5.7	-	237.2	$ 26.69	$ -	$ -	$ -	$ -	$ 26.69	$ -	$ 30,713	$ -	$ 397,963	-	1,147	-	45,880
ROD 97			Spread loose lift before compaction (Pond)	-	13,760	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	2.1	100%	-	6.6	-	20.6	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 34,950				
ROD 98	Stormwater Controls (for stormwater after cover is constructed) (cont.)	Pond (cont.)	Compact Liner & Berm (Pond)	-	9,828	Structural Fill / Clay	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235640	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	1,300	1.5	2.0	100%	-	3.8	-	11.3	$ -	$ 0.62	$ -	$ 1.15	$ -	$ 1.77	$ -	$ -	$ -	$ 17,396				
ROD 99			Pond Perimeter Berm Structural Rock	-	1,130	Structural Rock	L.C.Y.	RS Means, Year 2016 Quarter 1	313713100100	Rip-rap and rock lining, random, broken stone, machine placed for slope protection	B12G	62	2.0	1.0	100%	-	18.2	-	36.5	$ 31.59	$ 16.76	$ -	$ 14.69	$ -	$ 63.04	$ -	$ 2,986	$ -	$ 74,241				
ROD 100			Final Stormwater Controls	1,778	2,000	Riprap	S.Y.	RS Means, Year 2016 Quarter 1	313713100110	Rip-rap and rock lining, random, broken stone, 3/8 to 1/4 C.Y. pieces, machine placed for slope protection, grouted	B13	80	7.0	3.0	100%	7.4	8.3	155.6	175.0	$ 65.49	$ 42.14	$ -	$ 11.64	$ -	$ 119.27	$ 9,737	$ 10,954	$ 221,772	$ 249,494				
ROD 101		Diverson Berms	Purchase and deliver berm material	3,169	23,049	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	354113200040	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	41.4	100%	1.3	9.6	54.6	397.4	$ 26.69	$ -	$ -	$ -	$ -	$ 26.69	$ 7,074	$ 51,448	$ 91,663	$ 666,630	265	1,921	10,600	76,840
ROD 102			Spread loose lift before compaction	3,169	23,049	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	2.1	100%	1.5	11.0	4.8	34.6	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ 8,050	$ 58,545				
ROD 103			Compact Berms	2,264	16,464	Structural Fill / Clay	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235060	Compaction, riding, vibrating roller, 2 passes, 12" lifts	B10Y	5,200	1.5	2.0	100%	0.2	1.6	0.7	4.7	$ -	$ 0.15	$ -	$ 0.14	$ -	$ 0.29	$ -	$ -	$ 657	$ 4,774				
ROD 104			Perimeter Road Stormwater Crossings	-	123	Riprap	L.C.Y.	RS Means, Year 2016 Quarter 1	313713100100	Rip-rap and rock lining, random, broken stone, machine placed for slope protection	B12G	62	2.0	1.0	100%	-	2.0	-	4.0	$ 31.59	$ 16.76	$ -	$ 14.69	$ -	$ 63.04	$ -	$ 325	$ -	$ 8,092				
ROD 105	Site Completion		Apply seeding to cover	740	2,238	Seeding	M.S.F.	RS Means, Year 2016 Quarter 1	329219142400	Seeding athletic fields, seeding fescue, tall with mulch and fertilizer, 5.5 lb. per M.S.F., hydro/air seeding	B81	80	3.0	1.0	100%	9.3	28.0	27.8	83.9	$ 26.26	$ 19.04	$ -	$ 10.79	$ -	$ 56.09	$ 1,625	$ 4,915	$ 43,135	$ 130,453				
ROD 106			Install temporary irrigation system	61,671	186,512	Irrigation System	S.F.	RS Means, Year 2016 Quarter 1	328423100800	Underground sprinklers irrigation system, for lawns, residential system, custom, 1" supply	B20	2,000	3.0	10.0	100%	3.1	9.3	92.5	279.8	$ 0.27	$ 0.75	$ -	$ -	$ -	$ 1.02	$ 1,393	$ 4,211	$ 64,297	$ 194,454				
ROD 107			Install Fencing	4,954	6,672	Fencing	L.F.	RS Means, Year 2016 Quarter 1	323113200920	Fence, chain link industrial, galvanized steel, 6 ga. wire, 2-1/2" posts @ 10' OC, 8' high, includes excavation, in concrete, excludes barbed wire	B80C	180	3.0	2.0	100%	13.8	18.5	82.6	111.2	$ 37.00	$ 8.06	$ -	$ 1.77	$ -	$ 46.83	$ 15,329	$ 20,644	$ 247,322	$ 333,075				
																										Totals		*Totals*		*Totals*		*Totals*	
																	Overall	6,860	12,800							$ 478,000	$1,460,000	$ 11,800,000	$ 29,800,000	16,700	53,300	435,000	1,430,000
																			19,700								**$1,940,000**		**$ 41,600,000**		**70,000**		**1,860,000**

Radiological Survey and Health and Safety Costs
ROD Remedy Alternative

Total Estimated Costs for Radiological Survey and Health & Safety Support	
Total Labor Cost	$990,000
Professional Services	$182,000
Equipment	$97,000
Materials/PPE	$303,000
Travel	$198,000
Off-Site Laboratory	$101,000
Total	**$1,871,000**

3/15/2018	Estimated Start Date	Road construction
3/1/2019	Estimated End Date	Rock cover installation
351	No. of calendar days	
1.0	No. years	
12	No. Months	
4	No. of quarters	
50	No. of weeks	
251	No. of working days	
100	No. of weekend days	
105	No. of field personnel requiring badges	
27	No. of field personnel in PPE	

Estimated Labor Costs

	Personnel Description	Cost/day*	Notes:
$268,000	Sr Rad Tech	$1,070	Run Dosimetry Program; Environmental Monitoring - Collect samples and deliver to outside lab; Maintain records; Surveys
$218,000	Rad Tech	$870	Run personal air sampling program; Available for decon, distributing protective clothing, assist with survey vehicle moving on-site
$218,000	Rad Tech	$870	Preliminary survey, run control points
$218,000	Rad Tech	$870	Preliminary survey, run control points
$68,000.00	Perdiem Weekend days		

$990,000 Total Estimated Labor Costs during Construction

* Includes per diem at $170/day

Estimate of Non-Labor Costs

ITEM NO.	DESCRIPTION		UNIT	QUANTITY	RATE	COSTS
1	**PROFESSIONAL SERVICES**					**$ 182,000**
1.1	Oversight					
		CHP	hourly	125	$ 170	21,311
		Sr. Health Physicist	hourly	1,003	$ 115	115,329
		Project Coordinator	hourly	251	$ 85	21,311
1.3	Training					
		Sr. Health Physicist	hourly	40	$ 115	4,600
		**Estimated 4 trips for GERT training courses.				
1.4	Report Assistance					
		CHP	hourly	40	$ 170	6,800
		Graphics Support	hourly	40	$ 120	4,800
		Sr. Health Physicist	hourly	40	$ 115	4,600
		Project Coordinator	hourly	40	$ 85	3,400
2	**EQUIPMENT**					**$ 97,000**
2.1	Equipment					
		Model 2929 w/ 43-10-1	/month	12	$ 320	3,840
		Model 2360 w/ 43-93 (3)	/month	12	$ 825	9,900
		Extra Mylars for 43-93	/unit	4	$ 40	160
		Model 2221 w/44-20	/month	12	$ -	0
		Th-230 source	/month	12	$ 75	900
		Cs-137 source	/month	12	$ 75	900
		Tc-99 source	/month	12	$ 75	900
		PID	/month	12	$ 750	9,000
		PID 5 gas	/month	12	$ 725	8,700
		Air Monitors (4)	/month	12	$ 660	7,920
		Trimble GPS Unit + Model 2221 w/ 44-10	/month	12	$ 3,000	36,000
		Model 2221 w/44-10	/month	12	$ 500	6,000
		Field Computer	/month	12	$ 250	3,000
		Model 19 (2)	/month	12	$ 400	4,800
		Model 2221 w/ 44-2 (2)	/month	12	$ -	0
		Tax on outside rentals		9.5%	$ 33,400	3,173
2.2	Shipping					
		FedEx Charges	/shipment	24	$ 75	1,800
		**Estimate of 2 shipments per month				

Estimate of Non-Labor Costs (continued)

3	**MATERIALS/PPE**						**$**		**303,000**	
3.1	Training									
		Rad Training packets	/unit	40	$	25		1,000		
3.2	Health and Safety Monitoring & PPE									
		Mirion TLDs (20)	/unit, /quarter	420	$	50		21,000		
	50/ case	Boot Covers	/case	1,083	$	150		162,463		
	25/case	Tyvek Coveralls	/case	1,083	$	100		108,309		
	1000/case	Gloves	/case	81	$	125		10,154		
4	**TRAVEL**						**$**		**198,000**	
4.1	Training/Audits									
		Travel Time	1 person * 4 trips	64	$	115	$	7,360		
		Per Diem	1 person * 12 days	12	$	170	$	2,040		
		Air Fare	1 person * 4 trips	4	$	850	$	3,400		
		Car Rental	1 person * 4 trips	4	$	300	$	1,200		
		Gas	1 person * 4 trips	4	$	50	$	200		
4.2	HP Technicians									
		Travel Time	staff * 4 trips	320	$	300	$	96,000		
		Per Diem	staff * 4 trips	40	$	170	$	6,800		
		Air Fare	staff * 4 trips	20	$	850	$	17,000		5
		Mileage	vehicles * project duration	100	$	70	$	7,020		
		Car Rental	# vehicles * project duration	100	$	400	$	40,114		
		Supplies	/month	12	$	500	$	6,000		
		Gas	/month	12	$	400	$	4,800		
		Misc Items	/month	12	$	500	$	6,000		
5	**LABORATORY**						**$**		**101,000**	
5.1	Air Filter Analysis									
		Gross Alpha Beta	2 air filter * # of working days	501	$	65	$	32,593		
		Isotopic Thorium	2 air filter * # of working days	501	$	100	$	50,143		
5.2	Water Sample Analysis									
		Gross Alpha Beta	Estimated 5 samples	5	$	65	$	325		
		Isotopic Thorium	Estimated 5 samples	5	$	100	$	500		
		Isotopic Uranium	Estimated 5 samples	5	$	100	$	500		
		Radium-226	Estimated 5 samples	5	$	85	$	425		
5.3	Soil Sample Analysis									
		Gamma Spec	Estimated 50 samples	50	$	85	$	4,250		
		Isotopic Thorium	Estimated 50 samples	50	$	100	$	5,000		
		Isotopic Uranium	Estimated 50 samples	50	$	100	$	5,000		
5.4	Vegetation									
		Gamma Spec	Estimated 0 samples	0	$	85	$	-		
		Isotopic Thorium	Estimated 0 samples	0	$	100	$	-		
		Isotopic Uranium	Estimated 0 samples	0	$	100	$	-		
		Radium-226	Estimated 0 samples	0	$	85	$	-		
		Radium-228	Estimated 0 samples	0	$	85	$	-		
5.5	Shipping									
		FedEx Charges	/shipment	36	$	75		2,700		
		Estimate of 3 shipments per month								

DRAFT

Capital Cost Estimate - Long-Term Monitoring
FFS ROD Remedy Alternative

Description	Quantity	Units	Unit Rate	Estimated Cost ($)
Secure easements	1	LS	5,000	5,000
Landfill Gas:				
Driller: Install radon/landfill gas monitoring probes, MDNR "Code Wells"; 10' deep	31	each	2,000	62,000
Misc. wellhead sampling fittings and locks	31	each	40	1,200
Field technician observation during drilling and construction of probes (4/day)	64	hour	90	5,800
Mileage for field technician during probe construction	400	mile	0.54	200
Multi-gas detector (e.g., Industrial Scientific iBrid™ MX6), incl regulator, tubing, calbrtn gas	1	LS	4,806	4,800
Portable radon gas monitor and detector (e.g., Pylon AB6 monitor w/ 300A detector)	1	LS	9,075	9,100
Groundwater:				
Construction of new groundwater monitoring wells	12	each	10,000	120,000
Flat-bottom polyethylene tank to store purge water prior to disposal	1,500	gallon	2	3,000
Estimated Long-term Monitoring Capital Costs - Total				**211,000**

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Post-Construction Radon Flux Monitoring Cost Estimate
FFS ROD Remedy Alternative

Description	Quantity	Units	Unit Rate	Estimated Cost ($)
Radon Flux (once after cover construction is complete):				
Number of Monitoring Locatons (assume same as post-NCC program):	*130*			
Surveying of locations	1	day	1,500	1,500
Auxier labor	1	LS	6,345	6,350
Per diem	2	each	1,190	2,380
Airfare and vehicle rental	2	each	1,000	2,000
Overnight shipping to lab	1	LS	1,200	1,200
Lab analysis (Eberline)	1	LS	11,050	11,050
Data validation and management	1	each	1,000	1,000
Reporting	4	hour	150	600
Estimated Post-Construction Radon Flux Monitoring Costs - Total				**26,000**

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Stormwater and Air Monitoring During Construction Cost Estimates
FFS ROD Remedy Alternative

Description	Quantity	Units	Unit Rate ($)	Estimated Cost ($)
Stormwater Monitoring and Inspection (Quarterly - only during remedy construction)				
4 sampling locations				
1 field duplicate				
5 total samples				
Sampling and Inspection (Feezor Engineering estimate)	1	LS	5,000	5,000
Laboratory Analysis:				
Eberline (T-uranium, iso-uranium, iso-thorium, gross alpha/beta, Ra-226, Ra-228)	1	LS	2,325	2,330
TekLab (all other parameters)	1	LS	2,743	2,740
Data validation and management	1	LS	1,500	1,500
Reporting	4	hour	150	600
Estimated Quarterly Stormwater Monitoring and Inspection Costs - Total				**12,000**
Air Monitoring during Construction				
13 air monitoring stations and one MET station				
Auxier & Associates FY2016 Air Monitoring Program Estimate (minus contingency)	1	LS	172,852	172,900
Data validation	1	LS	6,800	6,800
Power costs (13 stations plus one MET station; $10/month per station)	12	months	140	1,700
Estimated Air Monitoring during Construction Costs - Annual Total				181,000
Estimated Quarterly Air Monitoring Costs during Construction (assuming annual costs divided by 4)				**45,000**

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Capital Cost Estimate - Amend Existing/Additional Institutional Controls
FFS ROD Remedy Alternative

Description	Quantity	Units	Unit Rate	Estimated Cost
Prepare Institutional Controls planning documents	1	LS	10,000	10,000
Attorney labor: prepare draft amended existing and additional ICs	1	LS	20,000	20,000
Review of draft documents	1	LS	5,000	5,000
Revise amended and additional Institutional Controls documents	1	LS	10,000	10,000
Filings and registrations	1	LS	5,000	5,000
Estimated Institutional Controls Capital Costs - Total				**50,000**

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Long-Term Post-Construction Monitoring (per event) Cost Estimate
FFS ROD Remedy Alternative

(Landfill Gas/Radon, Groundwater Monitoring and Annual Post-Construction Site Inspections)

Description	Analytical Method	Quantity	Units	Unit Rate ($)	Estimated Cost ($)
Landfill Gas/Radon (quarterly after contruction complete):					
Number of Landfill Gas/Radon Monitoring Wells		*31*			
Labor - field technician		9	hour	90	810
Field vehicle		1	day	120	120
Replacement radon detector (Pylon 300A)		1	each	550	550
Calibration gas for multi-gas detector		1	each	449	450
Data management		2	hour	100	200
Reporting		8	hour	150	1,200
Estimated Landfill Gas/Radon Monitoring Costs - Subtotal					3,300
Contingency			*%*	*20*	*700*
Estimated Landfill Gas/Radon Monitoring Costs - Total (per Event)					**4,000**

Description	Analytical Method	Quantity	Units	Unit Rate ($)	Estimated Cost ($)
Groundwater (semi-annual first 5 years after construction; annually thereafter):					
Number of Samples:			*For VOCs*		
Investigative Groundwater (5, 3-wells clusters in Area 2; 3, 3-well clusters in Area 1)		*24*	*24*		
Field Duplicates (one per every 10 investigative samples)		*3*	*3*		
Trip blank (one per day per cooler)			*15*		
Matrix Spike			*1*		
Matrix Spike Duplicate			*1*		
Sub-total number of unfiltered samples:		*27*	*44*		
Sub-total number of filtered samples for radionuclide and metals analyses:		*27*			
Total number of samples:		*54*	*44*		
Labor:					
Labor - field technicians (assume 2 people, 5 days, 10-hr days)		100	hour	90	9,000
Materials and equipment:					
Sample kits, incl. filters		24	each	50	1,200
Field instrumentation and flowcell rental - groundwater		5	day	100	500
Field Vehicle		5	day	120	600
Overnight shipping of sample coolers (assume 1 per day to rad lab)		5	coolers	100	500
Delivery of sample coolers to local lab (2 to 3 coolers per day)		5	hour	90	450
Disposal of purge water (assumes PE tank previously purchased is onsite):					
Vacuum truck		4	hour	200	800
Transportation and disposal (assumes approx 25 gal per well per event)		600	gallon	2.00	1,200
Laboratory Sample Analysis:	*Analytical Method:*				
Gross alpha and beta	EPA 900.0	54	each	50	2,700
Total Uranium		54	each	65	3,510
Iso-Uranium-234, 235, 238	EML U-02 Mod	54	each	100	5,400
Iso-Thorium-228, 230, 232	EML Th-01 Mod	54	each	100	5,400
Radium 228	EPA 904.0	54	each	75	4,050
Radium 226	EPA 903.0 Mod	54	each	75	4,050
Radon 222 - 72 hr hold time	SM 20th ED 7500-Rn B	54	each	85	4,590
Volatile Organic Compounds [VOCs] (GC/MS)	8260B	44	each	110	4,840
Semivolatile Organic Compounds [SVOCs] (GC/MS)	8270C	54	each	220	11,880
22 Metals Target Analyte List (ICP/AES)	6010B	54	each	115	6,210
Mercury (CVAA)	7470A	54	each	35	1,890
4 Anions (IC) - Bromide, Chloride, Fluoride, Sulfate	300.0	54	each	72	3,890
2 Anions (IC) - Nitrate, Nitrite - 48 hr hold time	300.0	54	each	36	1,940
Sulfide, Total	SM 4500 S2 D	54	each	35	1,890
Phosphorus, Total	365.1	54	each	40	2,160
Organic carbon, Total (TOC)	SM 5310B	54	each	40	2,160
Total Alkalinity, Carbonate, Bicarbonate	SM 2320B	54	each	20	1,080
Nitrogen, Ammonia	350.1	54	each	25	1,350
Level IV data deliverable		$ 68,990	%	10%	6,900
Data validation (assumes validation of 100% of Level IV data will be required)		1	LS	6,600	6,600
Data management		7	SDG	100	700
Reporting		40	hour	150	6,000
Estimated Groundwater Monitoring Costs - Subtotal					103,400
Contingency			*%*	*20*	*20,700*
Estimated Groundwater Monitoring Costs - Total (per Event)					**124,000**

DVR = data validation report
SDG = sample delivery group

Description	Analytical Method	Quantity	Units	Unit Rate ($)	Estimated Cost ($)
Annual Post-Construction Site Inspections					
Labor - Engineer		9	hour	130	1,170
Field vehicle		1	day	120	120
Site Inspection Report		4	hour	130	520
Estimated Annual Post-Construction Site Inspections Costs - Subtotal					1,800
Contingency			*%*	*20*	*400*
Estimated Annual Post-Construction Site Inspections Costs - Total					**2,200**

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Operation and Maintenance Cost Estimate - Annual Cover System Maintenance
FFS ROD Remedy Alternative

Description	Quantity	Units	Unit Rate	Estimated Cost
Mowing; tractor w/ rotary mower (once/year)	55.3	acre	40.00	2,200
Fill depressions in cover w/ topsoil, assume 1% of area; 6 inches deep	446	bcy	37.53	16,700
Seeding of filled area	24.1	M.S.F.	66.04	1,600
Estimated Cover System O&M Costs - Subtotal				20,500
Contingency		*%*	*20*	*4,100*
Estimated Annual Cover Maintenance O&M Costs - Total				**25,000**

M.S.F. = 1,000 square feet

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Periodic Cost Estimate - 5 year Review
FFS ROD Remedy Alternative

Description	Quantity	Units	Unit Rate	Estimated Cost ($)
Access Restrictions (inspect/repair fencing and signage)	16	hours	150	2,400
Institutional Controls verification	8	hours	150	1,200
Document that landfill cover is effective	8	hours	150	1,200
Assemble Monitoring Data (landfill gas/radon, groundwater, surface water)	40	hours	150	6,000
Summarize Annual Post-Construction Site Inspections	8	hours	150	1,200
Summarize Annual Cover Maintenance Documentation	8	hours	150	1,200
Water supply well inventory review	8	hours	150	1,200
Document any changes in Land Use at and around West Lake Landfill	16	hours	150	2,400
Prepare Summary Report	80	hours	150	12,000
Estimated 5-year Maint/Review O&M Costs - Subtotal				**29,000**
Contingency		*%*	*20*	*6,000*
Estimated 5-year Maintenance O&M Costs - Total				**35,000**

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Present Worth Cost Estimate
FFS ROD Remedy Alternative

			Capital Costs ($)		Operation, Maintenance, Monitoring, and Periodic Costs ($/yr)							
Year	*n*	P/F(*i*=7%)	ROD Remedy	Subtotal Capital Costs	Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000	2,650,000	2,650,000					0	2,650,000	2,650,000	2,650,000
2018	1	0.93458	37,430,000	37,430,000					0	37,430,000	34,981,000	37,631,000
2019	2	0.87344	27,040,000	27,040,000					0	27,040,000	23,618,000	61,249,000
2020	3	0.81630			16,000	248,000	27,000		291,000	291,000	238,000	61,487,000
2021	4	0.76290			16,000	248,000	27,000		291,000	291,000	222,000	61,709,000
2022	5	0.71299			16,000	248,000	27,000		291,000	291,000	207,000	61,916,000
2023	6	0.66634			16,000	248,000	27,000		291,000	291,000	194,000	62,110,000
2024	7	0.62275			16,000	248,000	27,000	35,000	326,000	326,000	203,000	62,313,000
2025	8	0.58201			16,000	124,000	27,000		167,000	167,000	97,000	62,410,000
2026	9	0.54393			16,000	124,000	27,000		167,000	167,000	91,000	62,501,000
2027	10	0.50835			16,000	124,000	27,000		167,000	167,000	85,000	62,586,000
2028	11	0.47509			16,000	124,000	27,000		167,000	167,000	79,000	62,665,000
2029	12	0.44401			16,000	124,000	27,000	35,000	202,000	202,000	90,000	62,755,000
2030	13	0.41496			16,000	124,000	27,000		167,000	167,000	69,000	62,824,000
2031	14	0.38782			16,000	124,000	27,000		167,000	167,000	65,000	62,889,000
2032	15	0.36245			16,000	124,000	27,000		167,000	167,000	61,000	62,950,000
2033	16	0.33873			16,000	124,000	27,000		167,000	167,000	57,000	63,007,000
2034	17	0.31657			16,000	124,000	27,000	35,000	202,000	202,000	64,000	63,071,000
2035	18	0.29586			16,000	124,000	27,000		167,000	167,000	49,000	63,120,000
2036	19	0.27651			16,000	124,000	27,000		167,000	167,000	46,000	63,166,000
2037	20	0.25842			16,000	124,000	27,000		167,000	167,000	43,000	63,209,000
2038	21	0.24151			16,000	124,000	27,000		167,000	167,000	40,000	63,249,000
2039	22	0.22571			16,000	124,000	27,000	35,000	202,000	202,000	46,000	63,295,000
2040	23	0.21095			16,000	124,000	27,000		167,000	167,000	35,000	63,330,000
2041	24	0.19715			16,000	124,000	27,000		167,000	167,000	33,000	63,363,000
2042	25	0.18425			16,000	124,000	27,000		167,000	167,000	31,000	63,394,000
2043	26	0.17220			16,000	124,000	27,000		167,000	167,000	29,000	63,423,000
2044	27	0.16093			16,000	124,000	27,000	35,000	202,000	202,000	33,000	63,456,000
2045	28	0.15040			16,000	124,000	27,000		167,000	167,000	25,000	63,481,000
2046	29	0.14056			16,000	124,000	27,000		167,000	167,000	23,000	63,504,000
2047	30	0.13137			16,000	124,000	27,000		167,000	167,000	22,000	63,526,000
		Estimated Non-discounted Capital Costs:		67,000,000					Estimated Non-discounted Total Costs:	73,000,000		
											Estimated 30-year Present Worth Costs:	64,000,000

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. In accordance with USEPA Guidance, this is an order-of-magnitude engineering estimate that is expected to be within -30 to +50 percent of the actual project cost.

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Present Worth Cost Estimate
FFS ROD Remedy Alternative

			Capital Costs ($)		Operation, Maintenance, Monitoring, and Periodic Costs ($/yr)							
Year	*n*	P/F(*i* =1.5%)	ROD Remedy	Subtotal Capital Costs	Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000	2,650,000	2,650,000					0	2,650,000	2,650,000	2,650,000
2018	1	0.98522	37,430,000	37,430,000					0	37,430,000	36,877,000	39,527,000
2019	2	0.97066	27,040,000	27,040,000					0	27,040,000	26,247,000	65,774,000
2020	3	0.95632			16,000	248,000	27,000		291,000	291,000	278,000	66,052,000
2021	4	0.94218			16,000	248,000	27,000		291,000	291,000	274,000	66,326,000
2022	5	0.92826			16,000	248,000	27,000		291,000	291,000	270,000	66,596,000
2023	6	0.91454			16,000	248,000	27,000		291,000	291,000	266,000	66,862,000
2024	7	0.90103			16,000	248,000	27,000	35,000	326,000	326,000	294,000	67,156,000
2025	8	0.88771			16,000	124,000	27,000		167,000	167,000	148,000	67,304,000
2026	9	0.87459			16,000	124,000	27,000		167,000	167,000	146,000	67,450,000
2027	10	0.86167			16,000	124,000	27,000		167,000	167,000	144,000	67,594,000
2028	11	0.84893			16,000	124,000	27,000		167,000	167,000	142,000	67,736,000
2029	12	0.83639			16,000	124,000	27,000	35,000	202,000	202,000	169,000	67,905,000
2030	13	0.82403			16,000	124,000	27,000		167,000	167,000	138,000	68,043,000
2031	14	0.81185			16,000	124,000	27,000		167,000	167,000	136,000	68,179,000
2032	15	0.79985			16,000	124,000	27,000		167,000	167,000	134,000	68,313,000
2033	16	0.78803			16,000	124,000	27,000		167,000	167,000	132,000	68,445,000
2034	17	0.77639			16,000	124,000	27,000	35,000	202,000	202,000	157,000	68,602,000
2035	18	0.76491			16,000	124,000	27,000		167,000	167,000	128,000	68,730,000
2036	19	0.75361			16,000	124,000	27,000		167,000	167,000	126,000	68,856,000
2037	20	0.74247			16,000	124,000	27,000		167,000	167,000	124,000	68,980,000
2038	21	0.73150			16,000	124,000	27,000		167,000	167,000	122,000	69,102,000
2039	22	0.72069			16,000	124,000	27,000	35,000	202,000	202,000	146,000	69,248,000
2040	23	0.71004			16,000	124,000	27,000		167,000	167,000	119,000	69,367,000
2041	24	0.69954			16,000	124,000	27,000		167,000	167,000	117,000	69,484,000
2042	25	0.68921			16,000	124,000	27,000		167,000	167,000	115,000	69,599,000
2043	26	0.67902			16,000	124,000	27,000		167,000	167,000	113,000	69,712,000
2044	27	0.66899			16,000	124,000	27,000	35,000	202,000	202,000	135,000	69,847,000
2045	28	0.65910			16,000	124,000	27,000		167,000	167,000	110,000	69,957,000
2046	29	0.64936			16,000	124,000	27,000		167,000	167,000	108,000	70,065,000
2047	30	0.63976			16,000	124,000	27,000		167,000	167,000	107,000	70,172,000

Estimated Non-discounted Capital Costs: 67,000,000

Estimated Non-discounted Total Costs: 73,000,000

Estimated 30-year Present Worth Costs: 70,000,000

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Present Worth Cost Estimate
FFS ROD Remedy Alternative

			Capital Costs ($)		Operation, Maintenance, Monitoring, and Periodic Costs ($/yr)							
Year	*n*	P/F(*i* =7%)	ROD Remedy	Subtotal Capital Costs	Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000	2,650,000	2,650,000					0	2,650,000	2,650,000	2,650,000
2018	1	0.93458	37,430,000	37,430,000					0	37,430,000	34,981,000	37,631,000
2019	2	0.87344	27,040,000	27,040,000					0	27,040,000	23,618,000	61,249,000
2020	3	0.81630			16,000	248,000	27,000		291,000	291,000	238,000	61,487,000
2021	4	0.76290			16,000	248,000	27,000		291,000	291,000	222,000	61,709,000
2022	5	0.71299			16,000	248,000	27,000		291,000	291,000	207,000	61,916,000
2023	6	0.66634			16,000	248,000	27,000		291,000	291,000	194,000	62,110,000
2024	7	0.62275			16,000	248,000	27,000	35,000	326,000	326,000	203,000	62,313,000
2025	8	0.58201			16,000	124,000	27,000		167,000	167,000	97,000	62,410,000
2026	9	0.54393			16,000	124,000	27,000		167,000	167,000	91,000	62,501,000
2027	10	0.50835			16,000	124,000	27,000		167,000	167,000	85,000	62,586,000
2028	11	0.47509			16,000	124,000	27,000		167,000	167,000	79,000	62,665,000
2029	12	0.44401			16,000	124,000	27,000	35,000	202,000	202,000	90,000	62,755,000
2030	13	0.41496			16,000	124,000	27,000		167,000	167,000	69,000	62,824,000
2031	14	0.38782			16,000	124,000	27,000		167,000	167,000	65,000	62,889,000
2032	15	0.36245			16,000	124,000	27,000		167,000	167,000	61,000	62,950,000
2033	16	0.33873			16,000	124,000	27,000		167,000	167,000	57,000	63,007,000
2034	17	0.31657			16,000	124,000	27,000	35,000	202,000	202,000	64,000	63,071,000
2035	18	0.29586			16,000	124,000	27,000		167,000	167,000	49,000	63,120,000
2036	19	0.27651			16,000	124,000	27,000		167,000	167,000	46,000	63,166,000
2037	20	0.25842			16,000	124,000	27,000		167,000	167,000	43,000	63,209,000
2038	21	0.24151			16,000	124,000	27,000		167,000	167,000	40,000	63,249,000
2039	22	0.22571			16,000	124,000	27,000	35,000	202,000	202,000	46,000	63,295,000
2040	23	0.21095			16,000	124,000	27,000		167,000	167,000	35,000	63,330,000
2041	24	0.19715			16,000	124,000	27,000		167,000	167,000	33,000	63,363,000
2042	25	0.18425			16,000	124,000	27,000		167,000	167,000	31,000	63,394,000
2043	26	0.17220			16,000	124,000	27,000		167,000	167,000	29,000	63,423,000
2044	27	0.16093			16,000	124,000	27,000	35,000	202,000	202,000	33,000	63,456,000
2045	28	0.15040			16,000	124,000	27,000		167,000	167,000	25,000	63,481,000
2046	29	0.14056			16,000	124,000	27,000		167,000	167,000	23,000	63,504,000
2047	30	0.13137			16,000	124,000	27,000		167,000	167,000	22,000	63,526,000
2216	199	0.0000014			16,000	124,000	27,000		167,000	167,000	0	63,849,000
2217	200	0.0000013			16,000	124,000	27,000		167,000	167,000	0	63,849,000
	Estimated Non-discounted Capital Costs:			67,000,000			Estimated Non-discounted Total Costs:			102,000,000		
										Estimated 200-year Present Worth Costs:		64,000,000

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. In accordance with USEPA Guidance, this is an order-of-magnitude engineering estimate that is expected to be within -30 to +50 percent of the actual project cost.

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Present Worth Cost Estimate
FFS ROD Remedy Alternative

Year	*n*	P/F(*i* =1.5%)	Capital Costs ($): ROD Remedy	Capital Costs ($): Subtotal Capital Costs	Operation, Maintenance, Monitoring, and Periodic Costs ($/yr): Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000	2,650,000	2,650,000					0	2,650,000	2,650,000	2,650,000
2018	1	0.98522	37,430,000	37,430,000					0	37,430,000	36,877,000	39,527,000
2019	2	0.97066	27,040,000	27,040,000					0	27,040,000	26,247,000	65,774,000
2020	3	0.95632			16,000	248,000	27,000		291,000	291,000	278,000	66,052,000
2021	4	0.94218			16,000	248,000	27,000		291,000	291,000	274,000	66,326,000
2022	5	0.92826			16,000	248,000	27,000		291,000	291,000	270,000	66,596,000
2023	6	0.91454			16,000	248,000	27,000		291,000	291,000	266,000	66,862,000
2024	7	0.90103			16,000	248,000	27,000	35,000	326,000	326,000	294,000	67,156,000
2025	8	0.88771			16,000	124,000	27,000		167,000	167,000	148,000	67,304,000
2026	9	0.87459			16,000	124,000	27,000		167,000	167,000	146,000	67,450,000
2027	10	0.86167			16,000	124,000	27,000		167,000	167,000	144,000	67,594,000
2028	11	0.84893			16,000	124,000	27,000		167,000	167,000	142,000	67,736,000
2029	12	0.83639			16,000	124,000	27,000	35,000	202,000	202,000	169,000	67,905,000
2030	13	0.82403			16,000	124,000	27,000		167,000	167,000	138,000	68,043,000
2031	14	0.81185			16,000	124,000	27,000		167,000	167,000	136,000	68,179,000
2032	15	0.79985			16,000	124,000	27,000		167,000	167,000	134,000	68,313,000
2033	16	0.78803			16,000	124,000	27,000		167,000	167,000	132,000	68,445,000
2034	17	0.77639			16,000	124,000	27,000	35,000	202,000	202,000	157,000	68,602,000
2035	18	0.76491			16,000	124,000	27,000		167,000	167,000	128,000	68,730,000
2036	19	0.75361			16,000	124,000	27,000		167,000	167,000	126,000	68,856,000
2037	20	0.74247			16,000	124,000	27,000		167,000	167,000	124,000	68,980,000
2038	21	0.73150			16,000	124,000	27,000		167,000	167,000	122,000	69,102,000
2039	22	0.72069			16,000	124,000	27,000	35,000	202,000	202,000	146,000	69,248,000
2040	23	0.71004			16,000	124,000	27,000		167,000	167,000	119,000	69,367,000
2041	24	0.69954			16,000	124,000	27,000		167,000	167,000	117,000	69,484,000
2042	25	0.68921			16,000	124,000	27,000		167,000	167,000	115,000	69,599,000
2043	26	0.67902			16,000	124,000	27,000		167,000	167,000	113,000	69,712,000
2044	27	0.66899			16,000	124,000	27,000	35,000	202,000	202,000	135,000	69,847,000
2045	28	0.65910			16,000	124,000	27,000		167,000	167,000	110,000	69,957,000
2046	29	0.64936			16,000	124,000	27,000		167,000	167,000	108,000	70,065,000
2047	30	0.63976			16,000	124,000	27,000		167,000	167,000	107,000	70,172,000
2216	199	0.05167			16,000	124,000	27,000		167,000	167,000	9,000	76,993,000
2217	200	0.05091			16,000	124,000	27,000		167,000	167,000	9,000	77,002,000

Estimated Non-discounted Capital Costs: 67,000,000

Estimated Non-discounted Total Costs: 102,000,000

Estimated 200-year Present Worth Costs: 77,000,000

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Present Worth Cost Estimate
FFS ROD Remedy Alternative

Year	*n*	P/F(*i* =7%)	Capital Costs ($) ROD Remedy	Capital Costs ($) Subtotal Capital Costs	OM&M and Periodic Costs ($/yr) Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000	2,650,000	2,650,000					0	2,650,000	2,650,000	2,650,000
2018	1	0.93458	37,430,000	37,430,000					0	37,430,000	34,981,000	37,631,000
2019	2	0.87344	27,040,000	27,040,000					0	27,040,000	23,618,000	61,249,000
2020	3	0.81630			16,000	248,000	27,000		291,000	291,000	238,000	61,487,000
2021	4	0.76290			16,000	248,000	27,000		291,000	291,000	222,000	61,709,000
2022	5	0.71299			16,000	248,000	27,000		291,000	291,000	207,000	61,916,000
2023	6	0.66634			16,000	248,000	27,000		291,000	291,000	194,000	62,110,000
2024	7	0.62275			16,000	248,000	27,000	35,000	326,000	326,000	203,000	62,313,000
2025	8	0.58201			16,000	124,000	27,000		167,000	167,000	97,000	62,410,000
2026	9	0.54393			16,000	124,000	27,000		167,000	167,000	91,000	62,501,000
2027	10	0.50835			16,000	124,000	27,000		167,000	167,000	85,000	62,586,000
2028	11	0.47509			16,000	124,000	27,000		167,000	167,000	79,000	62,665,000
2029	12	0.44401			16,000	124,000	27,000	35,000	202,000	202,000	90,000	62,755,000
2030	13	0.41496			16,000	124,000	27,000		167,000	167,000	69,000	62,824,000
2031	14	0.38782			16,000	124,000	27,000		167,000	167,000	65,000	62,889,000
2032	15	0.36245			16,000	124,000	27,000		167,000	167,000	61,000	62,950,000
2033	16	0.33873			16,000	124,000	27,000		167,000	167,000	57,000	63,007,000
2034	17	0.31657			16,000	124,000	27,000	35,000	202,000	202,000	64,000	63,071,000
2035	18	0.29586			16,000	124,000	27,000		167,000	167,000	49,000	63,120,000
2036	19	0.27651			16,000	124,000	27,000		167,000	167,000	46,000	63,166,000
2037	20	0.25842			16,000	124,000	27,000		167,000	167,000	43,000	63,209,000
2038	21	0.24151			16,000	124,000	27,000		167,000	167,000	40,000	63,249,000
2039	22	0.22571			16,000	124,000	27,000	35,000	202,000	202,000	46,000	63,295,000
2040	23	0.21095			16,000	124,000	27,000		167,000	167,000	35,000	63,330,000
2041	24	0.19715			16,000	124,000	27,000		167,000	167,000	33,000	63,363,000
2042	25	0.18425			16,000	124,000	27,000		167,000	167,000	31,000	63,394,000
2043	26	0.17220			16,000	124,000	27,000		167,000	167,000	29,000	63,423,000
2044	27	0.16093			16,000	124,000	27,000	35,000	202,000	202,000	33,000	63,456,000
2045	28	0.15040			16,000	124,000	27,000		167,000	167,000	25,000	63,481,000
2046	29	0.14056			16,000	124,000	27,000		167,000	167,000	23,000	63,504,000
2047	30	0.13137			16,000	124,000	27,000		167,000	167,000	22,000	63,526,000
3016	999	4.422E-30			16,000	124,000	27,000		167,000	167,000	0	63,849,000
3017	1000	4.133E-30			16,000	124,000	27,000		167,000	167,000	0	63,849,000

Estimated Non-discounted Capital Costs: 67,000,000

Estimated Non-discounted Total Costs: 241,000,000

Estimated 1,000-year Present Worth Costs: 64,000,000

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Present Worth Cost Estimate
FFS ROD Remedy Alternative

			Capital Costs ($)		Operation, Maintenance, Monitoring, and Periodic Costs ($/yr)							
Year	*n*	P/F(*i* =1.5%)	ROD Remedy	Subtotal Capital Costs	Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000	2,650,000	2,650,000					0	2,650,000	2,650,000	2,650,000
2018	1	0.98522	37,430,000	37,430,000					0	37,430,000	36,877,000	39,527,000
2019	2	0.97066	27,040,000	27,040,000					0	27,040,000	26,247,000	65,774,000
2020	3	0.95632			16,000	248,000	27,000		291,000	291,000	278,000	66,052,000
2021	4	0.94218			16,000	248,000	27,000		291,000	291,000	274,000	66,326,000
2022	5	0.92826			16,000	248,000	27,000		291,000	291,000	270,000	66,596,000
2023	6	0.91454			16,000	248,000	27,000		291,000	291,000	266,000	66,862,000
2024	7	0.90103			16,000	248,000	27,000	35,000	326,000	326,000	294,000	67,156,000
2025	8	0.88771			16,000	124,000	27,000		167,000	167,000	148,000	67,304,000
2026	9	0.87459			16,000	124,000	27,000		167,000	167,000	146,000	67,450,000
2027	10	0.86167			16,000	124,000	27,000		167,000	167,000	144,000	67,594,000
2028	11	0.84893			16,000	124,000	27,000		167,000	167,000	142,000	67,736,000
2029	12	0.83639			16,000	124,000	27,000	35,000	202,000	202,000	169,000	67,905,000
2030	13	0.82403			16,000	124,000	27,000		167,000	167,000	138,000	68,043,000
2031	14	0.81185			16,000	124,000	27,000		167,000	167,000	136,000	68,179,000
2032	15	0.79985			16,000	124,000	27,000		167,000	167,000	134,000	68,313,000
2033	16	0.78803			16,000	124,000	27,000		167,000	167,000	132,000	68,445,000
2034	17	0.77639			16,000	124,000	27,000	35,000	202,000	202,000	157,000	68,602,000
2035	18	0.76491			16,000	124,000	27,000		167,000	167,000	128,000	68,730,000
2036	19	0.75361			16,000	124,000	27,000		167,000	167,000	126,000	68,856,000
2037	20	0.74247			16,000	124,000	27,000		167,000	167,000	124,000	68,980,000
2038	21	0.73150			16,000	124,000	27,000		167,000	167,000	122,000	69,102,000
2039	22	0.72069			16,000	124,000	27,000	35,000	202,000	202,000	146,000	69,248,000
2040	23	0.71004			16,000	124,000	27,000		167,000	167,000	119,000	69,367,000
2041	24	0.69954			16,000	124,000	27,000		167,000	167,000	117,000	69,484,000
2042	25	0.68921			16,000	124,000	27,000		167,000	167,000	115,000	69,599,000
2043	26	0.67902			16,000	124,000	27,000		167,000	167,000	113,000	69,712,000
2044	27	0.66899			16,000	124,000	27,000	35,000	202,000	202,000	135,000	69,847,000
2045	28	0.65910			16,000	124,000	27,000		167,000	167,000	110,000	69,957,000
2046	29	0.64936			16,000	124,000	27,000		167,000	167,000	108,000	70,065,000
2047	30	0.63976			16,000	124,000	27,000		167,000	167,000	107,000	70,172,000
2048	31	0.63031			16,000	124,000	27,000		167,000	167,000	105,000	70,277,000
3016	999	3.471E-07			16,000	124,000	27,000		167,000	167,000	0	77,570,000
3017	1000	3.419E-07			16,000	124,000	27,000		167,000	167,000	0	77,570,000
	Estimated Non-discounted Capital Costs:			67,000,000			Estimated Non-discounted Total Costs:			241,000,000		
									Estimated 1,000-year Present Worth Costs:			78,000,000

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. In accordance with USEPA Guidance, this is an order-of-magnitude engineering estimate that is expected to be within -30 to +50 percent of the actual project cost.

Appendix K-4

Cost Estimates for the “Complete Rad Removal” with Off-site Disposal Alternative

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Preliminary Estimated Capital Costs
Complete Rad Removal (7.9 pCi/g) Remedy Alternative

Cost Item			Estimated Capital Costs
Construction Costs		$	162,800,000
Radiological Survey/H&S Support Costs		$	62,292,000
On-site Rad Laboratory		$	1,144,000
Long-Term Monitoring Facilities		$	211,000
Post Construction Radon Flux Monitoring		$	26,000
Stormwater Monitoring during Construction		$	588,000
Air Monitoring during Construction		$	2,205,000
Institutional Controls		$	50,000
Subtotal		$	229,316,000
Project Management	5%	$	11,466,000
Engineering Design	6%	$	13,759,000
Construction Management	6%	$	13,759,000
Subtotal - Construction On-Site		$	268,300,000
Off-site Transportation and Disposal (@229/lcy)		$	102,000,000
Subtotal - Transport/Disposal Off-site		$	102,000,000
Contingencies:			
Scope (construction onsite)	55%	$	147,565,000
Scope (transport/disposal offsite)	15%	$	15,300,000
Bid (all activities)	20%	$	74,060,000
Subtotal - Contingency		$	236,930,000
Other Requirements:			
Buy-out Asphalt Plant Lease		$	3,200,000
Permitting for Relocation of Transfer Station		$	500,000
Relocate Transfer Station		$	5,260,000
Subtotal - Other Requirements		$	8,960,000
Total: Complete Rad Removal (7.9 pCi/g)	Remedy	$	616,000,000

Estimated Length Construction	3/5/18	start
	4/2/30	end
	4,411	no. Days
	12.1	no. Years
	49	no. Quarters

Construction Cost Worksheet - FFS 7.9 DRAFT

Step #	Category	Sub-Category	Task	Quantity Area 1	Quantity Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Construction Days Area 1	Construction Days Area 2	Crew Man-days Area 1	Crew Man-days Area 2	Unit Costs Ext. Mat, O&P	Unit Costs Ext. Labor, O&P	Unit Costs Ext. Labor, O&P Ineff.	Unit Costs Ext. Equip, O&P	Unit Costs Ext. Equip, O&P Ineff.	Unit Costs Ext. Total, O&P	Bridgeton Taxes Area 1	Bridgeton Taxes Area 2	Total Cost Area 1	Total Cost Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Delivery Miles Area 1	Total Delivery Miles Area 2
FFS 7.9 DRAFT 1	Temporary Construction Facilities / Utilities / Personnel	Construction Trailers	Capital Expenses	2	-	Group of Trailers		See separate Assumptions sheet								25.0	-	39.2	-	$ -					$ 106,698.53	$ -	$ -	$ 213,397	$ -	10	-	200	-
FFS 7.9 DRAFT 2			Operating Expenses	183	-	Group of Trailers	Months	See separate Assumptions sheet												$ -					$ 2,786.52	$ -	$ -	$ 511,139	$ -				
FFS 7.9 DRAFT 3			Parking Area	4,444	-	Gravel Area	S.Y.	RS Means, Year 2016 Quarter 1	015523500050	Temporary, roads, gravel fill, 4" gravel depth, excl surfacing	B14	715	6.0	1.0	100%	6.2	-	37.3	-	$ 4.10	$ 4.35	$ -	$ 0.63	$ -	$ 9.08	$ 1,524	$ -	$ 41,879	$ -				
FFS 7.9 DRAFT 4			Portable Toilets in Construction Areas	75	108	Portable Toilets	Month	RS Means, Year 2016 Quarter 1	015433406420	Rent portable toilet chemical, recycle, flush type, Incl. Hourly Oper. Cost.					100%					$ -	$ -	$ -	$ 317.05	$ -	$ 317.05	$ -	$ -	$ 23,893	$ 34,257				
FFS 7.9 DRAFT 5		Contractor's Construction Management Personnel	Project Manager	630	-	Personnel	Week	RS Means, Year 2016 Quarter 1	013113200220	Field personnel, project manager, maximum		0	1.0	1.0	100%	3,019	-	3,019.3	-	$ -	$ 4,100.00	$ -	$ -	$ -	$ 4,100.00	$ -	$ -	$ 2,583,722	$ -				
FFS 7.9 DRAFT 6			Construction Superintendent(s)	798	-	Personnel	Week	RS Means, Year 2016 Quarter 1	013113200260	Field personnel, superintendent, average		0	1.0	1.0	100%	3,822	-	3,821.5	-	$ -	$ 3,350.00	$ -	$ -	$ -	$ 3,350.00	$ -	$ -	$ 2,671,975	$ -				
FFS 7.9 DRAFT 7			Clerk(s)	798	-	Personnel	Week	RS Means, Year 2016 Quarter 1	013113200020	Field personnel, clerk, average		0	1.0	1.0	100%	3,822	-	3,821.5	-	$ -	$ 710.00	$ -	$ -	$ -	$ 710.00	$ -	$ -	$ 566,299	$ -				
FFS 7.9 DRAFT 8			Field Engineer(s) / Safety Officer(s)	798	-	Personnel	Week	RS Means, Year 2016 Quarter 1	013113200120	Field personnel, field engineer, average		0	1.0	1.0	100%	3,822	-	3,821.5	-	$ -	$ 2,200.00	$ -	$ -	$ -	$ 2,200.00	$ -	$ -	$ 1,754,730	$ -				
FFS 7.9 DRAFT 9	Temporary Stormwater Infrastructure (for stormwater during construction)	Frac Tanks	Delivery	58	58	Frac Tanks	Ea.	See separate Assumptions sheet				3	2.0	2.0	100%	9.7	9.7	38.7	38.7	$ -	$ 200.00	$ -		$ -	$ 200.00	$ -	$ -	$ 11,600	$ 11,600	58	58	3,480	3,480
FFS 7.9 DRAFT 10			Monthly Rental (or Purchase)	2,042	2,042	Frac Tanks	Tank-Months	See separate Assumptions sheet							100%					$ 852.25		$ -		$ -	$ 852.25	$ 145,516	$ 145,516	$ 1,885,516	$ 1,885,516				
FFS 7.9 DRAFT 11			Cleaning	58	58	Frac Tanks	Ea.	See separate Assumptions sheet				1	2.0	1.0	100%	58.0	58.0	116.0	116.0	$ -	$ 1,500.00	$ -		$ -	$ 1,500.00	$ -	$ -	$ 87,000	$ 87,000				
FFS 7.9 DRAFT 12			Removal	58	58	Frac Tanks	Ea.	See separate Assumptions sheet				3	2.0	2.0	100%	9.7	9.7	38.7	38.7	$ -	$ 200.00	$ -		$ -	$ 200.00	$ -	$ -	$ 11,600	$ 11,600	58	58	3,480	3,480
FFS 7.9 DRAFT 13		Forcemain	Install forcemain from Excavation Area to Tank Area	4,500	7,000	HDPE Pipe	L.F.	RS Means, Year 2016 Quarter 1	331113350100	Water supply distribution piping, piping HDPE, butt fusion joints, 40' lengths, 4" diameter, SDR 21	B22A	400	5.0	1.0	100%	11.3	17.5	56.3	87.5	$ 2.61	$ 7.12	$ -	$ 2.05	$ -	$ 11.78	$ 982	$ 1,528	$ 53,992	$ 83,988				
FFS 7.9 DRAFT 14			Install forcemain from Tank Area to Treatment Plant and Discharge Point	500	500	HDPE Pipe	L.F.	RS Means, Year 2016 Quarter 1	331113350100	Water supply distribution piping, piping HDPE, butt fusion joints, 40' lengths, 4" diameter, SDR 21	B22A	400	5.0	1.0	100%	1.3	1.3	6.3	6.3	$ 2.61	$ 7.12	$ -	$ 2.05	$ -	$ 11.78	$ 109	$ 109	$ 5,999	$ 5,999				
FFS 7.9 DRAFT 15			Install forcemain valves	6	8	Pipe Valves	Ea.	RS Means, Year 2016 Quarter 1	220523601310	Valves, plastic, PVC, ball, true union, socket or threaded, 4"	Q1	20	2.0	1.0	100%	0.3	0.4	0.6	0.8	$ 472.63	$ 68.18	$ -	$ -	$ -	$ 540.81	$ 237	$ 316	$ 3,482	$ 4,643				
FFS 7.9 DRAFT 16		Treatment Facility	Construct Treatment Facility	1	-	Treatment Facility	Each	See separate Assumptions sheet				0.067	2.0	1.0	100%	15.0	-	30.0	-	$ 71,000.00					$ 102,000.00	$ 5,938	$ -	$ 107,938	$ -				
FFS 7.9 DRAFT 17			Treatment Facility Demolition	1	-	Treatment Facility	Each	See separate Assumptions sheet				0.48	9.2	1.0	100%	2.1	-	19.0	-	$ 4,000.00					$ 27,000.00	$ 335	$ -	$ 27,335	$ -				
FFS 7.9 DRAFT 18			Monthly Rent	134	-	Treatment Facility Operation	Each	See separate Assumptions sheet							100%					$ 1,630.00					$ 1,630.00	$ 18,266	$ -	$ 236,686	$ -				
FFS 7.9 DRAFT 19			Monthly Operation during remediation	134	-	Treatment Facility Operation	Months	See separate Assumptions sheet				0.20	1.0	1.0	100%	680.3	-	680.3	-	$ 4,270.68					$ 4,270.68	$ 47,793	$ -	$ 619,275	$ -				
FFS 7.9 DRAFT 20		Stormwater events during construction	Dewater excavation construction after rain events	524	1,811	Days of Pumping Construction Stormwater	Day	RS Means, Year 2016 Quarter 1	312319200650	Dewatering, pumping 8 hours, attended 2 hrs per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose	B10I	4	1.5	4.0	100%	32.7	113.2	196.4	679.1	$ -	$ 201.71	$ -	$ 38.99	$ -	$ 240.70	$ -	$ -	$ 126,083	$ 435,860				
FFS 7.9 DRAFT 21			Dewater backfill construction after rain events	507	837	Days of Pumping Construction Stormwater	Day	RS Means, Year 2016 Quarter 1	312319200650	Dewatering, pumping 8 hours, attended 2 hrs per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose	B10I	4	1.5	4.0	100%	31.7	52.3	190.0	313.8	$ -	$ 201.71	$ -	$ 38.99	$ -	$ 240.70	$ -	$ -	$ 121,949	$ 201,399				
FFS 7.9 DRAFT 22			Dispose of contact stormwater to MSD	3,600,000	5,000,000	Contact Stormwater	Gallons	St. Louis Sewer District, May 2011							100%					$ -					$ 0.14	$ -	$ -	$ 504,000	$ 700,000				
FFS 7.9 DRAFT 23	Leachate Handling	Frac Tanks	Delivery	20	20	Frac Tanks	Ea.	See separate Assumptions sheet				3	2.0	2.0	100%	3.3	3.3	13.3	13.3	$ -	$ 200.00	$ -		$ -	$ 200.00	$ -	$ -	$ 4,000	$ 4,000	20	20	1,200	1,200
FFS 7.9 DRAFT 24			Monthly Rental (or Purchase)	704	704	Frac Tanks	Tank-Months	See separate Assumptions sheet							100%					$ 852.25		$ -		$ -	$ 852.25	$ 50,178	$ 50,178	$ 650,178	$ 650,178				
FFS 7.9 DRAFT 25			Cleaning	20	20	Frac Tanks	Ea.	See separate Assumptions sheet				1	2.0	1.0	100%	20.0	20.0	40.0	40.0	$ -	$ 1,500.00	$ -		$ -	$ 1,500.00	$ -	$ -	$ 30,000	$ 30,000				
FFS 7.9 DRAFT 26			Removal	20	20	Frac Tanks	Ea.	See separate Assumptions sheet				3	2.0	2.0	100%	3.3	3.3	13.3	13.3	$ -	$ 200.00	$ -		$ -	$ 200.00	$ -	$ -	$ 4,000	$ 4,000	20	20	1,200	1,200
FFS 7.9 DRAFT 27		Secondary Containment for Frac Tanks	Purchase and deliver liner & berm material	2,178	2,178	Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	354113200040	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	41.4	100%	0.9	0.9	37.6	37.6	$ 26.69	$ -	$ -	$ -	$ -	$ 26.69	$ 4,862	$ 4,862	$ 63,005	$ 63,005	182	182	7,280	7,280
FFS 7.9 DRAFT 28			Spread loose lift before compaction	2,178	2,178	Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	2.1	100%	1.0	1.0	3.3	3.3	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ 5,533	$ 5,533				
FFS 7.9 DRAFT 29			Compact Liner & Berms	1,556	1,556	Clay	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235640	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	1,300	1.5	2.0	100%	0.6	0.6	1.8	1.8	$ -	$ 0.62	$ -	$ 1.15	$ -	$ 1.77	$ -	$ -	$ 2,754	$ 2,754				
FFS 7.9 DRAFT 30		Leachate Storage &	Pumping from Excavation Site	16	14	Leachate	Day	RS Means, Year 2016 Quarter 1	312319200650	Dewatering, pumping 8 hours, attended 2 hrs per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose	B10I	4	1.5	1.0	100%	4.1	3.6	6.2	5.4	$ -	$ 201.71	$ -	$ 38.99	$ -	$ 240.70	$ -	$ -	$ 3,963	$ 3,457				
FFS 7.9 DRAFT 31			Move Tank from Tank Area to Excavation Site	159	138	Tanks	Ea.	See separate Assumptions sheet				4	2.0	1.0	100%	39.8	34.5	79.5	69.0	$ -	$ 70.00	$ -	$ 70.00	$ -	$ 140.00	$ -	$ -	$ 22,260	$ 19,320				

Construction Cost Worksheet - FFS 7.9 DRAFT

Step #	Category	Sub-Category	Task	Quantity Area 1	Quantity Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Construction Days Area 1	Construction Days Area 2	Crew Man-days Area 1	Crew Man-days Area 2	Unit Costs Ext. Mat, O&P	Unit Costs Ext. Labor, O&P	Unit Costs Ext. Labor, O&P Ineff.	Unit Costs Ext. Equip, O&P	Unit Costs Ext. Equip, O&P Ineff.	Unit Costs Ext. Total, O&P	Bridgeton Taxes Area 1	Bridgeton Taxes Area 2	Total Cost Area 1	Total Cost Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Delivery Miles Area 1	Total Delivery Miles Area 2
FFS 7.9 DRAFT 32		Testing	Leachate Sampling	159	138	Lab Tests	Ea.	RS Means, Year 2016 Quarter 1	029110100100	Field testing equipment, sampling & testing soil/sediment, sample collection, field samples, sludge	1 Skwk	32	1.0	1.0	100%	5.0	4.3	5.0	4.3	$ -	$ 20.28	$ -	$ -	$ -	$ 20.28	$ -	$ -	$ 3,225	$ 2,799				
FFS 7.9 DRAFT 33			Leachate Testing - VOC's	159	138	Lab Tests	Ea.	RS Means, Year 2016 Quarter 1	029110100600	Laboratory analytical services, laboratory testing, volatile organics without GC/MS					100%					$ 173.20	$ -	$ -	$ -	$ -	$ 173.20	$ 2,303	$ 1,999	$ 29,842	$ 25,900				
FFS 7.9 DRAFT 34			Hauling and Disposal	3,161,453	2,757,173	Leachate	Gallons	See separate Assumptions sheet			B34B	5,000	1.0	2.0	100%	316.1	275.7	632.3	551.4	$ -	$ 0.28	$ -	$ 0.28	$ -	$ 0.57	$ -	$ -	$ 1,798,867	$ 1,568,832	633	552	379,800	331,200
FFS 7.9 DRAFT 35			Budget for Contaminated Stormwater Prevention or Disposal	66	97	Budget	Months	Budgeted Monthly Amount							100%					$ 10,000.00		$ -		$ -	$ 10,000.00	$ 55,331	$ 81,500	$ 716,950	$ 1,056,030				
FFS 7.9 DRAFT 36	RIM Loading Station	Structure	Structure Construction	1	-	Clear Span Structure	Ea.	See separate Assumptions sheet			Structure Construction Crew	0	30.0	1	100%	110.0	-	3,300.0	-	$ 4,800,000		$ -		$ -	$ 4,800,000.00	$ 401,424	$ -	$ 5,201,424	$ -				
FFS 7.9 DRAFT 37			Demolition	1	-	Clear Span Structure	Ea.	See separate Assumptions sheet			Structure Demolition Crew	0	30.0	1	100%	15.0	-	450.0	-	$ -	$ 80,000.00	$ -	$ 80,000.00	$ -	$ 160,000.00	$ -	$ -	$ 160,000	$ -				
FFS 7.9 DRAFT 38		Air Treatment System	Startup Capital Expenses	1	-	Air Treatment System	Ea.	See separate Assumptions sheet			Treatment System Crew	0	7.1	1	100%	10.0	-	71.0	-	$ 386,200.00	$ 122,600	$ -		$ -	$ 508,800.00	$ 32,298	$ -	$ 541,098	$ -	9	-	9,360	-
FFS 7.9 DRAFT 39			Vessel Rental Costs (Project Total)	1	-	Air Treatment System	Ea.	See separate Assumptions sheet							100%			-	-	$ 3,168,000.00		$ -		$ -	$ 3,168,000.00	$ 264,940	$ -	$ 3,432,940	$ -				
FFS 7.9 DRAFT 40			Blower Costs (Purchase or Rental Total)	1	-	Air Treatment System	Ea.	See separate Assumptions sheet							100%			-	-	$ 975,000.00		$ -		$ -	$ 975,000.00	$ 81,539	$ -	$ 1,056,539	$ -				
FFS 7.9 DRAFT 41			Media Replacement (for all vessels)	5	-	Air Treatment System Media	Instances	See separate Assumptions sheet			Treatment System Crew	0	4.0	1	100%	37.5	-	150.0	-	$ 432,000.00		$ -		$ -	$ 432,000.00	$ 180,641	$ -	$ 2,340,641	$ -				
FFS 7.9 DRAFT 42			Demobilization	1	-	Air Treatment System	Ea.	See separate Assumptions sheet			Treatment System Crew	0	3.5	1	100%	11.6	-	41.0	-	$ 85,000.00	$ 36,000.00	$ -		$ -	$ 121,000.00	$ 7,109	$ -	$ 128,109	$ -	9	-	9,360	-
FFS 7.9 DRAFT 43		Haul Road Improvements	Fencing along road for RIM hauling	1,600	1,600	Fencing	L.F.	RS Means, Year 2016 Quarter 1	323113200800	Fence, chain link industrial, galvanized steel, 6 ga. wire, 2" posts @ 10' OC, 6' high, includes excavation, & concrete, excludes barbed wire	B80C	250	3.0	2.0	100%	3.2	3.2	19.2	19.2	$ 23.25	$ 5.80	$ -	$ 1.28	$ -	$ 30.33	$ 3,111	$ 3,111	$ 51,639	$ 51,639				
FFS 7.9 DRAFT 44			Silt Fencing along road for RIM hauling	58,000	108,000	Silt Fence	Per L.F., per Month	See separate Assumptions sheet		Monthly cost for Silt fence, 3' high. Install, maintain monthly, and replace each 6 months.	B62	3,120	3.0	1.0	100%	18.6	34.6	55.8	103.8	$ 0.11	$ 0.27	$ -	$ 0.27	$ -	$ 0.64	$ 525	$ 978	$ 37,742	$ 70,278				
FFS 7.9 DRAFT 45			Remove potentially contaminated road surface	356	356	Roadway Gravel	B.C.Y.	RS Means, Year 2016 Quarter 1	312316465000	Excavating, bulk, dozer, open site, bank measure, sand and gravel, 300 H.P. dozer, 50' haul	B10M	1,900	1.5	1.0	100%	0.2	0.2	0.3	0.3	$ -	$ 0.43	$ -	$ 1.23	$ -	$ 1.66	$ -	$ -	$ 590	$ 590				
FFS 7.9 DRAFT 46			Loading for previous line	356	356	Roadway Gravel	B.C.Y.	RS Means, Year 2016 Quarter 1	312316421250 A	Excavating, bulk bank measure, for loading onto trucks, add	B10O	5,016	1.5	1.0	100%	0.1	0.1	0.1	0.1	$ -	$ 0.16	$ -	$ 0.24	$ -	$ 0.40	$ -	$ -	$ 142	$ 142				
FFS 7.9 DRAFT 47			Hauling for previous line	427	427	Roadway Gravel	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205060	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2000 ft, 10 MPH, excludes loading equipment	B34F	594	1.0	1.0	100%	0.7	0.7	0.7	0.7	$ -	$ 0.83	$ -	$ 3.20	$ -	$ 4.03	$ -	$ -	$ 1,719	$ 1,719				
FFS 7.9 DRAFT 48			Repairs to road remediation	2,133	2,133	Gravel Roads	S.Y.	RS Means, Year 2016 Quarter 1	015523500100	Temporary, roads, gravel fill, 8" gravel depth, excl surfacing	B14	615	6.0	1.0	100%	3.5	3.5	20.8	20.8	$ 8.21	$ 5.06	$ -	$ 0.73	$ -	$ 14.00	$ 1,465	$ 1,465	$ 31,331	$ 31,331				
FFS 7.9 DRAFT 49		Mobilization	Mobilize and Demobilize Equipment by Pickup Truck	16	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501200	Mobilization or demobilization, delivery charge for small equipment, placed in rear of, or towed by pickup truck	A3A	4	1.0	1.0	100%	4.0	-	4.0	-	$ -	$ 157.34	$ -	$ 48.59	$ -	$ 205.93	$ -	$ -	$ 3,295	$ -				
FFS 7.9 DRAFT 50			Extra Mileage for Mobilizations	240	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501200 A	Mobilization or demobilization, each additional 5 miles haul distance, add	A3A	72	1.0	1.0	100%	3.3	-	3.3	-	$ -	$ 15.73	$ -	$ 4.86	$ -	$ 20.59	$ -	$ -	$ 4,942	$ -				
FFS 7.9 DRAFT 51			Mobilize and Demobilize Equipment by 3-Ton Trailer	6	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501300	Mobilization or demobilization, delivery charge for equipment, hauled on 3-ton capacity towed trailer	A3Q	3	1.0	1.0	100%	2.2	-	2.2	-	$ -	$ 235.49	$ -	$ 84.19	$ -	$ 319.68	$ -	$ -	$ 1,918	$ -				
FFS 7.9 DRAFT 52			Extra Mileage for Mobilizations	90	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501300 A	Mobilization or demobilization, each additional 5 miles haul distance, add	A3Q	72	1.0	1.0	100%	1.3	-	1.3	-	$ -	$ 23.55	$ -	$ 8.42	$ -	$ 31.97	$ -	$ -	$ 2,877	$ -				
FFS 7.9 DRAFT 53			Mobilize and Demobilize Equipment by 20-Ton Trailer	36	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501400	Mobilization or demobilization, delivery charge for equipment, hauled on 20-ton capacity towed trailer	B34U	2	2.0	3.0	100%	6.0	-	36.0	-	$ -	$ 591.36	$ -	$ 293.80	$ -	$ 885.16	$ -	$ -	$ 31,866	$ -				
FFS 7.9 DRAFT 54			Extra Mileage for Mobilizations	540	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501400 A	Mobilization or demobilization, each additional 5 miles haul distance, add	B34U	72	2.0	3.0	100%	2.5	-	15.0	-	$ -	$ 59.14	$ -	$ 29.38	$ -	$ 88.52	$ -	$ -	$ 47,801	$ -				
FFS 7.9 DRAFT 55			Mobilize and Demobilize Equipment by 40-Ton Trailer	50	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501500	Mobilization or demobilization, delivery charge for equipment, hauled on 40-ton capacity towed trailer	B34N	2	2.0	5.0	100%	5.0	-	50.0	-	$ -	$ 601.92	$ -	$ 468.95	$ -	$ 1,070.87	$ -	$ -	$ 53,544	$ -				
FFS 7.9 DRAFT 56			Extra Mileage for Mobilizations	750	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501500 A	Mobilization or demobilization, each additional 5 miles haul distance, add	B34N	72	2.0	5.0	100%	2.1	-	20.8	-	$ -	$ 60.19	$ -	$ 46.90	$ -	$ 107.09	$ -	$ -	$ 80,318	$ -				
FFS 7.9 DRAFT 57			Mobilize and Demobilize Crane Equipment (more than 75 tons)	2	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501800	Mobilization or demobilization, crane, truck-mounted, over 75 ton, (with chase vehicle)	A3E	3	2.0	1.0	100%	0.8	-	1.6	-	$ -	$ 485.76	$ -	$ 77.97	$ -	$ 563.73	$ -	$ -	$ 1,127	$ -				
FFS 7.9 DRAFT 58			Extra Mileage for Mobilizations	30	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501800 A	Mobilization or demobilization, each additional 5 miles haul distance, add	A3E	72	2.0	1.0	100%	0.4	-	0.8	-	$ -	$ 48.58	$ -	$ 7.80	$ -	$ 56.38	$ -	$ -	$ 1,691	$ -				
FFS 7.9 DRAFT 59			Mobilize and Demobilize Equipment by Pickup Truck	16	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501200	Mobilization or demobilization, delivery charge for small equipment, placed in rear of, or towed by pickup truck	A3A	4	1.0	1.0	100%	4.0	-	4.0	-	$ -	$ 157.34	$ -	$ 48.59	$ -	$ 205.93	$ -	$ -	$ 3,295	$ -				
FFS 7.9 DRAFT 60			Extra Mileage for Mobilizations	240	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501200 A	Mobilization or demobilization, each additional 5 miles haul distance, add	A3A	72	1.0	1.0	100%	3.3	-	3.3	-	$ -	$ 15.73	$ -	$ 4.86	$ -	$ 20.59	$ -	$ -	$ 4,942	$ -				
FFS 7.9 DRAFT 61			Mobilize and Demobilize Equipment by 3-Ton Trailer	6	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501300	Mobilization or demobilization, delivery charge for equipment, hauled on 3-ton capacity towed trailer	A3Q	3	1.0	1.0	100%	2.2	-	2.2	-	$ -	$ 235.49	$ -	$ 84.19	$ -	$ 319.68	$ -	$ -	$ 1,918	$ -				

Construction Cost Worksheet - FFS 7.9 DRAFT

Step #	Category	Sub-Category	Task	Quantity Area 1	Quantity Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Construction Days Area 1	Construction Days Area 2	Crew Man-days Area 1	Crew Man-days Area 2	Unit Costs Ext. Mat, O&P	Ext. Labor, O&P	Ext. Labor, O&P Ineff.	Ext. Equip, O&P	Ext. Equip, O&P Ineff.	Ext. Total, O&P	Bridgeton Taxes Area 1	Bridgeton Taxes Area 2	Total Cost Area 1	Total Cost Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Delivery Miles Area 1	Total Delivery Miles Area 2
FFS 7.9 DRAFT 62		Supplemental Mobilizations	Extra Mileage for Mobilizations	90	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501300 A	Mobilization or demobilization, each additional 5 miles haul distance, add	A3Q	72	1.0	1.0	100%	1.3	-	1.3	-	$ -	$ 23.55	$ -	$ 8.42	$ -	$ 31.97	$ -	$ -	$ 2,877	$ -				
FFS 7.9 DRAFT 63			Mobilize and Demobilize Equipment by 20-Ton Trailer	36	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501400	Mobilization or demobilization, delivery charge for equipment, hauled on 20-ton capacity towed trailer	B34U	2	2.0	3.0	100%	6.0	-	36.0	-	$ -	$ 591.36	$ -	$ 293.80	$ -	$ 885.16	$ -	$ -	$ 31,866	$ -				
FFS 7.9 DRAFT 64			Extra Mileage for Mobilizations	540	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501400 A	Mobilization or demobilization, each additional 5 miles haul distance, add	B34U	72	2.0	3.0	100%	2.5	-	15.0	-	$ -	$ 59.14	$ -	$ 29.38	$ -	$ 88.52	$ -	$ -	$ 47,801	$ -				
FFS 7.9 DRAFT 65			Mobilize and Demobilize Equipment by 40-Ton Trailer	50	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501500	Mobilization or demobilization, delivery charge for equipment, hauled on 40-ton capacity towed trailer	B34N	2	2.0	5.0	100%	5.0	-	50.0	-	$ -	$ 601.92	$ -	$ 468.95	$ -	$ 1,070.87	$ -	$ -	$ 53,544	$ -				
FFS 7.9 DRAFT 66			Extra Mileage for Mobilizations	750	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501500 A	Mobilization or demobilization, each additional 5 miles haul distance, add	B34N	72	2.0	5.0	100%	2.1	-	20.8	-	$ -	$ 60.19	$ -	$ 46.90	$ -	$ 107.09	$ -	$ -	$ 80,318	$ -				
FFS 7.9 DRAFT 67			Mobilize and Demobilize Crane Equipment (more than 75 tons)	2	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501800	Mobilization or demobilization, crane, truck-mounted, over 75 ton, (with chase vehicle)	A3E	3	2.0	1.0	100%	0.8	-	1.6	-	$ -	$ 485.76	$ -	$ 77.97	$ -	$ 563.73	$ -	$ -	$ 1,127	$ -				
FFS 7.9 DRAFT 68			Extra Mileage for Mobilizations	30	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501800 A	Mobilization or demobilization, each additional 5 miles haul distance, add	A3E	72	2.0	1.0	100%	0.4	-	0.8	-	$ -	$ 48.58	$ -	$ 7.80	$ -	$ 56.38	$ -	$ -	$ 1,691	$ -				
FFS 7.9 DRAFT 69		Traffic Improvements	Create Temporary Roads	15,467	26,667	Gravel Roads	S.Y.	RS Means, Year 2016 Quarter 1	015523500050	Temporary, roads, gravel fill, 4" gravel depth, excl surfacing	B14	715	6.0	1.0	100%	21.6	37.3	129.8	223.8	$ 4.10	$ 4.35	$ -	$ 0.63	$ -	$ 9.08	$ 5,303	$ 9,144	$ 145,741	$ 251,277				
FFS 7.9 DRAFT 70			Bridge from Area 1 to Area 2 over Site Entrance Road	1	-	Modular Bridge	Ea.	See separate Assumptions sheet			Bridge Construction Crew	0	1.0	1.0	100%	9.0	-	143.2	-	$ 230,000					$ 266,000.00	$ 19,235	$ -	$ 285,235	$ -	549		21,410	
FFS 7.9 DRAFT 71			Bridge Demolition	1	-	Modular Bridge	Ea.	See separate Assumptions sheet			Bridge Construction Crew	2	1.0	1.0	100%	0.5	-	2.0	-	$ -	$ 2,350.00				$ 2,350.00	$ -	$ -	$ 2,350	$ -				
FFS 7.9 DRAFT 72			Extend Permanent Road to new Transfer Station Location	2,000	-	Roadway	Ft.	Estimate			B25	34	11.0	1.0	100%	58.5	-	643.1	-	$ 190.00					$ 190.00	$ 31,779	$ -	$ 411,779	$ -				
FFS 7.9 DRAFT 73			Budget for Add'l Traffic Improvements	$ 108,000	$ 108,000	TBD (shown as budget estimate)	$	SFS budget (plus inflation)					6.0	1.0	100%	10.0	10.0	60.0	60.0	$ 1.00					$ 1.00	$ 9,032	$ 9,032	$ 117,032	$ 117,032				
FFS 7.9 DRAFT 74		Dust Control	Water Truck Depreciation	1	1	Water Trucks	Trucks	Estimate												$ 55,000.00					$ 55,000.00	$ 4,600	$ 4,600	$ 59,600	$ 59,600				
FFS 7.9 DRAFT 75			Water Truck Operation	74	106	Water Trucks	Months	Estimate				0	1.0	1.0	100%	2,254	3,212	2,253.8	3,212.2	$ -					$ 19,790.74	$ -	$ -	$ 1,465,428	$ 2,088,631				
FFS 7.9 DRAFT 76			Use Water to Control Dust	3.38E+07	4.82E+07	Water	Gallons	Missouri American Water Company, 7/19/2016							100%					$ -					$ 0.00	$ -	$ -	$ 114,943	$ 163,824				
FFS 7.9 DRAFT 77	Site Preparation		Prepare area with Stormwater BMPs	5,378	7,781	Erosion Control Measures	L.F.	RS Means, Year 2016 Quarter 1	312514161250	Synthetic erosion control, hay bales, staked	A2	2,500	3.0	1.0	100%	2.2	3.1	6.5	9.3	$ 3.56	$ 0.54	$ -	$ 0.12	$ -	$ 4.22	$ 1,601	$ 2,317	$ 24,296	$ 35,152				
FFS 7.9 DRAFT 78		Decontamination Area	Floor	56	56	Concrete	C.Y.	RS Means, Year 2016 Quarter 1	033113350300	Structural concrete, ready mix, heavyweight, 4000 psi, includes local aggregate, sand, Portland cement (Type I) and water, delivered, excludes all additives and treatments					100%					$ 113.96	$ -	$ -	$ -	$ -	$ 113.96	$ 529	$ 529	$ 6,861	$ 6,861				
FFS 7.9 DRAFT 79			Floor Installation	56	56	Concrete	C.Y.	RS Means, Year 2016 Quarter 1	033113704650	Structural concrete, placing, slab on grade, pumped, over 6" thick, includes leveling (strike off) & consolidation, excludes material	C20	185	8.0	1.0	100%	0.3	0.3	2.4	2.4	$ -	$ 22.40	$ -	$ 5.31	$ -	$ 27.71	$ -	$ -	$ 1,539	$ 1,539				
FFS 7.9 DRAFT 80			Building	1,000	1,000	Steel Building	SF Flr.	RS Means, Year 2016 Quarter 1	133419500170	Pre-engineered steel building, clear span rigid frame, 30 psf roof and 20 psf wind load, 20' to 29' W x 16' eave H, incl. 26 ga. colored ribbed roofing & siding, excl. footings, slab, anchor bolts	E2	320	7.0	1.0	100%	3.1	3.1	21.9	21.9	$ 10.54	$ 15.61	$ -	$ 5.93	$ -	$ 32.08	$ 881	$ 881	$ 32,961	$ 32,961				
FFS 7.9 DRAFT 81		Clearing & Grubbing	Clear Vegetation (Light)	0	3	Vegetation	Acre	RS Means, Year 2016 Quarter 1	311313101020	Selective tree and shrub removal, selective clearing brush mowing, light density, tractor with rotary mower, excludes removal offsite	B84	2	1.0	1.0	100%	0.1	1.3	0.1	1.3	$ -	$ 296.36	$ -	$ 229.39	$ -	$ 525.75	$ -	$ -	$ 110	$ 1,383				
FFS 7.9 DRAFT 82			Clear Vegetation (Heavy)	8	15	Vegetation	Acre	RS Means, Year 2016 Quarter 1	311110100020	Clearing & grubbing, cut & chip light trees, to 6" diameter	B7	1	6.0	1.0	100%	8.5	15.3	50.9	91.7	$ -	$ 2,844.10	$ -	$ 2,090.50	$ -	$ 4,934.60	$ -	$ -	$ 41,895	$ 75,450				
FFS 7.9 DRAFT 83			Clear Small Trees	117	355	Trees	Ea.	RS Means, Year 2016 Quarter 1	311313201650	Selective felling trees and piling, large tract clearing & piling, firm level terrain, no boulders, hardwood, per tree, 300 H.P. dozer, 12" to 24" diameter	B10M	80	1.5	8.0	100%	0.2	0.6	2.2	6.7	$ -	$ 10.18	$ -	$ 29.38	$ -	$ 39.56	$ -	$ -	$ 4,629	$ 14,044				
FFS 7.9 DRAFT 84			Clear Large Trees	33	98	Trees	Ea.	RS Means, Year 2016 Quarter 1	311313201750	Selective felling trees and piling, large tract clearing & piling, firm level terrain, no boulders, hardwood, per tree, 300 H.P. dozer, 24" to 36" diameter	B10M	50	1.5	4.0	100%	0.2	0.5	1.0	2.9	$ -	$ 16.25	$ -	$ 46.90	$ -	$ 63.15	$ -	$ -	$ 2,084	$ 6,189				
FFS 7.9 DRAFT 85			Clear Small Stumps	117	355	Trees	Ea.	RS Means, Year 2016 Quarter 1	311313202100	Selective clearing and grubbing, 1-1/2 C.Y. excavator, 14" to 24" diameter, stump removal on site by hydraulic excavator	B30	25	3.0	2.0	100%	2.3	7.1	14.0	42.6	$ -	$ 63.57	$ -	$ 119.78	$ -	$ 183.35	$ -	$ -	$ 21,452	$ 65,089				
FFS 7.9 DRAFT 86			Clear Large Stumps	33	98	Trees	Ea.	RS Means, Year 2016 Quarter 1	311313202150	Selective clearing and grubbing, 1-1/2 C.Y. excavator, 26" to 36" diameter, stump removal on site by hydraulic excavator	B30	16	3.0	2.0	100%	1.0	3.1	6.2	18.4	$ -	$ 99.42	$ -	$ 187.58	$ -	$ 287.00	$ -	$ -	$ 9,471	$ 28,126				
FFS 7.9 DRAFT 87		Bird Mitigation	Average Monthly Expense	71	98	Months	Months	See separate Assumptions sheet			Bird Mitigation Crew	0.03	2.0	1.0	100%	2,160.0	2,996.5	4,320.0	5,992.9	$ 14,700.00	$ 18,300	$ -		$ -	$ 33,000.00	$ 87,242	$ 121,026	$ 2,429,090	$ 3,369,763				
FFS 7.9 DRAFT 88		Temporary Gas System for Stockpile in Area 2	Capital Expenses	1	-	Temporary Gas System	Ea.	See separate Assumptions sheet				0	6.0	1.0	100%	62.0	-	372.0	-	$ 41,107.50					$ 279,157.50	$ 3,438	$ -	$ 282,595	$ -				
FFS 7.9 DRAFT 89			Monthly Expenses	71	-	Months	Months	See separate Assumptions sheet				1	1.0	1.0	100%	77.1	-	77.1	-	$ -					$ 6,642.78	$ -	$ -	$ 471,405	$ -				
FFS 7.9 DRAFT 90			Apply daily cover to remaining excavation	78,264	-	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	130.4	-	965.3	-	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ 82,666	$ -	$ 2,449,130	$ -	10,762	-	161,430	-

Construction Cost Worksheet - FFS 7.9 DRAFT

				Quantity												Construction Days		Crew Man-days		Unit Costs						Bridgeton Taxes		Total Cost		Delivery Truckloads		Total Delivery Miles	
Step #	Category	Sub-Category	Task	Area 1	Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Area 1	Area 2	Area 1	Area 2	Ext. Mat, O&P	Ext. Labor, O&P	Ext. Labor, O&P Ineff.	Ext. Equip, O&P	Ext. Equip, O&P Ineff.	Ext. Total, O&P	Area 1	Area 2	Area 1	Area 2	Area 1	Area 2	Area 1	Area 2
FFS 7.9 DRAFT 91	Excavate Waste	Area 1	Excavate and Sort RIM and Overburden (incl. minor sources)	868,696	-	RIM and Overburden	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	362.0	-	1,447.8	-	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ 2,970,941	$ -				
FFS 7.9 DRAFT 92		Area 2 SW	Apply daily cover to remaining excavation	-	34,482	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	57.5	-	425.3	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 36,421	$ -	$ 1,079,049	-	4,742	-	71,130
FFS 7.9 DRAFT 93			Excavate and Sort RIM and Overburden (incl. minor sources)	-	396,731	RIM and Overburden	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	-	165.3	-	661.2	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ -	$ 1,356,821				
FFS 7.9 DRAFT 94		Area 2 NE	Apply daily cover to remaining excavation	-	33,774	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	56.3	-	416.5	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 35,673	$ -	$ 1,056,891	-	4,644	-	69,660
FFS 7.9 DRAFT 95			Excavate and Sort RIM and Overburden (NOT incl. minor sources)	-	389,150	RIM and Overburden	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	-	162.1	-	648.6	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ -	$ 1,330,892				
FFS 7.9 DRAFT 96	Handle Excavated RIM	Area 1	Load piled RIM into Haul Trucks	50,865	-	RIM	B.C.Y.	RS Means, Year 2016 Quarter 1	312316421250	Excavating, bulk bank measure, 2-1/2 C.Y. capacity = 95 C.Y./hour, front end loader, track mounted, excluding truck loading	B10O	760	1.5	1.0	50%	133.9	-	200.8	-	$ -	$ 1.06	$ 1.06	$ 1.58	$ 1.58	$ 5.28	$ -	$ -	$ 268,568	$ -				
FFS 7.9 DRAFT 97			(additional cost to previous line)	50,865	-	RIM		RS Means, Year 2016 Quarter 1	312316421250 A	Excavating, bulk bank measure, for loading onto trucks, add	B10O	5,016	1.5	1.0	50%	20.3	-	30.4	-	$ -	$ 0.16	$ 0.16	$ 0.24	$ 0.24	$ 0.80	$ -	$ -	$ 40,692	$ -				
FFS 7.9 DRAFT 98			Haul RIM to on-site Loading Station (incl. RIM from minor sources)	76,298	-	RIM	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	36.3	-	204.0	-	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ 489,831	$ -				
FFS 7.9 DRAFT 99			RIM Hauling & Disposal (during 3-month learning curve for loading)	4,688	-	RIM	L.C.Y.	Off-site Disposal Facility estimate	See Assumptions	Custom line item: Transport and dispose of RIM at off-site disposal facility. Assume 3-month learning curve from 0 to 100% production (averaging 50%).	RIM Shipping Crew	150	8.0	1.0	50%	62.5	-	500.0	-	$ -	$ 114.50		$ 114.50		$ 229.00	$ -	$ -	$ 1,073,438	$ -	314	-	14,130	-
FFS 7.9 DRAFT 100			RIM Hauling & Disposal (normal production)	71,610	-	RIM	L.C.Y.	Off-site Disposal Facility estimate	See Assumptions	Custom line item: Transport and dispose of RIM at off-site disposal facility. (Full production for remainder of project.)	RIM Shipping Crew	150	8.0	1.0	100%	477.4	-	3,819.2	-	$ -	$ 114.50		$ 114.50		$ 229.00	$ -	$ -	$ 16,398,724	$ -	4,776	-	214,920	-
FFS 7.9 DRAFT 101			Off-Site Disposal Facility Coordinator	652	-	Personnel	Work Days	Off-site Disposal Facility estimate	See Assumptions	Custom line item: Oversight of RIM shipping process by off-site disposal facility's coordinator.	Coordinator	1	1.0	1.0	100%	652.0	-	652.0	-	$ -	$ 1,100.00	$ -		$ -	$ 1,100.00	$ -	$ -	$ 717,200	$ -				
FFS 7.9 DRAFT 102			RIM Loading Crew	652	-	Personnel	Work Days	See separate Assumptions sheet	See Assumptions	Custom line item: Stockpile and Load RIM in RIM Loading Station	RIM Loading Crew	1	4.0	1.0	100%	652.0	-	2,608.0	-	$ -	$ 3,908.80	$ -		$ -	$ 3,908.80	$ -	$ -	$ 2,548,538	$ -				
FFS 7.9 DRAFT 103		Area 2 SW	Load piled RIM into Haul Trucks	-	121,553	RIM	B.C.Y.	RS Means, Year 2016 Quarter 1	312316421250	Excavating, bulk bank measure, 2-1/2 C.Y. capacity = 95 C.Y./hour, front end loader, track mounted, excluding truck loading	B10O	760	1.5	2.0	50%	-	159.9	-	479.8	$ -	$ 1.06	$ 1.06	$ 1.58	$ 1.58	$ 5.28	$ -	$ -	$ -	$ 641,801				
FFS 7.9 DRAFT 104			(additional cost to previous line)	-	121,553	RIM		RS Means, Year 2016 Quarter 1	312316421250 A	Excavating, bulk bank measure, for loading onto trucks, add	B10O	5,016	1.5	2.0	50%	-	24.2	-	72.7	$ -	$ 0.16	$ 0.16	$ 0.24	$ 0.24	$ 0.80	$ -	$ -	$ -	$ 97,243				
FFS 7.9 DRAFT 105			Haul RIM to on-site Loading Station (incl. RIM from minor sources)	-	186,677	RIM	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205100	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 1 mile, 10 MPH, excludes loading equipment	B34F	506	1.0	4.2	100%	-	88.9	-	368.9	$ -	$ 0.98	$ -	$ 3.75	$ -	$ 4.73	$ -	$ -	$ -	$ 882,980				
FFS 7.9 DRAFT 106			RIM Hauling & Disposal (normal production)	-	186,677	RIM	L.C.Y.	Off-site Disposal Facility estimate	See Assumptions	Custom line item: Transport and dispose of RIM at off-site disposal facility. (Full production for remainder of project.)	RIM Shipping Crew	1,000	30.0	1.0	100%	-	186.7	-	5,600.3	$ -	$ 114.50		$ 114.50		$ 229.00	$ -	$ -	$ -	$ 42,748,927	-	12,446	-	560,070
FFS 7.9 DRAFT 107			Off-Site Disposal Facility Coordinator	-	386	Personnel	Work Days	Off-site Disposal Facility estimate	See Assumptions	Custom line item: Oversight of RIM shipping process by off-site disposal facility's coordinator.	Coordinator	1	1.0	1.0	100%	-	386.0	-	386.0	$ -	$ 1,100.00	$ -		$ -	$ 1,100.00	$ -	$ -	$ -	$ 424,600				
FFS 7.9 DRAFT 108			RIM Loading Crew	-	386	Personnel	Work Days	See separate Assumptions sheet	See Assumptions	Custom line item: Stockpile and Load RIM in RIM Loading Station	RIM Loading Crew	1	13.0	1.0	100%	-	386.0	-	5,018.0	$ -	$ 10,142.60	$ -		$ -	$ 10,142.60	$ -	$ -	$ -	$ 3,915,044				
FFS 7.9 DRAFT 109		Area 2 NE	Load piled RIM into Haul Trucks	-	120,479	RIM	B.C.Y.	RS Means, Year 2016 Quarter 1	312316421250	Excavating, bulk bank measure, 2-1/2 C.Y. capacity = 95 C.Y./hour, front end loader, track mounted, excluding truck loading	B10O	760	1.5	2.0	50%	-	158.5	-	475.6	$ -	$ 1.06	$ 1.06	$ 1.58	$ 1.58	$ 5.28	$ -	$ -	$ -	$ 636,128				
FFS 7.9 DRAFT 110			(additional cost to previous line)	-	120,479	RIM		RS Means, Year 2016 Quarter 1	312316421250 A	Excavating, bulk bank measure, for loading onto trucks, add	B10O	5,016	1.5	2.0	50%	-	24.0	-	72.1	$ -	$ 0.16	$ 0.16	$ 0.24	$ 0.24	$ 0.80	$ -	$ -	$ -	$ 96,383				
FFS 7.9 DRAFT 111			Haul RIM to on-site Loading Station (NOT incl. RIM from minor sources)	-	180,718	RIM	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	-	86.1	-	483.2	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ -	$ 1,160,210				
FFS 7.9 DRAFT 112			RIM Hauling & Disposal (normal production)	-	180,718	RIM	L.C.Y.	Off-site Disposal Facility estimate	See Assumptions	Custom line item: Transport and dispose of RIM at off-site disposal facility. (Full production for remainder of project.)	RIM Shipping Crew	1,000	30.0	1.0	100%	-	180.7	-	5,421.5	$ -	$ 114.50		$ 114.50		$ 229.00	$ -	$ -	$ -	$ 41,384,439	-	12,048	-	542,160
FFS 7.9 DRAFT 113			Off-Site Disposal Facility Coordinator	-	286	Personnel	Work Days	Off-site Disposal Facility estimate	See Assumptions	Custom line item: Oversight of RIM shipping process by off-site disposal facility's coordinator.	Coordinator	1	1.0	1.0	100%	-	286.0	-	286.0	$ -	$ 1,100.00	$ -		$ -	$ 1,100.00	$ -	$ -	$ -	$ 314,600				
FFS 7.9 DRAFT 114			RIM Loading Crew	-	286	Personnel	Work Days	See separate Assumptions sheet	See Assumptions	Custom line item: Stockpile and Load RIM in RIM Loading Station	RIM Loading Crew	1	13.0	1.0	100%	-	286.0	-	3,718.0	$ -	$ 10,142.60	$ -		$ -	$ 10,142.60	$ -	$ -	$ -	$ 2,900,784				
FFS 7.9 DRAFT 115			Load Overburden directly into Haul Trucks	818,611	-	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305 A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	51.9	-	207.4	-	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ 425,677	$ -				

Construction Cost Worksheet - FFS 7.9 DRAFT

Step #	Category	Sub-Category	Task	Quantity Area 1	Quantity Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Construction Days Area 1	Construction Days Area 2	Crew Man-days Area 1	Crew Man-days Area 2	Unit Costs Ext. Mat, O&P	Unit Costs Ext. Labor, O&P	Unit Costs Ext. Labor, O&P Ineff.	Unit Costs Ext. Equip, O&P	Unit Costs Ext. Equip, O&P Ineff.	Unit Costs Ext. Total, O&P	Bridgeton Taxes Area 1	Bridgeton Taxes Area 2	Total Cost Area 1	Total Cost Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Delivery Miles Area 1	Total Delivery Miles Area 2
FFS 7.9 DRAFT 116	Load and Haul Overburden	Area 1	Relocate Overburden to Area 2 NE Stockpile	1,227,916	-	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	584.7	-	3,283.2	-	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ 7,883,220	$ -				
FFS 7.9 DRAFT 117		Area 2 SW	Load Overburden directly into Haul Trucks	-	264,764	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305 A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	-	16.8	-	67.1	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ -	$ 137,677				
FFS 7.9 DRAFT 118			Relocate Overburden to backfill Area 1	-	397,146	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	-	189.1	-	1,061.9	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ -	$ 2,549,674				
FFS 7.9 DRAFT 119		Area 2 NE	Load Overburden directly into Haul Trucks	-	282,592	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305 A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	-	17.9	-	71.6	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ -	$ 146,948				
FFS 7.9 DRAFT 120			Relocate Overburden to Area 2 SW Stockpile	-	423,888	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	-	201.9	-	1,133.4	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ -	$ 2,721,364				
FFS 7.9 DRAFT 121	Place Overburden	Area 1 Overburden on NE Stockpile	Spread Overburden	1,227,916	-	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	409.3	-	1,841.9	-	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ 3,118,906	$ -				
FFS 7.9 DRAFT 122			Apply daily cover to stockpiled Overburden	81,861	-	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	136.4	-	1,009.6	-	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ 86,465	$ -	$ 2,561,698	$ -	11,256	-	168,840	-
FFS 7.9 DRAFT 123		Area 2 SW Overburden backfilled in Area 1	Spread Overburden	-	397,146	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	-	132.4	-	595.7	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 1,008,750				
FFS 7.9 DRAFT 124			Apply daily cover to backfilled Overburden	-	26,476	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	44.1	-	326.5	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 27,966	$ -	$ 828,532	-	3,641	-	54,615
FFS 7.9 DRAFT 125			Compact Overburden	-	291,240	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	-	56.0	-	168.0	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ -	$ 259,204				
FFS 7.9 DRAFT 126		Area 2 NE Overburden on SW Stockpile	Spread Overburden	-	423,888	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	-	141.3	-	635.8	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 1,076,677				
FFS 7.9 DRAFT 127			Apply daily cover to stockpiled Overburden	-	28,259	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	47.1	-	348.5	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 29,849	$ -	$ 884,323	-	3,886	-	58,290
FFS 7.9 DRAFT 128	Relocate Stockpiled Overburden from NE Stockpile	From NE Stockpile to backfill remaining Area 1 (to drainage grades)	Apply daily cover to remaining stockpile	29,829	-	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	49.7	-	367.9	-	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ 31,507	$ -	$ 933,441	$ -	4,102	-	61,530	-
FFS 7.9 DRAFT 129			Excavate Stockpile	328,117	-	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	136.7	-	546.9	-	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ 1,122,161	$ -				
FFS 7.9 DRAFT 130			Load into Haul Trucks	328,117	-	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305 A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	20.8	-	83.1	-	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ 170,621	$ -				
FFS 7.9 DRAFT 131			Relocate Overburden to backfill Area 1 (drainage grades)	492,176	-	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	234.4	-	1,316.0	-	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ 3,159,769	$ -				
FFS 7.9 DRAFT 132			Spread Overburden	492,176	-	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	164.1	-	738.3	-	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ 1,250,127	$ -				
FFS 7.9 DRAFT 133			Apply daily cover to backfilled material	32,812	-	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	54.7	-	404.7	-	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ 34,657	$ -	$ 1,026,785	$ -	4,512	-	67,680	-
FFS 7.9 DRAFT 134			Compact backfilled material	360,929	-	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	69.4	-	208.2	-	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ 321,227	$ -				
FFS 7.9 DRAFT 135		From NE Stockpile to backfill Area 2 SW (to drainage grades)	Apply daily cover to remaining stockpile	-	26,776	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	44.6	-	330.2	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 28,283	$ -	$ 837,923	-	3,682	-	55,230
FFS 7.9 DRAFT 136			Excavate Stockpile	-	294,541	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	-	122.7	-	490.9	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ -	$ 1,007,331				
FFS 7.9 DRAFT 137			Load into Haul Trucks	-	294,541	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305 A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	-	18.7	-	74.6	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ -	$ 153,161				
FFS 7.9 DRAFT 138			Relocate Overburden to backfill Area 2 SW (drainage grades)	-	441,812	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	-	210.4	-	1,181.3	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ -	$ 2,836,432				
FFS 7.9 DRAFT 139			Spread Overburden	-	441,812	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	-	147.3	-	662.7	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 1,122,202				
FFS 7.9 DRAFT 140			Apply daily cover to backfilled material	-	29,454	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	49.1	-	363.3	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 31,111	$ -	$ 921,715	-	4,050	-	60,750
FFS 7.9 DRAFT 141			Compact backfilled material	-	323,995	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	-	62.3	-	186.9	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ -	$ 288,356				
FFS 7.9 DRAFT 142			Apply daily cover to remaining stockpile	-	4,730	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	7.9	-	58.3	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 4,996	$ -	$ 148,015	-	651	-	9,765
FFS 7.9 DRAFT 143			Excavate Stockpile	-	52,029	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	-	21.7	-	86.7	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ -	$ 177,940				

Construction Cost Worksheet - FFS 7.9 DRAFT

Step #	Category	Sub-Category	Task	Quantity Area 1	Quantity Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Construction Days Area 1	Construction Days Area 2	Crew Man-days Area 1	Crew Man-days Area 2	Unit Costs Ext. Mat, O&P	Ext. Labor, O&P	Ext. Labor, O&P Ineff.	Ext. Equip, O&P	Ext. Equip, O&P Ineff.	Ext. Total, O&P	Bridgeton Taxes Area 1	Bridgeton Taxes Area 2	Total Cost Area 1	Total Cost Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Delivery Miles Area 1	Total Delivery Miles Area 2
FFS 7.9 DRAFT 144		From NE Stockpile to backfill Area 2 SW (to final grades)	Load into Haul Trucks	-	52,029	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305 A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	-	3.3	-	13.2	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ -	$ 27,055				
FFS 7.9 DRAFT 145			Relocate Overburden to backfill Area 2 SW (final grades)	-	78,044	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	-	37.2	-	208.7	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ -	$ 501,041				
FFS 7.9 DRAFT 146			Spread Overburden	-	78,044	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	-	26.0	-	117.1	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 198,231				
FFS 7.9 DRAFT 147			Apply daily cover to backfilled material	-	5,203	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	8.7	-	64.2	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 5,496	$ -	$ 162,816	-	716	-	10,740
FFS 7.9 DRAFT 148			Compact backfilled material	-	57,232	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	-	11.0	-	33.0	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ -	$ 50,937				
FFS 7.9 DRAFT 149		From any remaining NE Stockpile to SW Stockpile	Apply daily cover to remaining stockpile	-	28,712	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	47.9	-	354.1	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 30,327	$ -	$ 898,489	-	3,948	-	59,220
FFS 7.9 DRAFT 150			Excavate Stockpile	-	315,831	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	-	131.6	-	526.4	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ -	$ 1,080,143				
FFS 7.9 DRAFT 151			Load into Haul Trucks	-	315,831	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305 A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	-	20.0	-	80.0	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ -	$ 164,232				
FFS 7.9 DRAFT 152			Relocate Overburden to Area 2 SW Stockpile	-	473,747	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	-	225.6	-	1,266.7	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ -	$ 3,041,454				
FFS 7.9 DRAFT 153			Spread Overburden	-	473,747	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	-	157.9	-	710.6	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 1,203,317				
FFS 7.9 DRAFT 154			Apply daily cover to stockpiled material	-	31,583	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	52.6	-	389.5	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 33,360	$ -	$ 988,338	-	4,343	-	65,145
FFS 7.9 DRAFT 155	Relocate Stockpiled Overburden from SW Stockpile	From SW Stockpile to backfill Area 2 NE (to drainage grades)	Apply daily cover to remaining stockpile	-	47,948	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	79.9	-	591.4	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 50,645	$ -	$ 1,500,439	-	6,593	-	98,895
FFS 7.9 DRAFT 156			Excavate Stockpile	-	527,425	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	-	219.8	-	879.0	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ -	$ 1,803,792				
FFS 7.9 DRAFT 157			Load into Haul Trucks	-	527,425	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305 A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	-	33.4	-	133.7	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ -	$ 274,261				
FFS 7.9 DRAFT 158			Relocate Overburden to backfill Area 2 NE (drainage grades)	-	791,137	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	-	376.7	-	2,115.3	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ -	$ 5,079,100				
FFS 7.9 DRAFT 159			Spread Overburden	-	791,137	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	-	263.7	-	1,186.7	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 2,009,488				
FFS 7.9 DRAFT 160			Apply daily cover to backfilled material	-	52,742	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	87.9	-	650.5	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 55,709	$ -	$ 1,650,483	-	7,253	-	108,795
FFS 7.9 DRAFT 161			Compact backfilled material	-	580,167	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	-	111.6	-	334.7	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ -	$ 516,349				
FFS 7.9 DRAFT 162		From SW Stockpile to backfill Area 2 NE (to final grades)	Apply daily cover to remaining stockpile	-	17,879	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	29.8	-	220.5	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 18,885	$ -	$ 559,488	-	2,459	-	36,885
FFS 7.9 DRAFT 163			Excavate Stockpile	-	196,668	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	-	81.9	-	327.8	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ -	$ 672,604				
FFS 7.9 DRAFT 164			Load into Haul Trucks	-	196,668	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305 A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	-	12.5	-	49.8	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ -	$ 102,267				
FFS 7.9 DRAFT 165			Relocate Overburden to backfill Area 2 NE (final grades)	-	295,002	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	-	140.5	-	788.8	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ -	$ 1,893,910				
FFS 7.9 DRAFT 166			Spread Overburden	-	295,002	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	-	98.3	-	442.5	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 749,304				
FFS 7.9 DRAFT 167			Apply daily cover to backfilled material	-	19,667	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	32.8	-	242.6	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 20,773	$ -	$ 615,437	-	2,705	-	40,575
FFS 7.9 DRAFT 168			Compact backfilled material	-	216,335	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	-	41.6	-	124.8	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ -	$ 192,538				
FFS 7.9 DRAFT 169		Relocate	Apply daily cover to remaining excavation	1,958	1,822	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	3.3	3.0	24.1	22.5	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ 2,068	$ 1,924	$ 61,259	$ 57,004	270	251	4,050	3,765
FFS 7.9 DRAFT 170			Excavate	21,533	20,038	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	9.0	8.3	35.9	33.4	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ 73,644	$ 68,529				
FFS 7.9 DRAFT 171			Load into Haul Trucks	21,533	20,038	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305 A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	1.4	1.3	5.5	5.1	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ 11,197	$ 10,420				

Construction Cost Worksheet - FFS 7.9 DRAFT

Step #	Category	Sub-Category	Task	Quantity Area 1	Quantity Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Construction Days Area 1	Construction Days Area 2	Crew Man-days Area 1	Crew Man-days Area 2	Unit Costs Ext. Mat, O&P	Ext. Labor, O&P	Ext. Labor, O&P Ineff.	Ext. Equip, O&P	Ext. Equip, O&P Ineff.	Ext. Total, O&P	Bridgeton Taxes Area 1	Bridgeton Taxes Area 2	Total Cost Area 1	Total Cost Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Delivery Miles Area 1	Total Delivery Miles Area 2
FFS 7.9 DRAFT 172		within the same Area. (Area 1 and Area 2 SW)	Transport to new location	32,300	30,056	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205060	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2000 ft, 10 MPH, excludes loading equipment	B34F	594	1.0	3.5	100%	15.4	14.3	54.4	50.6	$ -	$ 0.83	$ -	$ 3.20	$ -	$ 4.03	$ -	$ -	$ 130,169	$ 121,127				
FFS 7.9 DRAFT 173			Spread Waste	32,300	30,056	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	10.8	10.0	48.4	45.1	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ 82,042	$ 76,343				
FFS 7.9 DRAFT 174			Apply daily cover to backfilled material	2,153	2,004	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	3.6	3.3	26.6	24.7	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ 2,274	$ 2,116	$ 67,385	$ 62,704	297	276	4,455	4,140
FFS 7.9 DRAFT 175	Reduce Slope Steepness		Compact backfilled material	23,687	22,041	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	4.6	4.2	13.7	12.7	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ 21,081	$ 19,617				
FFS 7.9 DRAFT 176			Apply daily cover to remaining excavation	-	2,299	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	3.8	-	28.4	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 2,428	$ -	$ 71,943	-	317	-	4,755
FFS 7.9 DRAFT 177			Excavate	-	25,289	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	-	10.5	-	42.1	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ -	$ 86,488		14		
FFS 7.9 DRAFT 178			Load into Haul Trucks	-	25,289	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305 A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	-	1.6	-	6.4	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ -	$ 13,150				
FFS 7.9 DRAFT 179		Same as above, for Area 2 NE	Transport to new location	-	37,934	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205060	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2000 ft, 10 MPH, excludes loading equipment	B34F	594	1.0	3.5	100%	-	18.1	-	63.9	$ -	$ 0.83	$ -	$ 3.20	$ -	$ 4.03	$ -	$ -	$ -	$ 152,872				
FFS 7.9 DRAFT 180			Spread Waste	-	37,934	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	-	12.6	-	56.9	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 96,351				
FFS 7.9 DRAFT 181			Apply daily cover to backfilled material	-	2,529	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	4.2	-	31.2	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 2,671	$ -	$ 79,137	-	348	-	5,220
FFS 7.9 DRAFT 182			Compact backfilled material	-	27,818	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	-	5.3	-	16.0	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ -	$ 24,758				
FFS 7.9 DRAFT 183			Relocate Stockpiled Material on-site - Excavate	7,794	35,069	C&D Rubble	B.C.Y.	RS Means, Year 2016 Quarter 1	312316305000	Drilling and blasting rock, less than 0.5 C.Y., excavate and load boulders	B10T	80	1.5	10.0	100%	9.7	43.8	146.1	657.5	$ -	$ 9.58	$ -	$ 6.56	$ -	$ 16.14	$ -	$ -	$ 125,795	$ 566,014				
FFS 7.9 DRAFT 184	Relocation of Other Waste	C&D Rubble Stockpiles	Relocate Stockpiled Material on-site - Haul and Dump	7,794	35,069	C&D Rubble	B.C.Y.	RS Means, Year 2016 Quarter 1	312316305400	Drilling and blasting rock, 25 ton off-highway dump, 1 mile round trip, haul boulders	B34E	330	1.0	5.3	100%	4.5	20.0	23.6	106.3	$ -	$ 0.17	$ -	$ 0.07	$ -	$ 0.24	$ -	$ -	$ 1,871	$ 8,417				
FFS 7.9 DRAFT 185			Bury Stockpiled Material	7,794	35,069	C&D Rubble	B.C.Y.	RS Means, Year 2016 Quarter 1	312316305620	Drilling and blasting rock, 300 H.P. dozer, less than 0.5 C.Y., 150' haul, bury boulders on site	B10M	310	1.5	12.0	100%	2.1	9.4	37.7	169.7	$ -	$ 1.49	$ -	$ 5.25	$ -	$ 6.74	$ -	$ -	$ 52,532	$ 236,365				
FFS 7.9 DRAFT 186	Buffer Zone		Buffer Zone Activity	-	1	See separate Assumptions sheet		See separate Assumptions sheet						1.0	100%	-	6.4	-	42.0	$ 35,337.43					$ 86,296.91	$ -	$ 2,955	$ -	$ 89,252				
FFS 7.9 DRAFT 187	Rad. Survey		Conduct final radiological survey and wait for approval	1	1	This activity is handled by others, and does not have a direct cost to the contractor. However, there are the indirect costs due to the duration and associated waiting.								1.0	100%	7.0	7.0	-	-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -				
FFS 7.9 DRAFT 188			Purchase material and spread	-	31,772	Common Borrow	C.Y.	RS Means, Year 2016 Quarter 1	310513100200	Soils for earthwork, common borrow, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	12.0	100%	-	4.4	-	185.3	$ 12.63	$ 3.02	$ -	$ 5.76	$ -	$ 21.41	$ -	$ 33,559	$ -	$ 713,787	-	4,369	-	65,535
FFS 7.9 DRAFT 189	Additional Fill		Additional delivery distance	-	41,303	Common Borrow (per hauling increment)	C.Y.	RS Means, Year 2016 Quarter 1	310513100900	Soils for earthwork, borrow, spread with 200 HP dozer, includes load at pit and haul, round trip, excludes compaction, for 5 mile haul, add	B34B	200	1.0	23.6	100%	-	8.8	-	206.5	$ -	$ 2.50	$ -	$ 4.29	$ -	$ 6.79	$ -	$ -	$ -	$ 280,447				
FFS 7.9 DRAFT 190			Compact material	-	31,772	Common Borrow	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	-	6.1	-	18.3	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ -	$ 28,277				
FFS 7.9 DRAFT 191			Purchase and deliver material	-	55,516	Riprap	Ton	RS Means, Year 2016 Quarter 1	313713100350	Rip-rap and rock lining, random, broken stone, 100 lb. average, dumped	B11A	700	2.0	8.0	100%	-	9.9	-	158.6	$ 27.87	$ 1.47	$ -	$ 2.49	$ -	$ 31.83	$ -	$ 129,395	$ -	$ 1,896,467	-	2,776	-	111,040
FFS 7.9 DRAFT 192		Starter Berms	Spread loose lift before compaction	-	33,310	Riprap	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	4.0	100%	-	8.3	-	50.0	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 84,606				
FFS 7.9 DRAFT 193			Special grading for steep slopes	-	12,791	Riprap	S.Y.	RS Means, Year 2016 Quarter 1	312216103310	Fine grading, slopes, steep, finish grading	B11L	7,100	2.0	1.0	100%	-	1.8	-	3.6	$ -	$ 0.14	$ -	$ 0.12	$ -	$ 0.26	$ -	$ -	$ -	$ 3,326				
FFS 7.9 DRAFT 194			Compact starter berms	-	27,758	Riprap	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235060	Compaction, riding, vibrating roller, 2 passes, 12" lifts	B10Y	5,200	1.5	2.0	100%	-	2.7	-	8.0	$ -	$ 0.15	$ -	$ 0.14	$ -	$ 0.29	$ -	$ -	$ -	$ 8,050				
FFS 7.9 DRAFT 195	Final Cover		Purchase and deliver clay material	122,444	226,771	Clay Material	L.C.Y.	RS Means, Year 2016 Quarter 1	354113200040	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	41.4	100%	51.0	94.5	2,111.1	3,909.8	$ 26.69	$ -	$ -	$ -	$ -	$ 26.69	$ 273,305	$ 506,173	$ 3,541,327	$ 6,558,698	10,204	18,898	408,160	755,920
FFS 7.9 DRAFT 196		Clay	Spread loose lift before compaction	122,444	226,771	Clay Material	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	12.0	100%	10.2	18.9	183.7	340.2	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ 311,007	$ 575,999				
FFS 7.9 DRAFT 197			Compact Clay (Final Cover)	87,460	161,979	Clay Material	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235640	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	1,300	1.5	2.0	100%	33.6	62.3	100.9	186.9	$ -	$ 0.62	$ -	$ 1.15	$ -	$ 1.77	$ -	$ -	$ 154,804	$ 286,704				
FFS 7.9 DRAFT 198			Purchase and place Topsoil	39,754	73,627	Topsoil	C.Y.	RS Means, Year 2016 Quarter 1	310513100800	Soils for earthwork, topsoil borrow, weed free, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	12.0	100%	5.5	10.2	231.9	429.5	$ 24.98	$ 3.02	$ -	$ 5.76	$ -	$ 33.76	$ 83,050	$ 153,813	$ 1,425,160	$ 2,639,461	4,142	7,670	62,130	115,050
FFS 7.9 DRAFT 199		Top Soil	Addition for Topsoil Delivery	51,681	95,715	Topsoil (per Hauling Increment)	C.Y.	RS Means, Year 2016 Quarter 1	310513100900	Soils for earthwork, borrow, spread with 200 HP dozer, includes load at pit and haul, round trip, excludes compaction, for 5 mile haul, add	B34B	200	1.0	23.6	100%	10.9	20.3	258.4	478.6	$ -	$ 2.50	$ -	$ 4.29	$ -	$ 6.79	$ -	$ -	$ 350,912	$ 649,906				
FFS 7.9 DRAFT 200		Terraces	Purchase and place Topsoil	3,929	4,697	Topsoil	C.Y.	RS Means, Year 2016 Quarter 1	310513100800	Soils for earthwork, topsoil borrow, weed free, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	2.0	100%	3.3	3.9	22.9	27.4	$ 24.98	$ 3.02	$ -	$ 5.76	$ -	$ 33.76	$ 8,208	$ 9,812	$ 140,847	$ 168,384	410	490	6,150	7,350

Construction Cost Worksheet - FFS 7.9 DRAFT

Step #	Category	Sub-Category	Task	Quantity Area 1	Quantity Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Construction Days Area 1	Construction Days Area 2	Crew Man-days Area 1	Crew Man-days Area 2	Unit Costs Ext. Mat, O&P	Unit Costs Ext. Labor, O&P	Unit Costs Ext. Labor, O&P Ineff.	Unit Costs Ext. Equip, O&P	Unit Costs Ext. Equip, O&P Ineff.	Unit Costs Ext. Total, O&P	Bridgeton Taxes Area 1	Bridgeton Taxes Area 2	Total Cost Area 1	Total Cost Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Delivery Miles Area 1	Total Delivery Miles Area 2
FFS 7.9 DRAFT 201	Stormwater Controls (for stormwater after cover is constructed)	Terraces	Addition for Topsoil Delivery	5,108	6,106	Topsoil (per Hauling Increment)	C.Y.	RS Means, Year 2016 Quarter 1	310513100900	Soils for earthwork, borrow, spread with 200 HP dozer, includes load at pit and haul, round trip, excludes compaction, for 5 mile haul, add	B34B	200	1.0	23.6	100%	1.1	1.3	25.5	30.5	$ -	$ 2.50	$ -	$ 4.29	$ -	$ 6.79	$ -	$ -	$ 34,680	$ 41,461				
FFS 7.9 DRAFT 202		Pond	Purchase and deliver liner & berm material	-	13,760	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	354113200040	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	41.4	100%	-	5.7	-	237.2	$ 26.69	$ -	$ -	$ -	$ -	$ 26.69	$ -	$ 30,713	$ -	$ 397,963	-	1,147	-	45,880
FFS 7.9 DRAFT 203			Spread loose lift before compaction (Pond)	-	13,760	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	2.1	100%	-	6.6	-	20.6	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 34,950				
FFS 7.9 DRAFT 204			Compact Liner & Berm (Pond)	-	9,828	Structural Fill / Clay	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235640	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	1,300	1.5	2.0	100%	-	3.8	-	11.3	$ -	$ 0.62	$ -	$ 1.15	$ -	$ 1.77	$ -	$ -	$ -	$ 17,396				
FFS 7.9 DRAFT 205			Pond Perimeter Berm Structural Rock	-	1,130	Structural Rock	L.C.Y.	RS Means, Year 2016 Quarter 1	313713100100	Rip-rap and rock lining, random, broken stone, machine placed for slope protection	B12G	62	2.0	1.0	100%	-	18.2	-	36.5	$ 31.59	$ 16.76	$ -	$ 14.69	$ -	$ 63.04	$ -	$ 2,986	$ -	$ 74,241				
FFS 7.9 DRAFT 206		Diversion Berms	Purchase and deliver berm material	1,425	693	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	354113200040	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	41.4	100%	0.6	0.3	24.6	11.9	$ 26.69	$ -	$ -	$ -	$ -	$ 26.69	$ 3,180	$ 1,547	$ 41,200	$ 20,043	119	58	4,760	2,320
FFS 7.9 DRAFT 207			Spread loose lift before compaction	1,425	693	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	2.1	100%	0.7	0.3	2.1	1.0	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ 3,618	$ 1,760				
FFS 7.9 DRAFT 208			Compact Berms	1,018	495	Structural Fill / Clay	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235060	Compaction, riding, vibrating roller, 2 passes, 12" lifts	B10Y	5,200	1.5	2.0	100%	0.1	0.0	0.3	0.1	$ -	$ 0.15	$ -	$ 0.14	$ -	$ 0.29	$ -	$ -	$ 295	$ 144				
FFS 7.9 DRAFT 209			Perimeter Road Stormwater Crossings	-	123	Riprap	L.C.Y.	RS Means, Year 2016 Quarter 1	313713100100	Rip-rap and rock lining, random, broken stone, machine placed for slope protection	B12G	62	2.0	1.0	100%	-	2.0	-	4.0	$ 31.59	$ 16.76	$ -	$ 14.69	$ -	$ 63.04	$ -	$ 325	$ -	$ 8,092				
FFS 7.9 DRAFT 210			Final Stormwater Controls (letdowns, swales, etc.)	889	2,467	Riprap	S.Y.	RS Means, Year 2016 Quarter 1	313713100110	Rip-rap and rock lining, random, broken stone, 3/8 to 1/4 C.Y. pieces, machine placed for slope protection, grouted	B13	80	7.0	3.0	100%	3.7	10.3	77.8	215.8	$ 65.49	$ 42.14	$ -	$ 11.64	$ -	$ 119.27	$ 4,868	$ 13,510	$ 110,886	$ 307,709				
FFS 7.9 DRAFT 211	Site Completion		Apply seeding to cover	1,288	2,386	Seeding	M.S.F.	RS Means, Year 2016 Quarter 1	329219142400	Seeding athletic fields, seeding fescue, tall with mulch and fertilizer, 5.5 lb. per M.S.F., hydro/air seeding	B81	80	3.0	1.0	100%	16.1	29.8	48.3	89.5	$ 26.26	$ 19.04	$ -	$ 10.79	$ -	$ 56.09	$ 2,829	$ 5,239	$ 75,075	$ 139,042				
FFS 7.9 DRAFT 212			Install temporary irrigation system	107,337	198,793	Irrigation System	S.F.	RS Means, Year 2016 Quarter 1	328423100800	Underground sprinklers irrigation system, for lawns, residential system, custom, 1" supply	B20	2,000	3.0	10.0	100%	5.4	9.9	161.0	298.2	$ 0.27	$ 0.75	$ -	$ -	$ -	$ 1.02	$ 2,424	$ 4,489	$ 111,907	$ 207,258				
FFS 7.9 DRAFT 213			Install Fencing	5,770	6,998	Fencing	L.F.	RS Means, Year 2016 Quarter 1	323113200920	Fence, chain link industrial, galvanized steel, 6 ga. wire, 2-1/2" posts @ 10' OC, 8' high, includes excavation, in concrete, excludes barbed wire	B80C	180	3.0	2.0	100%	16.0	19.4	96.2	116.6	$ 37.00	$ 8.06	$ -	$ 1.77	$ -	$ 46.83	$ 17,854	$ 21,654	$ 288,063	$ 349,370				

	Crew Man-days Area 1	Crew Man-days Area 2	Bridgeton Taxes Area 1	Bridgeton Taxes Area 2	Total Cost Area 1	Total Cost Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Delivery Miles Area 1	Total Delivery Miles Area 2
Overall / *Totals*	53,400	64,600	$ 2,110,000	$1,770,000	$ 91,000,000	$ 174,000,000	52,700	115,000	1,620,000	3,370,000
		118,000		**$3,880,000**		**$ 265,000,000**		**168,000**		**4,990,000**

	Area 1	Area 2
RIM Transporation & Disposal	$ 17,500,000	$ 84,100,000
		$ 102,000,000
RIM Loading Operation	$ 3,270,000	$ 7,560,000
		$ 10,800,000
On-Site Costs	$ 70,300,000	$ 82,100,000
		$ 152,000,000

DRAFT

Radiological Survey and Health and Safety Costs
7.9 pCi/g

Total Estimated Costs for Radiological Survey and Health & Safety Support	
Total Labor Cost	$32,836,000
Professional Services	$2,082,000
Equipment	$3,607,000
Materials/PPE	$18,321,000
Travel	$4,696,000
Off-Site Laboratory	$750,000
Total	**$62,292,000**

Estimate of Labor Costs

Estimated Labor Costs	Team	Personnel Description	Cost/day*	Notes:			
$3,242,000	Team 1	Sr Rad Tech	$1,070	Supervise field activities; Collect samples and deliver to outside lab; Maintain records; Surveys		$824,000	Perdiem Weekend days
$2,636,000		Rad Tech	$870	Run personal air sampling program; Available for decon, distributing protective clothing, assist with survey vehicle moving on-site			
$2,636,000		Rad Tech	$870	Control entry/exit for contaminated areas			
$2,636,000		Rad Tech	$870	Control entry/exit for contaminated areas			
$728,000	Team 2	Sr Rad Tech	$1,070	Survey while moving RIM Area 1; Conduct Final Survey		$618,000	Perdiem Weekend days
$592,000		Rad Tech	$870	Survey while moving RIM Area 1; Conduct Final Survey			
$592,000		Rad Tech	$870	Survey while moving RIM Area 1; Conduct Final Survey			
$1,412,000	Team 3	Sr Rad Tech	$1,070	Survey while moving RIM Area 2; Conduct Final Survey		$618,000	Perdiem Weekend days
$1,148,000		Rad Tech	$870	Survey while moving RIM Area 2; Conduct Final Survey			
$1,148,000		Rad Tech	$870	Survey while moving RIM Area 2; Conduct Final Survey			
$15,000.00	Team 4	Sr Rad Tech	$1,070	Final Survey for Buffer/Crossroads property after RIM relocated		$412,000	Perdiem Weekend days
$12,000.00		Rad Tech	$870	Final Survey for Buffer/Crossroads property after RIM relocated			
$2,419,000.00	Team 5	Sr Rad Tech	$1,070	RIM transfer station		$412,000	Perdiem Weekend days
$1,967,000.00		Rad Tech	$870	RIM transfer station			
$5,939,600.00	Team 6	Lab Supervisor	$2,170	Run On-site Laboratory	includes 3 months set-up and training	$412,000	Perdiem Weekend days
$2,417,000.00		Lab Tech	$1,070	Conduct detailed activities at On-site laboratory	includes 3 months set-up and training		

$29,540,000 Total Estimated Labor Costs during Construction
* Includes per diem at $170/day

Team 1			Team 2		
3/15/2018	Estimated Start Date	Road construction	8/8/2018	Estimated Start Date	Start Exc Area 1
10/25/2029	Estimated End Date	Clean-up	3/17/2021	Estimated End Date	FSS Area 1
4242	No. of calendar days		952	No. of calendar days	
11.6	No. years		2.6	No. years	
141	No. Months		31	No. Months	
47	No. of quarters		10	No. of quarters	
606	No. of weeks		136	No. of weeks	
3030	No. of working days		680	No. of working days	
1212	No. of weekend days		272	No. of weekend days	
143	No. of field personnel requiring badges				
49	No. of field personnel in PPE				

Team 3			Team 4		
9/3/2021	Estimated Start Date	Start Exc Area 2	9/25/2026	Estimated Start Date	Start Exc BZ
9/25/2026	Estimated End Date	FSS Area 2	10/14/2026	Estimated End Date	FSS BZ
1848	No. of calendar days		19	No. of calendar days	
5.1	No. years		0.1	No. years	
60	No. Months		1	No. Months	
20	No. of quarters		0	No. of quarters	
264	No. of weeks		3	No. of weeks	
1320	No. of working days		14	No. of working days	
528	No. of weekend days		5	No. of weekend days	

Team 5			Team 6		
7/1/2018	Estimated Start Date	RIM Xfer Station-1m	5/1/2018	Estimated Start Date	Start Exc minus 3 months
3/1/2027	Estimated End Date	Demo+3 mo	12/25/2026	Estimated End Date	End of Exc plus 3 month
3165	No. of calendar days		3160	No. of calendar days	
8.7	No. years		8.7	No. years	
104	No. Months		103	No. Months	
35	No. of quarters		34	No. of quarters	
452	No. of weeks		451	No. of weeks	
2261	No. of working days		2257	No. of working days	
904	No. of weekend days		903	No. of weekend days	

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Estimate of Non-Labor Costs

ITEM NO.		DESCRIPTION	UNIT	QUANTITY	RATE	COSTS	
1	**PROFESSIONAL SERVICES**					**$ 2,082,000**	
1.1	Oversight						
		CHP	hourly	1,515	$ 170	257,550	
		Sr. Health Physicist	hourly	12,120	$ 115	1,504,200	includes 6 months to recruit staff and set up the on-site laboratory
		Project Coordinator	hourly	3,030	$ 85	257,550	
1.3	Training						
		Sr. Health Physicist	hourly	200	$ 115	23,000	
		**Estimated 2 trips per year for 10 years for GERT training courses.					
1.4	Report Assistance						
		CHP	hourly	80	$ 170	13,600	
		Graphics Support	hourly	80	$ 120	9,600	
		Sr. Health Physicist	hourly	80	$ 115	9,200	
		Project Coordinator	hourly	80	$ 85	6,800	
2	**EQUIPMENT**					**$ 3,607,000**	
2.1	Equipment						
		Model 2929 w/ 43-10-1 (3)	/month	424	$ 320	135,744	
		Model 2360 w/ 43-93 (7)	/month	990	$ 825	816,585	
		Extra Mylars for 43-93	/unit	8	$ 40	320	
		Model 2221 w/44-20 (3)	/month	0	$ -	0	
		Th-230 source (3)	/month	424	$ 75	31,815	
		Cs-137 source (3)	/month	424	$ 75	31,815	
		Tc-99 source (3)	/month	424	$ 75	31,815	
		PID (3)	/month	424	$ 750	318,150	
		PID 5 gas (3)	/month	424	$ 725	307,545	
		Air Monitors (8)	/month	1,131	$ 165	186,648	
		Trimble GPS Unit + Model 2221 w/ 44-10 (2)	/month	283	$ 3,000	848,400	
		Model 2221 w/44-10 (5)	/month	707	$ 500	353,500	
		Field Computer (4)	/month	566	$ 250	141,400	
		Model 19 (4)	/month	566	$ 400	226,240	
		Model 2221 w/ 44-2 (2)	/month	0	$ -	0	
		Tax on outside rentals		9.5%	$ 1,641,974	155,988	
2.2	Shipping						
		FedEx Charges	/shipment	283	$ 75	21,210	
		**Estimate of 2 shipments per month					
3	**MATERIALS/PPE**					**$ 18,321,000**	
3.1	Training						
		Rad Training packets	/unit	100	$ 25	2,500	
3.2	Health and Safety Monitoring & PPE						
		Mirion TLDs	/unit, /quarter	6,740	$ 50	337,003	
	50/ case	Boot Covers	/case	69,326	$ 150	10,398,960	
	25/case	Tyvek Coveralls	/case	69,326	$ 100	6,932,640	
	1000/case	Gloves	/case	5,199	$ 125	649,935	

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Estimate of Non-Labor Costs (continued)

ITEM NO.	DESCRIPTION		UNIT	QUANTITY	RATE	COSTS	
4	**TRAVEL**					**$ 4,696,000**	
4.1	Training/Audits						
		Travel Time	1 person/Quarter	754	$ 115	$ 86,725	
		Per Diem	2 days per trip	94	$ 170	$ 16,025	
		Air Fare	1 person/Quarter	47	$ 850	$ 40,063	
		Car Rental	2 person/Quarter	47	$ 300	$ 14,140	
		Gas	3 person/Quarter	47	$ 50	$ 2,357	
4.2	HP Technicians		Team 1				
		Travel Time	staff * 49 trips	3136	$ 300	$ 940,800	
		Per Diem	staff * 49 trips	392	$ 170	$ 66,640	
		Air Fare	staff * 49 trips	196	$ 850	$ 166,600	49
		Mileage	vehicles * project duration	1212	$ 70	$ 84,840	
		Car Rental	# vehicles * project duration	1212	$ 400	$ 484,800	
		Supplies	/month	141	$ 500	$ 70,700	
		Gas	/month	141	$ 400	$ 56,560	
		Misc Items	/month	141	$ 500	$ 70,700	
4.3	HP Technicians		Team 2				
		Travel Time	staff * 12 trips	576	$ 300	$ 172,800	
		Per Diem	staff * 12 trips	72	$ 170	$ 12,240	
		Air Fare	staff * 12 trips	36	$ 850	$ 30,600	12
		Mileage	vehicles * project duration	204	$ 70	$ 14,280	
		Car Rental	# vehicles * project duration	204	$ 400	$ 81,600	
		Supplies	/month	31	$ 500	$ 15,500	
		Gas	/month	31	$ 400	$ 12,400	
		Misc Items	/month	31	$ 500	$ 15,500	
4.4	HP Technicians		Team 3				
		Travel Time	staff * 21 trips	1008	$ 300	$ 302,400	
		Per Diem	staff * 21 trips	126	$ 170	$ 21,420	
		Air Fare	staff * 21 trips	63	$ 850	$ 53,550	21
		Mileage	vehicles * project duration	396	$ 70	$ 27,720	
		Car Rental	# vehicles * project duration	396	$ 400	$ 158,400	
		Supplies	/month	60	$ 500	$ 30,000	
		Gas	/month	60	$ 400	$ 24,000	
		Misc Items	/month	60	$ 500	$ 30,000	
4.5	HP Technicians		Team 4				
		Travel Time	staff * 2 trips	64	$ 300	$ 19,200	
		Per Diem	staff * 2 trips	8	$ 170	$ 1,360	
		Air Fare	staff * 2 trips	4	$ 850	$ 3,400	2
		Mileage	vehicles * project duration	3	$ 70	$ 190	
		Car Rental	# vehicles * project duration	3	$ 400	$ 1,086	
		Supplies	/month	1	$ 500	$ 500	
		Gas	/month	1	$ 400	$ 400	
		Misc Items	/month	1	$ 500	$ 500	
4.6	HP Technicians		Team 5				
		Travel Time	staff * 36 trips	1152	$ 300	$ 345,600	
		Per Diem	staff * 36 trips	144	$ 170	$ 24,480	
		Air Fare	staff * 36 trips	72	$ 850	$ 61,200	36
		Mileage	vehicles * project duration	452	$ 70	$ 31,650	
		Car Rental	# vehicles * project duration	452	$ 400	$ 180,857	
		Supplies	/month	104	$ 500	$ 52,000	
		Gas	/month	104	$ 400	$ 41,600	
		Misc Items	/month	104	$ 500	$ 52,000	
4.7	Lab Staff		Team 6				
		Travel Time	staff * 36 trips	1152	$ 290	$ 334,080	
		Per Diem	staff * 36 trips	144	$ 170	$ 24,480	
		Air Fare	staff * 36 trips	72	$ 850	$ 61,200	36
		Mileage	vehicles * project duration	451	$ 70	$ 31,600	
		Car Rental	# vehicles * project duration	451	$ 400	$ 180,571	
		Supplies	/month	103	$ 500	$ 51,500	
		Gas	/month	103	$ 400	$ 41,200	
		Misc Items	/month	103	$ 500	$ 51,500	

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Estimate of Non-Labor Costs (continued)

ITEM NO.	DESCRIPTION		UNIT	QUANTITY	RATE	COSTS
5	**LABORATORY**					**$ 750,000**
5.1	Air Filter Analysis					
		Gross Alpha Beta	1 air filter * 5 days * week	3030	$ 65	$ 196,950
		Isotopic Thorium	1 air filter * 5 days * week	3030	$ 100	$ 303,000
5.2	Water Sample Analysis					
		Gross Alpha Beta	Estimated 30 samples	30	$ 65	$ 1,950
		Isotopic Thorium	Estimated 30 samples	30	$ 100	$ 3,000
		Isotopic Uranium	Estimated 30 samples	30	$ 100	$ 3,000
		Radium-226	Estimated 30 samples	30	$ 85	$ 2,550
5.3	Soil Sample Analysis					
		Gamma Spec	Estimated 730 samples	730	$ 85	$ 62,050
		Isotopic Thorium	Estimated 730 samples	730	$ 100	$ 73,000
		Isotopic Uranium	Estimated 730 samples	730	$ 100	$ 73,000
5.4	Vegetation					
		Gamma Spec	Estimated 0 samples	0	$ 85	$ -
		Isotopic Thorium	Estimated 0 samples	0	$ 100	$ -
		Isotopic Uranium	Estimated 0 samples	0	$ 100	$ -
		Radium-226	Estimated 0 samples	0	$ 85	$ -
		Radium-228	Estimated 0 samples	0	$ 85	$ -
5.5	Shipping					
		FedEx Charges	/shipment	424	$ 75	31,815
		Estimate of 3 shipments per month				

start exc Area 1	end exc Area 2			
8/6/2018	8/16/2026	2932	418.857143	weeks

7300 103 2000m2 SU in Area 2 and 43 SR in Area 1. Estimate 50 samples per SU.
10% of those go to off-site laboratory. 50 from reference area but those will be analyzed at the on-site lab.

On-Site Radiological Laboratory
Complete Rad Removal (7.9 pCi/g) Remedy Alternative

Equipment Price List

Item Description	Vendor(s)	Unit Cost	Quantity	Total Cost	Total Shipping Cost	Taxes	Extended Price
Modular Analytical Lab (MAL):							
Cost of MAL	CPM LabFab	$ 3,800	96	$ 364,800	$ 21,576	$ 33,817	$ 420,193
MAL Analytical Equipment							
Discover SPD 80 system (microwave digestion)							
SPD 80 System	CEM Corporation	$ 20,351	1	$ 20,351	$ 2,035	$ 1,887	$ 24,273
Scrubber Option (mandtory for HF application		$ 2,691	1	$ 2,691	$ 269	$ 249	$ 3,210
Synergy External Controller Optior		$ 2,714	1	$ 2,714	$ 271	$ 252	$ 3,237
80-ml quartz vial (set of twelve)		$ 1,751	1	$ 1,751	$ 175	$ 162	$ 2,088
35ml/80ml Vial Caps (100)		$ 99	1	$ 99	$ 10	$ 9	$ 118
Installation and Training		$ 837	1	$ 837	$ 84	$ 78	$ 998
Maintence Contract		$ 3,095	8	$ 24,760	$ 2,476	$ 2,295	$ 29,531
SUB-TOTAL MAL Microwave				**$ 31,538**			**$ 5,320**
Nuclear Instrumentation for Sample Analysis							
Computer to run APEX software for 2 gamma and 12 alpha diodes	DELL	$ 2,700	1	$ 2,700	$ 270	$ 250	$ 3,220
Alpha Spectroscopy							
Alpha Analyst	Canberra	$ 36,540	1	$ 36,540	$ 3,654	$ 3,387	$ 43,581
PIPS Detectors		$ 1,026	96	$ 98,496	$ 9,850	$ 9,131	$ 117,476
Chassis and Hardware		$ 5,857	2	$ 11,714	$ 1,171	$ 1,086	$ 13,971
Vacuum Pump		$ 1,868	1	$ 1,868	$ 187	$ 173	$ 2,228
Alpha Spec Installation Kit		$ 518	1	$ 518	$ 52	$ 48	$ 618
Training		$ 2,250	2	$ 4,500	$ 450	$ 417	$ 5,367
Apex-Alpha Desktop Package		$ 7,430	1	$ 7,430	$ 743	$ 689	$ 8,862
Mixed Alpha Standard		$ 1,850	6	$ 11,100	$ 1,110	$ 1,029	$ 13,239
Maintence Contract		$ 1,000	8	$ 8,000	$ 800	$ 742	$ 9,542
SUB-TOTAL MAL Alpha Spec				**$ 172,166**			**$ 205,342**
Gamma Spectroscopy							
SAGE Well Detector	Canberra	$ 114,993	1	$ 114,993	$ 11,499	$ 10,660	$ 137,152
Ultra low background shielc		$ 27,000	1	$ 27,000	$ 2,700	$ 2,503	$ 32,203
Solid Side Plug		$ 390	1	$ 390	$ 39	$ 36	$ 465
Detector Lift		$ 3,087	1	$ 3,087	$ 309	$ 286	$ 3,682
Genie 2000 Basic		$ 1,316	1	$ 1,316	$ 132	$ 122	$ 1,570
Genie 2000 Gamma Option		$ 4,336	1	$ 4,336	$ 434	$ 402	$ 5,172
LABSOCS Efficiency Calibration Software		$ 6,990	1	$ 6,990	$ 699	$ 648	$ 8,337
ISOXCAL		$ 5,040	1	$ 5,040	$ 504	$ 467	$ 6,011
LYNX-Digital Signal Analyzer		$ 15,887	1	$ 15,887	$ 1,589	$ 1,473	$ 18,948
Maintence Contract		$ 1,000	8	$ 8,000	$ 800	$ 742	$ 9,542
SUB-TOTAL MAL LB4200				**$ 179,039**			**$ 213,540**
LB4200 System							
Base Platform	Canberra	$ 7,339	2	$ 14,678	$ 1,468	$ 1,361	$ 17,506
Drawer		$ 20,920	8	$ 167,360	$ 16,736	$ 15,514	$ 199,610
Apex Software		$ 3,827	1	$ 3,827	$ 383	$ 355	$ 4,564
Mounting Table		$ 1,584	2	$ 3,168	$ 317	$ 294	$ 3,778
Multi Core CPU		$ 2,700	1	$ 2,700	$ 270	$ 250	$ 3,220
Maintence Contract		$ 1,000	8	$ 8,000	$ 800	$ 742	$ 9,542
SUB-TOTAL MAL LB4200				**$ 58,297**			**$ 22,066**
Eichrom Resin System							
24 Hole Vacuum Box with Rack	EiChrom	$ 1,315	1	$ 1,315	$ 132	$ 122	$ 1,568
Inner Liner		$ 215	1	$ 215	$ 22	$ 20	$ 256
White Inner Support Tube-PE 1000/box		$ 118	92	$ 10,875	$ 1,087	$ 1,008	$ 12,970
Yellow Outer Tips 1000/box		$ 89	92	$ 8,202	$ 820	$ 760	$ 9,783
20ml Cartridge Reservoir 25/box		$ 28	3,840	$ 107,520	$ 10,752	$ 9,967	$ 128,239
Resolve Filters in Funnel 25/box		$ 47	3,840	$ 180,480	$ 18,048	$ 16,730	$ 215,258
Pump	Fisher	$ 1,005	1	$ 1,005	$ 101	$ 93	$ 1,199
SUB-TOTAL MAL LB4200				**$ 7,049**			**$ 14,200**
MAL Other Equipment							
Bench-top drying ovens (2)		$ 2,500	2	$ 5,000	$ 500	$ 464	$ 5,964
Muffle Furnace		$ 2,600	1	$ 2,600	$ 260	$ 241	$ 3,101
Analytical Balance (0.0001g)		$ 2,000	1	$ 2,000	$ 200	$ 185	$ 2,385
Top loading balance (1 kg)		$ 1,000	1	$ 1,000	$ 100	$ 93	$ 1,193
Centrifuge		$ 1,000	2	$ 2,000	$ 200	$ 185	$ 2,385
Heat Lamps		$ 1,000	2	$ 2,000	$ 200	$ 185	$ 2,385
Hot Plates		$ 500	4	$ 2,000	$ 200	$ 185	$ 2,385
Zirconium crudibles		$ 200	24	$ 4,800	$ 480	$ 445	$ 5,725
Labware		$ 15,000	1	$ 15,000	$ 1,500	$ 1,391	$ 17,891
Acids, Reagents, and standards		$ 20,000	8	$ 160,000	$ 16,000	$ 14,832	$ 190,832
SUB-TOTAL MAL Other Equipment				**$ 33,901**			**$ 234,246**
MAL Support Equipment							
Copier		$ 15,000	1	$ 15,000	$ 1,500	$ 1,391	$ 17,891
Printer		$ 5,000	1	$ 5,000	$ 500	$ 464	$ 5,964
Desks		$ 500	2	$ 1,000	$ 100	$ 93	$ 1,193
Chairs		$ 300	5	$ 1,500	$ 150	$ 139	$ 1,789
Tables		$ 200	2	$ 400	$ 40	$ 37	$ 477
Filing Cabinets		$ 1,000	2	$ 2,000	$ 200	$ 185	$ 2,385
Storage Cabinets		$ 1,000	4	$ 4,000	$ 400	$ 371	$ 4,771
Initial office supply setup		$ 2,500	1	$ 2,500	$ 250	$ 232	$ 2,982
Stools for lab area		$ 100	6	$ 600	$ 60	$ 56	$ 716
Safety shower / eyewash		$ 1,000	1	$ 1,000	$ 100	$ 93	$ 1,193
Cellular phones for lab employees		$ 150	2	$ 300	$ 30	$ 28	$ 358
SUB-TOTAL MAL Support				**$ 6,750**			**$ 39,717**
GRAND TOTAL EQUIPMENT				**$ 849,000**			**$ 1,144,000**

Capital Cost Estimate - Long-Term Monitoring
Complete Rad Removal (7.9 pCi/g) Remedy Alternative

Description	Quantity	Units	Unit Rate	Estimated Cost ($)
Secure easements	1	LS	5,000	5,000
Landfill Gas:				
Driller: Install radon/landfill gas monitoring probes, MDNR "Code Wells"; 10' deep	31	each	2,000	62,000
Misc. wellhead sampling fittings and locks	31	each	40	1,200
Field technician observation during drilling and construction of probes (4/day)	64	hour	90	5,800
Mileage for field technician during probe construction	400	mile	0.54	200
Multi-gas detector (e.g., Industrial Scientific iBrid ™ MX6), incl regulator, tubing, calbrtn gas	1	LS	4,806	4,800
Portable radon gas monitor and detector (e.g., Pylon AB6 monitor w/ 300A detector)	1	LS	9,075	9,100
Groundwater:				
Construction of new groundwater monitoring wells	12	each	10,000	120,000
Flat-bottom polyethylene tank to store purge water prior to disposal	1,500	gallon	2	3,000
Estimated Long-term Monitoring Capital Costs - Total				**211,000**

Post-Construction Radon Flux Monitoring Cost Estimate
Complete Rad Removal (7.9 pCi/g) Remedy Alternative

Description	Quantity	Units	Unit Rate	Estimated Cost ($)
Radon Flux (once after cover construction is complete):				
Number of Monitoring Locatons (assume same as post-NCC program):	*130*			
Surveying of locations	1	day	1,500	1,500
Auxier labor	1	LS	6,345	6,350
Per diem	2	each	1,190	2,380
Airfare and vehicle rental	2	each	1,000	2,000
Overnight shipping to lab	1	LS	1,200	1,200
Lab analysis (Eberline)	1	LS	11,050	11,050
Data validation and management	1	each	1,000	1,000
Reporting	4	hour	150	600
Estimated Post-Construction Radon Flux Monitoring Costs - Total				**26,000**

Stormwater and Air Monitoring During Construction Cost Estimates
Complete Rad Removal (7.9 pCi/g) Remedy Alternative

Description	Analytical Methc	Quantity	Units	Unit Rate ($)	Estimated Cost ($)
Stormwater Monitoring and Inspection (Quarterly - only during remedy construction					
4 sampling locations					
1 field duplicate					
5 total samples					
Sampling and Inspection (Feezor Engineering estimate)		1	LS	5,000	5,000
Laboratory Analysis:					
Eberline (T-uranium, iso-uranium, iso-thorium, gross alpha/beta, Ra-226, Ra-228)		1	LS	2,325	2,330
TekLab (all other parameters)		1	LS	2,743	2,740
Data validation and management		1	LS	1,500	1,500
Reporting		4	hour	150	600
Estimated Quarterly Stormwater Monitoring and Inspection Costs - Total					**12,000**
Air Monitoring during Construction					
13 air monitoring stations and one MET station					
Auxier & Associates FY2016 Air Monitoring Program Estimate (minus contingency)		1	LS	172,852	172,900
Data validation		1	LS	6,800	6,800
Power costs (13 stations plus one MET station; $10/month per station)		12	months	140	1,700
Estimated Air Monitoring during Construction Costs - Annual Total					181,000
Estimated Quarterly Air Monitoring Costs during Construction (assuming annual costs divided by 4					**45,000**

Capital Cost Estimate - Amend Existing/Additional Institutional Controls
Complete Rad Removal (7.9 pCi/g) Remedy Alternative

Description	Quantity	Units	Unit Rate	Estimated Cost
Prepare Institutional Controls planning documents	1	LS	10,000	10,000
Attorney labor: prepare draft amended existing and additional ICs	1	LS	20,000	20,000
Review of draft documents	1	LS	5,000	5,000
Revise amended and additional Institutional Controls documents	1	LS	10,000	10,000
Filings and registrations	1	LS	5,000	5,000
Estimated Institutional Controls Capital Costs - Total				**50,000**

Long-Term Post-Construction Monitoring (per event) Cost Estimate
Complete Rad Removal (7.9 pCi/g) Remedy Alternative

(Landfill Gas/Radon, Groundwater Monitoring and Annual Post-Construction Site Inspections)

Description	Analytical Method	Quantity	Units	Unit Rate ($)	Estimated Cost ($)
Landfill Gas/Radon (quarterly after contruction complete):					
Number of Landfill Gas/Radon Monitoring Wells		*31*			
Labor - field technician		9	hour	90	810
Field vehicle		1	day	120	120
Replacement radon detector (Pylon 300A)		1	each	550	550
Calibration gas for multi-gas detector		1	each	449	450
Data management		2	hour	100	200
Reporting		8	hour	150	1,200
Estimated Landfill Gas/Radon Monitoring Costs - Subtotal					3,300
Contingency			*%*	*20*	*700*
Estimated Landfill Gas/Radon Monitoring Costs - Total (per Event)					**4,000**

Description	Analytical Method	Quantity	Units	Unit Rate ($)	Estimated Cost ($)
Groundwater (semi-annual first 5 years after construction; annually thereafter):					
Number of Samples:			*For VOCs*		
Investigative Groundwater (5, 3-wells clusters in Area 2; 3, 3-well clusters in Area 1)		*24*	*24*		
Field Duplicates (one per every 10 investigative samples)		*3*	*3*		
Trip blank (one per day per cooler)			*15*		
Matrix Spike			*1*		
Matrix Spike Duplicate			*1*		
Sub-total number of unfiltered samples:		*27*	*44*		
Sub-total number of filtered samples for radionuclide and metals analyses:		*27*			
Total number of samples:		*54*	*44*		
Labor:					
Labor - field technicians (assume 2 people, 5 days, 10-hr days)		100	hour	90	9,000
Materials and equipment:					
Sample kits, incl. filters		24	each	50	1,200
Field instrumentation and flowcell rental - groundwater		5	day	100	500
Field Vehicle		5	day	120	600
Overnight shipping of sample coolers (assume 1 per day to rad lab)		5	coolers	100	500
Delivery of sample coolers to local lab (2 to 3 coolers per day)		5	hour	90	450
Disposal of purge water (assumes PE tank previously purchased is onsite):					
Vacuum truck		4	hour	200	800
Transportation and disposal (assumes approx 25 gal per well per event)		600	gallon	2.00	1,200
Laboratory Sample Analysis:	*Analytical Method:*				
Gross alpha and beta	EPA 900.0	54	each	50	2,700
Total Uranium		54	each	65	3,510
Iso-Uranium-234, 235, 238	EML U-02 Mod	54	each	100	5,400
Iso-Thorium-228, 230, 232	EML Th-01 Mod	54	each	100	5,400
Radium 228	EPA 904.0	54	each	75	4,050
Radium 226	EPA 903.0 Mod	54	each	75	4,050
Radon 222 - 72 hr hold time	SM 20th ED 7500-Rn B	54	each	85	4,590
Volatile Organic Compounds [VOCs] (GC/MS)	8260B	44	each	110	4,840
Semivolatile Organic Compounds [SVOCs] (GC/MS)	8270C	54	each	220	11,880
22 Metals Target Analyte List (ICP/AES)	6010B	54	each	115	6,210
Mercury (CVAA)	7470A	54	each	35	1,890
4 Anions (IC) - Bromide, Chloride, Fluoride, Sulfate	300.0	54	each	72	3,890
2 Anions (IC) - Nitrate, Nitrite - 48 hr hold time	300.0	54	each	36	1,940
Sulfide, Total	SM 4500 S2 D	54	each	35	1,890
Phosphorus, Total	365.1	54	each	40	2,160
Organic carbon, Total (TOC)	SM 5310B	54	each	40	2,160
Total Alkalinity, Carbonate, Bicarbonate	SM 2320B	54	each	20	1,080
Nitrogen, Ammonia	350.1	54	each	25	1,350
Level IV data deliverable		$ 68,990	%	10%	6,900
Data validation (assumes validation of 100% of Level IV data will be required)		1	LS	6,600	6,600
Data management		7	SDG	100	700
Reporting		40	hour	150	6,000
Estimated Groundwater Monitoring Costs - Subtotal					103,400
Contingency			*%*	*20*	*20,700*
Estimated Groundwater Monitoring Costs - Total (per Event)					**124,000**

DVR = data validation report
SDG = sample delivery group

Description	Analytical Method	Quantity	Units	Unit Rate ($)	Estimated Cost ($)
Annual Post-Construction Site Inspections					
Labor - Engineer		9	hour	130	1,170
Field vehicle		1	day	120	120
Site Inspection Report		4	hour	130	520
Estimated Annual Post-Construction Site Inspections Costs - Subtotal					1,800
Contingency			*%*	*20*	*400*
Estimated Annual Post-Construction Site Inspections Costs - Total					**2,200**

Operation and Maintenance Cost Estimate - Annual Cover System Maintenance
Complete Rad Removal (7.9 pCi/g) Remedy Alternative

Description	Quantity	Units	Unit Rate	Estimated Cost
Mowing; tractor w/ rotary mower (once/year)	55.3	acre	40.00	2,200
Fill depressions in cover w/ topsoil, assume 1% of area; 6 inches deep	446	bcy	37.53	16,700
Seeding of filled area	24.1	M.S.F.	66.04	1,600
Estimated Cover System O&M Costs - Subtotal				20,500
Contingency		*%*	*20*	*4,100*
Estimated Annual Cover Maintenance O&M Costs - Total				**25,000**

M.S.F. = 1,000 square feet

Periodic Cost Estimate - 5 year Review
Complete Rad Removal (7.9 pCi/g) Remedy Alternative

Description	Quantity	Units	Unit Rate	Estimated Cost ($)
Access Restrictions (inspect/repair fencing and signage)	16	hours	150	2,400
Institutional Controls verification	8	hours	150	1,200
Document that landfill cover is effective	8	hours	150	1,200
Assemble Monitoring Data (landfill gas/radon, groundwater, surface water)	40	hours	150	6,000
Summarize Annual Post-Construction Site Inspections	8	hours	150	1,200
Summarize Annual Cover Maintenance Documentation	8	hours	150	1,200
Water supply well inventory review	8	hours	150	1,200
Document any changes in Land Use at and around West Lake Landfill	16	hours	150	2,400
Prepare Summary Report	80	hours	150	12,000
Estimated 5-year Maint/Review O&M Costs - Subtotal				**29,000**
Contingency		*%*	*20*	*6,000*
Estimated 5-year Maintenance O&M Costs - Total				**35,000**

Present Worth Cost Estimate
Complete Rad Removal (7.9 pCi/g) Remedy Alternative

			Capital Costs ($)		Operation, Maintenance, Monitoring, and Periodic Costs ($/yr)							
Year	*n*	P/F(*i* =7%)	Remediation	Subtotal Capital Costs	Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000	17,340,000	17,340,000					0	17,340,000	17,340,000	17,340,000
2018	1	0.93458	52,830,000	52,830,000					0	52,830,000	49,374,000	66,714,000
2019	2	0.87344	57,080,000	57,080,000					0	57,080,000	49,856,000	116,570,000
2020	3	0.81630	34,780,000	34,780,000					0	34,780,000	28,391,000	144,961,000
2021	4	0.76290	57,630,000	57,630,000					0	57,630,000	43,966,000	188,927,000
2022	5	0.71299	76,260,000	76,260,000					0	76,260,000	54,372,000	243,299,000
2023	6	0.66634	35,650,000	35,650,000					0	35,650,000	23,755,000	267,054,000
2024	7	0.62275	50,290,000	50,290,000					0	50,290,000	31,318,000	298,372,000
2025	8	0.58201	67,720,000	67,720,000					0	67,720,000	39,414,000	337,786,000
2026	9	0.54393	47,250,000	47,250,000					0	47,250,000	25,701,000	363,487,000
2027	10	0.50835	35,860,000	35,860,000					0	35,860,000	18,229,000	381,716,000
2028	11	0.47509	25,720,000	25,720,000					0	25,720,000	12,219,000	393,935,000
2029	12	0.44401	52,920,000	52,920,000					0	52,920,000	23,497,000	417,432,000
2030	13	0.41496	4,390,000	4,390,000	16,000	248,000	27,000		291,000	4,681,000	1,942,000	419,374,000
2031	14	0.38782			16,000	248,000	27,000		291,000	291,000	113,000	419,487,000
2032	15	0.36245			16,000	248,000	27,000		291,000	291,000	105,000	419,592,000
2033	16	0.33873			16,000	248,000	27,000		291,000	291,000	99,000	419,691,000
2034	17	0.31657			16,000	248,000	27,000	35,000	326,000	326,000	103,000	419,794,000
2035	18	0.29586			16,000	124,000	27,000		167,000	167,000	49,000	419,843,000
2036	19	0.27651			16,000	124,000	27,000		167,000	167,000	46,000	419,889,000
2037	20	0.25842			16,000	124,000	27,000		167,000	167,000	43,000	419,932,000
2038	21	0.24151			16,000	124,000	27,000		167,000	167,000	40,000	419,972,000
2039	22	0.22571			16,000	124,000	27,000	35,000	202,000	202,000	46,000	420,018,000
2040	23	0.21095			16,000	124,000	27,000		167,000	167,000	35,000	420,053,000
2041	24	0.19715			16,000	124,000	27,000		167,000	167,000	33,000	420,086,000
2042	25	0.18425			16,000	124,000	27,000		167,000	167,000	31,000	420,117,000
2043	26	0.17220			16,000	124,000	27,000		167,000	167,000	29,000	420,146,000
2044	27	0.16093			16,000	124,000	27,000	35,000	202,000	202,000	33,000	420,179,000
2045	28	0.15040			16,000	124,000	27,000		167,000	167,000	25,000	420,204,000
2046	29	0.14056			16,000	124,000	27,000		167,000	167,000	23,000	420,227,000
2047	30	0.13137			16,000	124,000	27,000		167,000	167,000	22,000	420,249,000

Estimated Non-discounted Capital Costs: 616,000,000

Estimated Non-discounted Total Costs: 619,000,000

Estimated 30-year Present Worth Costs: 420,000,000

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. In accordance with USEPA Guidance, this is an order-of-magnitude engineering estimate that is expected to be within -30 to +50 percent of the actual project cost.

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Present Worth Cost Estimate
Complete Rad Removal (7.9 pCi/g) Remedy Alternative

			Capital Costs ($)		Operation, Maintenance, Monitoring, and Periodic Costs ($/yr)							
Year	*n*	P/F(*i* =1.5%)	Remediation	Subtotal Capital Costs	Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000	17,340,000	17,340,000					0	17,340,000	17,340,000	17,340,000
2018	1	0.98522	52,830,000	52,830,000					0	52,830,000	52,049,000	69,389,000
2019	2	0.97066	57,080,000	57,080,000					0	57,080,000	55,405,000	124,794,000
2020	3	0.95632	34,780,000	34,780,000					0	34,780,000	33,261,000	158,055,000
2021	4	0.94218	57,630,000	57,630,000					0	57,630,000	54,298,000	212,353,000
2022	5	0.92826	76,260,000	76,260,000					0	76,260,000	70,789,000	283,142,000
2023	6	0.91454	35,650,000	35,650,000					0	35,650,000	32,603,000	315,745,000
2024	7	0.90103	50,290,000	50,290,000					0	50,290,000	45,313,000	361,058,000
2025	8	0.88771	67,720,000	67,720,000					0	67,720,000	60,116,000	421,174,000
2026	9	0.87459	47,250,000	47,250,000					0	47,250,000	41,324,000	462,498,000
2027	10	0.86167	35,860,000	35,860,000					0	35,860,000	30,899,000	493,397,000
2028	11	0.84893	25,720,000	25,720,000					0	25,720,000	21,835,000	515,232,000
2029	12	0.83639	52,920,000	52,920,000					0	52,920,000	44,262,000	559,494,000
2030	13	0.82403	4,390,000	4,390,000	16,000	248,000	27,000		291,000	4,681,000	3,857,000	563,351,000
2031	14	0.81185			16,000	248,000	27,000		291,000	291,000	236,000	563,587,000
2032	15	0.79985			16,000	248,000	27,000		291,000	291,000	233,000	563,820,000
2033	16	0.78803			16,000	248,000	27,000		291,000	291,000	229,000	564,049,000
2034	17	0.77639			16,000	248,000	27,000	35,000	326,000	326,000	253,000	564,302,000
2035	18	0.76491			16,000	124,000	27,000		167,000	167,000	128,000	564,430,000
2036	19	0.75361			16,000	124,000	27,000		167,000	167,000	126,000	564,556,000
2037	20	0.74247			16,000	124,000	27,000		167,000	167,000	124,000	564,680,000
2038	21	0.73150			16,000	124,000	27,000		167,000	167,000	122,000	564,802,000
2039	22	0.72069			16,000	124,000	27,000	35,000	202,000	202,000	146,000	564,948,000
2040	23	0.71004			16,000	124,000	27,000		167,000	167,000	119,000	565,067,000
2041	24	0.69954			16,000	124,000	27,000		167,000	167,000	117,000	565,184,000
2042	25	0.68921			16,000	124,000	27,000		167,000	167,000	115,000	565,299,000
2043	26	0.67902			16,000	124,000	27,000		167,000	167,000	113,000	565,412,000
2044	27	0.66899			16,000	124,000	27,000	35,000	202,000	202,000	135,000	565,547,000
2045	28	0.65910			16,000	124,000	27,000		167,000	167,000	110,000	565,657,000
2046	29	0.64936			16,000	124,000	27,000		167,000	167,000	108,000	565,765,000
2047	30	0.63976			16,000	124,000	27,000		167,000	167,000	107,000	565,872,000

Estimated Non-discounted Capital Costs: 616,000,000

Estimated Non-discounted Total Costs: 619,000,000

Estimated 30-year Present Worth Costs: 566,000,000

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. In accordance with USEPA Guidance, this is an order-of-magnitude engineering estimate that is expected to be within -30 to +50 percent of the actual project cost.

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Present Worth Cost Estimate
Complete Rad Removal (7.9 pCi/g) Remedy Alternative

Year	*n*	P/F(*i* =7%)	Capital Costs ($) Remediation	Capital Costs ($) Subtotal Capital Costs	Operation, Maintenance, Monitoring, and Periodic Costs ($/yr) Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000	17,340,000	17,340,000					0	17,340,000	17,340,000	17,340,000
2018	1	0.93458	52,830,000	52,830,000					0	52,830,000	49,374,000	66,714,000
2019	2	0.87344	57,080,000	57,080,000					0	57,080,000	49,856,000	116,570,000
2020	3	0.81630	34,780,000	34,780,000					0	34,780,000	28,391,000	144,961,000
2021	4	0.76290	57,630,000	57,630,000					0	57,630,000	43,966,000	188,927,000
2022	5	0.71299	76,260,000	76,260,000					0	76,260,000	54,372,000	243,299,000
2023	6	0.66634	35,650,000	35,650,000					0	35,650,000	23,755,000	267,054,000
2024	7	0.62275	50,290,000	50,290,000					0	50,290,000	31,318,000	298,372,000
2025	8	0.58201	67,720,000	67,720,000					0	67,720,000	39,414,000	337,786,000
2026	9	0.54393	47,250,000	47,250,000					0	47,250,000	25,701,000	363,487,000
2027	10	0.50835	35,860,000	35,860,000					0	35,860,000	18,229,000	381,716,000
2028	11	0.47509	25,720,000	25,720,000					0	25,720,000	12,219,000	393,935,000
2029	12	0.44401	52,920,000	52,920,000					0	52,920,000	23,497,000	417,432,000
2030	13	0.41496	4,390,000	4,390,000	16,000	248,000	27,000	0	291,000	4,681,000	1,942,000	419,374,000
2031	14	0.38782			16,000	248,000	27,000	0	291,000	291,000	113,000	419,487,000
2032	15	0.36245			16,000	248,000	27,000	0	291,000	291,000	105,000	419,592,000
2033	16	0.33873			16,000	248,000	27,000	0	291,000	291,000	99,000	419,691,000
2034	17	0.31657			16,000	248,000	27,000	35,000	326,000	326,000	103,000	419,794,000
2035	18	0.29586			16,000	124,000	27,000	0	167,000	167,000	49,000	419,843,000
2036	19	0.27651			16,000	124,000	27,000	0	167,000	167,000	46,000	419,889,000
2037	20	0.25842			16,000	124,000	27,000	0	167,000	167,000	43,000	419,932,000
2038	21	0.24151			16,000	124,000	27,000	0	167,000	167,000	40,000	419,972,000
2039	22	0.22571			16,000	124,000	27,000	35,000	202,000	202,000	46,000	420,018,000
2040	23	0.21095			16,000	124,000	27,000	0	167,000	167,000	35,000	420,053,000
2041	24	0.19715			16,000	124,000	27,000	0	167,000	167,000	33,000	420,086,000
2042	25	0.18425			16,000	124,000	27,000	0	167,000	167,000	31,000	420,117,000
2043	26	0.17220			16,000	124,000	27,000	0	167,000	167,000	29,000	420,146,000
2044	27	0.16093			16,000	124,000	27,000	35,000	202,000	202,000	33,000	420,179,000
2045	28	0.15040			16,000	124,000	27,000	0	167,000	167,000	25,000	420,204,000
2046	29	0.14056			16,000	124,000	27,000	0	167,000	167,000	23,000	420,227,000
2047	30	0.13137			16,000	124,000	27,000	0	167,000	167,000	22,000	420,249,000
2216	199	0.0000014			16,000	124,000	27,000	0	167,000	167,000	0	420,572,000
2217	200	0.0000013			16,000	124,000	27,000	0	167,000	167,000	0	420,572,000

Estimated Non-discounted Capital Costs: 616,000,000

Estimated Non-discounted Total Costs: 649,000,000

Estimated 200-year Present Worth Costs: 421,000,000

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. In accordance with USEPA Guidance, this is an order-of-magnitude engineering estimate that is expected to be within -30 to +50 percent of the actual project cost.

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Present Worth Cost Estimate
Complete Rad Removal (7.9 pCi/g) Remedy Alternative

			Capital Costs ($)		Operation, Maintenance, Monitoring, and Periodic Costs ($/yr)							
Year	*n*	P/F(*i* =1.5%)	Remediation	Subtotal Capital Costs	Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000	17,340,000	17,340,000					0	17,340,000	17,340,000	17,340,000
2018	1	0.98522	52,830,000	52,830,000					0	52,830,000	52,049,000	69,389,000
2019	2	0.97066	57,080,000	57,080,000					0	57,080,000	55,405,000	124,794,000
2020	3	0.95632	34,780,000	34,780,000					0	34,780,000	33,261,000	158,055,000
2021	4	0.94218	57,630,000	57,630,000					0	57,630,000	54,298,000	212,353,000
2022	5	0.92826	76,260,000	76,260,000					0	76,260,000	70,789,000	283,142,000
2023	6	0.91454	35,650,000	35,650,000					0	35,650,000	32,603,000	315,745,000
2024	7	0.90103	50,290,000	50,290,000					0	50,290,000	45,313,000	361,058,000
2025	8	0.88771	67,720,000	67,720,000					0	67,720,000	60,116,000	421,174,000
2026	9	0.87459	47,250,000	47,250,000					0	47,250,000	41,324,000	462,498,000
2027	10	0.86167	35,860,000	35,860,000					0	35,860,000	30,899,000	493,397,000
2028	11	0.84893	25,720,000	25,720,000					0	25,720,000	21,835,000	515,232,000
2029	12	0.83639	52,920,000	52,920,000					0	52,920,000	44,262,000	559,494,000
2030	13	0.82403	4,390,000	4,390,000	16,000	248,000	27,000	0	291,000	4,681,000	3,857,000	563,351,000
2031	14	0.81185			16,000	248,000	27,000	0	291,000	291,000	236,000	563,587,000
2032	15	0.79985			16,000	248,000	27,000	0	291,000	291,000	233,000	563,820,000
2033	16	0.78803			16,000	248,000	27,000	0	291,000	291,000	229,000	564,049,000
2034	17	0.77639			16,000	248,000	27,000	35,000	326,000	326,000	253,000	564,302,000
2035	18	0.76491			16,000	124,000	27,000	0	167,000	167,000	128,000	564,430,000
2036	19	0.75361			16,000	124,000	27,000	0	167,000	167,000	126,000	564,556,000
2037	20	0.74247			16,000	124,000	27,000	0	167,000	167,000	124,000	564,680,000
2038	21	0.73150			16,000	124,000	27,000	0	167,000	167,000	122,000	564,802,000
2039	22	0.72069			16,000	124,000	27,000	35,000	202,000	202,000	146,000	564,948,000
2040	23	0.71004			16,000	124,000	27,000	0	167,000	167,000	119,000	565,067,000
2041	24	0.69954			16,000	124,000	27,000	0	167,000	167,000	117,000	565,184,000
2042	25	0.68921			16,000	124,000	27,000	0	167,000	167,000	115,000	565,299,000
2043	26	0.67902			16,000	124,000	27,000	0	167,000	167,000	113,000	565,412,000
2044	27	0.66899			16,000	124,000	27,000	35,000	202,000	202,000	135,000	565,547,000
2045	28	0.65910			16,000	124,000	27,000	0	167,000	167,000	110,000	565,657,000
2046	29	0.64936			16,000	124,000	27,000	0	167,000	167,000	108,000	565,765,000
2047	30	0.63976			16,000	124,000	27,000	0	167,000	167,000	107,000	565,872,000
2216	199	0.05167			16,000	124,000	27,000	0	167,000	167,000	9,000	572,693,000
2217	200	0.05091			16,000	124,000	27,000	0	167,000	167,000	9,000	572,702,000

Estimated Non-discounted Capital Costs: 616,000,000

Estimated Non-discounted Total Costs: 649,000,000

Estimated 200-year Present Worth Costs: 573,000,000

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. In accordance with USEPA Guidance, this is an order-of-magnitude engineering estimate that is expected to be within -30 to +50 percent of the actual project cost.

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Present Worth Cost Estimate
Complete Rad Removal (7.9 pCi/g) Remedy Alternative

Year	*n*	P/F(*i* =7%)	Capital Costs ($) Remediation	Capital Costs ($) Subtotal Capital Costs	Operation, Maintenance, Monitoring, and Periodic Costs ($/yr) Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000	17,340,000	17,340,000					0	17,340,000	17,340,000	17,340,000
2018	1	0.93458	52,830,000	52,830,000					0	52,830,000	49,374,000	66,714,000
2019	2	0.87344	57,080,000	57,080,000					0	57,080,000	49,856,000	116,570,000
2020	3	0.81630	34,780,000	34,780,000					0	34,780,000	28,391,000	144,961,000
2021	4	0.76290	57,630,000	57,630,000					0	57,630,000	43,966,000	188,927,000
2022	5	0.71299	76,260,000	76,260,000					0	76,260,000	54,372,000	243,299,000
2023	6	0.66634	35,650,000	35,650,000					0	35,650,000	23,755,000	267,054,000
2024	7	0.62275	50,290,000	50,290,000					0	50,290,000	31,318,000	298,372,000
2025	8	0.58201	67,720,000	67,720,000					0	67,720,000	39,414,000	337,786,000
2026	9	0.54393	47,250,000	47,250,000					0	47,250,000	25,701,000	363,487,000
2027	10	0.50835	35,860,000	35,860,000					0	35,860,000	18,229,000	381,716,000
2028	11	0.47509	25,720,000	25,720,000					0	25,720,000	12,219,000	393,935,000
2029	12	0.44401	52,920,000	52,920,000					0	52,920,000	23,497,000	417,432,000
2030	13	0.41496	4,390,000	4,390,000	16,000	248,000	27,000	0	291,000	4,681,000	1,942,000	419,374,000
2031	14	0.38782			16,000	248,000	27,000	0	291,000	291,000	113,000	419,487,000
2032	15	0.36245			16,000	248,000	27,000	0	291,000	291,000	105,000	419,592,000
2033	16	0.33873			16,000	248,000	27,000	0	291,000	291,000	99,000	419,691,000
2034	17	0.31657			16,000	248,000	27,000	35,000	326,000	326,000	103,000	419,794,000
2035	18	0.29586			16,000	124,000	27,000	0	167,000	167,000	49,000	419,843,000
2036	19	0.27651			16,000	124,000	27,000	0	167,000	167,000	46,000	419,889,000
2037	20	0.25842			16,000	124,000	27,000	0	167,000	167,000	43,000	419,932,000
2038	21	0.24151			16,000	124,000	27,000	0	167,000	167,000	40,000	419,972,000
2039	22	0.22571			16,000	124,000	27,000	35,000	202,000	202,000	46,000	420,018,000
2040	23	0.21095			16,000	124,000	27,000	0	167,000	167,000	35,000	420,053,000
2041	24	0.19715			16,000	124,000	27,000	0	167,000	167,000	33,000	420,086,000
2042	25	0.18425			16,000	124,000	27,000	0	167,000	167,000	31,000	420,117,000
2043	26	0.17220			16,000	124,000	27,000	0	167,000	167,000	29,000	420,146,000
2044	27	0.16093			16,000	124,000	27,000	35,000	202,000	202,000	33,000	420,179,000
2045	28	0.15040			16,000	124,000	27,000	0	167,000	167,000	25,000	420,204,000
2046	29	0.14056			16,000	124,000	27,000	0	167,000	167,000	23,000	420,227,000
2047	30	0.13137			16,000	124,000	27,000	0	167,000	167,000	22,000	420,249,000
3016	999	4.422E-30			16,000	124,000	27,000	0	167,000	167,000	0	420,572,000
3017	1000	4.133E-30			16,000	124,000	27,000	0	167,000	167,000	0	420,572,000
		Estimated Non-discounted Capital Costs:		616,000,000				Estimated Non-discounted Total Costs:		788,000,000		

Estimated 1,000-year Present Worth Costs: 421,000,000

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. In accordance with USEPA Guidance, this is an order-of-magnitude engineering estimate that is expected to be within -30 to +50 percent of the actual project cost.

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Present Worth Cost Estimate
Complete Rad Removal (7.9 pCi/g) Remedy Alternative

			Capital Costs ($)		Operation, Maintenance, Monitoring, and Periodic Costs ($/yr)							
Year	*n*	P/F(*i* =1.5%)	Remediation	Subtotal Capital Costs	Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000	17,340,000	17,340,000					0	17,340,000	17,340,000	17,340,000
2018	1	0.98522	52,830,000	52,830,000					0	52,830,000	52,049,000	69,389,000
2019	2	0.97066	57,080,000	57,080,000					0	57,080,000	55,405,000	124,794,000
2020	3	0.95632	34,780,000	34,780,000					0	34,780,000	33,261,000	158,055,000
2021	4	0.94218	57,630,000	57,630,000					0	57,630,000	54,298,000	212,353,000
2022	5	0.92826	76,260,000	76,260,000					0	76,260,000	70,789,000	283,142,000
2023	6	0.91454	35,650,000	35,650,000					0	35,650,000	32,603,000	315,745,000
2024	7	0.90103	50,290,000	50,290,000					0	50,290,000	45,313,000	361,058,000
2025	8	0.88771	67,720,000	67,720,000					0	67,720,000	60,116,000	421,174,000
2026	9	0.87459	47,250,000	47,250,000					0	47,250,000	41,324,000	462,498,000
2027	10	0.86167	35,860,000	35,860,000					0	35,860,000	30,899,000	493,397,000
2028	11	0.84893	25,720,000	25,720,000					0	25,720,000	21,835,000	515,232,000
2029	12	0.83639	52,920,000	52,920,000					0	52,920,000	44,262,000	559,494,000
2030	13	0.82403	4,390,000	4,390,000	16,000	248,000	27,000	0	291,000	4,681,000	3,857,000	563,351,000
2031	14	0.81185			16,000	248,000	27,000	0	291,000	291,000	236,000	563,587,000
2032	15	0.79985			16,000	248,000	27,000	0	291,000	291,000	233,000	563,820,000
2033	16	0.78803			16,000	248,000	27,000	0	291,000	291,000	229,000	564,049,000
2034	17	0.77639			16,000	248,000	27,000	35,000	326,000	326,000	253,000	564,302,000
2035	18	0.76491			16,000	124,000	27,000	0	167,000	167,000	128,000	564,430,000
2036	19	0.75361			16,000	124,000	27,000	0	167,000	167,000	126,000	564,556,000
2037	20	0.74247			16,000	124,000	27,000	0	167,000	167,000	124,000	564,680,000
2038	21	0.73150			16,000	124,000	27,000	0	167,000	167,000	122,000	564,802,000
2039	22	0.72069			16,000	124,000	27,000	35,000	202,000	202,000	146,000	564,948,000
2040	23	0.71004			16,000	124,000	27,000	0	167,000	167,000	119,000	565,067,000
2041	24	0.69954			16,000	124,000	27,000	0	167,000	167,000	117,000	565,184,000
2042	25	0.68921			16,000	124,000	27,000	0	167,000	167,000	115,000	565,299,000
2043	26	0.67902			16,000	124,000	27,000	0	167,000	167,000	113,000	565,412,000
2044	27	0.66899			16,000	124,000	27,000	35,000	202,000	202,000	135,000	565,547,000
2045	28	0.65910			16,000	124,000	27,000	0	167,000	167,000	110,000	565,657,000
2046	29	0.64936			16,000	124,000	27,000	0	167,000	167,000	108,000	565,765,000
2047	30	0.63976			16,000	124,000	27,000	0	167,000	167,000	107,000	565,872,000
3016	999	3.471E-07			16,000	124,000	27,000	0	167,000	167,000	0	573,270,000
3017	1000	3.419E-07			16,000	124,000	27,000	0	167,000	167,000	0	573,270,000

Estimated Non-discounted Capital Costs: 616,000,000

Estimated Non-discounted Total Costs: 788,000,000

Estimated 1,000-year Present Worth Costs: 573,000,000

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. In accordance with USEPA Guidance, this is an order-of-magnitude engineering estimate that is expected to be within -30 to +50 percent of the actual project cost.

Appendix K-5

Cost Estimates for the Partial Excavation of Shallow RIM with Activities above 52.9 pCi/g Alternative

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Preliminary Estimated Capital Costs
Complete Rad Removal (52.9 pCi/g) Remedy Alternative

Cost Item		Estimated Capital Costs
Construction Costs		$ 89,520,000
Radiological Survey/H&S Support Costs		$ 19,439,000
On-site Rad Laboratory		$ 596,000
Long-Term Monitoring Facilities		$ 211,000
Post Construction Radon Flux Monitoring		$ 26,000
Stormwater Monitoring during Construction		$ 228,000
Air Monitoring during Construction		$ 855,000
Institutional Controls		$ 50,000
Subtotal		$ 110,925,000
Project Management	5%	$ 5,546,000
Engineering Design	6%	$ 6,656,000
Construction Management	6%	$ 6,656,000
Subtotal - Construction On-Site		$ 129,780,000
Off-site Transportation and Disposal (@229/lcy)		$ 56,900,000
Subtotal - Transport/Disposal Off-site		$ 56,900,000
Contingencies:		
Scope (construction onsite)	55%	$ 71,379,000
Scope (transport/disposal offsite)	15%	$ 8,535,000
Bid (all activities)	20%	$ 37,336,000
Subtotal - Contingency		$ 117,250,000
Other Requirements:		
Buy-out Asphalt Plant Lease		$ 3,200,000
Permitting for Relocation of Transfer Station		$ 500,000
Relocate Transfer Station		$ 5,260,000
Subtotal - Other Requirements		$ 8,960,000
Total: 52.9 pCi/g Partial Excavation Remedy		$ 313,000,000

Estimated Length Construction	3/5/18	start
	9/22/22	end
	1,662	no. Days
	4.6	no. Years
	19	no. Quarters

Construction Cost Worksheet - FFS 52.9 DRAFT

Step #	Category	Sub-Category	Task	Quantity Area 1	Quantity Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Construction Days Area 1	Construction Days Area 2	Crew Man-days Area 1	Crew Man-days Area 2	Unit Costs Ext. Mat, O&P	Unit Costs Ext. Labor, O&P	Unit Costs Ext. Labor, O&P Ineff.	Unit Costs Ext. Equip, O&P	Unit Costs Ext. Equip, O&P Ineff.	Unit Costs Ext. Total, O&P	Bridgeton Taxes Area 1	Bridgeton Taxes Area 2	Total Cost Area 1	Total Cost Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Delivery Miles Area 1	Total Delivery Miles Area 2
FFS 52.9 DRAFT 1	Temporary Construction Facilitities / Utilities / Personnel	Construction Trailers	Capital Expenses	2	-	Group of Trailers		See separate Assumptions sheet								25.0	-	39.2	-	$ -					$ 106,698.53	$ -	$ -	$ 213,397	$ -	10	-	200	-
FFS 52.9 DRAFT 2			Operating Expenses	72	-	Group of Trailers	Months	See separate Assumptions sheet												$ -					$ 2,786.52	$ -	$ -	$ 201,509	$ -				
FFS 52.9 DRAFT 3			Parking Area	4,444	-	Gravel Area	S.Y.	RS Means, Year 2016 Quarter 1	015523500050	Temporary, roads, gravel fill, 4" gravel depth, excl surfacing	B14	715	6.0	1.0	100%	6.2	-	37.3	-	$ 4.10	$ 4.35	$ -	$ 0.63	$ -	$ 9.08	$ 1,524	$ -	$ 41,879	$ -				
FFS 52.9 DRAFT 4			Portable Toilets in Construction Areas	27	45	Portable Toilets	Month	RS Means, Year 2016 Quarter 1	015433406420	Rent portable toilet chemical, recycle, flush type, Incl. Hourly Oper. Cost.					100%					$ -	$ -	$ -	$ 317.05	$ -	$ 317.05	$ -	$ -	$ 8,522	$ 14,153				
FFS 52.9 DRAFT 5		Contractor's Construction Management Personnel	Project Manager	237	-	Personnel	Week	RS Means, Year 2016 Quarter 1	013113200220	Field personnel, project manager, maximum		0	1.0	1.0	100%	######	-	1,137.7	-	$ -	$ 4,100.00	$ -	$ -	$ -	$ 4,100.00	$ -	$ -	$ 973,590	$ -				
FFS 52.9 DRAFT 6			Construction Superintendent(s)	314	-	Personnel	Week	RS Means, Year 2016 Quarter 1	013113200260	Field personnel, superintendent, average		0	1.0	1.0	100%	######	-	1,506.6	-	$ -	$ 3,350.00	$ -	$ -	$ -	$ 3,350.00	$ -	$ -	$ 1,053,386	$ -				
FFS 52.9 DRAFT 7			Clerk(s)	314	-	Personnel	Week	RS Means, Year 2016 Quarter 1	013113200020	Field personnel, clerk, average		0	1.0	1.0	100%	######	-	1,506.6	-	$ -	$ 710.00	$ -	$ -	$ -	$ 710.00	$ -	$ -	$ 223,255	$ -				
FFS 52.9 DRAFT 8			Field Engineer(s) / Safety Officer(s)	314	-	Personnel	Week	RS Means, Year 2016 Quarter 1	013113200120	Field personnel, field engineer, average		0	1.0	1.0	100%	######	-	1,506.6	-	$ -	$ 2,200.00	$ -	$ -	$ -	$ 2,200.00	$ -	$ -	$ 691,776	$ -				
FFS 52.9 DRAFT 9	Temporary Stormwater Infrastructure (for stormwater during construction)	Frac Tanks	Delivery	58	58	Frac Tanks	Ea.	See separate Assumptions sheet				3	2.0	2.0	100%	9.7	9.7	38.7	38.7	$ -	$ 200.00	$ -		$ -	$ 200.00	$ -	$ -	$ 11,600	$ 11,600	58	58	3,480	3,480
FFS 52.9 DRAFT 10			Monthly Rental (or Purchase)	505	1,023	Frac Tanks	Tank-Months	See separate Assumptions sheet							100%					$ 852.25		$ -		$ -	$ 852.25	$ 36,016	$ 72,916	$ 466,670	$ 944,805				
FFS 52.9 DRAFT 11			Cleaning	58	58	Frac Tanks	Ea.	See separate Assumptions sheet				1	2.0	1.0	100%	58.0	58.0	116.0	116.0	$ -	$ 1,500.00	$ -		$ -	$ 1,500.00	$ -	$ -	$ 87,000	$ 87,000				
FFS 52.9 DRAFT 12			Removal	58	58	Frac Tanks	Ea.	See separate Assumptions sheet				3	2.0	2.0	100%	9.7	9.7	38.7	38.7	$ -	$ 200.00	$ -		$ -	$ 200.00	$ -	$ -	$ 11,600	$ 11,600	58	58	3,480	3,480
FFS 52.9 DRAFT 13		Forcemain	Install forcemain from Excavation Area to Tank Area	4,500	7,000	HDPE Pipe	L.F.	RS Means, Year 2016 Quarter 1	331113350100	Water supply distribution piping, piping HDPE, butt fusion joints, 40' lengths, 4" diameter, SDR 21	B22A	400	5.0	1.0	100%	11.3	17.5	56.3	87.5	$ 2.61	$ 7.12	$ -	$ 2.05	$ -	$ 11.78	$ 982	$ 1,528	$ 53,992	$ 83,988				
FFS 52.9 DRAFT 14			Install forcemain from Tank Area to Treatment Plant and Discharge Point	500	500	HDPE Pipe	L.F.	RS Means, Year 2016 Quarter 1	331113350100	Water supply distribution piping, piping HDPE, butt fusion joints, 40' lengths, 4" diameter, SDR 21	B22A	400	5.0	1.0	100%	1.3	1.3	6.3	6.3	$ 2.61	$ 7.12	$ -	$ 2.05	$ -	$ 11.78	$ 109	$ 109	$ 5,999	$ 5,999				
FFS 52.9 DRAFT 15			Install forcemain valves	6	8	Pipe Valves	Ea.	RS Means, Year 2016 Quarter 1	220523601310	Valves, plastic, PVC, ball, true union, socket or threaded, 4"	Q1	20	2.0	1.0	100%	0.3	0.4	0.6	0.8	$ 472.63	$ 68.18	$ -	$ -	$ -	$ 540.81	$ 237	$ 316	$ 3,482	$ 4,643				
FFS 52.9 DRAFT 16		Treatment Facility	Construct Treatment Facility	1	-	Treatment Facility	Each	See separate Assumptions sheet				0.067	2.0	1.0	100%	15.0	-	30.0	-	$ 71,000.00					$ 102,000.00	$ 5,938	$ -	$ 107,938	$ -				
FFS 52.9 DRAFT 17			Treatment Facility Demolition	1	-	Treatment Facility	Each	See separate Assumptions sheet				0.48	9.2	1.0	100%	2.1	-	19.0	-	$ 4,000.00					$ 27,000.00	$ 335	$ -	$ 27,335	$ -				
FFS 52.9 DRAFT 18			Monthly Rent	36	-	Treatment Facility Operation	Each	See separate Assumptions sheet							100%					$ 1,970.00					$ 1,970.00	$ 5,931	$ -	$ 76,851	$ -				
FFS 52.9 DRAFT 19			Monthly Operation during remediation	35	-	Treatment Facility Operation	Months	See separate Assumptions sheet				0.20	1.0	1.0	100%	179.7	-	179.7	-	$ 4,270.68					$ 4,270.68	$ 12,626	$ -	$ 163,599	$ -				
FFS 52.9 DRAFT 20		Stormwater events during construction	Dewater excavation construction after rain events	113	449	Days of Pumping Construction Stormwater	Day	RS Means, Year 2016 Quarter 1	312319200650	Dewatering, pumping 8 hours, attended 2 hrs per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose	B10I	4	1.5	4.0	100%	7.0	28.1	42.2	168.3	$ -	$ 201.71	$ -	$ 38.99	$ -	$ 240.70	$ -	$ -	$ 27,118	$ 108,038				
FFS 52.9 DRAFT 21			Dewater backfill construction after rain events	132	251	Days of Pumping Construction Stormwater	Day	RS Means, Year 2016 Quarter 1	312319200650	Dewatering, pumping 8 hours, attended 2 hrs per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose	B10I	4	1.5	4.0	100%	8.2	15.7	49.4	94.1	$ -	$ 201.71	$ -	$ 38.99	$ -	$ 240.70	$ -	$ -	$ 31,723	$ 60,411				
FFS 52.9 DRAFT 22			Dispose of contact stormwater to MSD	1,000,000	1,400,000	Contact Stormwater	Gallons	St. Louis Sewer District, May 2011							100%					$ -					$ 0.14	$ -	$ -	$ 140,000	$ 196,000				
FFS 52.9 DRAFT 23	Leachate Handling	Frac Tanks	Delivery	20	20	Frac Tanks	Ea.	See separate Assumptions sheet				3	2.0	2.0	100%	3.3	3.3	13.3	13.3	$ -	$ 200.00	$ -		$ -	$ 200.00	$ -	$ -	$ 4,000	$ 4,000	20	20	1,200	1,200
FFS 52.9 DRAFT 24			Monthly Rental (or Purchase)	282	527	Frac Tanks	Tank-Months	See separate Assumptions sheet							100%					$ 852.25		$ -		$ -	$ 852.25	$ 20,105	$ 37,560	$ 260,510	$ 486,680				
FFS 52.9 DRAFT 25			Cleaning	20	20	Frac Tanks	Ea.	See separate Assumptions sheet				1	2.0	1.0	100%	20.0	20.0	40.0	40.0	$ -	$ 1,500.00	$ -		$ -	$ 1,500.00	$ -	$ -	$ 30,000	$ 30,000				
FFS 52.9 DRAFT 26			Removal	20	20	Frac Tanks	Ea.	See separate Assumptions sheet				3	2.0	2.0	100%	3.3	3.3	13.3	13.3	$ -	$ 200.00	$ -		$ -	$ 200.00	$ -	$ -	$ 4,000	$ 4,000	20	20	1,200	1,200
FFS 52.9 DRAFT 27		Secondary Containment for Frac Tanks	Purchase and deliver liner & berm material	2,178	2,178	Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	354113200040	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	41.4	100%	0.9	0.9	37.6	37.6	$ 26.69	$ -	$ -	$ -	$ -	$ 26.69	$ 4,862	$ 4,862	$ 63,005	$ 63,005	182	182	7,280	7,280
FFS 52.9 DRAFT 28			Spread loose lift before compaction	2,178	2,178	Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	2.1	100%	1.0	1.0	3.3	3.3	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ 5,533	$ 5,533				
FFS 52.9 DRAFT 29			Compact Liner & Berms	1,556	1,556	Clay	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235640	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	1,300	1.5	2.0	100%	0.6	0.6	1.8	1.8	$ -	$ 0.62	$ -	$ 1.15	$ -	$ 1.77	$ -	$ -	$ 2,754	$ 2,754				
FFS 52.9 DRAFT 30		Leachate Storage & Testing	Pumping from Excavation Site	2	6	Leachate	Day	RS Means, Year 2016 Quarter 1	312319200650	Dewatering, pumping 8 hours, attended 2 hrs per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose	B10I	4	1.5	1.0	100%	0.4	1.5	0.6	2.3	$ -	$ 201.71	$ -	$ 38.99	$ -	$ 240.70	$ -	$ -	$ 373	$ 1,447				
FFS 52.9 DRAFT 31			Move Tank from Tank Area to Excavation Site	15	58	Tanks	Ea.	See separate Assumptions sheet				4	2.0	1.0	100%	3.8	14.5	7.5	29.0	$ -	$ 70.00	$ -	$ 70.00	$ -	$ 140.00	$ -	$ -	$ 2,100	$ 8,120				
FFS 52.9 DRAFT 32			Leachate Sampling	15	58	Lab Tests	Ea.	RS Means, Year 2016 Quarter 1	029110100100	Field testing equipment, sampling & testing soil/sediment, sample collection, field samples, sludge	1 Skwk	32	1.0	1.0	100%	0.5	1.8	0.5	1.8	$ -	$ 20.28	$ -	$ -	$ -	$ 20.28	$ -	$ -	$ 304	$ 1,176				

Construction Cost Worksheet - FFS 52.9 DRAFT

				Quantity												Construction Days		Crew Man-days		Unit Costs						Bridgeton Taxes		Total Cost		Delivery Truckloads		Total Delivery Miles	
Step #	Category	Sub-Category	Task	Area 1	Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Area 1	Area 2	Area 1	Area 2	Ext. Mat, O&P	Ext. Labor, O&P	Ext. Labor, O&P Ineff.	Ext. Equip, O&P	Ext. Equip, O&P Ineff.	Ext. Total, O&P	Area 1	Area 2	Area 1	Area 2	Area 1	Area 2	Area 1	Area 2
FFS 52.9 DRAFT 33			Leachate Testing - VOC's	15	58	Lab Tests	Ea.	RS Means, Year 2016 Quarter 1	029110100600	Laboratory analytical services, laboratory testing, volatile organics without GC/MS					100%					$ 173.20	$ -	$ -	$ -	$ -	$ 173.20	$ 217	$ 840	$ 2,815	$ 10,886				
FFS 52.9 DRAFT 34			Hauling and Disposal	297,328	1,154,467	Leachate	Gallons	See separate Assumptions sheet			B34B	5,000	1.0	2.0	100%	29.7	115.4	59.5	230.9	$ -	$ 0.28	$ -	$ 0.28	$ -	$ 0.57	$ -	$ -	$ 169,180	$ 656,892	60	231	36,000	138,600
FFS 52.9 DRAFT 35			Budget for Contaminated Stormwater Prevention or Disposal	14	26	Budget	Months	Budgeted Monthly Amount							100%					$ 10,000.00		$ -		$ -	$ 10,000.00	$ 11,795	$ 22,036	$ 152,836	$ 285,526				
FFS 52.9 DRAFT 36		Structure	Structure Construction	1	-	Clear Span Structure	Ea.	See separate Assumptions sheet			Structure Construction Crew	0	30.0	1	100%	110.0	-	3,300.0	-	$ 4,800,000		$ -		$ -	$ 4,800,000.00	$ 401,424	$ -	$ 5,201,424	$ -				
FFS 52.9 DRAFT 37			Demolition	1	-	Clear Span Structure	Ea.	See separate Assumptions sheet			Structure Demolition Crew	0	30.0	1	100%	15.0	-	450.0	-	$ -	$ 80,000.00	$ -	$ 80,000.00	$ -	$ 160,000.00	$ -	$ -	$ 160,000	$ -				
FFS 52.9 DRAFT 38			Startup Capital Expenses	1	-	Air Treatment System	Ea.	See separate Assumptions sheet			Treatment System Crew	0	7.1	1	100%	10.0	-	71.0	-	$ 386,200.00	$ 122,600	$ -		$ -	$ 508,800.00	$ 32,298	$ -	$ 541,098	$ -	9	-	9,360	-
FFS 52.9 DRAFT 39			Vessel Rental Costs (Project Total)	1	-	Air Treatment System	Ea.	See separate Assumptions sheet							100%			-	-	$ 956,000.00		$ -		$ -	$ 956,000.00	$ 79,950	$ -	$ 1,035,950	$ -				
FFS 52.9 DRAFT 40		Air Treatment System	Blower Costs (Purchase or Rental Total)	1	-	Air Treatment System	Ea.	See separate Assumptions sheet							100%			-	-	$ 709,000.00		$ -		$ -	$ 709,000.00	$ 59,294	$ -	$ 768,294	$ -				
FFS 52.9 DRAFT 41			Media Replacement (for all vessels)	1	-	Air Treatment System Media	Instances	See separate Assumptions sheet			Treatment System Crew	0	4.0	1	100%	7.5	-	30.0	-	$ 432,000.00		$ -		$ -	$ 432,000.00	$ 36,128	$ -	$ 468,128	$ -				
FFS 52.9 DRAFT 42	RIM Loading Station		Demobilization	1	-	Air Treatment System	Ea.	See separate Assumptions sheet			Treatment System Crew	0	3.5	1	100%	11.6	-	41.0	-	$ 85,000.00	$ 36,000.00	$ -		$ -	$ 121,000.00	$ 7,109	$ -	$ 128,109	$ -	9	-	9,360	-
FFS 52.9 DRAFT 43			Fencing along road for RIM hauling	1,600	1,600	Fencing	L.F.	RS Means, Year 2016 Quarter 1	323113200800	Fence, chain link industrial, galvanized steel, 6 ga. wire, 2" posts @ 10' OC, 6' high, includes excavation, & concrete, excludes barbed wire	B80C	250	3.0	2.0	100%	3.2	3.2	19.2	19.2	$ 23.25	$ 5.80	$ -	$ 1.28	$ -	$ 30.33	$ 3,111	$ 3,111	$ 51,639	$ 51,639				
FFS 52.9 DRAFT 44			Silt Fencing along road for RIM hauling	14,000	28,000	Silt Fence	Per L.F., per Month	See separate Assumptions sheet		Monthly cost for Silt fence, 3' high. Install, maintain monthly, and replace each 6 months.	B62	3,120	3.0	1.0	100%	4.5	9.0	13.5	26.9	$ 0.11	$ 0.27	$ -	$ 0.27	$ -	$ 0.64	$ 127	$ 254	$ 9,110	$ 18,220				
FFS 52.9 DRAFT 45			Remove potentially contaminated road surface	356	356	Roadway Gravel	B.C.Y.	RS Means, Year 2016 Quarter 1	312316465000	Excavating, bulk, dozer, open site, bank measure, sand and gravel, 300 H.P. dozer, 50' haul	B10M	1,900	1.5	1.0	100%	0.2	0.2	0.3	0.3	$ -	$ 0.43	$ -	$ 1.23	$ -	$ 1.66	$ -	$ -	$ 590	$ 590				
FFS 52.9 DRAFT 46		Haul Road Improvements	Loading for previous line	356	356	Roadway Gravel	B.C.Y.	RS Means, Year 2016 Quarter 1	312316421250A	Excavating, bulk bank measure, for loading onto trucks, add	B10O	5,016	1.5	1.0	100%	0.1	0.1	0.1	0.1	$ -	$ 0.16	$ -	$ 0.24	$ -	$ 0.40	$ -	$ -	$ 142	$ 142				
FFS 52.9 DRAFT 47			Hauling for previous line	427	427	Roadway Gravel	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205060	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2000 ft, 10 MPH, excludes loading equipment	B34F	594	1.0	1.0	100%	0.7	0.7	0.7	0.7	$ -	$ 0.83	$ -	$ 3.20	$ -	$ 4.03	$ -	$ -	$ 1,719	$ 1,719				
FFS 52.9 DRAFT 48			Repairs to road remediation	2,133	2,133	Gravel Roads	S.Y.	RS Means, Year 2016 Quarter 1	015523500100	Temporary, roads, gravel fill, 8" gravel depth, excl surfacing	B14	615	6.0	1.0	100%	3.5	3.5	20.8	20.8	$ 8.21	$ 5.06	$ -	$ 0.73	$ -	$ 14.00	$ 1,465	$ 1,465	$ 31,331	$ 31,331				
FFS 52.9 DRAFT 49			Mobilize and Demobilize Equipment by Pickup Truck	16	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501200	Mobilization or demobilization, delivery charge for small equipment, placed in rear of, or towed by pickup truck	A3A	4	1.0	1.0	100%	4.0	-	4.0	-	$ -	$ 157.34	$ -	$ 48.59	$ -	$ 205.93	$ -	$ -	$ 3,295	$ -				
FFS 52.9 DRAFT 50			Extra Mileage for Mobilizations	240	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501200A	Mobilization or demobilization, each additional 5 miles haul distance, add	A3A	72	1.0	1.0	100%	3.3	-	3.3	-	$ -	$ 15.73	$ -	$ 4.86	$ -	$ 20.59	$ -	$ -	$ 4,942	$ -				
FFS 52.9 DRAFT 51			Mobilize and Demobilize Equipment by 3-Ton Trailer	6	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501300	Mobilization or demobilization, delivery charge for equipment, hauled on 3-ton capacity towed trailer	A3Q	3	1.0	1.0	100%	2.2	-	2.2	-	$ -	$ 235.49	$ -	$ 84.19	$ -	$ 319.68	$ -	$ -	$ 1,918	$ -				
FFS 52.9 DRAFT 52			Extra Mileage for Mobilizations	90	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501300A	Mobilization or demobilization, each additional 5 miles haul distance, add	A3Q	72	1.0	1.0	100%	1.3	-	1.3	-	$ -	$ 23.55	$ -	$ 8.42	$ -	$ 31.97	$ -	$ -	$ 2,877	$ -				
FFS 52.9 DRAFT 53		Mobilization	Mobilize and Demobilize Equipment by 20-Ton Trailer	38	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501400	Mobilization or demobilization, delivery charge for equipment, hauled on 20-ton capacity towed trailer	B34U	2	2.0	3.0	100%	6.3	-	38.0	-	$ -	$ 591.36	$ -	$ 293.80	$ -	$ 885.16	$ -	$ -	$ 33,636	$ -				
FFS 52.9 DRAFT 54			Extra Mileage for Mobilizations	570	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501400A	Mobilization or demobilization, each additional 5 miles haul distance, add	B34U	72	2.0	3.0	100%	2.6	-	15.8	-	$ -	$ 59.14	$ -	$ 29.38	$ -	$ 88.52	$ -	$ -	$ 50,456	$ -				
FFS 52.9 DRAFT 55			Mobilize and Demobilize Equipment by 40-Ton Trailer	50	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501500	Mobilization or demobilization, delivery charge for equipment, hauled on 40-ton capacity towed trailer	B34N	2	2.0	5.0	100%	5.0	-	50.0	-	$ -	$ 601.92	$ -	$ 468.95	$ -	$ 1,070.87	$ -	$ -	$ 53,544	$ -				
FFS 52.9 DRAFT 56			Extra Mileage for Mobilizations	750	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501500A	Mobilization or demobilization, each additional 5 miles haul distance, add	B34N	72	2.0	5.0	100%	2.1	-	20.8	-	$ -	$ 60.19	$ -	$ 46.90	$ -	$ 107.09	$ -	$ -	$ 80,318	$ -				
FFS 52.9 DRAFT 57			Mobilize and Demobilize Crane Equipment (more than 75 tons)	2	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501800	Mobilization or demobilization, crane, truck-mounted, over 75 ton, (with chase vehicle)	A3E	3	2.0	1.0	100%	0.8	-	1.6	-	$ -	$ 485.76	$ -	$ 77.97	$ -	$ 563.73	$ -	$ -	$ 1,127	$ -				
FFS 52.9 DRAFT 58			Extra Mileage for Mobilizations	30	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501800A	Mobilization or demobilization, each additional 5 miles haul distance, add	A3E	72	2.0	1.0	100%	0.4	-	0.8	-	$ -	$ 48.58	$ -	$ 7.80	$ -	$ 56.38	$ -	$ -	$ 1,691	$ -				
FFS 52.9 DRAFT 59			Mobilize and Demobilize Equipment by Pickup Truck	16	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501200	Mobilization or demobilization, delivery charge for small equipment, placed in rear of, or towed by pickup truck	A3A	4	1.0	1.0	100%	4.0	-	4.0	-	$ -	$ 157.34	$ -	$ 48.59	$ -	$ 205.93	$ -	$ -	$ 3,295	$ -				
FFS 52.9 DRAFT 60			Extra Mileage for Mobilizations	240	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501200A	Mobilization or demobilization, each additional 5 miles haul distance, add	A3A	72	1.0	1.0	100%	3.3	-	3.3	-	$ -	$ 15.73	$ -	$ 4.86	$ -	$ 20.59	$ -	$ -	$ 4,942	$ -				
FFS 52.9 DRAFT 61			Mobilize and Demobilize Equipment by 3-Ton Trailer	6	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501300	Mobilization or demobilization, delivery charge for equipment, hauled on 3-ton capacity towed trailer	A3Q	3	1.0	1.0	100%	2.2	-	2.2	-	$ -	$ 235.49	$ -	$ 84.19	$ -	$ 319.68	$ -	$ -	$ 1,918	$ -				
FFS 52.9 DRAFT 62	Site-wide Preparation		Extra Mileage for Mobilizations	90	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501300A	Mobilization or demobilization, each additional 5 miles haul distance, add	A3Q	72	1.0	1.0	100%	1.3	-	1.3	-	$ -	$ 23.55	$ -	$ 8.42	$ -	$ 31.97	$ -	$ -	$ 2,877	$ -				

Construction Cost Worksheet - FFS 52.9 DRAFT

Step #	Category	Sub-Category	Task	Quantity Area 1	Quantity Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor
FFS 52.9 DRAFT 63		Supplemental Mobilizations	Mobilize and Demobilize Equipment by 20-Ton Trailer	38	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501400	Mobilization or demobilization, delivery charge for equipment, hauled on 20-ton capacity towed trailer	B34U	2	2.0	3.0	100%
FFS 52.9 DRAFT 64			Extra Mileage for Mobilizations	570	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501400A	Mobilization or demobilization, each additional 5 miles haul distance, add	B34U	72	2.0	3.0	100%
FFS 52.9 DRAFT 65			Mobilize and Demobilize Equipment by 40-Ton Trailer	50	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501500	Mobilization or demobilization, delivery charge for equipment, hauled on 40-ton capacity towed trailer	B34N	2	2.0	5.0	100%
FFS 52.9 DRAFT 66			Extra Mileage for Mobilizations	750	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501500A	Mobilization or demobilization, each additional 5 miles haul distance, add	B34N	72	2.0	5.0	100%
FFS 52.9 DRAFT 67			Mobilize and Demobilize Crane Equipment (more than 75 tons)	2	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501800	Mobilization or demobilization, crane, truck-mounted, over 75 ton, (with chase vehicle)	A3E	3	2.0	1.0	100%
FFS 52.9 DRAFT 68			Extra Mileage for Mobilizations	30	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501800A	Mobilization or demobilization, each additional 5 miles haul distance, add	A3E	72	2.0	1.0	100%
FFS 52.9 DRAFT 69		Traffic Improvements	Create Temporary Roads	15,467	26,667	Gravel Roads	S.Y.	RS Means, Year 2016 Quarter 1	015523500050	Temporary, roads, gravel fill, 4" gravel depth, excl surfacing	B14	715	6.0	1.0	100%
FFS 52.9 DRAFT 70			Bridge from Area 1 to Area 2 over Site Entrance Road	1	-	Modular Bridge	Ea.	See separate Assumptions sheet			Bridge Construction Crew	0	1.0	1.0	100%
FFS 52.9 DRAFT 71			Bridge Demolition	1	-	Modular Bridge	Ea.	See separate Assumptions sheet			Bridge Construction Crew	2	1.0	1.0	100%
FFS 52.9 DRAFT 72			Extend Permanent Road to new Transfer Station Location	2,000	-	Roadway	Ft.	Estimate			B25	34	11.0	1.0	100%
FFS 52.9 DRAFT 73			Budget for Add'l Traffic Improvements	$ 108,000	$ 108,000	TBD (shown as budget estimate)	$	SFS budget (plus inflation)					6.0	1.0	100%
FFS 52.9 DRAFT 74		Dust Control	Water Truck Depreciation	2	2	Water Trucks	Trucks	Estimate							
FFS 52.9 DRAFT 75			Water Truck Operation	52	86	Water Trucks	Months	Estimate				0	1.0	2.0	100%
FFS 52.9 DRAFT 76			Use Water to Control Dust	2.38E+07	3.92E+07	Water	Gallons	Missouri American Water Company, 7/19/2016							100%
FFS 52.9 DRAFT 77	Site Preparation		Prepare area with Stormwater BMPs	4,909	7,520	Erosion Control Measures	L.F.	RS Means, Year 2016 Quarter 1	312514161250	Synthetic erosion control, hay bales, staked	A2	2,500	3.0	1.0	100%
FFS 52.9 DRAFT 78		Decontamination Area	Floor	56	56	Concrete	C.Y.	RS Means, Year 2016 Quarter 1	033113350300	Structural concrete, ready mix, heavyweight, 4000 psi, includes local aggregate, sand, Portland cement (Type I) and water, delivered, excludes all additives and treatments					100%
FFS 52.9 DRAFT 79			Floor Installation	56	56	Concrete	C.Y.	RS Means, Year 2016 Quarter 1	033113704650	Structural concrete, placing, slab on grade, pumped, over 6" thick, includes leveling (strike off) & consolidation, excludes material	C20	185	8.0	1.0	100%
FFS 52.9 DRAFT 80			Building	1,000	1,000	Steel Building	SF Flr.	RS Means, Year 2016 Quarter 1	133419500170	Pre-engineered steel building, clear span rigid frame, 30 psf roof and 20 psf wind load, 20' to 29' W x 16' eave H, incl. 26 ga. colored ribbed roofing & siding, excl. footings, slab, anchor bolts	E2	320	7.0	1.0	100%
FFS 52.9 DRAFT 81		Clearing & Grubbing	Clear Vegetation (Light)	0	3	Vegetation	Acre	RS Means, Year 2016 Quarter 1	311313101020	Selective tree and shrub removal, selective clearing brush mowing, light density, tractor with rotary mower, excludes removal offsite	B84	2	1.0	1.0	100%
FFS 52.9 DRAFT 82			Clear Vegetation (Heavy)	8	15	Vegetation	Acre	RS Means, Year 2016 Quarter 1	311110100020	Clearing & grubbing, cut & chip light trees, to 6" diameter	B7	1	6.0	1.0	100%
FFS 52.9 DRAFT 83			Clear Small Trees	117	355	Trees	Ea.	RS Means, Year 2016 Quarter 1	311313201650	Selective felling trees and piling, large tract clearing & piling, firm level terrain, no boulders, hardwood, per tree, 300 H.P. dozer, 12" to 24" diameter	B10M	80	1.5	8.0	100%
FFS 52.9 DRAFT 84			Clear Large Trees	33	98	Trees	Ea.	RS Means, Year 2016 Quarter 1	311313201750	Selective felling trees and piling, large tract clearing & piling, firm level terrain, no boulders, hardwood, per tree, 300 H.P. dozer, 24" to 36" diameter	B10M	50	1.5	4.0	100%
FFS 52.9 DRAFT 85			Clear Small Stumps	117	355	Trees	Ea.	RS Means, Year 2016 Quarter 1	311313202100	Selective clearing and grubbing, 1-1/2 C.Y. excavator, 14" to 24" diameter, stump removal on site by hydraulic excavator	B30	25	3.0	2.0	100%
FFS 52.9 DRAFT 86			Clear Large Stumps	33	98	Trees	Ea.	RS Means, Year 2016 Quarter 1	311313202150	Selective clearing and grubbing, 1-1/2 C.Y. excavator, 26" to 36" diameter, stump removal on site by hydraulic excavator	B30	16	3.0	2.0	100%
FFS 52.9 DRAFT 87		Bird Mitigation	Average Monthly Expense	19	28	Months	Months	See separate Assumptions sheet			Bird Mitigation Crew	0.03	2.0	1.0	100%
FFS 52.9 DRAFT 88		Temporary Gas System for Stockpile in Area 2	Capital Expenses	1	-	Temporary Gas System	Ea.	See separate Assumptions sheet				0	6.0	1.0	100%
FFS 52.9 DRAFT 89			Monthly Expenses	19	-	Months	Months	See separate Assumptions sheet				1	1.0	1.0	100%
FFS 52.9 DRAFT 90		Area 1	Apply daily cover to remaining excavation	7,361	-	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%
FFS 52.9 DRAFT 91			Excavate and Sort RIM and Overburden (incl. minor sources)	88,760	-	RIM and Overburden	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%

Step #	Construction Days Area 1	Construction Days Area 2	Crew Man-days Area 1	Crew Man-days Area 2	Unit Costs: Ext. Mat, O&P	Ext. Labor, O&P	Ext. Labor, O&P Ineff.	Ext. Equip, O&P	Ext. Equip, O&P Ineff.	Ext. Total, O&P	Bridgeton Taxes Area 1	Bridgeton Taxes Area 2	Total Cost Area 1	Total Cost Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Delivery Miles Area 1	Total Delivery Miles Area 2
FFS 52.9 DRAFT 63	6.3	-	38.0	-	$ -	$ 591.36	$ -	$ 293.80	$ -	$ 885.16	$ -	$ -	$ 33,636	$ -				
FFS 52.9 DRAFT 64	2.6	-	15.8	-	$ -	$ 59.14	$ -	$ 29.38	$ -	$ 88.52	$ -	$ -	$ 50,456	$ -				
FFS 52.9 DRAFT 65	5.0	-	50.0	-	$ -	$ 601.92	$ -	$ 468.95	$ -	$ 1,070.87	$ -	$ -	$ 53,544	$ -				
FFS 52.9 DRAFT 66	2.1	-	20.8	-	$ -	$ 60.19	$ -	$ 46.90	$ -	$ 107.09	$ -	$ -	$ 80,318	$ -				
FFS 52.9 DRAFT 67	0.8	-	1.6	-	$ -	$ 485.76	$ -	$ 77.97	$ -	$ 563.73	$ -	$ -	$ 1,127	$ -				
FFS 52.9 DRAFT 68	0.4	-	0.8	-	$ -	$ 48.58	$ -	$ 7.80	$ -	$ 56.38	$ -	$ -	$ 1,691	$ -				
FFS 52.9 DRAFT 69	21.6	37.3	129.8	223.8	$ 4.10	$ 4.35	$ -	$ 0.63	$ -	$ 9.08	$ 5,303	$ 9,144	$ 145,741	$ 251,277				
FFS 52.9 DRAFT 70	9.0	-	143.2	-	$ 230,000					$ 266,000.00	$ 19,235	$ -	$ 285,235	$ -	549		21,410	
FFS 52.9 DRAFT 71	0.5	-	2.0	-	$ -	$ 2,350.00				$ 2,350.00	$ -	$ -	$ 2,350	$ -				
FFS 52.9 DRAFT 72	58.5	-	643.1	-	$ 190.00					$ 190.00	$ 31,779	$ -	$ 411,779	$ -				
FFS 52.9 DRAFT 73	10.0	10.0	60.0	60.0	$ 1.00					$ 1.00	$ 9,032	$ 9,032	$ 117,032	$ 117,032				
FFS 52.9 DRAFT 74					$ 55,000.00					$ 55,000.00	$ 9,199	$ 9,199	$ 119,199	$ 119,199				
FFS 52.9 DRAFT 75	791.8	1,305.2	1,583.6	2,610.4	$ -					$ 19,790.74	$ -	$ -	$ 1,029,696	$ 1,697,278				
FFS 52.9 DRAFT 76					$ -					$ 0.00	$ -	$ -	$ 80,766	$ 133,128				
FFS 52.9 DRAFT 77	2.0	3.0	5.9	9.0	$ 3.56	$ 0.54	$ -	$ 0.12	$ -	$ 4.22	$ 1,462	$ 2,239	$ 22,178	$ 33,973				
FFS 52.9 DRAFT 78					$ 113.96	$ -	$ -	$ -	$ -	$ 113.96	$ 529	$ 529	$ 6,861	$ 6,861				
FFS 52.9 DRAFT 79	0.3	0.3	2.4	2.4	$ -	$ 22.40	$ -	$ 5.31	$ -	$ 27.71	$ -	$ -	$ 1,539	$ 1,539				
FFS 52.9 DRAFT 80	3.1	3.1	21.9	21.9	$ 10.54	$ 15.61	$ -	$ 5.93	$ -	$ 32.08	$ 881	$ 881	$ 32,961	$ 32,961				
FFS 52.9 DRAFT 81	0.1	1.3	0.1	1.3	$ -	$ 296.36	$ -	$ 229.39	$ -	$ 525.75	$ -	$ -	$ 110	$ 1,383				
FFS 52.9 DRAFT 82	8.5	15.3	50.9	91.7	$ -	$ 2,844.10	$ -	$ 2,090.50	$ -	$ 4,934.60	$ -	$ -	$ 41,895	$ 75,450				
FFS 52.9 DRAFT 83	0.2	0.6	2.2	6.7	$ -	$ 10.18	$ -	$ 29.38	$ -	$ 39.56	$ -	$ -	$ 4,629	$ 14,044				
FFS 52.9 DRAFT 84	0.2	0.5	1.0	2.9	$ -	$ 16.25	$ -	$ 46.90	$ -	$ 63.15	$ -	$ -	$ 2,084	$ 6,189				
FFS 52.9 DRAFT 85	2.3	7.1	14.0	42.6	$ -	$ 63.57	$ -	$ 119.78	$ -	$ 183.35	$ -	$ -	$ 21,452	$ 65,089				
FFS 52.9 DRAFT 86	1.0	3.1	6.2	18.4	$ -	$ 99.42	$ -	$ 187.58	$ -	$ 287.00	$ -	$ -	$ 9,471	$ 28,126				
FFS 52.9 DRAFT 87	575.4	837.1	1,150.8	1,674.2	$ 14,700.00	$ 18,300	$ -		$ -	$ 33,000.00	$ 23,240	$ 33,810	$ 647,076	$ 941,366				
FFS 52.9 DRAFT 88	62.0	-	372.0	-	$ 41,107.50					$ 279,157.50	$ 3,438	$ -	$ 282,595	$ -				
FFS 52.9 DRAFT 89	20.5	-	20.5	-	$ -					$ 6,642.78	$ -	$ -	$ 125,576	$ -				
FFS 52.9 DRAFT 90	12.3	-	90.8	-	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ 7,775	$ -	$ 230,335	$ -	1,013	-	15,195	-
FFS 52.9 DRAFT 91	37.0	-	147.9	-	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ 303,559	$ -				

Construction Cost Worksheet - FFS 52.9 DRAFT

Step #	Category	Sub-Category	Task	Quantity Area 1	Quantity Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Construction Days Area 1	Construction Days Area 2	Crew Man-days Area 1	Crew Man-days Area 2	Unit Costs Ext. Mat. O&P	Unit Costs Ext. Labor, O&P	Unit Costs Ext. Labor, O&P Ineff.	Unit Costs Ext. Equip, O&P	Unit Costs Ext. Equip, O&P Ineff.	Unit Costs Ext. Total, O&P	Bridgeton Taxes Area 1	Bridgeton Taxes Area 2	Total Cost Area 1	Total Cost Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Delivery Miles Area 1	Total Delivery Miles Area 2
FFS 52.9 DRAFT 92	Excavate Waste	Area 2 SW	Apply daily cover to remaining excavation	-	15,800	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	26.3	-	194.9	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 16,688	$ -	$ 494,426	-	2,173	-	32,595
FFS 52.9 DRAFT 93			Excavate and Sort RIM and Overburden (incl. minor sources)	-	192,754	RIM and Overburden	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	-	80.3	-	321.3	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ -	$ 659,218				
FFS 52.9 DRAFT 94		Area 2 NE	Apply daily cover to remaining excavation	-	12,490	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	20.8	-	154.0	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 13,193	$ -	$ 390,854	-	1,718	-	25,770
FFS 52.9 DRAFT 95			Excavate and Sort RIM and Overburden (NOT incl. minor sources)	-	153,503	RIM and Overburden	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	-	64.0	-	255.8	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ -	$ 524,980				
FFS 52.9 DRAFT 96	Handle Excavated RIM	Area 1	Load piled RIM into Haul Trucks	22,836	-	RIM	B.C.Y.	RS Means, Year 2016 Quarter 1	312316421250	Excavating, bulk bank measure, 2-1/2 C.Y. capacity = 95 C.Y./hour, front end loader, track mounted, excluding truck loading	B10O	760	1.5	1.0	50%	60.1	-	90.1	-	$ -	$ 1.06	$ 1.06	$ 1.58	$ 1.58	$ 5.28	$ -	$ -	$ 120,574	$ -				
FFS 52.9 DRAFT 97			(additional cost to previous line)	22,836	-	RIM		RS Means, Year 2016 Quarter 1	312316421250A	Excavating, bulk bank measure, for loading onto trucks, add	B10O	5,016	1.5	1.0	50%	9.1	-	13.7	-	$ -	$ 0.16	$ 0.16	$ 0.24	$ 0.24	$ 0.80	$ -	$ -	$ 18,269	$ -				
FFS 52.9 DRAFT 98			Haul RIM to on-site Loading Station (incl. RIM from minor sources)	34,254	-	RIM	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	16.3	-	91.6	-	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ 219,911	$ -				
FFS 52.9 DRAFT 99			RIM Hauling & Disposal (during 3-month learning curve for loading)	25,000	-	RIM	L.C.Y.	Off-site Disposal Facility estimate	See Assumptions	Custom line item: Transport and dispose of RIM at off-site disposal facility. Assume 3-month learning curve from 0 to 100% production (averaging 50%).	RIM Shipping Crew	800	24.0	1.0	50%	62.5	-	1,500.0	-	$ -	$ 114.50		$ 114.50		$ 229.00	$ -	$ -	$ 5,725,000	$ -	1,668	-	75,060	-
FFS 52.9 DRAFT 100			RIM Hauling & Disposal (normal production)	9,254	-	RIM	L.C.Y.	Off-site Disposal Facility estimate	See Assumptions	Custom line item: Transport and dispose of RIM at off-site disposal facility. (Full production for remainder of project.)	RIM Shipping Crew	800	24.0	1.0	100%	11.6	-	277.6	-	$ -	$ 114.50		$ 114.50		$ 229.00	$ -	$ -	$ 2,119,166	$ -	618	-	27,810	-
FFS 52.9 DRAFT 101			Off-Site Disposal Facility Coordinator	82	-	Personnel	Work Days	Off-site Disposal Facility estimate	See Assumptions	Custom line item: Oversight of RIM shipping process by off-site disposal facility's coordinator.	Coordinator	1	1.0	1.0	100%	82.0	-	82.0	-	$ -	$ 1,100.00	$ -		$ -	$ 1,100.00	$ -	$ -	$ 90,200	$ -				
FFS 52.9 DRAFT 102			RIM Loading Crew	82	-	Personnel	Work Days	See separate Assumptions sheet	See Assumptions	Custom line item: Stockpile and Load RIM in RIM Loading Station	RIM Loading Crew	1	11.0	1.0	100%	82.0	-	902.0	-	$ -	$ 9,212.60	$ -		$ -	$ 9,212.60	$ -	$ -	$ 755,433	$ -				
FFS 52.9 DRAFT 103		Area 2 SW	Load piled RIM into Haul Trucks	-	73,418	RIM	B.C.Y.	RS Means, Year 2016 Quarter 1	312316421250	Excavating, bulk bank measure, 2-1/2 C.Y. capacity = 95 C.Y./hour, front end loader, track mounted, excluding truck loading	B10O	760	1.5	2.0	50%	-	96.6	-	289.8	$ -	$ 1.06	$ 1.06	$ 1.58	$ 1.58	$ 5.28	$ -	$ -	$ -	$ 387,649				
FFS 52.9 DRAFT 104			(additional cost to previous line)	-	73,418	RIM		RS Means, Year 2016 Quarter 1	312316421250A	Excavating, bulk bank measure, for loading onto trucks, add	B10O	5,016	1.5	2.0	50%	-	14.6	-	43.9	$ -	$ 0.16	$ 0.16	$ 0.24	$ 0.24	$ 0.80	$ -	$ -	$ -	$ 58,735				
FFS 52.9 DRAFT 105			Haul RIM to on-site Loading Station (incl. RIM from minor sources)	-	110,128	RIM	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205100	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 1 mile, 10 MPH, excludes loading equipment	B34F	506	1.0	4.2	100%	-	52.4	-	217.6	$ -	$ 0.98	$ -	$ 3.75	$ -	$ 4.73	$ -	$ -	$ -	$ 520,903				
FFS 52.9 DRAFT 106			RIM Hauling & Disposal (normal production)	-	110,128	RIM	L.C.Y.	Off-site Disposal Facility estimate	See Assumptions	Custom line item: Transport and dispose of RIM at off-site disposal facility. (Full production for remainder of project.)	RIM Shipping Crew	1,000	30.0	1.0	100%	-	110.1	-	3,303.8	$ -	$ 114.50		$ 114.50		$ 229.00	$ -	$ -	$ -	$ 25,219,212	-	7,342	-	330,390
FFS 52.9 DRAFT 107			Off-Site Disposal Facility Coordinator	-	158	Personnel	Work Days	Off-site Disposal Facility estimate	See Assumptions	Custom line item: Oversight of RIM shipping process by off-site disposal facility's coordinator.	Coordinator	1	1.0	1.0	100%	-	158.0	-	158.0	$ -	$ 1,100.00	$ -		$ -	$ 1,100.00	$ -	$ -	$ -	$ 173,800				
FFS 52.9 DRAFT 108			RIM Loading Crew	-	158	Personnel	Work Days	See separate Assumptions sheet	See Assumptions	Custom line item: Stockpile and Load RIM in RIM Loading Station	RIM Loading Crew	1	13.0	1.0	100%	-	158.0	-	2,054.0	$ -	$ 10,142.60	$ -		$ -	$ 10,142.60	$ -	$ -	$ -	$ 1,602,531				
FFS 52.9 DRAFT 109		Area 2 NE	Load piled RIM into Haul Trucks	-	69,447	RIM	B.C.Y.	RS Means, Year 2016 Quarter 1	312316421250	Excavating, bulk bank measure, 2-1/2 C.Y. capacity = 95 C.Y./hour, front end loader, track mounted, excluding truck loading	B10O	760	1.5	2.0	50%	-	91.4	-	274.1	$ -	$ 1.06	$ 1.06	$ 1.58	$ 1.58	$ 5.28	$ -	$ -	$ -	$ 366,682				
FFS 52.9 DRAFT 110			(additional cost to previous line)	-	69,447	RIM		RS Means, Year 2016 Quarter 1	312316421250A	Excavating, bulk bank measure, for loading onto trucks, add	B10O	5,016	1.5	2.0	50%	-	13.8	-	41.5	$ -	$ 0.16	$ 0.16	$ 0.24	$ 0.24	$ 0.80	$ -	$ -	$ -	$ 55,558				
FFS 52.9 DRAFT 111			Haul RIM to on-site Loading Station (NOT incl. RIM from minor sources)	-	104,171	RIM	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	-	49.6	-	278.5	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ -	$ 668,779				
FFS 52.9 DRAFT 112			RIM Hauling & Disposal (normal production)	-	104,171	RIM	L.C.Y.	Off-site Disposal Facility estimate	See Assumptions	Custom line item: Transport and dispose of RIM at off-site disposal facility. (Full production for remainder of project.)	RIM Shipping Crew	1,000	30.0	1.0	100%	-	104.2	-	3,125.1	$ -	$ 114.50		$ 114.50		$ 229.00	$ -	$ -	$ -	$ 23,855,191	-	6,946	-	312,570
FFS 52.9 DRAFT 113			Off-Site Disposal Facility Coordinator	-	124	Personnel	Work Days	Off-site Disposal Facility estimate	See Assumptions	Custom line item: Oversight of RIM shipping process by off-site disposal facility's coordinator.	Coordinator	1	1.0	1.0	100%	-	124.0	-	124.0	$ -	$ 1,100.00	$ -		$ -	$ 1,100.00	$ -	$ -	$ -	$ 136,400				
FFS 52.9 DRAFT 114			RIM Loading Crew	-	124	Personnel	Work Days	See separate Assumptions sheet	See Assumptions	Custom line item: Stockpile and Load RIM in RIM Loading Station	RIM Loading Crew	1	13.0	1.0	100%	-	124.0	-	1,612.0	$ -	$ 10,142.60	$ -		$ -	$ 10,142.60	$ -	$ -	$ -	$ 1,257,682				
FFS 52.9 DRAFT 115		Area 1	Load Overburden directly into Haul Trucks	66,703	-	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	4.2	-	16.9	-	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ 34,686	$ -				
FFS 52.9 DRAFT 116			Relocate Overburden to Area 2 NE Stockpile	100,055	-	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	47.6	-	267.5	-	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ 642,354	$ -				
FFS 52.9 DRAFT 117			Load Overburden directly into Haul Trucks	-	109,074	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	-	6.9	-	27.6	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ -	$ 56,718				

Construction Cost Worksheet - FFS 52.9 DRAFT

				Quantity												Construction Days		Crew Man-days		Unit Costs						Bridgeton Taxes		Total Cost		Delivery Truckloads		Total Delivery Miles	
Step #	Category	Sub-Category	Task	Area 1	Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Area 1	Area 2	Area 1	Area 2	Ext. Mat, O&P	Ext. Labor, O&P	Ext. Labor, O&P Ineff.	Ext. Equip, O&P	Ext. Equip, O&P Ineff.	Ext. Total, O&P	Area 1	Area 2	Area 1	Area 2	Area 1	Area 2	Area 1	Area 2
FFS 52.9 DRAFT 118	Load and Haul Overburden	Area 2 SW	Relocate Overburden to backfill Area 1	-	163,611	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	-	77.9	-	437.5	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ -	$ 1,050,380				
FFS 52.9 DRAFT 119		Area 2 NE	Load Overburden directly into Haul Trucks	-	101,012	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	-	6.4	-	25.6	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ -	$ 52,526				
FFS 52.9 DRAFT 120			Relocate Overburden to Area 2 SW Stockpile	-	151,518	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	-	72.2	-	405.1	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ -	$ 972,744				
FFS 52.9 DRAFT 121	Place Overburden	Area 1 Overburden on NE Stockpile	Spread Overburden	100,055	-	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	33.4	-	150.1	-	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ 254,140	$ -				
FFS 52.9 DRAFT 122			Apply daily cover to stockpiled Overburden	6,670	-	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	11.1	-	82.3	-	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ 7,046	$ -	$ 208,737	$ -	918	-	13,770	-
FFS 52.9 DRAFT 123		Area 2 SW Overburden backfilled in Area 1	Spread Overburden	-	163,611	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	-	54.5	-	245.4	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 415,571				
FFS 52.9 DRAFT 124			Apply daily cover to backfilled Overburden	-	10,907	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	18.2	-	134.5	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 11,521	$ -	$ 341,327	-	1,500	-	22,500
FFS 52.9 DRAFT 125			Compact Overburden	-	119,981	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	-	23.1	-	69.2	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ -	$ 106,783				
FFS 52.9 DRAFT 126		Area 2 NE Overburden on SW Stockpile	Spread Overburden	-	151,518	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	-	50.5	-	227.3	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 384,855				
FFS 52.9 DRAFT 127			Apply daily cover to stockpiled Overburden	-	10,101	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	16.8	-	124.6	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 10,669	$ -	$ 316,099	-	1,389	-	20,835
FFS 52.9 DRAFT 128	Relocate Stockpiled Overburden from NE Stockpile	From NE Stockpile to backfill remaining Area 1 (to drainage grades)	Apply daily cover to remaining stockpile	2,847	-	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	4.7	-	35.1	-	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ 3,007	$ -	$ 89,092	$ -	392	-	5,880	-
FFS 52.9 DRAFT 129			Excavate Stockpile	31,317	-	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	13.0	-	52.2	-	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ 107,104	$ -				
FFS 52.9 DRAFT 130			Load into Haul Trucks	31,317	-	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	2.0	-	7.9	-	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ 16,285	$ -				
FFS 52.9 DRAFT 131			Relocate Overburden to backfill Area 1 (drainage grades)	46,975	-	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	22.4	-	125.6	-	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ 301,582	$ -				
FFS 52.9 DRAFT 132			Spread Overburden	46,975	-	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	15.7	-	70.5	-	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ 119,317	$ -				
FFS 52.9 DRAFT 133			Apply daily cover to backfilled material	3,132	-	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	5.2	-	38.6	-	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ 3,308	$ -	$ 98,001	$ -	431	-	6,465	-
FFS 52.9 DRAFT 134			Compact backfilled material	34,449	-	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	6.6	-	19.9	-	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ 30,659	$ -				
FFS 52.9 DRAFT 135		From NE Stockpile to backfill Area 2 SW (to drainage grades)	Apply daily cover to remaining stockpile	-	4,490	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	7.5	-	55.4	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 4,743	$ -	$ 140,519	-	618	-	9,270
FFS 52.9 DRAFT 136			Excavate Stockpile	-	49,394	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	-	20.6	-	82.3	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ -	$ 168,928				
FFS 52.9 DRAFT 137			Load into Haul Trucks	-	49,394	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	-	3.1	-	12.5	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ -	$ 25,685				
FFS 52.9 DRAFT 138			Relocate Overburden to backfill Area 2 SW (drainage grades)	-	74,091	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	-	35.3	-	198.1	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ -	$ 475,666				
FFS 52.9 DRAFT 139			Spread Overburden	-	74,091	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	-	24.7	-	111.1	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 188,192				
FFS 52.9 DRAFT 140			Apply daily cover to backfilled material	-	4,939	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	8.2	-	60.9	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 5,217	$ -	$ 154,571	-	680	-	10,200
FFS 52.9 DRAFT 141			Compact backfilled material	-	54,334	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	-	10.4	-	31.3	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ -	$ 48,357				
FFS 52.9 DRAFT 142	Relocate Stockpiled Overburden from SW Stockpile	From SW Stockpile to backfill Area 2 NE (to drainage grades)	Apply daily cover to remaining stockpile	-	11,111	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	18.5	-	137.0	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 11,736	$ -	$ 347,709	-	1,528	-	22,920
FFS 52.9 DRAFT 143			Excavate Stockpile	-	122,224	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	-	50.9	-	203.7	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ -	$ 418,007				
FFS 52.9 DRAFT 144			Load into Haul Trucks	-	122,224	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	-	7.7	-	31.0	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ -	$ 63,557				
FFS 52.9 DRAFT 145			Relocate Overburden to backfill Area 2 NE (drainage grades)	-	183,336	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	-	87.3	-	490.2	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ -	$ 1,177,020				

Construction Cost Worksheet - FFS 52.9 DRAFT

Step #	Category	Sub-Category	Task	Quantity Area 1	Quantity Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Construction Days Area 1	Construction Days Area 2	Crew Man-days Area 1	Crew Man-days Area 2	Unit Costs Ext. Mat. O&P	Unit Costs Ext. Labor, O&P	Unit Costs Ext. Labor, O&P Ineff.	Unit Costs Ext. Equip, O&P	Unit Costs Ext. Equip, O&P Ineff.	Unit Costs Ext. Total, O&P	Bridgeton Taxes Area 1	Bridgeton Taxes Area 2	Total Cost Area 1	Total Cost Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Delivery Miles Area 1	Total Delivery Miles Area 2
FFS 52.9 DRAFT 146			Spread Overburden	-	183,336	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	-	61.1	-	275.0	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 465,674				
FFS 52.9 DRAFT 147			Apply daily cover to backfilled material	-	12,222	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	20.4	-	150.7	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 12,910	$ -	$ 382,479	-	1,681	-	25,215
FFS 52.9 DRAFT 148			Compact backfilled material	-	134,447	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	-	25.9	-	77.6	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ -	$ 119,658				
FFS 52.9 DRAFT 149	Reduce Slope Steepness	Relocate within the same Area. (Area 1 and Area 2 SW)	Apply daily cover to remaining excavation	3,379	3,708	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	5.6	6.2	41.7	45.7	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ 3,569	$ 3,916	$ 105,725	$ 116,026	465	510	6,975	7,650
FFS 52.9 DRAFT 150			Excavate	37,164	40,785	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	15.5	17.0	61.9	68.0	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ 127,101	$ 139,484				
FFS 52.9 DRAFT 151			Load into Haul Trucks	37,164	40,785	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	2.4	2.6	9.4	10.3	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ 19,325	$ 21,208				
FFS 52.9 DRAFT 152			Transport to new location	55,746	61,177	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205060	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2000 ft, 10 MPH, excludes loading equipment	B34F	594	1.0	3.5	100%	26.5	29.1	93.8	103.0	$ -	$ 0.83	$ -	$ 3.20	$ -	$ 4.03	$ -	$ -	$ 224,656	$ 246,543				
FFS 52.9 DRAFT 153			Spread Waste	55,746	61,177	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	18.6	20.4	83.6	91.8	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ 141,595	$ 155,390				
FFS 52.9 DRAFT 154			Apply daily cover to backfilled material	3,716	4,078	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	6.2	6.8	45.8	50.3	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ 3,925	$ 4,308	$ 116,298	$ 127,628	512	561	7,680	8,415
FFS 52.9 DRAFT 155			Compact backfilled material	40,880	44,863	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	7.9	8.6	23.6	25.9	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ 36,383	$ 39,928				
FFS 52.9 DRAFT 156		Same as above, for Area 2 NE	Apply daily cover to remaining excavation	-	2,757	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	4.6	-	34.0	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 2,912	$ -	$ 86,272	-	380	-	5,700
FFS 52.9 DRAFT 157			Excavate	-	30,326	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	-	12.6	-	50.5	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ -	$ 103,715		14		
FFS 52.9 DRAFT 158			Load into Haul Trucks	-	30,326	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	-	1.9	-	7.7	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ -	$ 15,769				
FFS 52.9 DRAFT 159			Transport to new location	-	45,489	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205060	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2000 ft, 10 MPH, excludes loading equipment	B34F	594	1.0	3.5	100%	-	21.7	-	76.6	$ -	$ 0.83	$ -	$ 3.20	$ -	$ 4.03	$ -	$ -	$ -	$ 183,320				
FFS 52.9 DRAFT 160			Spread Waste	-	45,489	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	-	15.2	-	68.2	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 115,542				
FFS 52.9 DRAFT 161			Apply daily cover to backfilled material	-	3,033	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	5.1	-	37.4	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 3,203	$ -	$ 94,900	-	417	-	6,255
FFS 52.9 DRAFT 162			Compact backfilled material	-	33,358	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	-	6.4	-	19.2	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ -	$ 29,689				
FFS 52.9 DRAFT 163	Relocation of Other Waste	C&D Rubble Stockpiles	Relocate Stockpiled Material on-site - Excavate	7,794	35,069	C&D Rubble	B.C.Y.	RS Means, Year 2016 Quarter 1	312316305000	Drilling and blasting rock, less than 0.5 C.Y., excavate and load boulders	B10T	80	1.5	10.0	100%	9.7	43.8	146.1	657.5	$ -	$ 9.58	$ -	$ 6.56	$ -	$ 16.14	$ -	$ -	$ 125,795	$ 566,014				
FFS 52.9 DRAFT 164			Relocate Stockpiled Material on-site - Haul and Dump	7,794	35,069	C&D Rubble	B.C.Y.	RS Means, Year 2016 Quarter 1	312316305400	Drilling and blasting rock, 25 ton off-highway dump, 1 mile round trip, haul boulders	B34E	330	1.0	5.3	100%	4.5	20.0	23.6	106.3	$ -	$ 0.17	$ -	$ 0.07	$ -	$ 0.24	$ -	$ -	$ 1,871	$ 8,417				
FFS 52.9 DRAFT 165			Bury Stockpiled Material	7,794	35,069	C&D Rubble	B.C.Y.	RS Means, Year 2016 Quarter 1	312316305620	Drilling and blasting rock, 300 H.P. dozer, less than 0.5 C.Y., 150' haul, bury boulders on site	B10M	310	1.5	12.0	100%	2.1	9.4	37.7	169.7	$ -	$ 1.49	$ -	$ 5.25	$ -	$ 6.74	$ -	$ -	$ 52,532	$ 236,365				
FFS 52.9 DRAFT 166	Buffer Zone		Buffer Zone Activity	-	1	See separate Assumptions sheet		See separate Assumptions sheet						1.0	100%	-	6.4	-	42.0	$ 35,337.43					$ 86,296.91	$ -	$ 2,955	$ -	$ 89,252				
FFS 52.9 DRAFT 167	Rad. Survey		Conduct final radiological survey and wait for approval	1	1	This activity is handled by others, and does not have a direct cost to the contractor. However, there are the indirect costs due to the duration and associated waiting.								1.0	100%	7.0	7.0	-	-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -				
FFS 52.9 DRAFT 168	Additional Fill		Purchase material and spread	-	231,104	Common Borrow	C.Y.	RS Means, Year 2016 Quarter 1	310513100200	Soils for earthwork, common borrow, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	12.0	100%	-	32.1	-	1,348.1	$ 12.63	$ 3.02	$ -	$ 5.76	$ -	$ 21.41	$ -	$ 244,103	$ -	$ 5,192,038	-	31,777	-	476,655
FFS 52.9 DRAFT 169			Additional delivery distance	-	300,435	Common Borrow (per hauling increment)	C.Y.	RS Means, Year 2016 Quarter 1	310513100900	Soils for earthwork, borrow, spread with 200 HP dozer, includes load at pit and haul, round trip, excludes compaction, for 5 mile haul, add	B34B	200	1.0	23.6	100%	-	63.7	-	1,502.2	$ -	$ 2.50	$ -	$ 4.29	$ -	$ 6.79	$ -	$ -	$ -	$ 2,039,955				
FFS 52.9 DRAFT 170			Compact material	-	231,104	Common Borrow	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	-	44.4	-	133.3	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ -	$ 205,683				
FFS 52.9 DRAFT 171		Starter Berms	Purchase and deliver material	-	55,516	Riprap	Ton	RS Means, Year 2016 Quarter 1	313713100350	Rip-rap and rock lining, random, broken stone, 100 lb. average, dumped	B11A	700	2.0	8.0	100%	-	9.9	-	158.6	$ 27.87	$ 1.47	$ -	$ 2.49	$ -	$ 31.83	$ -	$ 129,395	$ -	$ 1,896,467	-	2,776	-	111,040
FFS 52.9 DRAFT 172			Spread loose lift before compaction	-	33,310	Riprap	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	4.0	100%	-	8.3	-	50.0	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 84,606				
FFS 52.9 DRAFT 173			Special grading for steep slopes	-	12,791	Riprap	S.Y.	RS Means, Year 2016 Quarter 1	312216103310	Fine grading, slopes, steep, finish grading	B11L	7,100	2.0	1.0	100%	-	1.8	-	3.6	$ -	$ 0.14	$ -	$ 0.12	$ -	$ 0.26	$ -	$ -	$ -	$ 3,326				
FFS 52.9 DRAFT 174			Compact starter berms	-	27,758	Riprap	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235060	Compaction, riding, vibrating roller, 2 passes, 12" lifts	B10Y	5,200	1.5	2.0	100%	-	2.7	-	8.0	$ -	$ 0.15	$ -	$ 0.14	$ -	$ 0.29	$ -	$ -	$ -	$ 8,050				
FFS 52.9 DRAFT 175			Purchase and Spread Bio-Intrusion Layer Material	122,675	241,399	4-in Minus Aggregate	L.C.Y.	RS Means, Year 2016 Quarter 1	310516100300	Aggregate for earthwork, crushed stone, 1.40 tons per C.Y., 1-1/2", spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	12.0	100%	17.0	33.5	715.6	1,408.2	$ 24.51	$ 3.02	$ -	$ 5.76	$ -	$ 33.29	$ 251,455	$ 494,812	$ 4,335,301	$ 8,530,976	10,223	20,117	153,345	301,755

Construction Cost Worksheet - FFS 52.9 DRAFT

Step #	Category	Sub-Category	Task	Quantity Area 1	Quantity Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Construction Days Area 1	Construction Days Area 2	Crew Man-days Area 1	Crew Man-days Area 2	Unit Costs Ext. Mat, O&P	Unit Costs Ext. Labor, O&P	Unit Costs Ext. Labor, O&P Ineff.	Unit Costs Ext. Equip, O&P	Unit Costs Ext. Equip, O&P Ineff.	Unit Costs Ext. Total, O&P	Bridgeton Taxes Area 1	Bridgeton Taxes Area 2	Total Cost Area 1	Total Cost Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Delivery Miles Area 1	Total Delivery Miles Area 2
FFS 52.9 DRAFT 176	Final Cover	Bio-Intrusion	Deliver Bio-Intrusion Layer Material	159,477	313,818	4-in Minus Aggregate (per Hauling Increment)	L.C.Y.	RS Means, Year 2016 Quarter 1	310516100900	Aggregate for earthwork, aggregate or sand, spread with 200 HP dozer, includes load at pit and haul, round trip, for 5 mile haul add	B34B	200	1.0	23.6	100%	33.8	66.5	797.4	1,569.1	$ -	$ 2.50	$ -	$ 4.29	$ -	$ 6.79	$ -	$ -	$ 1,082,851	$ 2,130,827				
FFS 52.9 DRAFT 177			Compact Bio-Intrusion Layer Material	74,348	146,302	4-in Minus Aggregate	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235060	Compaction, riding, vibrating roller, 2 passes, 12" lifts	B10Y	5,200	1.5	2.0	100%	7.1	14.1	21.4	42.2	$ -	$ 0.15	$ -	$ 0.14	$ -	$ 0.29	$ -	$ -	$ 21,561	$ 42,428				
FFS 52.9 DRAFT 178		Clay	Purchase and deliver clay material	109,044	214,577	Clay Material	L.C.Y.	RS Means, Year 2016 Quarter 1	354113200040	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	41.4	100%	45.4	89.4	1,880.1	3,699.6	$ 26.69	$ -	$ -	$ -	$ -	$ 26.69	$ 243,396	$ 478,953	$ 3,153,789	$ 6,206,004	9,088	17,882	363,520	715,280
FFS 52.9 DRAFT 179			Spread loose lift before compaction	109,044	214,577	Clay Material	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	12.0	100%	9.1	17.9	163.6	321.9	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ 276,973	$ 545,025				
FFS 52.9 DRAFT 180			Compact Clay (Final Cover)	77,889	153,269	Clay Material	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235640	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	1,300	1.5	2.0	100%	30.0	58.9	89.9	176.8	$ -	$ 0.62	$ -	$ 1.15	$ -	$ 1.77	$ -	$ -	$ 137,863	$ 271,286				
FFS 52.9 DRAFT 181		Top Soil	Purchase and place Topsoil	35,404	69,668	Topsoil	C.Y.	RS Means, Year 2016 Quarter 1	310513100800	Soils for earthwork, topsoil borrow, weed free, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	12.0	100%	4.9	9.7	206.5	406.4	$ 24.98	$ 3.02	$ -	$ 5.76	$ -	$ 33.76	$ 73,962	$ 145,541	$ 1,269,201	$ 2,497,524	3,688	7,258	55,320	108,870
FFS 52.9 DRAFT 182			Addition for Topsoil Delivery	46,025	90,568	Topsoil (per Hauling Increment)	C.Y.	RS Means, Year 2016 Quarter 1	310513100900	Soils for earthwork, borrow, spread with 200 HP dozer, includes load at pit and haul, round trip, excludes compaction, for 5 mile haul, add	B34B	200	1.0	23.6	100%	9.8	19.2	230.1	452.8	$ -	$ 2.50	$ -	$ 4.29	$ -	$ 6.79	$ -	$ -	$ 312,511	$ 614,957				
FFS 52.9 DRAFT 183	Stormwater Controls (for stormwater after cover is constructed)	Terraces	Purchase and place Topsoil	1,681	3,306	Topsoil	C.Y.	RS Means, Year 2016 Quarter 1	310513100800	Soils for earthwork, topsoil borrow, weed free, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	2.0	100%	1.4	2.8	9.8	19.3	$ 24.98	$ 3.02	$ -	$ 5.76	$ -	$ 33.76	$ 3,512	$ 6,906	$ 60,266	$ 118,501	176	345	2,640	5,175
FFS 52.9 DRAFT 184			Addition for Topsoil Delivery	2,185	4,297	Topsoil (per Hauling Increment)	C.Y.	RS Means, Year 2016 Quarter 1	310513100900	Soils for earthwork, borrow, spread with 200 HP dozer, includes load at pit and haul, round trip, excludes compaction, for 5 mile haul, add	B34B	200	1.0	23.6	100%	0.5	0.9	10.9	21.5	$ -	$ 2.50	$ -	$ 4.29	$ -	$ 6.79	$ -	$ -	$ 14,839	$ 29,178				
FFS 52.9 DRAFT 185		Pond	Purchase and deliver liner & berm material	-	13,760	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	354113200040	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	41.4	100%	-	5.7	-	237.2	$ 26.69	$ -	$ -	$ -	$ -	$ 26.69	$ -	$ 30,713	$ -	$ 397,963	-	1,147	-	45,880
FFS 52.9 DRAFT 186			Spread loose lift before compaction (Pond)	-	13,760	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	2.1	100%	-	6.6	-	20.6	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 34,950				
FFS 52.9 DRAFT 187			Compact Liner & Berm (Pond)	-	9,828	Structural Fill / Clay	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235640	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	1,300	1.5	2.0	100%	-	3.8	-	11.3	$ -	$ 0.62	$ -	$ 1.15	$ -	$ 1.77	$ -	$ -	$ -	$ 17,396				
FFS 52.9 DRAFT 188			Pond Perimeter Berm Structural Rock	-	1,130	Structural Rock	L.C.Y.	RS Means, Year 2016 Quarter 1	313713100100	Rip-rap and rock lining, random, broken stone, machine placed for slope protection	B12G	62	2.0	1.0	100%	-	18.2	-	36.5	$ 31.59	$ 16.76	$ -	$ 14.69	$ -	$ 63.04	$ -	$ 2,986	$ -	$ 74,241				
FFS 52.9 DRAFT 189		Diversion Berms	Purchase and deliver berm material	2,518	2,603	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	354113200040	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	41.4	100%	1.0	1.1	43.4	44.9	$ 26.69	$ -	$ -	$ -	$ -	$ 26.69	$ 5,620	$ 5,809	$ 72,823	$ 75,273	210	217	8,400	8,680
FFS 52.9 DRAFT 190			Spread loose lift before compaction	2,518	2,603	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	2.1	100%	1.2	1.2	3.8	3.9	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ 6,395	$ 6,611				
FFS 52.9 DRAFT 191			Compact Berms	1,799	1,859	Structural Fill / Clay	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235060	Compaction, riding, vibrating roller, 2 passes, 12" lifts	B10Y	5,200	1.5	2.0	100%	0.2	0.2	0.5	0.5	$ -	$ 0.15	$ -	$ 0.14	$ -	$ 0.29	$ -	$ -	$ 522	$ 539				
FFS 52.9 DRAFT 192			Perimeter Road Stormwater Crossings	-	123	Riprap	L.C.Y.	RS Means, Year 2016 Quarter 1	313713100100	Rip-rap and rock lining, random, broken stone, machine placed for slope protection	B12G	62	2.0	1.0	100%	-	2.0	-	4.0	$ 31.59	$ 16.76	$ -	$ 14.69	$ -	$ 63.04	$ -	$ 325	$ -	$ 8,092				
FFS 52.9 DRAFT 193			Final Stormwater Controls (letdowns, swales, etc.)	689	956	Riprap	S.Y.	RS Means, Year 2016 Quarter 1	313713100110	Rip-rap and rock lining, random, broken stone, 3/8 to 1/4 C.Y. pieces, machine placed for slope protection, grouted	B13	80	7.0	3.0	100%	2.9	4.0	60.3	83.6	$ 65.49	$ 42.14	$ -	$ 11.64	$ -	$ 119.27	$ 3,773	$ 5,234	$ 85,937	$ 119,203				
FFS 52.9 DRAFT 194	Site Completion		Apply seeding to cover	1,147	2,257	Seeding	M.S.F.	RS Means, Year 2016 Quarter 1	329219142400	Seeding athletic fields, seeding fescue, tall with mulch and fertilizer, 5.5 lb. per M.S.F., hydro/air seeding	B81	80	3.0	1.0	100%	14.3	28.2	43.0	84.6	$ 26.26	$ 19.04	$ -	$ 10.79	$ -	$ 56.09	$ 2,519	$ 4,957	$ 66,859	$ 131,565				
FFS 52.9 DRAFT 195			Install temporary irrigation system	95,591	188,103	Irrigation System	S.F.	RS Means, Year 2016 Quarter 1	328423100800	Underground sprinklers irrigation system, for lawns, residential system, custom, 1" supply	B20	2,000	3.0	10.0	100%	4.8	9.4	143.4	282.2	$ 0.27	$ 0.75	$ -	$ -	$ -	$ 1.02	$ 2,158	$ 4,247	$ 99,661	$ 196,112				
FFS 52.9 DRAFT 196			Install Fencing	5,096	6,735	Fencing	L.F.	RS Means, Year 2016 Quarter 1	323113200920	Fence, chain link industrial, galvanized steel, 6 ga. wire, 2-1/2" posts @ 10' OC, 8' high, includes excavation, in concrete, excludes barbed wire	B80C	180	3.0	2.0	100%	14.2	18.7	84.9	112.3	$ 37.00	$ 8.06	$ -	$ 1.77	$ -	$ 46.83	$ 15,769	$ 20,840	$ 254,414	$ 336,240				

	Crew Man-days Area 1	Crew Man-days Area 2	Bridgeton Taxes Area 1	Bridgeton Taxes Area 2	Total Cost Area 1	Total Cost Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Delivery Miles Area 1	Total Delivery Miles Area 2
			Totals		***Totals***		***Totals***		***Totals***	
Overall	24,100	35,700	$ 1,460,000	$1,890,000	$ 41,300,000	$ 105,000,000	30,400	110,000	835,000	2,770,000
		59,800		**$3,350,000**		**$ 146,000,000**		**140,000**		**3,600,000**

	Area 1	Area 2
RIM Transporation & Disposal	$ 7,840,000	$ 49,100,000
		$ 56,900,000
RIM Loading Operation	$ 846,000	$ 3,170,000
		$ 4,020,000
On-Site Costs	$ 32,600,000	$ 52,900,000
		$ 85,500,000

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Radiological Survey and Health and Safety Costs
52.9 pCi/g

Total Estimated Costs for Radiological Survey and Health & Safety Support

Total Labor Cost	$9,844,000
Professional Services	$776,000
Equipment	$1,133,000
Materials/PPE	$5,926,000
Travel	$1,370,000
Off-Site Laboratory	$390,000
Total	**$19,439,000**

Estimate of Labor Costs

Estimated Labor Costs	Team	Personnel Description	Cost/day*	Notes:		
$1,049,000	Team 1	Sr Rad Tech	$1,070	Supervise field activities; Collect samples and deliver to outside lab; Maintain records; Surveys	$267,000	Perdiem Weekend days
$853,000		Rad Tech	$870	Run personal air sampling program; Available for decon, distributing protective clothing, assist with survey vehicle moving on-site		
$853,000		Rad Tech	$870	Control entry/exit for contaminated areas		
$853,000		Rad Tech	$870	Control entry/exit for contaminated areas		
$91,000	Team 2	Sr Rad Tech	$1,070	Survey while moving RIM Area 1; Conduct Final Survey	$200,000	Perdiem Weekend days
$74,000		Rad Tech	$870	Survey while moving RIM Area 1; Conduct Final Survey		
$74,000		Rad Tech	$870	Survey while moving RIM Area 1; Conduct Final Survey		
$342,000	Team 3	Sr Rad Tech	$1,070	Survey while moving RIM Area 2; Conduct Final Survey	$200,000	Perdiem Weekend days
$278,000		Rad Tech	$870	Survey while moving RIM Area 2; Conduct Final Survey		
$278,000		Rad Tech	$870	Survey while moving RIM Area 2; Conduct Final Survey		
$13,000.00	Team 4	Sr Rad Tech	$1,070	Final Survey for Buffer/Crossroads property after RIM relocated	$133,000	Perdiem Weekend days
$11,000.00		Rad Tech	$870	Final Survey for Buffer/Crossroads property after RIM relocated		
$623,000.00	Team 5	Sr Rad Tech	$1,070	RIM transfer station	$133,000	Perdiem Weekend days
$506,000.00		Rad Tech	$870	RIM transfer station		
$2,272,300.00	Team 6	Lab Supervisor	$2,170	Run On-site Laboratory includes 3 months set-up and training	$133,000	Perdiem Weekend days
$608,000.00		Lab Tech	$1,070	Conduct detailed activities at On-site laboratory includes 3 months set-up and training		

$8,778,000 Total Estimated Labor Costs during Construction

* Includes per diem at $170/day

Team 1

3/15/2018	Estimated Start Date	Road construction
12/16/2021	Estimated End Date	Clean-up
1372	No. of calendar days	
3.8	No. years	
45	No. Months	
15	No. of quarters	
196	No. of weeks	
980	No. of working days	
392	No. of weekend days	
143	No. of field personnel requiring badges	
49	No. of field personnel in PPE	

Team 2

8/8/2018	Estimated Start Date	Start Exc Area 1
12/5/2018	Estimated End Date	FSS Area 1
119	No. of calendar days	
0.3	No. years	
4	No. Months	
1	No. of quarters	
17	No. of weeks	
85	No. of working days	
34	No. of weekend days	

Team 3

1/29/2019	Estimated Start Date	Start Exc Area 2
4/21/2020	Estimated End Date	FSS Area 2
448	No. of calendar days	
1.2	No. years	
15	No. Months	
5	No. of quarters	
64	No. of weeks	
320	No. of working days	
128	No. of weekend days	

Team 4

4/21/2020	Estimated Start Date	Start Exc BZ
5/8/2020	Estimated End Date	FSS BZ
17	No. of calendar days	
0.0	No. years	
1	No. Months	
0	No. of quarters	
2	No. of weeks	
12	No. of working days	
5	No. of weekend days	

Team 5

7/1/2018	Estimated Start Date	RIM Xfer Station-1m
9/23/2020	Estimated End Date	Demo+3 mo
815	No. of calendar days	
2.2	No. years	
26	No. Months	
9	No. of quarters	
116	No. of weeks	
582	No. of working days	
233	No. of weekend days	

Team 6

5/1/2018	Estimated Start Date	Start Exc minus 3 months
7/3/2020	Estimated End Date	End of Exc plus 2 month
794	No. of calendar days	
2.2	No. years	
26	No. Months	
9	No. of quarters	
113	No. of weeks	
567	No. of working days	
227	No. of weekend days	

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Estimate of Non-Labor Costs

ITEM NO.	DESCRIPTION		UNIT	QUANTITY	RATE	COSTS	
1	**PROFESSIONAL SERVICES**					**$ 776,000**	
1.1	Oversight						
		CHP	hourly	490	$ 170	83,300	
		Sr. Health Physicist	hourly	3,920	$ 115	561,200	includes 6 months to recruit staff and set up the on-site laboratory
		Project Coordinator	hourly	980	$ 85	83,300	
1.3	Training						
		Sr. Health Physicist	hourly	80	$ 115	9,200	
		**Estimated 2 trips for 4 years for GERT training courses.					
1.4	Report Assistance						
		CHP	hourly	80	$ 170	13,600	
		Graphics Support	hourly	80	$ 120	9,600	
		Sr. Health Physicist	hourly	80	$ 115	9,200	
		Project Coordinator	hourly	80	$ 85	6,800	
2	**EQUIPMENT**					**$ 1,133,000**	
2.1	Equipment						
		Model 2929 w/ 43-10-1 (3)	/month	135	$ 320	43,200	
		Model 2360 w/ 43-93 (7)	/month	315	$ 825	259,875	
		Extra Mylars for 43-93	/unit	8	$ 40	320	
		Model 2221 w/44-20 (3)	/month	0	$ -	0	
		Th-230 source (3)	/month	135	$ 75	10,125	
		Cs-137 source (3)	/month	135	$ 75	10,125	
		Tc-99 source (3)	/month	135	$ 75	10,125	
		PID (3)	/month	135	$ 750	101,250	
		PID 5 gas (3)	/month	135	$ 725	97,875	
		Air Monitors (6)	/month	270	$ 165	44,550	
		Trimble GPS Unit + Model 2221 w/ 44-10 (2)	/month	90	$ 3,000	270,000	
		Model 2221 w/44-10 (5)	/month	225	$ 500	112,500	
		Field Computer (4)	/month	180	$ 250	45,000	
		Model 19 (4)	/month	180	$ 400	72,000	
		Model 2221 w/ 44-2 (2)	/month	0	$ -	0	
		Tax on outside rentals		9.5%	$ 522,770	49,663	
2.2	Shipping						
		FedEx Charges	/shipment	90	$ 75	6,750	
		**Estimate of 2 shipments per month					
3	**MATERIALS/PPE**					**$ 5,926,000**	
3.1	Training						
		Rad Training packets	/unit	100	$ 25	2,500	
3.2	Health and Safety Monitoring & PPE						
		Mirion TLDs	/unit, /quarter	2,145	$ 50	107,250	
	50/ case	Boot Covers	/case	22,422	$ 150	3,363,360	
	25/case	Tyvek Coveralls	/case	22,422	$ 100	2,242,240	
	1000/case	Gloves	/case	1,682	$ 125	210,210	

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Estimate of Non-Labor Costs (continued)

ITEM NO.	DESCRIPTION		UNIT	QUANTITY	RATE	COSTS	
4	**TRAVEL**					**$ 1,370,000**	
4.1	Training/Audits						
		Travel Time	1 person/Quarter	240	$ 115	$ 27,600	
		Per Diem	2 days per trip	30	$ 170	$ 5,100	
		Air Fare	1 person/Quarter	15	$ 850	$ 12,750	
		Car Rental	2 person/Quarter	15	$ 300	$ 4,500	
		Gas	3 person/Quarter	15	$ 50	$ 750	
4.2	HP Technicians		Team 1				
		Travel Time	staff * 16 trips	1024	$ 300	$ 307,200	
		Per Diem	staff * 16 trips	128	$ 170	$ 21,760	
		Air Fare	staff * 16 trips	64	$ 850	$ 54,400	16
		Mileage	vehicles * project duration	392	$ 70	$ 27,440	
		Car Rental	# vehicles * project duration	392	$ 400	$ 156,800	
		Supplies	/month	45	$ 500	$ 22,500	
		Gas	/month	45	$ 400	$ 18,000	
		Misc Items	/month	45	$ 500	$ 22,500	
4.3	HP Technicians		Team 2				
		Travel Time	staff * 3 trips	144	$ 300	$ 43,200	
		Per Diem	staff * 3 trips	18	$ 170	$ 3,060	
		Air Fare	staff * 3 trips	9	$ 850	$ 7,650	3
		Mileage	vehicles * project duration	26	$ 70	$ 1,785	
		Car Rental	# vehicles * project duration	26	$ 400	$ 10,200	
		Supplies	/month	4	$ 500	$ 2,000	
		Gas	/month	4	$ 400	$ 1,600	
		Misc Items	/month	4	$ 500	$ 2,000	
4.4	HP Technicians		Team 3				
		Travel Time	staff * 6 trips	288	$ 300	$ 86,400	
		Per Diem	staff * 6 trips	36	$ 170	$ 6,120	
		Air Fare	staff * 6 trips	18	$ 850	$ 15,300	6
		Mileage	vehicles * project duration	96	$ 70	$ 6,720	
		Car Rental	# vehicles * project duration	96	$ 400	$ 38,400	
		Supplies	/month	15	$ 500	$ 7,500	
		Gas	/month	15	$ 400	$ 6,000	
		Misc Items	/month	15	$ 500	$ 7,500	
4.5	HP Technicians		Team 4				
		Travel Time	staff * 2 trips	64	$ 300	$ 19,200	
		Per Diem	staff * 2 trips	8	$ 170	$ 1,360	
		Air Fare	staff * 2 trips	4	$ 850	$ 3,400	2
		Mileage	vehicles * project duration	2	$ 70	$ 170	
		Car Rental	# vehicles * project duration	2	$ 400	$ 971	
		Supplies	/month	1	$ 500	$ 500	
		Gas	/month	1	$ 400	$ 400	
		Misc Items	/month	1	$ 500	$ 500	
4.6	HP Technicians		Team 5				
		Travel Time	staff * 10 trips	320	$ 300	$ 96,000	
		Per Diem	staff * 10 trips	40	$ 170	$ 6,800	
		Air Fare	staff * 10 trips	20	$ 850	$ 17,000	10
		Mileage	vehicles * project duration	116	$ 70	$ 8,150	
		Car Rental	# vehicles * project duration	116	$ 400	$ 46,571	
		Supplies	/month	26	$ 500	$ 13,000	
		Gas	/month	26	$ 400	$ 10,400	
		Misc Items	/month	26	$ 500	$ 13,000	
4.7	Lab Staff		Team 6				
		Travel Time	staff * 10 trips	320	$ 290	$ 92,800	
		Per Diem	staff * 10 trips	40	$ 170	$ 6,800	
		Air Fare	staff * 10 trips	20	$ 850	$ 17,000	10
		Mileage	vehicles * project duration	113	$ 70	$ 7,940	
		Car Rental	# vehicles * project duration	113	$ 400	$ 45,371	
		Supplies	/month	26	$ 500	$ 13,000	
		Gas	/month	26	$ 400	$ 10,400	
		Misc Items	/month	26	$ 500	$ 13,000	

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Estimate of Non-Labor Costs (continued)

ITEM NO.	DESCRIPTION		UNIT	QUANTITY	RATE	COSTS
5	**LABORATORY**					**$ 390,000**
5.1	Air Filter Analysis					
		Gross Alpha Beta	1 air filter * 5 days * weeks	980	$ 65	$ 63,700
		Isotopic Thorium	1 air filter * 5 days * weeks	980	$ 100	$ 98,000
5.2	Water Sample Analysis					
		Gross Alpha Beta	Estimated 30 samples	30	$ 65	$ 1,950
		Isotopic Thorium	Estimated 30 samples	30	$ 100	$ 3,000
		Isotopic Uranium	Estimated 30 samples	30	$ 100	$ 3,000
		Radium-226	Estimated 30 samples	30	$ 85	$ 2,550
5.3	Soil Sample Analysis					
		Gamma Spec	Estimated 730 samples	730	$ 85	$ 62,050
		Isotopic Thorium	Estimated 730 samples	730	$ 100	$ 73,000
		Isotopic Uranium	Estimated 730 samples	730	$ 100	$ 73,000
5.4	Vegetation					
		Gamma Spec	Estimated 0 samples	0	$ 85	$ -
		Isotopic Thorium	Estimated 0 samples	0	$ 100	$ -
		Isotopic Uranium	Estimated 0 samples	0	$ 100	$ -
		Radium-226	Estimated 0 samples	0	$ 85	$ -
		Radium-228	Estimated 0 samples	0	$ 85	$ -
5.5	Shipping					
		FedEx Charges	/shipment	135	$ 75	10,125
		Estimate of 3 shipments per month				

start exc Area 1 end exc Area 2
8/6/2018 8/16/2026 2932 418.857143 weeks

7300 103 2000m2 SU in Area 2 and 43 SR in Area 1. Estimate 50 samples per SU.
10% of those go to off-site laboratory. 50 from reference area but those will be analyzed at the on-site lab.

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On-Site Radiological Laboratory
Complete Rad Removal (52.9 pCi/g) Remedy Alternative

Equipment Price List

Item Description	Vendor(s)	Unit Cost	Quantity	Total Cost	Total Shipping Cost	Taxes	Extended Price
Modular Analytical Lab (MAL):							
Cost of MAL	CPM LabFab	$ 3,800.00	20.4	$ 77,520.00	$ 21,576.00	$ 7,186.10	$ 106,282.10
MAL Analytical Equipment							
Discover SPD 80 system (microwave digestion)							
SPD 80 System	CEM Corporation	$ 20,351.26	1	$ 20,351.26	$ 2,035.13	$ 1,886.56	$ 24,272.95
Scrubber Option (mandtory for HF application)		$ 2,691.30	1	$ 2,691.30	$ 269.13	$ 249.48	$ 3,209.91
Synergy External Controller Optior		$ 2,713.80	1	$ 2,713.80	$ 271.38	$ 251.57	$ 3,236.75
80-ml quartz vial (set of twelve)		$ 1,750.69	1	$ 1,750.69	$ 175.07	$ 162.29	$ 2,088.05
35ml/80ml Vial Caps (100)		$ 99	$ 1	$ 99	$ 10	$ 9	$ 118
Installation and Training		$ 837	$ 1	$ 837	$ 84	$ 78	$ 998
Maintence Contract		$ 3,095	$ 2	$ 6,190	$ 619	$ 574	$ 7,383
SUB-TOTAL MAL Microwave				**$ 31,538**			**$ 3,463**
Nuclear Instrumentation for Sample Analysis							
Computer to run APEX software for 2 gamma and 12 alpha diodes	DELL	$ 2,700	$ 1	$ 2,700	$ 270	$ 250	$ 3,220
Alpha Spectroscopy							
Alpha Analyst	Canberra	$ 36,540	$ 1	$ 36,540	$ 3,654	$ 3,387	$ 43,581
PIPS Detectors		$ 1,026	$ 24	$ 24,624	$ 2,462	$ 2,283	$ 29,369
Chassis and Hardware		$ 5,857	$ 2	$ 11,714	$ 1,171	$ 1,086	$ 13,971
Vacuum Pump		$ 1,868	$ 1	$ 1,868	$ 187	$ 173	$ 2,228
Alpha Spec Installation Kit		$ 518	$ 1	$ 518	$ 52	$ 48	$ 618
Training		$ 2,250	$ 2	$ 4,500	$ 450	$ 417	$ 5,367
Apex-Alpha Desktop Package		$ 7,430	$ 1	$ 7,430	$ 743	$ 689	$ 8,862
Mixed Alpha Standard		$ 1,850	$ 6	$ 11,100	$ 1,110	$ 1,029	$ 13,239
Maintence Contract		$ 1,000	$ 2	$ 2,000	$ 200	$ 185	$ 2,385
SUB-TOTAL MAL Alpha Spec				**$ 98,294**			**$ 117,235**
Gamma Spectroscopy							
SAGE Well Detector	Canberra	$ 114,993	$ 1	$ 114,993	$ 11,499	$ 10,660	$ 137,152
Ultra low background shield		$ 27,000	$ 1	$ 27,000	$ 2,700	$ 2,503	$ 32,203
Solid Side Plug		$ 390	$ 1	$ 390	$ 39	$ 36	$ 465
Detector Lift		$ 3,087	$ 1	$ 3,087	$ 309	$ 286	$ 3,682
Genie 2000 Basic		$ 1,316	$ 1	$ 1,316	$ 132	$ 122	$ 1,570
Genie 2000 Gamma Option		$ 4,336	$ 1	$ 4,336	$ 434	$ 402	$ 5,172
LABSOCS Efficiency Calibration Software		$ 6,990	$ 1	$ 6,990	$ 699	$ 648	$ 8,337
ISOXCAL		$ 5,040	$ 1	$ 5,040	$ 504	$ 467	$ 6,011
LYNX-Digital Signal Analyzer		$ 15,887	$ 1	$ 15,887	$ 1,589	$ 1,473	$ 18,948
Maintence Contract		$ 1,000	$ 2	$ 2,000	$ 200	$ 185	$ 2,385
SUB-TOTAL MAL LB4200				**$ 179,039**			**$ 213,540**
LB4200 System							
Base Platform	Canberra	$ 7,339	$ 2	$ 14,678	$ 1,468	$ 1,361	$ 17,506
Drawer		$ 20,920	$ 8	$ 167,360	$ 16,736	$ 15,514	$ 199,610
Apex Software		$ 3,827	$ 1	$ 3,827	$ 383	$ 355	$ 4,564
Mounting Table		$ 1,584	$ 2	$ 3,168	$ 317	$ 294	$ 3,778
Multi Core CPU		$ 2,700	$ 1	$ 2,700	$ 270	$ 250	$ 3,220
Maintence Contract		$ 1,000	$ 2	$ 2,000	$ 200	$ 185	$ 2,385
SUB-TOTAL MAL LB4200				**$ 58,297**			**$ 21,466**
Eichrom Resin System							
24 Hole Vacuum Box with Rack	EiChrom	$ 1,315	$ 1	$ 1,315	$ 132	$ 122	$ 1,568
Inner Liner		$ 215	$ 1	$ 215	$ 22	$ 20	$ 256
White Inner Support Tube-PE 1000/box		$ 118	$ 20	$ 2,311	$ 231	$ 214	$ 2,756
Yellow Outer Tips 1000/box		$ 89	$ 20	$ 1,743	$ 174	$ 162	$ 2,079
20ml Cartridge Reservoir 25/box		$ 28	$ 576	$ 16,128	$ 1,613	$ 1,495	$ 19,236
Resolve Filters in Funnel 25/box		$ 47	$ 576	$ 27,072	$ 2,707	$ 2,510	$ 32,289
Pump	Fisher	$ 1,005	$ 1	$ 1,005	$ 101	$ 93	$ 1,199
SUB-TOTAL MAL LB4200				**$ 7,049**			**$ 2,958**
MAL Other Equipment							
Bench-top drying ovens (2)		$ 2,500	$ 2	$ 5,000	$ 500	$ 464	$ 5,964
Muffle Furnace		$ 2,600	$ 1	$ 2,600	$ 260	$ 241	$ 3,101
Analytical Balance (0.0001g)		$ 2,000	$ 1	$ 2,000	$ 200	$ 185	$ 2,385
Top loading balance (1 kg)		$ 1,000	$ 1	$ 1,000	$ 100	$ 93	$ 1,193
Centrifuge		$ 1,000	$ 2	$ 2,000	$ 200	$ 185	$ 2,385
Heat Lamps		$ 1,000	$ 2	$ 2,000	$ 200	$ 185	$ 2,385
Hot Plates		$ 500	$ 4	$ 2,000	$ 200	$ 185	$ 2,385
Zirconium crudibles		$ 200	$ 24	$ 4,800	$ 480	$ 445	$ 5,725
Labware		$ 15,000	$ 1	$ 15,000	$ 1,500	$ 1,391	$ 17,891
Acids, Reagents, and standards		$ 20,000	$ 2	$ 40,000	$ 4,000	$ 3,708	$ 47,708
SUB-TOTAL MAL Other Equipment				**$ 33,901**			**$ 91,122**
MAL Support Equipment							
Copier		$ 15,000	$ 1	$ 15,000	$ 1,500	$ 1,391	$ 17,891
Printer		$ 5,000	$ 1	$ 5,000	$ 500	$ 464	$ 5,964
Desks		$ 500	$ 2	$ 1,000	$ 100	$ 93	$ 1,193
Chairs		$ 300	$ 5	$ 1,500	$ 150	$ 139	$ 1,789
Tables		$ 200	$ 2	$ 400	$ 40	$ 37	$ 477
Filing Cabinets		$ 1,000	$ 2	$ 2,000	$ 200	$ 185	$ 2,385
Storage Cabinets		$ 1,000	$ 4	$ 4,000	$ 400	$ 371	$ 4,771
Initial office supply setup		$ 2,500	$ 1	$ 2,500	$ 250	$ 232	$ 2,982
Stools for lab area		$ 100	$ 6	$ 600	$ 60	$ 56	$ 716
Safety shower / eyewash		$ 1,000	$ 1	$ 1,000	$ 100	$ 93	$ 1,193
Cellular phones for lab employees		$ 150	$ 2	$ 300	$ 30	$ 28	$ 358
SUB-TOTAL MAL Support				**$ 6,750**			**$ 39,717**
GRAND TOTAL EQUIPMENT				**$ 488,000**			**$ 596,000**

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Capital Cost Estimate - Long-Term Monitoring
Complete Rad Removal (52.9 pCi/g) Remedy Alternative

Description	Quantity	Units	Unit Rate	Estimated Cost ($)
Secure easements	1	LS	5,000	5,000
Landfill Gas:				
Driller: Install radon/landfill gas monitoring probes, MDNR "Code Wells"; 10' deep	31	each	2,000	62,000
Misc. wellhead sampling fittings and locks	31	each	40	1,200
Field technician observation during drilling and construction of probes (4/day)	64	hour	90	5,800
Mileage for field technician during probe construction	400	mile	0.54	200
Multi-gas detector (e.g., Industrial Scientific iBrid™ MX6), incl regulator, tubing, calbrtn gas	1	LS	4,806	4,800
Portable radon gas monitor and detector (e.g., Pylon AB6 monitor w/ 300A detector	1	LS	9,075	9,100
Groundwater:				
Construction of new groundwater monitoring wells	12	each	10,000	120,000
Flat-bottom polyethylene tank to store purge water prior to disposa	1,500	gallon	2	3,000
Estimated Long-term Monitoring Capital Costs - Total				**211,000**

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Post-Construction Radon Flux Monitoring Cost Estimate
Complete Rad Removal (52.9 pCi/g) Remedy Alternative

Description	Quantity	Units	Unit Rate	Estimated Cost ($)
Radon Flux (once after cover construction is complete):				
Number of Monitoring Locatons (assume same as post-NCC program):	*130*			
Surveying of locations	1	day	1,500	1,500
Auxier labor	1	LS	6,345	6,350
Per diem	2	each	1,190	2,380
Airfare and vehicle rental	2	each	1,000	2,000
Overnight shipping to lab	1	LS	1,200	1,200
Lab analysis (Eberline)	1	LS	11,050	11,050
Data validation and management	1	each	1,000	1,000
Reporting	4	hour	150	600
Estimated Post-Construction Radon Flux Monitoring Costs - Total				**26,000**

Stormwater and Air Monitoring During Construction Cost Estimates
Complete Rad Removal (52.9 pCi/g) Remedy Alternative

Description	Quantity	Units	Unit Rate ($)	Estimated Cost ($)
Stormwater Monitoring and Inspection (Quarterly - only during remedy construction				
4 sampling locations				
1 field duplicate				
5 total samples				
Sampling and Inspection (Feezor Engineering estimate)	1	LS	5,000	5,000
Laboratory Analysis:				
Eberline (T-uranium, iso-uranium, iso-thorium, gross alpha/beta, Ra-226, Ra-228)	1	LS	2,325	2,330
TekLab (all other parameters)	1	LS	2,743	2,740
Data validation and management	1	LS	1,500	1,500
Reporting	4	hour	150	600
Estimated Quarterly Stormwater Monitoring and Inspection Costs - Total				**12,000**
Air Monitoring during Construction				
13 air monitoring stations and one MET station				
Auxier & Associates FY2016 Air Monitoring Program Estimate (minus contingency)	1	LS	172,852	172,900
Data validation	1	LS	6,800	6,800
Power costs (13 stations plus one MET station; $10/month per station)	12	months	140	1,700
Estimated Air Monitoring during Construction Costs - Annual Total				181,000
Estimated Quarterly Air Monitoring Costs during Construction (assuming annual costs divided by 4				**45,000**

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Capital Cost Estimate - Amend Existing/Additional Institutional Controls
Complete Rad Removal (52.9 pCi/g) Remedy Alternative

Description	Quantity	Units	Unit Rate	Estimated Cost
Prepare Institutional Controls planning documents	1	LS	10,000	10,000
Attorney labor: prepare draft amended existing and additional ICs	1	LS	20,000	20,000
Review of draft documents	1	LS	5,000	5,000
Revise amended and additional Institutional Controls documents	1	LS	10,000	10,000
Filings and registrations	1	LS	5,000	5,000
Estimated Institutional Controls Capital Costs - Total				**50,000**

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Long-Term Post-Construction Monitoring (per event) Cost Estimate
Complete Rad Removal (52.9 pCi/g) Remedy Alternative

(Landfill Gas/Radon, Groundwater Monitoring and Annual Post-Construction Site Inspections)

Description	Analytical Method	Quantity	Units	Unit Rate ($)	Estimated Cost ($)
Landfill Gas/Radon (quarterly after contruction complete):					
Number of Landfill Gas/Radon Monitoring Wells		*31*			
Labor - field technician		9	hour	90	810
Field vehicle		1	day	120	120
Replacement radon detector (Pylon 300A)		1	each	550	550
Calibration gas for multi-gas detector		1	each	449	450
Data management		2	hour	100	200
Reporting		8	hour	150	1,200
Estimated Landfill Gas/Radon Monitoring Costs - Subtotal					3,300
Contingency			*%*	*20*	*700*
Estimated Landfill Gas/Radon Monitoring Costs - Total (per Event)					**4,000**

Description	Analytical Method	Quantity	Units	Unit Rate ($)	Estimated Cost ($)
Groundwater (semi-annual first 5 years after construction; annually thereafter):					
Number of Samples:			*For VOCs*		
Investigative Groundwater (5, 3-wells clusters in Area 2; 3, 3-well clusters in Area 1)		*24*	*24*		
Field Duplicates (one per every 10 investigative samples)		*3*	*3*		
Trip blank (one per day per cooler)			*15*		
Matrix Spike			*1*		
Matrix Spike Duplicate			*1*		
Sub-total number of unfiltered samples:		*27*	*44*		
Sub-total number of filtered samples for radionuclide and metals analyses:		*27*			
Total number of samples:		*54*	*44*		
Labor:					
Labor - field technicians (assume 2 people, 5 days, 10-hr days)		100	hour	90	9,000
Materials and equipment:					
Sample kits, incl. filters		24	each	50	1,200
Field instrumentation and flowcell rental - groundwater		5	day	100	500
Field Vehicle		5	day	120	600
Overnight shipping of sample coolers (assume 1 per day to rad lab)		5	coolers	100	500
Delivery of sample coolers to local lab (2 to 3 coolers per day)		5	hour	90	450
Disposal of purge water (assumes PE tank previously purchased is onsite):					
Vacuum truck		4	hour	200	800
Transportation and disposal (assumes approx 25 gal per well per event)		600	gallon	2.00	1,200
Laboratory Sample Analysis:	*Analytical Method:*				
Gross alpha and beta	EPA 900.0	54	each	50	2,700
Total Uranium		54	each	65	3,510
Iso-Uranium-234, 235, 238	EML U-02 Mod	54	each	100	5,400
Iso-Thorium-228, 230, 232	EML Th-01 Mod	54	each	100	5,400
Radium 228	EPA 904.0	54	each	75	4,050
Radium 226	EPA 903.0 Mod	54	each	75	4,050
Radon 222 - 72 hr hold time	SM 20th ED 7500-Rn B	54	each	85	4,590
Volatile Organic Compounds [VOCs] (GC/MS)	8260B	44	each	110	4,840
Semivolatile Organic Compounds [SVOCs] (GC/MS)	8270C	54	each	220	11,880
22 Metals Target Analyte List (ICP/AES)	6010B	54	each	115	6,210
Mercury (CVAA)	7470A	54	each	35	1,890
4 Anions (IC) - Bromide, Chloride, Fluoride, Sulfate	300.0	54	each	72	3,890
2 Anions (IC) - Nitrate, Nitrite - 48 hr hold time	300.0	54	each	36	1,940
Sulfide, Total	SM 4500 S2 D	54	each	35	1,890
Phosphorus, Total	365.1	54	each	40	2,160
Organic carbon, Total (TOC)	SM 5310B	54	each	40	2,160
Total Alkalinity, Carbonate, Bicarbonate	SM 2320B	54	each	20	1,080
Nitrogen, Ammonia	350.1	54	each	25	1,350
Level IV data deliverable		$ 68,990	%	10%	6,900
Data validation (assumes validation of 100% of Level IV data will be required)		1	LS	6,600	6,600
Data management		7	SDG	100	700
Reporting		40	hour	150	6,000
Estimated Groundwater Monitoring Costs - Subtotal					103,400
Contingency			*%*	*20*	*20,700*
Estimated Groundwater Monitoring Costs - Total (per Event)					**124,000**

DVR = data validation report
SDG = sample delivery group

Description	Analytical Method	Quantity	Units	Unit Rate ($)	Estimated Cost ($)
Annual Post-Construction Site Inspections					
Labor - Engineer		9	hour	130	1,170
Field vehicle		1	day	120	120
Site Inspection Report		4	hour	130	520
Estimated Annual Post-Construction Site Inspections Costs - Subtotal					1,800
Contingency			*%*	*20*	*400*
Estimated Annual Post-Construction Site Inspections Costs - Total					**2,200**

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Operation and Maintenance Cost Estimate - Annual Cover System Maintenance
Complete Rad Removal (52.9 pCi/g) Remedy Alternative

Description	Quantity	Units	Unit Rate	Estimated Cost
Mowing; tractor w/ rotary mower (once/year)	55.3	acre	40.00	2,200
Fill depressions in cover w/ topsoil, assume 1% of area; 6 inches deep	446	bcy	37.53	16,700
Seeding of filled area	24.1	M.S.F.	66.04	1,600
Estimated Cover System O&M Costs - Subtotal				20,500
Contingency		*%*	*20*	*4,100*
Estimated Annual Cover Maintenance O&M Costs - Total				**25,000**

M.S.F. = 1,000 square feet

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Periodic Cost Estimate - 5 year Review
Complete Rad Removal (52.9 pCi/g) Remedy Alternative

Description	Quantity	Units	Unit Rate	Estimated Cost ($)
Access Restrictions (inspect/repair fencing and signage)	16	hours	150	2,400
Institutional Controls verification	8	hours	150	1,200
Document that landfill cover is effective	8	hours	150	1,200
Assemble Monitoring Data (landfill gas/radon, groundwater, surface water)	40	hours	150	6,000
Summarize Annual Post-Construction Site Inspections	8	hours	150	1,200
Summarize Annual Cover Maintenance Documentation	8	hours	150	1,200
Water supply well inventory review	8	hours	150	1,200
Document any changes in Land Use at and around West Lake Landfill	16	hours	150	2,400
Prepare Summary Report	80	hours	150	12,000
Estimated 5-year Maint/Review O&M Costs - Subtotal				**29,000**
Contingency		*%*	*20*	*6,000*
Estimated 5-year Maintenance O&M Costs - Total				**35,000**

Present Worth Cost Estimate
Complete Rad Removal (52.9 pCi/g) Remedy Alternative

			Capital Costs ($)		Operation, Maintenance, Monitoring, and Periodic Costs ($/yr)							
Year	*n*	P/F(*i* =7%)	Remediation	Subtotal Capital Costs	Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000	11,650,000	11,650,000					0	11,650,000	11,650,000	11,650,000
2018	1	0.93458	51,140,000	51,140,000					0	51,140,000	47,794,000	59,444,000
2019	2	0.87344	97,940,000	97,940,000					0	97,940,000	85,545,000	144,989,000
2020	3	0.81630	61,360,000	61,360,000					0	61,360,000	50,088,000	195,077,000
2021	4	0.76290	65,280,000	65,280,000					0	65,280,000	49,802,000	244,879,000
2022	5	0.71299	25,570,000	25,570,000	8,000	124,000	27,000		159,000	25,729,000	18,344,000	263,223,000
2023	6	0.66634			16,000	248,000	27,000		291,000	291,000	194,000	263,417,000
2024	7	0.62275			16,000	248,000	27,000		291,000	291,000	181,000	263,598,000
2025	8	0.58201			16,000	248,000	27,000		291,000	291,000	169,000	263,767,000
2026	9	0.54393			16,000	248,000	27,000		291,000	291,000	158,000	263,925,000
2027	10	0.50835			16,000	248,000	27,000	35,000	326,000	326,000	166,000	264,091,000
2028	11	0.47509			16,000	124,000	27,000		167,000	167,000	79,000	264,170,000
2029	12	0.44401			16,000	124,000	27,000		167,000	167,000	74,000	264,244,000
2030	13	0.41496			16,000	124,000	27,000		167,000	167,000	69,000	264,313,000
2031	14	0.38782			16,000	124,000	27,000		167,000	167,000	65,000	264,378,000
2032	15	0.36245			16,000	124,000	27,000	35,000	202,000	202,000	73,000	264,451,000
2033	16	0.33873			16,000	124,000	27,000		167,000	167,000	57,000	264,508,000
2034	17	0.31657			16,000	124,000	27,000		167,000	167,000	53,000	264,561,000
2035	18	0.29586			16,000	124,000	27,000		167,000	167,000	49,000	264,610,000
2036	19	0.27651			16,000	124,000	27,000		167,000	167,000	46,000	264,656,000
2037	20	0.25842			16,000	124,000	27,000	35,000	202,000	202,000	52,000	264,708,000
2038	21	0.24151			16,000	124,000	27,000		167,000	167,000	40,000	264,748,000
2039	22	0.22571			16,000	124,000	27,000		167,000	167,000	38,000	264,786,000
2040	23	0.21095			16,000	124,000	27,000		167,000	167,000	35,000	264,821,000
2041	24	0.19715			16,000	124,000	27,000		167,000	167,000	33,000	264,854,000
2042	25	0.18425			16,000	124,000	27,000	35,000	202,000	202,000	37,000	264,891,000
2043	26	0.17220			16,000	124,000	27,000		167,000	167,000	29,000	264,920,000
2044	27	0.16093			16,000	124,000	27,000		167,000	167,000	27,000	264,947,000
2045	28	0.15040			16,000	124,000	27,000		167,000	167,000	25,000	264,972,000
2046	29	0.14056			16,000	124,000	27,000		167,000	167,000	23,000	264,995,000
2047	30	0.13137			16,000	124,000	27,000	35,000	202,000	202,000	27,000	265,022,000

Estimated Non-discounted Capital Costs: 313,000,000

Estimated Non-discounted Total Costs: 318,000,000

Estimated 30-year Present Worth Costs: 265,000,000

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. In accordance with USEPA Guidance, this is an order-of-magnitude engineering estimate that is expected to be within -30 to +50 percent of the actual project cost.

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Present Worth Cost Estimate
Complete Rad Removal (52.9 pCi/g) Remedy Alternative

			Capital Costs ($)		Operation, Maintenance, Monitoring, and Periodic Costs ($/yr)							
Year	*n*	P/F(*i*=1.5%)	Remediation	Subtotal Capital Costs	Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000	11,650,000	11,650,000					0	11,650,000	11,650,000	11,650,000
2018	1	0.98522	51,140,000	51,140,000					0	51,140,000	50,384,000	62,034,000
2019	2	0.97066	97,940,000	97,940,000					0	97,940,000	95,067,000	157,101,000
2020	3	0.95632	61,360,000	61,360,000					0	61,360,000	58,680,000	215,781,000
2021	4	0.94218	65,280,000	65,280,000					0	65,280,000	61,506,000	277,287,000
2022	5	0.92826	25,570,000	25,570,000	8,000	124,000	27,000	0	159,000	25,729,000	23,883,000	301,170,000
2023	6	0.91454			16,000	248,000	27,000	0	291,000	291,000	266,000	301,436,000
2024	7	0.90103			16,000	248,000	27,000	0	291,000	291,000	262,000	301,698,000
2025	8	0.88771			16,000	248,000	27,000	0	291,000	291,000	258,000	301,956,000
2026	9	0.87459			16,000	248,000	27,000	0	291,000	291,000	255,000	302,211,000
2027	10	0.86167			16,000	248,000	27,000	35,000	326,000	326,000	281,000	302,492,000
2028	11	0.84893			16,000	124,000	27,000	0	167,000	167,000	142,000	302,634,000
2029	12	0.83639			16,000	124,000	27,000	0	167,000	167,000	140,000	302,774,000
2030	13	0.82403			16,000	124,000	27,000	0	167,000	167,000	138,000	302,912,000
2031	14	0.81185			16,000	124,000	27,000	0	167,000	167,000	136,000	303,048,000
2032	15	0.79985			16,000	124,000	27,000	35,000	202,000	202,000	162,000	303,210,000
2033	16	0.78803			16,000	124,000	27,000	0	167,000	167,000	132,000	303,342,000
2034	17	0.77639			16,000	124,000	27,000	0	167,000	167,000	130,000	303,472,000
2035	18	0.76491			16,000	124,000	27,000	0	167,000	167,000	128,000	303,600,000
2036	19	0.75361			16,000	124,000	27,000	0	167,000	167,000	126,000	303,726,000
2037	20	0.74247			16,000	124,000	27,000	35,000	202,000	202,000	150,000	303,876,000
2038	21	0.73150			16,000	124,000	27,000	0	167,000	167,000	122,000	303,998,000
2039	22	0.72069			16,000	124,000	27,000	0	167,000	167,000	120,000	304,118,000
2040	23	0.71004			16,000	124,000	27,000	0	167,000	167,000	119,000	304,237,000
2041	24	0.69954			16,000	124,000	27,000	0	167,000	167,000	117,000	304,354,000
2042	25	0.68921			16,000	124,000	27,000	35,000	202,000	202,000	139,000	304,493,000
2043	26	0.67902			16,000	124,000	27,000	0	167,000	167,000	113,000	304,606,000
2044	27	0.66899			16,000	124,000	27,000	0	167,000	167,000	112,000	304,718,000
2045	28	0.65910			16,000	124,000	27,000	0	167,000	167,000	110,000	304,828,000
2046	29	0.64936			16,000	124,000	27,000	0	167,000	167,000	108,000	304,936,000
2047	30	0.63976			16,000	124,000	27,000	35,000	202,000	202,000	129,000	305,065,000

Estimated Non-discounted Capital Costs: 313,000,000

Estimated Non-discounted Total Costs: 318,000,000

Estimated 30-year Present Worth Costs: 305,000,000

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. In accordance with USEPA Guidance, this is an order-of-magnitude engineering estimate that is expected to be within -30 to +50 percent of the actual project cost.

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Present Worth Cost Estimate
Complete Rad Removal (52.9 pCi/g) Remedy Alternative

			Capital Costs ($)		Operation, Maintenance, Monitoring, and Periodic Costs ($/yr)							
Year	*n*	P/F(*i* =7%)	Remediation	Subtotal Capital Costs	Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000	11,650,000	11,650,000					0	11,650,000	11,650,000	11,650,000
2018	1	0.93458	51,140,000	51,140,000					0	51,140,000	47,794,000	59,444,000
2019	2	0.87344	97,940,000	97,940,000					0	97,940,000	85,545,000	144,989,000
2020	3	0.81630	61,360,000	61,360,000					0	61,360,000	50,088,000	195,077,000
2021	4	0.76290	65,280,000	65,280,000					0	65,280,000	49,802,000	244,879,000
2022	5	0.71299	25,570,000	25,570,000	8,000	124,000	27,000	0	159,000	25,729,000	18,344,000	263,223,000
2023	6	0.66634			16,000	248,000	27,000	0	291,000	291,000	194,000	263,417,000
2024	7	0.62275			16,000	248,000	27,000	0	291,000	291,000	181,000	263,598,000
2025	8	0.58201			16,000	248,000	27,000	0	291,000	291,000	169,000	263,767,000
2026	9	0.54393			16,000	248,000	27,000	0	291,000	291,000	158,000	263,925,000
2027	10	0.50835			16,000	248,000	27,000	35,000	326,000	326,000	166,000	264,091,000
2028	11	0.47509			16,000	124,000	27,000	0	167,000	167,000	79,000	264,170,000
2029	12	0.44401			16,000	124,000	27,000	0	167,000	167,000	74,000	264,244,000
2030	13	0.41496			16,000	124,000	27,000	0	167,000	167,000	69,000	264,313,000
2031	14	0.38782			16,000	124,000	27,000	0	167,000	167,000	65,000	264,378,000
2032	15	0.36245			16,000	124,000	27,000	35,000	202,000	202,000	73,000	264,451,000
2033	16	0.33873			16,000	124,000	27,000	0	167,000	167,000	57,000	264,508,000
2034	17	0.31657			16,000	124,000	27,000	0	167,000	167,000	53,000	264,561,000
2035	18	0.29586			16,000	124,000	27,000	0	167,000	167,000	49,000	264,610,000
2036	19	0.27651			16,000	124,000	27,000	0	167,000	167,000	46,000	264,656,000
2037	20	0.25842			16,000	124,000	27,000	35,000	202,000	202,000	52,000	264,708,000
2038	21	0.24151			16,000	124,000	27,000	0	167,000	167,000	40,000	264,748,000
2039	22	0.22571			16,000	124,000	27,000	0	167,000	167,000	38,000	264,786,000
2040	23	0.21095			16,000	124,000	27,000	0	167,000	167,000	35,000	264,821,000
2041	24	0.19715			16,000	124,000	27,000	0	167,000	167,000	33,000	264,854,000
2042	25	0.18425			16,000	124,000	27,000	35,000	202,000	202,000	37,000	264,891,000
2043	26	0.17220			16,000	124,000	27,000	0	167,000	167,000	29,000	264,920,000
2044	27	0.16093			16,000	124,000	27,000	0	167,000	167,000	27,000	264,947,000
2045	28	0.15040			16,000	124,000	27,000	0	167,000	167,000	25,000	264,972,000
2046	29	0.14056			16,000	124,000	27,000	0	167,000	167,000	23,000	264,995,000
2047	30	0.13137			16,000	124,000	27,000	35,000	202,000	202,000	27,000	265,022,000
2216	199	0.0000014			16,000	124,000	27,000		167,000	167,000	0	265,342,000
2217	200	0.0000013			16,000	124,000	27,000	35,000	202,000	202,000	0	265,342,000

Estimated Non-discounted Capital Costs: 313,000,000

Estimated Non-discounted Total Costs: 348,000,000

Estimated 200-year Present Worth Costs: 265,000,000

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. In accordance with USEPA Guidance, this is an order-of-magnitude engineering estimate that is expected to be within -30 to +50 percent of the actual project cost.

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Present Worth Cost Estimate
Complete Rad Removal (52.9 pCi/g) Remedy Alternative

			Capital Costs ($)		Operation, Maintenance, Monitoring, and Periodic Costs ($/yr)							
Year	*n*	P/F(*i* =1.5%)	Remediation	Subtotal Capital Costs	Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000	11,650,000	11,650,000					0	11,650,000	11,650,000	11,650,000
2018	1	0.98522	51,140,000	51,140,000					0	51,140,000	50,384,000	62,034,000
2019	2	0.97066	97,940,000	97,940,000					0	97,940,000	95,067,000	157,101,000
2020	3	0.95632	61,360,000	61,360,000					0	61,360,000	58,680,000	215,781,000
2021	4	0.94218	65,280,000	65,280,000					0	65,280,000	61,506,000	277,287,000
2022	5	0.92826	25,570,000	25,570,000	8,000	124,000	27,000	0	159,000	25,729,000	23,883,000	301,170,000
2023	6	0.91454			16,000	248,000	27,000	0	291,000	291,000	266,000	301,436,000
2024	7	0.90103			16,000	248,000	27,000	0	291,000	291,000	262,000	301,698,000
2025	8	0.88771			16,000	248,000	27,000	0	291,000	291,000	258,000	301,956,000
2026	9	0.87459			16,000	248,000	27,000	0	291,000	291,000	255,000	302,211,000
2027	10	0.86167			16,000	248,000	27,000	35,000	326,000	326,000	281,000	302,492,000
2028	11	0.84893			16,000	124,000	27,000	0	167,000	167,000	142,000	302,634,000
2029	12	0.83639			16,000	124,000	27,000	0	167,000	167,000	140,000	302,774,000
2030	13	0.82403			16,000	124,000	27,000	0	167,000	167,000	138,000	302,912,000
2031	14	0.81185			16,000	124,000	27,000	0	167,000	167,000	136,000	303,048,000
2032	15	0.79985			16,000	124,000	27,000	35,000	202,000	202,000	162,000	303,210,000
2033	16	0.78803			16,000	124,000	27,000	0	167,000	167,000	132,000	303,342,000
2034	17	0.77639			16,000	124,000	27,000	0	167,000	167,000	130,000	303,472,000
2035	18	0.76491			16,000	124,000	27,000	0	167,000	167,000	128,000	303,600,000
2036	19	0.75361			16,000	124,000	27,000	0	167,000	167,000	126,000	303,726,000
2037	20	0.74247			16,000	124,000	27,000	35,000	202,000	202,000	150,000	303,876,000
2038	21	0.73150			16,000	124,000	27,000	0	167,000	167,000	122,000	303,998,000
2039	22	0.72069			16,000	124,000	27,000	0	167,000	167,000	120,000	304,118,000
2040	23	0.71004			16,000	124,000	27,000	0	167,000	167,000	119,000	304,237,000
2041	24	0.69954			16,000	124,000	27,000	0	167,000	167,000	117,000	304,354,000
2042	25	0.68921			16,000	124,000	27,000	35,000	202,000	202,000	139,000	304,493,000
2043	26	0.67902			16,000	124,000	27,000	0	167,000	167,000	113,000	304,606,000
2044	27	0.66899			16,000	124,000	27,000	0	167,000	167,000	112,000	304,718,000
2045	28	0.65910			16,000	124,000	27,000	0	167,000	167,000	110,000	304,828,000
2046	29	0.64936			16,000	124,000	27,000	0	167,000	167,000	108,000	304,936,000
2047	30	0.63976			16,000	124,000	27,000	35,000	202,000	202,000	129,000	305,065,000
2216	199	0.05167			16,000	124,000	27,000	0	167,000	167,000	9,000	311,875,000
2217	200	0.05091			16,000	124,000	27,000	35,000	202,000	202,000	10,000	311,885,000

Estimated Non-discounted Capital Costs: 313,000,000

Estimated Non-discounted Total Costs: 348,000,000

Estimated 200-year Present Worth Costs: 312,000,000

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Present Worth Cost Estimate
Complete Rad Removal (52.9 pCi/g) Remedy Alternative

Year	*n*	P/F(*i* =7%)	Capital Costs ($) Remediation	Capital Costs ($) Subtotal Capital Costs	Operation, Maintenance, Monitoring, and Periodic Costs ($/yr) Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000	11,650,000	11,650,000					0	11,650,000	11,650,000	11,650,000
2018	1	0.93458	51,140,000	51,140,000					0	51,140,000	47,794,000	59,444,000
2019	2	0.87344	97,940,000	97,940,000					0	97,940,000	85,545,000	144,989,000
2020	3	0.81630	61,360,000	61,360,000					0	61,360,000	50,088,000	195,077,000
2021	4	0.76290	65,280,000	65,280,000					0	65,280,000	49,802,000	244,879,000
2022	5	0.71299	25,570,000	25,570,000	8,000	124,000	27,000	0	159,000	25,729,000	18,344,000	263,223,000
2023	6	0.66634			16,000	248,000	27,000	0	291,000	291,000	194,000	263,417,000
2024	7	0.62275			16,000	248,000	27,000	0	291,000	291,000	181,000	263,598,000
2025	8	0.58201			16,000	248,000	27,000	0	291,000	291,000	169,000	263,767,000
2026	9	0.54393			16,000	248,000	27,000	0	291,000	291,000	158,000	263,925,000
2027	10	0.50835			16,000	248,000	27,000	35,000	326,000	326,000	166,000	264,091,000
2028	11	0.47509			16,000	124,000	27,000	0	167,000	167,000	79,000	264,170,000
2029	12	0.44401			16,000	124,000	27,000	0	167,000	167,000	74,000	264,244,000
2030	13	0.41496			16,000	124,000	27,000	0	167,000	167,000	69,000	264,313,000
2031	14	0.38782			16,000	124,000	27,000	0	167,000	167,000	65,000	264,378,000
2032	15	0.36245			16,000	124,000	27,000	35,000	202,000	202,000	73,000	264,451,000
2033	16	0.33873			16,000	124,000	27,000	0	167,000	167,000	57,000	264,508,000
2034	17	0.31657			16,000	124,000	27,000	0	167,000	167,000	53,000	264,561,000
2035	18	0.29586			16,000	124,000	27,000	0	167,000	167,000	49,000	264,610,000
2036	19	0.27651			16,000	124,000	27,000	0	167,000	167,000	46,000	264,656,000
2037	20	0.25842			16,000	124,000	27,000	35,000	202,000	202,000	52,000	264,708,000
2038	21	0.24151			16,000	124,000	27,000	0	167,000	167,000	40,000	264,748,000
2039	22	0.22571			16,000	124,000	27,000	0	167,000	167,000	38,000	264,786,000
2040	23	0.21095			16,000	124,000	27,000	0	167,000	167,000	35,000	264,821,000
2041	24	0.19715			16,000	124,000	27,000	0	167,000	167,000	33,000	264,854,000
2042	25	0.18425			16,000	124,000	27,000	35,000	202,000	202,000	37,000	264,891,000
2043	26	0.17220			16,000	124,000	27,000	0	167,000	167,000	29,000	264,920,000
2044	27	0.16093			16,000	124,000	27,000	0	167,000	167,000	27,000	264,947,000
2045	28	0.15040			16,000	124,000	27,000	0	167,000	167,000	25,000	264,972,000
2046	29	0.14056			16,000	124,000	27,000	0	167,000	167,000	23,000	264,995,000
2047	30	0.13137			16,000	124,000	27,000	35,000	202,000	202,000	27,000	265,022,000
3016	999	4.422E-30			16,000	124,000	27,000		167,000	167,000	0	265,342,000
3017	1000	4.133E-30			16,000	124,000	27,000	35,000	202,000	202,000	0	265,342,000

Estimated Non-discounted Capital Costs: 313,000,000

Estimated Non-discounted Total Costs: 487,000,000

Estimated 1,000-year Present Worth Costs: 265,000,000

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. In accordance with USEPA Guidance, this is an order-of-magnitude engineering estimate that is expected to be within -30 to +50 percent of the actual project cost.

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Present Worth Cost Estimate
Complete Rad Removal (52.9 pCi/g) Remedy Alternative

Year	*n*	P/F(*i* =1.5%)	Capital Costs ($) Remediation	Capital Costs ($) Subtotal Capital Costs	Operation, Maintenance, Monitoring, and Periodic Costs ($/yr) Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000	11,650,000	11,650,000					0	11,650,000	11,650,000	11,650,000
2018	1	0.98522	51,140,000	51,140,000					0	51,140,000	50,384,000	62,034,000
2019	2	0.97066	97,940,000	97,940,000					0	97,940,000	95,067,000	157,101,000
2020	3	0.95632	61,360,000	61,360,000					0	61,360,000	58,680,000	215,781,000
2021	4	0.94218	65,280,000	65,280,000					0	65,280,000	61,506,000	277,287,000
2022	5	0.92826	25,570,000	25,570,000	8,000	124,000	27,000	0	159,000	25,729,000	23,883,000	301,170,000
2023	6	0.91454			16,000	248,000	27,000	0	291,000	291,000	266,000	301,436,000
2024	7	0.90103			16,000	248,000	27,000	0	291,000	291,000	262,000	301,698,000
2025	8	0.88771			16,000	248,000	27,000	0	291,000	291,000	258,000	301,956,000
2026	9	0.87459			16,000	248,000	27,000	0	291,000	291,000	255,000	302,211,000
2027	10	0.86167			16,000	248,000	27,000	35,000	326,000	326,000	281,000	302,492,000
2028	11	0.84893			16,000	124,000	27,000	0	167,000	167,000	142,000	302,634,000
2029	12	0.83639			16,000	124,000	27,000	0	167,000	167,000	140,000	302,774,000
2030	13	0.82403			16,000	124,000	27,000	0	167,000	167,000	138,000	302,912,000
2031	14	0.81185			16,000	124,000	27,000	0	167,000	167,000	136,000	303,048,000
2032	15	0.79985			16,000	124,000	27,000	35,000	202,000	202,000	162,000	303,210,000
2033	16	0.78803			16,000	124,000	27,000	0	167,000	167,000	132,000	303,342,000
2034	17	0.77639			16,000	124,000	27,000	0	167,000	167,000	130,000	303,472,000
2035	18	0.76491			16,000	124,000	27,000	0	167,000	167,000	128,000	303,600,000
2036	19	0.75361			16,000	124,000	27,000	0	167,000	167,000	126,000	303,726,000
2037	20	0.74247			16,000	124,000	27,000	35,000	202,000	202,000	150,000	303,876,000
2038	21	0.73150			16,000	124,000	27,000	0	167,000	167,000	122,000	303,998,000
2039	22	0.72069			16,000	124,000	27,000	0	167,000	167,000	120,000	304,118,000
2040	23	0.71004			16,000	124,000	27,000	0	167,000	167,000	119,000	304,237,000
2041	24	0.69954			16,000	124,000	27,000	0	167,000	167,000	117,000	304,354,000
2042	25	0.68921			16,000	124,000	27,000	35,000	202,000	202,000	139,000	304,493,000
2043	26	0.67902			16,000	124,000	27,000	0	167,000	167,000	113,000	304,606,000
2044	27	0.66899			16,000	124,000	27,000	0	167,000	167,000	112,000	304,718,000
2045	28	0.65910			16,000	124,000	27,000	0	167,000	167,000	110,000	304,828,000
2046	29	0.64936			16,000	124,000	27,000	0	167,000	167,000	108,000	304,936,000
2047	30	0.63976			16,000	124,000	27,000	35,000	202,000	202,000	129,000	305,065,000
3016	999	3.471E-07			16,000	124,000	27,000	0	167,000	167,000	0	312,453,000
3017	1000	3.419E-07			16,000	124,000	27,000	35,000	202,000	202,000	0	312,453,000

Estimated Non-discounted Capital Costs: 313,000,000

Estimated Non-discounted Total Costs: 487,000,000

Estimated 1,000-year Present Worth Costs: 312,000,000

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. In accordance with USEPA Guidance, this is an order-of-magnitude engineering estimate that is expected to be within -30 to +50 percent of the actual project cost.

Appendix K-6

Cost Estimates for the Partial Excavation of RIM with Activities above 1,000 pCi/g Alternative

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Preliminary Estimated Capital Costs
1,000 pCi/g Remedy Alternative

Cost Item			Estimated Capital Costs
Construction Costs		$	123,260,000
Radiological Survey/H&S Support Costs		$	36,121,000
On-site Rad Laboratory		$	857,000
Long-Term Monitoring Facilities		$	211,000
Post Construction Radon Flux Monitoring		$	26,000
Stormwater Monitoring during Construction		$	372,000
Air Monitoring during Construction		$	1,395,000
Institutional Controls		$	50,000
Subtotal		$	162,292,000
Project Management	5%	$	8,115,000
Engineering Design	6%	$	9,738,000
Construction Management	6%	$	9,738,000
Subtotal - Construction On-Site		$	189,880,000
Off-site Transportation and Disposal (@229/lcy)		$	14,400,000
Subtotal - Transport/Disposal Off-site		$	14,400,000
Contingencies:			
Scope (construction onsite)	55%	$	104,434,000
Scope (transport/disposal offsite)	15%	$	2,160,000
Bid (all activities)	20%	$	40,856,000
Subtotal - Contingency		$	147,450,000
Other Requirements:			
Buy-out Asphalt Plant Lease		$	3,200,000
Permitting for Relocation of Transfer Station		$	500,000
Relocate Transfer Station		$	5,260,000
Subtotal - Other Requirements		$	8,960,000
Total: Complete Rad Removal (7.9 pCi/g) Remedy		$	361,000,000

Estimated Length Construction	3/5/18	start
	11/6/25	end
	2,803	no. Days
	7.7	no. Years
	31	no. Quarters

Construction Cost Worksheet - FFS 1000 DRAFT

Step #	Category	Sub-Category	Task	Quantity Area 1	Quantity Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Construction Days Area 1	Construction Days Area 2	Crew Man-days Area 1	Crew Man-days Area 2	Unit Costs Ext. Mat, O&P	Unit Costs Ext. Labor, O&P	Unit Costs Ext. Labor, O&P Ineff.	Unit Costs Ext. Equip, O&P	Unit Costs Ext. Equip, O&P Ineff.	Unit Costs Ext. Total, O&P	Bridgeton Taxes Area 1	Bridgeton Taxes Area 2	Total Cost Area 1	Total Cost Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Delivery Miles Area 1	Total Delivery Miles Area 2
FFS 1000 DRAFT 1	Temporary Construction Facilitities / Utilities / Personnel	Construction Trailers	Capital Expenses	2	-	Group of Trailers		See separate Assumptions sheet								25.0	-	39.2	-	$ -					$ 106,698.53	$ -	$ -	$ 213,397	$ -	10	-	200	-
FFS 1000 DRAFT 2			Operating Expenses	119	-	Group of Trailers	Months	See separate Assumptions sheet												$ -					$ 2,786.52	$ -	$ -	$ 330,383	$ -				
FFS 1000 DRAFT 3			Parking Area	4,444	-	Gravel Area	S.Y.	RS Means, Year 2016 Quarter 1	015523500050	Temporary, roads, gravel fill, 4" gravel depth, excl surfacing	B14	715	6.0	1.0	100%	6.2	-	37.3	-	$ 4.10	$ 4.35	$ -	$ 0.63	$ -	$ 9.08	$ 1,524	$ -	$ 41,879	$ -				
FFS 1000 DRAFT 4			Portable Toilets in Construction Areas	50	69	Portable Toilets	Month	RS Means, Year 2016 Quarter 1	015433406420	Rent portable toilet chemical, recycle, flush type, Incl. Hourly Oper. Cost.					100%					$ -	$ -	$ -	$ 317.05	$ -	$ 317.05	$ -	$ -	$ 15,705	$ 21,838				
FFS 1000 DRAFT 5		Contractor's Construction Management Personnel	Project Manager	400	-	Personnel	Week	RS Means, Year 2016 Quarter 1	013113200220	Field personnel, project manager, maximum		0	1.0	1.0	100%	1,919	-	1,918.5	-	$ -	$ 4,100.00	$ -	$ -	$ -	$ 4,100.00	$ -	$ -	$ 1,641,757	$ -				
FFS 1000 DRAFT 6			Construction Superintendent(s)	516	-	Personnel	Week	RS Means, Year 2016 Quarter 1	013113200260	Field personnel, superintendent, average		0	1.0	1.0	100%	2,470	-	2,470.1	-	$ -	$ 3,350.00	$ -	$ -	$ -	$ 3,350.00	$ -	$ -	$ 1,727,076	$ -				
FFS 1000 DRAFT 7			Clerk(s)	516	-	Personnel	Week	RS Means, Year 2016 Quarter 1	013113200020	Field personnel, clerk, average		0	1.0	1.0	100%	2,470	-	2,470.1	-	$ -	$ 710.00	$ -	$ -	$ -	$ 710.00	$ -	$ -	$ 366,037	$ -				
FFS 1000 DRAFT 8			Field Engineer(s) / Safety Officer(s)	516	-	Personnel	Week	RS Means, Year 2016 Quarter 1	013113200120	Field personnel, field engineer, average		0	1.0	1.0	100%	2,470	-	2,470.1	-	$ -	$ 2,200.00	$ -	$ -	$ -	$ 2,200.00	$ -	$ -	$ 1,134,199	$ -				
FFS 1000 DRAFT 9	Temporary Stormwater Infrastructure (for stormwater during construction)	Frac Tanks	Delivery	58	58	Frac Tanks	Ea.	See separate Assumptions sheet				3	2.0	2.0	100%	9.7	9.7	38.7	38.7	$ -	$ 200.00	$ -		$ -	$ 200.00	$ -	$ -	$ 11,600	$ 11,600	58	58	3,480	3,480
FFS 1000 DRAFT 10			Monthly Rental (or Purchase)	1,295	1,930	Frac Tanks	Tank-Months	See separate Assumptions sheet							100%					$ 852.25		$ -		$ -	$ 852.25	$ 92,333	$ 137,549	$ 1,196,401	$ 1,782,286				
FFS 1000 DRAFT 11			Cleaning	58	58	Frac Tanks	Ea.	See separate Assumptions sheet				1	2.0	1.0	100%	58.0	58.0	116.0	116.0	$ -	$ 1,500.00	$ -		$ -	$ 1,500.00	$ -	$ -	$ 87,000	$ 87,000				
FFS 1000 DRAFT 12			Removal	58	58	Frac Tanks	Ea.	See separate Assumptions sheet				3	2.0	2.0	100%	9.7	9.7	38.7	38.7	$ -	$ 200.00	$ -		$ -	$ 200.00	$ -	$ -	$ 11,600	$ 11,600	58	58	3,480	3,480
FFS 1000 DRAFT 13		Forcemain	Install forcemain from Excavation Area to Tank Area	4,500	7,000	HDPE Pipe	L.F.	RS Means, Year 2016 Quarter 1	331113350100	Water supply distribution piping, piping HDPE, butt fusion joints, 40' lengths, 4" diameter, SDR 21	B22A	400	5.0	1.0	100%	11.3	17.5	56.3	87.5	$ 2.61	$ 7.12	$ -	$ 2.05	$ -	$ 11.78	$ 982	$ 1,528	$ 53,992	$ 83,988				
FFS 1000 DRAFT 14			Install forcemain from Tank Area to Treatment Plant and Discharge Point	500	500	HDPE Pipe	L.F.	RS Means, Year 2016 Quarter 1	331113350100	Water supply distribution piping, piping HDPE, butt fusion joints, 40' lengths, 4" diameter, SDR 21	B22A	400	5.0	1.0	100%	1.3	1.3	6.3	6.3	$ 2.61	$ 7.12	$ -	$ 2.05	$ -	$ 11.78	$ 109	$ 109	$ 5,999	$ 5,999				
FFS 1000 DRAFT 15			Install forcemain valves	6	8	Pipe Valves	Ea.	RS Means, Year 2016 Quarter 1	220523601310	Valves, plastic, PVC, ball, true union, socket or threaded, 4"	Q1	20	2.0	1.0	100%	0.3	0.4	0.6	0.8	$ 472.63	$ 68.18	$ -	$ -	$ -	$ 540.81	$ 237	$ 316	$ 3,482	$ 4,643				
FFS 1000 DRAFT 16		Treatment Facility	Construct Treatment Facility	1	-	Treatment Facility	Each	See separate Assumptions sheet				0.067	2.0	1.0	100%	15.0	-	30.0	-	$ 71,000.00					$ 102,000.00	$ 5,938	$ -	$ 107,938	$ -				
FFS 1000 DRAFT 17			Treatment Facility Demolition	1	-	Treatment Facility	Each	See separate Assumptions sheet				0.48	9.2	1.0	100%	2.1	-	19.0	-	$ 4,000.00					$ 27,000.00	$ 335	$ -	$ 27,335	$ -				
FFS 1000 DRAFT 18			Monthly Rent	78	-	Treatment Facility Operation	Each	See separate Assumptions sheet							100%					$ 1,720.00					$ 1,720.00	$ 11,220	$ -	$ 145,380	$ -				
FFS 1000 DRAFT 19			Monthly Operation during remediation	77	-	Treatment Facility Operation	Months	See separate Assumptions sheet				0.20	1.0	1.0	100%	392.3	-	392.3	-	$ 4,270.68					$ 4,270.68	$ 27,561	$ -	$ 357,117	$ -				
FFS 1000 DRAFT 20		Stormwater events during construction	Dewater excavation construction after rain events	324	848	Days of Pumping Construction Stormwater	Day	RS Means, Year 2016 Quarter 1	312319200650	Dewatering, pumping 8 hours, attended 2 hrs per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose	B10I	4	1.5	4.0	100%	20.3	53.0	121.6	318.0	$ -	$ 201.71	$ -	$ 38.99	$ -	$ 240.70	$ -	$ -	$ 78,066	$ 204,121				
FFS 1000 DRAFT 21			Dewater backfill construction after rain events	208	568	Days of Pumping Construction Stormwater	Day	RS Means, Year 2016 Quarter 1	312319200650	Dewatering, pumping 8 hours, attended 2 hrs per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose	B10I	4	1.5	4.0	100%	13.0	35.5	78.1	212.8	$ -	$ 201.71	$ -	$ 38.99	$ -	$ 240.70	$ -	$ -	$ 50,146	$ 136,618				
FFS 1000 DRAFT 22			Dispose of contact stormwater to MSD	1,900,000	2,800,000	Contact Stormwater	Gallons	St. Louis Sewer District, May 2011							100%					$ -					$ 0.14	$ -	$ -	$ 266,000	$ 392,000				
FFS 1000 DRAFT 23	Leachate Handling	Frac Tanks	Delivery	20	20	Frac Tanks	Ea.	See separate Assumptions sheet				3	2.0	2.0	100%	3.3	3.3	13.3	13.3	$ -	$ 200.00	$ -		$ -	$ 200.00	$ -	$ -	$ 4,000	$ 4,000	20	20	1,200	1,200
FFS 1000 DRAFT 24			Monthly Rental (or Purchase)	638	704	Frac Tanks	Tank-Months	See separate Assumptions sheet							100%					$ 852.25		$ -		$ -	$ 852.25	$ 45,475	$ 50,178	$ 589,235	$ 650,178				
FFS 1000 DRAFT 25			Cleaning	20	20	Frac Tanks	Ea.	See separate Assumptions sheet				1	2.0	1.0	100%	20.0	20.0	40.0	40.0	$ -	$ 1,500.00	$ -		$ -	$ 1,500.00	$ -	$ -	$ 30,000	$ 30,000				
FFS 1000 DRAFT 26			Removal	20	20	Frac Tanks	Ea.	See separate Assumptions sheet				3	2.0	2.0	100%	3.3	3.3	13.3	13.3	$ -	$ 200.00	$ -		$ -	$ 200.00	$ -	$ -	$ 4,000	$ 4,000	20	20	1,200	1,200
FFS 1000 DRAFT 27		Secondary Containment for Frac Tanks	Purchase and deliver liner & berm material	2,178	2,178	Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	354113200040	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	41.4	100%	0.9	0.9	37.6	37.6	$ 26.69	$ -	$ -	$ -	$ -	$ 26.69	$ 4,862	$ 4,862	$ 63,005	$ 63,005	182	182	7,280	7,280
FFS 1000 DRAFT 28			Spread loose lift before compaction	2,178	2,178	Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	2.1	100%	1.0	1.0	3.3	3.3	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ 5,533	$ 5,533				
FFS 1000 DRAFT 29			Compact Liner & Berms	1,556	1,556	Clay	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235640	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	1,300	1.5	2.0	100%	0.6	0.6	1.8	1.8	$ -	$ 0.62	$ -	$ 1.15	$ -	$ 1.77	$ -	$ -	$ 2,754	$ 2,754				
FFS 1000 DRAFT 30		Leachate Storage & T	Pumping from Excavation Site	9	5	Leachate	Day	RS Means, Year 2016 Quarter 1	312319200650	Dewatering, pumping 8 hours, attended 2 hrs per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose	B10I	4	1.5	1.0	100%	2.3	1.2	3.4	1.8	$ -	$ 201.71	$ -	$ 38.99	$ -	$ 240.70	$ -	$ -	$ 2,177	$ 1,176				
FFS 1000 DRAFT 31			Move Tank from Tank Area to Excavation Site	87	47	Tanks	Ea.	See separate Assumptions sheet				4	2.0	1.0	100%	21.8	11.8	43.5	23.5	$ -	$ 70.00	$ -	$ 70.00	$ -	$ 140.00	$ -	$ -	$ 12,180	$ 6,580				

Construction Cost Worksheet - FFS 1000 DRAFT

				Quantity												Construction Days		Crew Man-days		Unit Costs						Bridgeton Taxes		Total Cost		Delivery Truckloads		Total Delivery Miles	
Step #	Category	Sub-Category	Task	Area 1	Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Area 1	Area 2	Area 1	Area 2	Ext. Mat, O&P	Ext. Labor, O&P	Ext. Labor, O&P Ineff.	Ext. Equip, O&P	Ext. Equip, O&P Ineff.	Ext. Total, O&P	Area 1	Area 2	Area 1	Area 2	Area 1	Area 2	Area 1	Area 2
FFS 1000 DRAFT 32		Testing	Leachate Sampling	87	47	Lab Tests	Ea.	RS Means, Year 2016 Quarter 1	029110100100	Field testing equipment, sampling & testing soil/sediment, sample collection, field samples, sludge	1 Skwk	32	1.0	1.0	100%	2.7	1.5	2.7	1.5	$ -	$ 20.28	$ -	$ -	$ -	$ 20.28	$ -	$ -	$ 1,764	$ 953				
FFS 1000 DRAFT 33			Leachate Testing - VOC's	87	47	Lab Tests	Ea.	RS Means, Year 2016 Quarter 1	029110100600	Laboratory analytical services, laboratory testing, volatile organics without GC/MS					100%					$ 173.20	$ -	$ -	$ -	$ -	$ 173.20	$ 1,260	$ 681	$ 16,329	$ 8,821				
FFS 1000 DRAFT 34			Hauling and Disposal	1,736,853	937,690	Leachate	Gallons	See separate Assumptions sheet			B34B	5,000	1.0	2.0	100%	173.7	93.8	347.4	187.5	$ -	$ 0.28	$ -	$ 0.28	$ -	$ 0.57	$ -	$ -	$ 988,269	$ 533,545	348	188	208,800	112,800
FFS 1000 DRAFT 35			Budget for Contaminated Stormwater Prevention or Disposal	32	54	Budget	Months	Budgeted Monthly Amount							100%					$ 10,000.00		$ -		$ -	$ 10,000.00	$ 26,679	$ 45,536	$ 345,694	$ 590,036				
FFS 1000 DRAFT 36		Structure	Structure Construction	1	-	Clear Span Structure	Ea.	See separate Assumptions sheet			Structure Construction Crew	0	30.0	1	100%	110.0	-	3,300.0	-	$ 4,800,000		$ -		$ -	$ 4,800,000.00	$ 401,424	$ -	$ 5,201,424	$ -				
FFS 1000 DRAFT 37			Demolition	1	-	Clear Span Structure	Ea.	See separate Assumptions sheet			Structure Demolition Crew	0	30.0	1	100%	15.0	-	450.0	-	$ -	$ 80,000.00	$ -	$ 80,000.00	$ -	$ 160,000.00	$ -	$ -	$ 160,000	$ -				
FFS 1000 DRAFT 38			Startup Capital Expenses	1	-	Air Treatment System	Ea.	See separate Assumptions sheet			Treatment System Crew	0	7.1	1	100%	10.0	-	71.0	-	$ 386,200.00	$ 122,600	$ -		$ -	$ 508,800.00	$ 32,298	$ -	$ 541,098	$ -	9	-	9,360	-
FFS 1000 DRAFT 39			Vessel Rental Costs (Project Total)	1	-	Air Treatment System	Ea.	See separate Assumptions sheet							100%			-	-	$ 1,768,000.00		$ -		$ -	$ 1,768,000.00	$ 147,858	$ -	$ 1,915,858	$ -				
FFS 1000 DRAFT 40		Air Treatment System	Blower Costs (Purchase or Rental Total)	1	-	Air Treatment System	Ea.	See separate Assumptions sheet							100%			-	-	$ 975,000.00		$ -		$ -	$ 975,000.00	$ 81,539	$ -	$ 1,056,539	$ -				
FFS 1000 DRAFT 41			Media Replacement (for all vessels)	2	-	Air Treatment System Media	Instances	See separate Assumptions sheet			Treatment System Crew	0	4.0	1	100%	15.0	-	60.0	-	$ 432,000.00		$ -		$ -	$ 432,000.00	$ 72,256	$ -	$ 936,256	$ -				
FFS 1000 DRAFT 42	RIM Loading Station		Demobilization	1	-	Air Treatment System	Ea.	See separate Assumptions sheet			Treatment System Crew	0	3.5	1	100%	11.6	-	41.0	-	$ 85,000.00	$ 36,000.00	$ -		$ -	$ 121,000.00	$ 7,109	$ -	$ 128,109	$ -	9	-	9,360	-
FFS 1000 DRAFT 43			Fencing along road for RIM hauling	1,600	1,600	Fencing	L.F.	RS Means, Year 2016 Quarter 1	323113200800	Fence, chain link industrial, galvanized steel, 6 ga. wire, 2" posts @ 10' OC, 6' high, includes excavation, & concrete, excludes barbed wire	B80C	250	3.0	2.0	100%	3.2	3.2	19.2	19.2	$ 23.25	$ 5.80	$ -	$ 1.28	$ -	$ 30.33	$ 3,111	$ 3,111	$ 51,639	$ 51,639				
FFS 1000 DRAFT 44			Silt Fencing along road for RIM hauling	36,000	53,000	Silt Fence	Per L.F., per Month	See separate Assumptions sheet		Monthly cost for Silt fence, 3' high. Install, maintain monthly, and replace each 6 months.	B62	3,120	3.0	1.0	100%	11.5	17.0	34.6	51.0	$ 0.11	$ 0.27	$ -	$ 0.27	$ -	$ 0.64	$ 326	$ 480	$ 23,426	$ 34,489				
FFS 1000 DRAFT 45			Remove potentially contaminated road surface	356	356	Roadway Gravel	B.C.Y.	RS Means, Year 2016 Quarter 1	312316465000	Excavating, bulk, dozer, open site, bank measure, sand and gravel, 300 H.P. dozer, 50' haul	B10M	1,900	1.5	1.0	100%	0.2	0.2	0.3	0.3	$ -	$ 0.43	$ -	$ 1.23	$ -	$ 1.66	$ -	$ -	$ 590	$ 590				
FFS 1000 DRAFT 46		Haul Road Improvements	Loading for previous line	356	356	Roadway Gravel	B.C.Y.	RS Means, Year 2016 Quarter 1	312316421250 A	Excavating, bulk bank measure, for loading onto trucks, add	B10O	5,016	1.5	1.0	100%	0.1	0.1	0.1	0.1	$ -	$ 0.16	$ -	$ 0.24	$ -	$ 0.40	$ -	$ -	$ 142	$ 142				
FFS 1000 DRAFT 47			Hauling for previous line	427	427	Roadway Gravel	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205060	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2000 ft, 10 MPH, excludes loading equipment	B34F	594	1.0	1.0	100%	0.7	0.7	0.7	0.7	$ -	$ 0.83	$ -	$ 3.20	$ -	$ 4.03	$ -	$ -	$ 1,719	$ 1,719				
FFS 1000 DRAFT 48			Repairs to road remediation	2,133	2,133	Gravel Roads	S.Y.	RS Means, Year 2016 Quarter 1	015523500100	Temporary, roads, gravel fill, 8" gravel depth, excl surfacing	B14	615	6.0	1.0	100%	3.5	3.5	20.8	20.8	$ 8.21	$ 5.06	$ -	$ 0.73	$ -	$ 14.00	$ 1,465	$ 1,465	$ 31,331	$ 31,331				
FFS 1000 DRAFT 49			Mobilize and Demobilize Equipment by Pickup Truck	16	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501200	Mobilization or demobilization, delivery charge for small equipment, placed in rear of, or towed by pickup truck	A3A	4	1.0	1.0	100%	4.0	-	4.0	-	$ -	$ 157.34	$ -	$ 48.59	$ -	$ 205.93	$ -	$ -	$ 3,295	$ -				
FFS 1000 DRAFT 50			Extra Mileage for Mobilizations	240	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501200 A	Mobilization or demobilization, each additional 5 miles haul distance, add	A3A	72	1.0	1.0	100%	3.3	-	3.3	-	$ -	$ 15.73	$ -	$ 4.86	$ -	$ 20.59	$ -	$ -	$ 4,942	$ -				
FFS 1000 DRAFT 51			Mobilize and Demobilize Equipment by 3-Ton Trailer	6	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501300	Mobilization or demobilization, delivery charge for equipment, hauled on 3-ton capacity towed trailer	A3Q	3	1.0	1.0	100%	2.2	-	2.2	-	$ -	$ 235.49	$ -	$ 84.19	$ -	$ 319.68	$ -	$ -	$ 1,918	$ -				
FFS 1000 DRAFT 52			Extra Mileage for Mobilizations	90	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501300 A	Mobilization or demobilization, each additional 5 miles haul distance, add	A3Q	72	1.0	1.0	100%	1.3	-	1.3	-	$ -	$ 23.55	$ -	$ 8.42	$ -	$ 31.97	$ -	$ -	$ 2,877	$ -				
FFS 1000 DRAFT 53		Mobilization	Mobilize and Demobilize Equipment by 20-Ton Trailer	36	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501400	Mobilization or demobilization, delivery charge for equipment, hauled on 20-ton capacity towed trailer	B34U	2	2.0	3.0	100%	6.0	-	36.0	-	$ -	$ 591.36	$ -	$ 293.80	$ -	$ 885.16	$ -	$ -	$ 31,866	$ -				
FFS 1000 DRAFT 54			Extra Mileage for Mobilizations	540	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501400 A	Mobilization or demobilization, each additional 5 miles haul distance, add	B34U	72	2.0	3.0	100%	2.5	-	15.0	-	$ -	$ 59.14	$ -	$ 29.38	$ -	$ 88.52	$ -	$ -	$ 47,801	$ -				
FFS 1000 DRAFT 55			Mobilize and Demobilize Equipment by 40-Ton Trailer	50	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501500	Mobilization or demobilization, delivery charge for equipment, hauled on 40-ton capacity towed trailer	B34N	2	2.0	5.0	100%	5.0	-	50.0	-	$ -	$ 601.92	$ -	$ 468.95	$ -	$ 1,070.87	$ -	$ -	$ 53,544	$ -				
FFS 1000 DRAFT 56			Extra Mileage for Mobilizations	750	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501500 A	Mobilization or demobilization, each additional 5 miles haul distance, add	B34N	72	2.0	5.0	100%	2.1	-	20.8	-	$ -	$ 60.19	$ -	$ 46.90	$ -	$ 107.09	$ -	$ -	$ 80,318	$ -				
FFS 1000 DRAFT 57			Mobilize and Demobilize Crane Equipment (more than 75 tons)	2	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501800	Mobilization or demobilization, crane, truck-mounted, over 75 ton, (with chase vehicle)	A3E	3	2.0	1.0	100%	0.8	-	1.6	-	$ -	$ 485.76	$ -	$ 77.97	$ -	$ 563.73	$ -	$ -	$ 1,127	$ -				
FFS 1000 DRAFT 58			Extra Mileage for Mobilizations	30	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501800 A	Mobilization or demobilization, each additional 5 miles haul distance, add	A3E	72	2.0	1.0	100%	0.4	-	0.8	-	$ -	$ 48.58	$ -	$ 7.80	$ -	$ 56.38	$ -	$ -	$ 1,691	$ -				
FFS 1000 DRAFT 59			Mobilize and Demobilize Equipment by Pickup Truck	16	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501200	Mobilization or demobilization, delivery charge for small equipment, placed in rear of, or towed by pickup truck	A3A	4	1.0	1.0	100%	4.0	-	4.0	-	$ -	$ 157.34	$ -	$ 48.59	$ -	$ 205.93	$ -	$ -	$ 3,295	$ -				
FFS 1000 DRAFT 60			Extra Mileage for Mobilizations	240	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501200 A	Mobilization or demobilization, each additional 5 miles haul distance, add	A3A	72	1.0	1.0	100%	3.3	-	3.3	-	$ -	$ 15.73	$ -	$ 4.86	$ -	$ 20.59	$ -	$ -	$ 4,942	$ -				
FFS 1000 DRAFT 61			Mobilize and Demobilize Equipment by 3-Ton Trailer	6	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501300	Mobilization or demobilization, delivery charge for equipment, hauled on 3-ton capacity towed trailer	A3Q	3	1.0	1.0	100%	2.2	-	2.2	-	$ -	$ 235.49	$ -	$ 84.19	$ -	$ 319.68	$ -	$ -	$ 1,918	$ -				

Construction Cost Worksheet - FFS 1000 DRAFT

Step #	Category	Sub-Category	Task	Quantity Area 1	Quantity Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Construction Days Area 1	Construction Days Area 2	Crew Man-days Area 1	Crew Man-days Area 2	Ext. Mat, O&P	Ext. Labor, O&P	Ext. Labor, O&P Ineff.	Ext. Equip, O&P	Ext. Equip, O&P Ineff.	Ext. Total, O&P	Bridgeton Taxes Area 1	Bridgeton Taxes Area 2	Total Cost Area 1	Total Cost Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Delivery Miles Area 1	Total Delivery Miles Area 2
FFS 1000 DRAFT 62	Site-wide Preparation	Supplemental Mobilizations	Extra Mileage for Mobilizations	90	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501300 A	Mobilization or demobilization, each additional 5 miles haul distance, add	A3Q	72	1.0	1.0	100%	1.3	-	1.3	-	$ -	$ 23.55	$ -	$ 8.42	$ -	$ 31.97	$ -	$ -	$ 2,877	$ -				
FFS 1000 DRAFT 63			Mobilize and Demobilize Equipment by 20-Ton Trailer	36	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501400	Mobilization or demobilization, delivery charge for equipment, hauled on 20-ton capacity towed trailer	B34U	2	2.0	3.0	100%	6.0	-	36.0	-	$ -	$ 591.36	$ -	$ 293.80	$ -	$ 885.16	$ -	$ -	$ 31,866	$ -				
FFS 1000 DRAFT 64			Extra Mileage for Mobilizations	540	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501400 A	Mobilization or demobilization, each additional 5 miles haul distance, add	B34U	72	2.0	3.0	100%	2.5	-	15.0	-	$ -	$ 59.14	$ -	$ 29.38	$ -	$ 88.52	$ -	$ -	$ 47,801	$ -				
FFS 1000 DRAFT 65			Mobilize and Demobilize Equipment by 40-Ton Trailer	50	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501500	Mobilization or demobilization, delivery charge for equipment, hauled on 40-ton capacity towed trailer	B34N	2	2.0	5.0	100%	5.0	-	50.0	-	$ -	$ 601.92	$ -	$ 468.95	$ -	$ 1,070.87	$ -	$ -	$ 53,544	$ -				
FFS 1000 DRAFT 66			Extra Mileage for Mobilizations	750	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501500 A	Mobilization or demobilization, each additional 5 miles haul distance, add	B34N	72	2.0	5.0	100%	2.1	-	20.8	-	$ -	$ 60.19	$ -	$ 46.90	$ -	$ 107.09	$ -	$ -	$ 80,318	$ -				
FFS 1000 DRAFT 67			Mobilize and Demobilize Crane Equipment (more than 75 tons)	2	-	Units of Equipment (up to 25 miles)	Ea.	RS Means, Year 2016 Quarter 1	015436501800	Mobilization or demobilization, crane, truck-mounted, over 75 ton, (with chase vehicle)	A3E	3	2.0	1.0	100%	0.8	-	1.6	-	$ -	$ 485.76	$ -	$ 77.97	$ -	$ 563.73	$ -	$ -	$ 1,127	$ -				
FFS 1000 DRAFT 68			Extra Mileage for Mobilizations	30	-	Per 5 additional miles		RS Means, Year 2016 Quarter 1	015436501800 A	Mobilization or demobilization, each additional 5 miles haul distance, add	A3E	72	2.0	1.0	100%	0.4	-	0.8	-	$ -	$ 48.58	$ -	$ 7.80	$ -	$ 56.38	$ -	$ -	$ 1,691	$ -				
FFS 1000 DRAFT 69		Traffic Improvements	Create Temporary Roads	15,467	26,667	Gravel Roads	S.Y.	RS Means, Year 2016 Quarter 1	015523500050	Temporary, roads, gravel fill, 4" gravel depth, excl surfacing	B14	715	6.0	1.0	100%	21.6	37.3	129.8	223.8	$ 4.10	$ 4.35	$ -	$ 0.63	$ -	$ 9.08	$ 5,303	$ 9,144	$ 145,741	$ 251,277				
FFS 1000 DRAFT 70			Bridge from Area 1 to Area 2 over Site Entrance Road	1	-	Modular Bridge	Ea.	See separate Assumptions sheet			Bridge Construction Crew	0	1.0	1.0	100%	9.0	-	143.2	-	$ 230,000					$ 266,000.00	$ 19,235	$ -	$ 285,235	$ -	549		21,410	
FFS 1000 DRAFT 71			Bridge Demolition	1	-	Modular Bridge	Ea.	See separate Assumptions sheet			Bridge Construction Crew	2	1.0	1.0	100%	0.5	-	2.0	-	$ -	$ 2,350.00				$ 2,350.00	$ -	$ -	$ 2,350	$ -				
FFS 1000 DRAFT 72			Extend Permanent Road to new Transfer Station Location	2,000	-	Roadway	Ft.	Estimate			B25	34	11.0	1.0	100%	58.5	-	643.1	-	$ 190.00					$ 190.00	$ 31,779	$ -	$ 411,779	$ -				
FFS 1000 DRAFT 73			Budget for Add'l Traffic Improvements	$ 108,000	$ 108,000	TBD (shown as budget estimate)	$	SFS budget (plus inflation)					6.0	1.0	100%	10.0	10.0	60.0	60.0	$ 1.00					$ 1.00	$ 9,032	$ 9,032	$ 117,032	$ 117,032				
FFS 1000 DRAFT 74		Dust Control	Water Truck Depreciation	2	2	Water Trucks	Trucks	Estimate												$ 55,000.00					$ 55,000.00	$ 9,199	$ 9,199	$ 119,199	$ 119,199				
FFS 1000 DRAFT 75			Water Truck Operation	97	133	Water Trucks	Months	Estimate				0	1.0	2.0	100%	1,475	2,028	2,950.4	4,055.1	$ -					$ 19,790.74	$ -	$ -	$ 1,918,380	$ 2,636,647				
FFS 1000 DRAFT 76			Use Water to Control Dust	4.43E+07	6.08E+07	Water	Gallons	Missouri American Water Company, 7/19/2016							100%					$ -					$ 0.00	$ -	$ -	$ 150,471	$ 206,809				
FFS 1000 DRAFT 77	Site Preparation		Prepare area with Stormwater BMPs	5,378	7,512	Erosion Control Measures	L.F.	RS Means, Year 2016 Quarter 1	312514161250	Synthetic erosion control, hay bales, staked	A2	2,500	3.0	1.0	100%	2.2	3.0	6.5	9.0	$ 3.56	$ 0.54	$ -	$ 0.12	$ -	$ 4.22	$ 1,601	$ 2,236	$ 24,296	$ 33,937				
FFS 1000 DRAFT 78		Decontamination Area	Floor	56	56	Concrete	C.Y.	RS Means, Year 2016 Quarter 1	033113350300	Structural concrete, ready mix, heavyweight, 4000 psi, includes local aggregate, sand, Portland cement (Type I) and water, delivered, excludes all additives and treatments					100%					$ 113.96	$ -	$ -	$ -	$ -	$ 113.96	$ 529	$ 529	$ 6,861	$ 6,861				
FFS 1000 DRAFT 79			Floor Installation	56	56	Concrete	C.Y.	RS Means, Year 2016 Quarter 1	033113704650	Structural concrete, placing, slab on grade, pumped, over 6" thick, includes leveling (strike off) & consolidation, excludes material	C20	185	8.0	1.0	100%	0.3	0.3	2.4	2.4	$ -	$ 22.40	$ -	$ 5.31	$ -	$ 27.71	$ -	$ -	$ 1,539	$ 1,539				
FFS 1000 DRAFT 80			Building	1,000	1,000	Steel Building	SF Flr.	RS Means, Year 2016 Quarter 1	133419500170	Pre-engineered steel building, clear span rigid frame, 30 psf roof and 20 psf wind load, 20' to 29' W x 16' eave H, incl. 26 ga. colored ribbed roofing & siding, excl. footings, slab, anchor bolts	E2	320	7.0	1.0	100%	3.1	3.1	21.9	21.9	$ 10.54	$ 15.61	$ -	$ 5.93	$ -	$ 32.08	$ 881	$ 881	$ 32,961	$ 32,961				
FFS 1000 DRAFT 81		Clearing & Grubbing	Clear Vegetation (Light)	0	3	Vegetation	Acre	RS Means, Year 2016 Quarter 1	311313101020	Selective tree and shrub removal, selective clearing brush mowing, light density, tractor with rotary mower, excludes removal offsite	B84	2	1.0	1.0	100%	0.1	1.3	0.1	1.3	$ -	$ 296.36	$ -	$ 229.39	$ -	$ 525.75	$ -	$ -	$ 110	$ 1,383				
FFS 1000 DRAFT 82			Clear Vegetation (Heavy)	8	15	Vegetation	Acre	RS Means, Year 2016 Quarter 1	311110100020	Clearing & grubbing, cut & chip light trees, to 6" diameter	B7	1	6.0	1.0	100%	8.5	15.3	50.9	91.7	$ -	$ 2,844.10	$ -	$ 2,090.50	$ -	$ 4,934.60	$ -	$ -	$ 41,895	$ 75,450				
FFS 1000 DRAFT 83			Clear Small Trees	117	355	Trees	Ea.	RS Means, Year 2016 Quarter 1	311313201650	Selective felling trees and piling, large tract clearing & piling, firm level terrain, no boulders, hardwood, per tree, 300 H.P. dozer, 12" to 24" diameter	B10M	80	1.5	8.0	100%	0.2	0.6	2.2	6.7	$ -	$ 10.18	$ -	$ 29.38	$ -	$ 39.56	$ -	$ -	$ 4,629	$ 14,044				
FFS 1000 DRAFT 84			Clear Large Trees	33	98	Trees	Ea.	RS Means, Year 2016 Quarter 1	311313201750	Selective felling trees and piling, large tract clearing & piling, firm level terrain, no boulders, hardwood, per tree, 300 H.P. dozer, 24" to 36" diameter	B10M	50	1.5	4.0	100%	0.2	0.5	1.0	2.9	$ -	$ 16.25	$ -	$ 46.90	$ -	$ 63.15	$ -	$ -	$ 2,084	$ 6,189				
FFS 1000 DRAFT 85			Clear Small Stumps	117	355	Trees	Ea.	RS Means, Year 2016 Quarter 1	311313202100	Selective clearing and grubbing, 1-1/2 C.Y. excavator, 14" to 24" diameter, stump removal on site by hydraulic excavator	B30	25	3.0	2.0	100%	2.3	7.1	14.0	42.6	$ -	$ 63.57	$ -	$ 119.78	$ -	$ 183.35	$ -	$ -	$ 21,452	$ 65,089				
FFS 1000 DRAFT 86			Clear Large Stumps	33	98	Trees	Ea.	RS Means, Year 2016 Quarter 1	311313202150	Selective clearing and grubbing, 1-1/2 C.Y. excavator, 26" to 36" diameter, stump removal on site by hydraulic excavator	B30	16	3.0	2.0	100%	1.0	3.1	6.2	18.4	$ -	$ 99.42	$ -	$ 187.58	$ -	$ 287.00	$ -	$ -	$ 9,471	$ 28,126				
FFS 1000 DRAFT 87		Bird Mitigation	Average Monthly Expense	37	56	Months	Months	See separate Assumptions sheet			Bird Mitigation Crew	0.03	2.0	1.0	100%	1,117	1,690.6	2,233.1	3,381.2	$ 14,700.00	$ 18,300	$ -		$ -	$ 33,000.00	$ 45,097	$ 68,283	$ 1,255,644	$ 1,901,229				
FFS 1000 DRAFT 88		Temporary Gas System for Stockpile in Area 2	Capital Expenses	1	-	Temporary Gas System	Ea.	See separate Assumptions sheet				0	6.0	1.0	100%	62.0	-	372.0	-	$ 41,107.50					$ 279,157.50	$ 3,438	$ -	$ 282,595	$ -				
FFS 1000 DRAFT 89			Monthly Expenses	37	-	Months	Months	See separate Assumptions sheet				1	1.0	1.0	100%	39.9	-	39.9	-	$ -					$ 6,642.78	$ -	$ -	$ 243,679	$ -				
FFS 1000 DRAFT 90			Apply daily cover to remaining excavation	42,997	-	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	71.7	-	530.3	-	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ 45,415	$ -	$ 1,345,513	$ -	5,913	-	88,695	-

Construction Cost Worksheet - FFS 1000 DRAFT

Step #	Category	Sub-Category	Task	Quantity Area 1	Quantity Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Construction Days Area 1	Construction Days Area 2	Crew Man-days Area 1	Crew Man-days Area 2	Unit Costs: Ext. Mat, O&P	Ext. Labor, O&P	Ext. Labor, O&P Ineff.	Ext. Equip, O&P	Ext. Equip, O&P Ineff.	Ext. Total, O&P	Bridgeton Taxes Area 1	Bridgeton Taxes Area 2	Total Cost Area 1	Total Cost Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Delivery Miles Area 1	Total Delivery Miles Area 2
FFS 1000 DRAFT 91	Excavate Waste	Area 1	Excavate and Sort RIM and Overburden (incl. minor sources)	480,760	-	RIM and Overburden	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	200.3	-	801.3	-	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ 1,644,200	$ -				
FFS 1000 DRAFT 92		Area 2 SW	Apply daily cover to remaining excavation	-	16,182	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	27.0	-	199.6	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 17,092	$ -	$ 506,391	-	2,226	-	33,390
FFS 1000 DRAFT 93			Excavate and Sort RIM and Overburden (incl. minor sources)	-	202,237	RIM and Overburden	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	-	84.3	-	337.1	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ -	$ 691,650				
FFS 1000 DRAFT 94		Area 2 NE	Apply daily cover to remaining excavation	-	6,741	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	11.2	-	83.1	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 7,120	$ -	$ 210,955	-	927	-	13,905
FFS 1000 DRAFT 95			Excavate and Sort RIM and Overburden (NOT incl. minor sources)	-	84,989	RIM and Overburden	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	-	35.4	-	141.6	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ -	$ 290,662				
FFS 1000 DRAFT 96	Handle Excavated RIM	Area 1	Load piled RIM into Haul Trucks	7,824	-	RIM	B.C.Y.	RS Means, Year 2016 Quarter 1	312316421250	Excavating, bulk bank measure, 2-1/2 C.Y. capacity = 95 C.Y./hour, front end loader, track mounted, excluding truck loading	B10O	760	1.5	1.0	50%	20.6	-	30.9	-	$ -	$ 1.06	$ 1.06	$ 1.58	$ 1.58	$ 5.28	$ -	$ -	$ 41,312	$ -				
FFS 1000 DRAFT 97			(additional cost to previous line)	7,824	-	RIM		RS Means, Year 2016 Quarter 1	312316421250 A	Excavating, bulk bank measure, for loading onto trucks, add	B10O	5,016	1.5	1.0	50%	3.1	-	4.7	-	$ -	$ 0.16	$ 0.16	$ 0.24	$ 0.24	$ 0.80	$ -	$ -	$ 6,259	$ -				
FFS 1000 DRAFT 98			Haul RIM to on-site Loading Station (incl. RIM from minor sources)	11,736	-	RIM	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	5.6	-	31.4	-	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ 75,348	$ -				
FFS 1000 DRAFT 99			RIM Hauling & Disposal (during 3-month learning curve for loading)	3,125	-	RIM	L.C.Y.	Off-site Disposal Facility estimate	See Assumptions	Custom line item: Transport and dispose of RIM at off-site disposal facility. Assume 3-month learning curve from 0 to 100% production (averaging 50%).	RIM Shipping Crew	100	7.0	1.0	50%	62.5	-	437.5	-	$ -	$ 114.50		$ 114.50		$ 229.00	$ -	$ -	$ 715,625	$ -	210	-	9,450	-
FFS 1000 DRAFT 100			RIM Hauling & Disposal (normal production)	8,611	-	RIM	L.C.Y.	Off-site Disposal Facility estimate	See Assumptions	Custom line item: Transport and dispose of RIM at off-site disposal facility. (Full production for remainder of project.)	RIM Shipping Crew	100	7.0	1.0	100%	86.1	-	602.8	-	$ -	$ 114.50		$ 114.50		$ 229.00	$ -	$ -	$ 1,972,022	$ -	576	-	25,920	-
FFS 1000 DRAFT 101			Off-Site Disposal Facility Coordinator	366	-	Personnel	Work Days	Off-site Disposal Facility estimate	See Assumptions	Custom line item: Oversight of RIM shipping process by off-site disposal facility's coordinator.	Coordinator	1	1.0	1.0	100%	366.0	-	366.0	-	$ -	$ 1,100.00	$ -		$ -	$ 1,100.00	$ -	$ -	$ 402,600	$ -				
FFS 1000 DRAFT 102			RIM Loading Crew	366	-	Personnel	Work Days	See separate Assumptions sheet	See Assumptions	Custom line item: Stockpile and Load RIM in RIM Loading Station	RIM Loading Crew	1	4.0	1.0	100%	366.0	-	1,464.0	-	$ -	$ 3,908.80	$ -		$ -	$ 3,908.80	$ -	$ -	$ 1,430,621	$ -				
FFS 1000 DRAFT 103		Area 2 SW	Load piled RIM into Haul Trucks	-	21,094	RIM	B.C.Y.	RS Means, Year 2016 Quarter 1	312316421250	Excavating, bulk bank measure, 2-1/2 C.Y. capacity = 95 C.Y./hour, front end loader, track mounted, excluding truck loading	B10O	760	1.5	1.0	50%	-	55.5	-	83.3	$ -	$ 1.06	$ 1.06	$ 1.58	$ 1.58	$ 5.28	$ -	$ -	$ -	$ 111,378				
FFS 1000 DRAFT 104			(additional cost to previous line)	-	21,094	RIM		RS Means, Year 2016 Quarter 1	312316421250 A	Excavating, bulk bank measure, for loading onto trucks, add	B10O	5,016	1.5	1.0	50%	-	8.4	-	12.6	$ -	$ 0.16	$ 0.16	$ 0.24	$ 0.24	$ 0.80	$ -	$ -	$ -	$ 16,875				
FFS 1000 DRAFT 105			Haul RIM to on-site Loading Station (incl. RIM from minor sources)	-	31,641	RIM	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205100	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 1 mile, 10 MPH, excludes loading equipment	B34F	506	1.0	4.2	100%	-	15.1	-	62.5	$ -	$ 0.98	$ -	$ 3.75	$ -	$ 4.73	$ -	$ -	$ -	$ 149,664				
FFS 1000 DRAFT 106			RIM Hauling & Disposal (normal production)	-	31,641	RIM	L.C.Y.	Off-site Disposal Facility estimate	See Assumptions	Custom line item: Transport and dispose of RIM at off-site disposal facility. (Full production for remainder of project.)	RIM Shipping Crew	400	15.0	1.0	100%	-	79.1	-	1,186.6	$ -	$ 114.50		$ 114.50		$ 229.00	$ -	$ -	$ -	$ 7,245,879	-	2,110	-	94,950
FFS 1000 DRAFT 107			Off-Site Disposal Facility Coordinator	-	184	Personnel	Work Days	Off-site Disposal Facility estimate	See Assumptions	Custom line item: Oversight of RIM shipping process by off-site disposal facility's coordinator.	Coordinator	1	1.0	1.0	100%	-	184.0	-	184.0	$ -	$ 1,100.00	$ -		$ -	$ 1,100.00	$ -	$ -	$ -	$ 202,400				
FFS 1000 DRAFT 108			RIM Loading Crew	-	184	Personnel	Work Days	See separate Assumptions sheet	See Assumptions	Custom line item: Stockpile and Load RIM in RIM Loading Station	RIM Loading Crew	1	5.0	1.0	100%	-	184.0	-	920.0	$ -	$ 4,373.80	$ -		$ -	$ 4,373.80	$ -	$ -	$ -	$ 804,779				
FFS 1000 DRAFT 109		Area 2 NE	Load piled RIM into Haul Trucks	-	13,138	RIM	B.C.Y.	RS Means, Year 2016 Quarter 1	312316421250	Excavating, bulk bank measure, 2-1/2 C.Y. capacity = 95 C.Y./hour, front end loader, track mounted, excluding truck loading	B10O	760	1.5	1.0	50%	-	34.6	-	51.9	$ -	$ 1.06	$ 1.06	$ 1.58	$ 1.58	$ 5.28	$ -	$ -	$ -	$ 69,367				
FFS 1000 DRAFT 110			(additional cost to previous line)	-	13,138	RIM		RS Means, Year 2016 Quarter 1	312316421250 A	Excavating, bulk bank measure, for loading onto trucks, add	B10O	5,016	1.5	1.0	50%	-	5.2	-	7.9	$ -	$ 0.16	$ 0.16	$ 0.24	$ 0.24	$ 0.80	$ -	$ -	$ -	$ 10,510				
FFS 1000 DRAFT 111			Haul RIM to on-site Loading Station (NOT incl. RIM from minor sources)	-	19,707	RIM	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	-	9.4	-	52.7	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ -	$ 126,516				
FFS 1000 DRAFT 112			RIM Hauling & Disposal (normal production)	-	19,707	RIM	L.C.Y.	Off-site Disposal Facility estimate	See Assumptions	Custom line item: Transport and dispose of RIM at off-site disposal facility. (Full production for remainder of project.)	RIM Shipping Crew	500	17.0	1.0	100%	-	39.4	-	670.0	$ -	$ 114.50		$ 114.50		$ 229.00	$ -	$ -	$ -	$ 4,512,813	-	1,314	-	59,130
FFS 1000 DRAFT 113			Off-Site Disposal Facility Coordinator	-	70	Personnel	Work Days	Off-site Disposal Facility estimate	See Assumptions	Custom line item: Oversight of RIM shipping process by off-site disposal facility's coordinator.	Coordinator	1	1.0	1.0	100%	-	70.0	-	70.0	$ -	$ 1,100.00	$ -		$ -	$ 1,100.00	$ -	$ -	$ -	$ 77,000				
FFS 1000 DRAFT 114			RIM Loading Crew	-	70	Personnel	Work Days	See separate Assumptions sheet	See Assumptions	Custom line item: Stockpile and Load RIM in RIM Loading Station	RIM Loading Crew	1	6.0	1.0	100%	-	70.0	-	420.0	$ -	$ 4,838.80	$ -		$ -	$ 4,838.80	$ -	$ -	$ -	$ 338,716				
FFS 1000 DRAFT 115			Load Overburden directly into Haul Trucks	473,715	-	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305 A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	30.0	-	120.0	-	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ 246,332	$ -				

Construction Cost Worksheet - FFS 1000 DRAFT

Step #	Category	Sub-Category	Task	Quantity Area 1	Quantity Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Construction Days Area 1	Construction Days Area 2	Crew Man-days Area 1	Crew Man-days Area 2	Ext. Mat, O&P	Ext. Labor, O&P	Ext. Labor, O&P Ineff.	Ext. Equip, O&P	Ext. Equip, O&P Ineff.	Ext. Total, O&P	Bridgeton Taxes Area 1	Bridgeton Taxes Area 2	Total Cost Area 1	Total Cost Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Delivery Miles Area 1	Total Delivery Miles Area 2
FFS 1000 DRAFT 116	Load and Haul Overburden	Area 1	Relocate Overburden to Area 2 NE Stockpile	710,573	-	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	338.4	-	1,899.9	-	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ 4,561,878	$ -				
FFS 1000 DRAFT 117		Area 2 SW	Load Overburden directly into Haul Trucks	-	171,408	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305 A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	-	10.9	-	43.4	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ -	$ 89,132				
FFS 1000 DRAFT 118			Relocate Overburden to backfill Area 1	-	257,113	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	-	122.4	-	687.5	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ -	$ 1,650,663				
FFS 1000 DRAFT 119		Area 2 NE	Load Overburden directly into Haul Trucks	-	88,280	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305 A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	-	5.6	-	22.4	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ -	$ 45,906				
FFS 1000 DRAFT 120			Relocate Overburden to Area 2 SW Stockpile	-	132,420	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	-	63.1	-	354.1	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ -	$ 850,135				
FFS 1000 DRAFT 121	Place Overburden	Area 1 Overburden on NE Stockpile	Spread Overburden	710,573	-	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	236.9	-	1,065.9	-	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ 1,804,855	$ -				
FFS 1000 DRAFT 122			Apply daily cover to stockpiled Overburden	47,372	-	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	79.0	-	584.2	-	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ 50,036	$ -	$ 1,482,409	$ -	6,514	-	97,710	-
FFS 1000 DRAFT 123		Area 2 SW Overburden backfilled in Area 1	Spread Overburden	-	257,113	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	-	85.7	-	385.7	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 653,066				
FFS 1000 DRAFT 124			Apply daily cover to backfilled Overburden	-	17,141	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	28.6	-	211.4	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 18,105	$ -	$ 536,393	-	2,357	-	35,355
FFS 1000 DRAFT 125			Compact Overburden	-	188,549	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	-	36.3	-	108.8	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ -	$ 167,809				
FFS 1000 DRAFT 126		Area 2 NE Overburden on SW Stockpile	Spread Overburden	-	132,420	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	-	44.1	-	198.6	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 336,346				
FFS 1000 DRAFT 127			Apply daily cover to stockpiled Overburden	-	8,828	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	14.7	-	108.9	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 9,325	$ -	$ 276,256	-	1,214	-	18,210
FFS 1000 DRAFT 128	Relocate Stockpiled Overburden from NE Stockpile	From NE Stockpile to backfill remaining Area 1 (to drainage grades)	Apply daily cover to remaining stockpile	5,907	-	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	9.8	-	72.9	-	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ 6,240	$ -	$ 184,864	$ -	813	-	12,195	-
FFS 1000 DRAFT 129			Excavate Stockpile	64,982	-	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	27.1	-	108.3	-	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ 222,240	$ -				
FFS 1000 DRAFT 130			Load into Haul Trucks	64,982	-	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305 A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	4.1	-	16.5	-	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ 33,791	$ -				
FFS 1000 DRAFT 131			Relocate Overburden to backfill Area 1 (drainage grades)	97,473	-	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	46.4	-	260.6	-	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ 625,780	$ -				
FFS 1000 DRAFT 132			Spread Overburden	97,473	-	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	32.5	-	146.2	-	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ 247,583	$ -				
FFS 1000 DRAFT 133			Apply daily cover to backfilled material	6,498	-	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	10.8	-	80.1	-	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ 6,864	$ -	$ 203,351	$ -	894	-	13,410	-
FFS 1000 DRAFT 134			Compact backfilled material	71,481	-	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	13.7	-	41.2	-	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ 63,618	$ -				
FFS 1000 DRAFT 135		From NE Stockpile to backfill Area 2 SW (to drainage grades)	Apply daily cover to remaining stockpile	-	11,055	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	18.4	-	136.3	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 11,676	$ -	$ 345,937	-	1,521	-	22,815
FFS 1000 DRAFT 136			Excavate Stockpile	-	121,602	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	-	50.7	-	202.7	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ -	$ 415,877				
FFS 1000 DRAFT 137			Load into Haul Trucks	-	121,602	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305 A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	-	7.7	-	30.8	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ -	$ 63,233				
FFS 1000 DRAFT 138			Relocate Overburden to backfill Area 2 SW (drainage grades)	-	182,402	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	-	86.9	-	487.7	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ -	$ 1,171,023				
FFS 1000 DRAFT 139			Spread Overburden	-	182,402	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	-	60.8	-	273.6	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 463,302				
FFS 1000 DRAFT 140			Apply daily cover to backfilled material	-	12,160	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	20.3	-	150.0	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 12,844	$ -	$ 380,531	-	1,673	-	25,095
FFS 1000 DRAFT 141			Compact backfilled material	-	133,762	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	-	25.7	-	77.2	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ -	$ 119,048				
FFS 1000 DRAFT 142			Apply daily cover to remaining stockpile	-	8,298	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	13.8	-	102.3	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 8,764	$ -	$ 259,657	-	1,141	-	17,115
FFS 1000 DRAFT 143			Excavate Stockpile	-	91,273	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	-	38.0	-	152.1	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ -	$ 312,154				

Construction Cost Worksheet - FFS 1000 DRAFT

Step #	Category	Sub-Category	Task	Quantity Area 1	Quantity Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Construction Days Area 1	Construction Days Area 2	Crew Man-days Area 1	Crew Man-days Area 2	Unit Costs Ext. Mat, O&P	Ext. Labor, O&P	Ext. Labor, O&P Ineff.	Ext. Equip, O&P	Ext. Equip, O&P Ineff.	Ext. Total, O&P	Bridgeton Taxes Area 1	Bridgeton Taxes Area 2	Total Cost Area 1	Total Cost Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Delivery Miles Area 1	Total Delivery Miles Area 2
FFS 1000 DRAFT 144		From NE Stockpile to backfill Area 2 SW (to final grades)	Load into Haul Trucks	-	91,273	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305 A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	-	5.8	-	23.1	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ -	$ 47,462				
FFS 1000 DRAFT 145			Relocate Overburden to backfill Area 2 SW (final grades)	-	136,910	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	-	65.2	-	366.1	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ -	$ 878,959				
FFS 1000 DRAFT 146			Spread Overburden	-	136,910	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	-	45.6	-	205.4	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 347,750				
FFS 1000 DRAFT 147			Apply daily cover to backfilled material	-	9,127	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	15.2	-	112.6	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 9,641	$ -	$ 285,623	-	1,256	-	18,840
FFS 1000 DRAFT 148			Compact backfilled material	-	100,400	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	-	19.3	-	57.9	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ -	$ 89,356				
FFS 1000 DRAFT 149		From any remaining NE Stockpile to SW Stockpile	Apply daily cover to remaining stockpile	-	26,849	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	44.7	-	331.1	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 28,359	$ -	$ 840,191	-	3,692	-	55,380
FFS 1000 DRAFT 150			Excavate Stockpile	-	295,339	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	-	123.1	-	492.2	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ -	$ 1,010,058				
FFS 1000 DRAFT 151			Load into Haul Trucks	-	295,339	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305 A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	-	18.7	-	74.8	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ -	$ 153,576				
FFS 1000 DRAFT 152			Relocate Overburden to Area 2 SW Stockpile	-	443,008	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	-	211.0	-	1,184.5	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ -	$ 2,844,111				
FFS 1000 DRAFT 153			Spread Overburden	-	443,008	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	-	147.7	-	664.5	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 1,125,240				
FFS 1000 DRAFT 154			Apply daily cover to stockpiled material	-	29,534	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	49.2	-	364.3	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 31,195	$ -	$ 924,210	-	4,061	-	60,915
FFS 1000 DRAFT 155	Relocate Stockpiled Overburden from SW Stockpile	From SW Stockpile to backfill Area 2 NE (to drainage grades)	Apply daily cover to remaining stockpile	-	20,121	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	33.5	-	248.2	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 21,252	$ -	$ 629,636	-	2,767	-	41,505
FFS 1000 DRAFT 156			Excavate Stockpile	-	221,326	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	-	92.2	-	368.9	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ -	$ 756,933				
FFS 1000 DRAFT 157			Load into Haul Trucks	-	221,326	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305 A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	-	14.0	-	56.1	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ -	$ 115,089				
FFS 1000 DRAFT 158			Relocate Overburden to backfill Area 2 NE (drainage grades)	-	331,988	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	-	158.1	-	887.7	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ -	$ 2,131,365				
FFS 1000 DRAFT 159			Spread Overburden	-	331,988	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	-	110.7	-	498.0	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 843,250				
FFS 1000 DRAFT 160			Apply daily cover to backfilled material	-	22,133	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	36.9	-	273.0	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 23,377	$ -	$ 692,599	-	3,044	-	45,660
FFS 1000 DRAFT 161			Compact backfilled material	-	243,458	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	-	46.8	-	140.5	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ -	$ 216,678				
FFS 1000 DRAFT 162		From SW Stockpile to backfill Area 2 NE (to final grades)	Apply daily cover to remaining stockpile	-	22,078	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	36.8	-	272.3	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 23,319	$ -	$ 690,878	-	3,036	-	45,540
FFS 1000 DRAFT 163			Excavate Stockpile	-	242,853	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	-	101.2	-	404.8	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ -	$ 830,557				
FFS 1000 DRAFT 164			Load into Haul Trucks	-	242,853	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305 A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	-	15.4	-	61.5	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ -	$ 126,283				
FFS 1000 DRAFT 165			Relocate Overburden to backfill Area 2 NE (final grades)	-	364,279	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205110	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment	B34F	374	1.0	5.6	100%	-	173.5	-	974.0	$ -	$ 1.33	$ -	$ 5.09	$ -	$ 6.42	$ -	$ -	$ -	$ 2,338,673				
FFS 1000 DRAFT 166			Spread Overburden	-	364,279	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	-	121.4	-	546.4	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 925,269				
FFS 1000 DRAFT 167			Apply daily cover to backfilled material	-	24,285	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	40.5	-	299.5	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 25,651	$ -	$ 759,965	-	3,340	-	50,100
FFS 1000 DRAFT 168			Compact backfilled material	-	267,138	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	-	51.4	-	154.1	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ -	$ 237,753				
FFS 1000 DRAFT 169			Apply daily cover to remaining excavation	5,644	3,469	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	9.4	5.8	69.6	42.8	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ 5,962	$ 3,664	$ 176,621	$ 108,548	777	477	11,655	7,155
FFS 1000 DRAFT 170			Excavate	62,085	38,156	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	25.9	15.9	103.5	63.6	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ 212,329	$ 130,494				
FFS 1000 DRAFT 171		Relocate	Load into Haul Trucks	62,085	38,156	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305 A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	3.9	2.4	15.7	9.7	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ 32,284	$ 19,841				

Construction Cost Worksheet - FFS 1000 DRAFT

Step #	Category	Sub-Category	Task	Quantity Area 1	Quantity Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Construction Days Area 1	Construction Days Area 2	Crew Man-days Area 1	Crew Man-days Area 2	Unit Costs Ext. Mat, O&P	Ext. Labor, O&P	Ext. Labor, O&P Ineff.	Ext. Equip, O&P	Ext. Equip, O&P Ineff.	Ext. Total, O&P	Bridgeton Taxes Area 1	Bridgeton Taxes Area 2	Total Cost Area 1	Total Cost Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Delivery Miles Area 1	Total Delivery Miles Area 2
FFS 1000 DRAFT 172	Reduce Slope Steepness	Relocate within the same Area. (Area 1 and Area 2 SW)	Transport to new location	93,127	57,234	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205060	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2000 ft, 10 MPH, excludes loading equipment	B34F	594	1.0	3.5	100%	44.3	27.3	156.8	96.4	$ -	$ 0.83	$ -	$ 3.20	$ -	$ 4.03	$ -	$ -	$ 375,301	$ 230,654				
FFS 1000 DRAFT 173			Spread Waste	93,127	57,234	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	31.0	19.1	139.7	85.9	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ 236,542	$ 145,375				
FFS 1000 DRAFT 174			Apply daily cover to backfilled material	6,208	3,816	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	10.3	6.4	76.6	47.1	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ 6,558	$ 4,030	$ 194,283	$ 119,403	854	525	12,810	7,875
FFS 1000 DRAFT 175			Compact backfilled material	68,293	41,972	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	13.1	8.1	39.4	24.2	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ 60,781	$ 37,355				
FFS 1000 DRAFT 176		Same as above, for Area 2 NE	Apply daily cover to remaining excavation	-	2,894	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	4.8	-	35.7	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 3,056	$ -	$ 90,547	-	398	-	5,970
FFS 1000 DRAFT 177			Excavate	-	31,829	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305	Excavating, bulk bank measure, 3-1/2 C.Y. capacity = 300 C.Y./hour, backhoe, hydraulic, crawler mounted, excluding truck loading	B12D	2,400	2.0	2.0	50%	-	13.3	-	53.0	$ -	$ 0.44	$ 0.44	$ 1.27	$ 1.27	$ 3.42	$ -	$ -	$ -	$ 108,853		14		
FFS 1000 DRAFT 178			Load into Haul Trucks	-	31,829	Overburden Waste	B.C.Y.	RS Means, Year 2016 Quarter 1	312316420305A	Excavating, bulk bank measure, for loading onto trucks, add	B12D	15,785	2.0	2.0	50%	-	2.0	-	8.1	$ -	$ 0.07	$ 0.07	$ 0.19	$ 0.19	$ 0.52	$ -	$ -	$ -	$ 16,551				
FFS 1000 DRAFT 179			Transport to new location	-	47,743	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323205060	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2000 ft, 10 MPH, excludes loading equipment	B34F	594	1.0	3.5	100%	-	22.7	-	80.4	$ -	$ 0.83	$ -	$ 3.20	$ -	$ 4.03	$ -	$ -	$ -	$ 192,403				
FFS 1000 DRAFT 180			Spread Waste	-	47,743	Overburden Waste	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	3.0	100%	-	15.9	-	71.6	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 121,267				
FFS 1000 DRAFT 181			Apply daily cover to backfilled material	-	3,183	Soil	B.C.Y.	RS Means, Year 2016 Quarter 1	See Assumptions	Common borrow, spread w/ dozer, includes load at pit & haul, excl. compaction (see Assumptions)	B15/B34B	600	7.4	1.0	100%	-	5.3	-	39.3	$ 12.63	$ 6.27	$ -	$ 11.34	$ -	$ 30.24	$ -	$ 3,362	$ -	$ 99,602	-	438	-	6,570
FFS 1000 DRAFT 182			Compact backfilled material	-	35,011	Overburden Waste	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	-	6.7	-	20.2	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ -	$ 31,160				
FFS 1000 DRAFT 183	Relocation of Other Waste	C&D Rubble Stockpiles	Relocate Stockpiled Material on-site - Excavate	7,794	35,069	C&D Rubble	B.C.Y.	RS Means, Year 2016 Quarter 1	312316305000	Drilling and blasting rock, less than 0.5 C.Y., excavate and load boulders	B10T	80	1.5	10.0	100%	9.7	43.8	146.1	657.5	$ -	$ 9.58	$ -	$ 6.56	$ -	$ 16.14	$ -	$ -	$ 125,795	$ 566,014				
FFS 1000 DRAFT 184			Relocate Stockpiled Material on-site - Haul and Dump	7,794	35,069	C&D Rubble	B.C.Y.	RS Means, Year 2016 Quarter 1	312316305400	Drilling and blasting rock, 25 ton off-highway dump, 1 mile round trip, haul boulders	B34E	330	1.0	5.3	100%	4.5	20.0	23.6	106.3	$ -	$ 0.17	$ -	$ 0.07	$ -	$ 0.24	$ -	$ -	$ 1,871	$ 8,417				
FFS 1000 DRAFT 185			Bury Stockpiled Material	7,794	35,069	C&D Rubble	B.C.Y.	RS Means, Year 2016 Quarter 1	312316305620	Drilling and blasting rock, 300 H.P. dozer, less than 0.5 C.Y., 150' haul, bury boulders on site	B10M	310	1.5	12.0	100%	2.1	9.4	37.7	169.7	$ -	$ 1.49	$ -	$ 5.25	$ -	$ 6.74	$ -	$ -	$ 52,532	$ 236,365				
FFS 1000 DRAFT 186	Buffer Zone		Buffer Zone Activity	-	1	See separate Assumptions sheet		See separate Assumptions sheet						1.0	100%	-	6.4	-	42.0	$ 35,337.43					$ 86,296.91	$ -	$ 2,955	$ -	$ 89,252				
FFS 1000 DRAFT 187	Rad. Survey		Conduct final radiological survey and wait for approval	1	1	This activity is handled by others, and does not have a direct cost to the contractor. However, there are the indirect costs due to the duration and associated waiting.								1.0	100%	7.0	7.0	-	-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -				
FFS 1000 DRAFT 188	Additional Fill		Purchase material and spread	-	5,578	Common Borrow	C.Y.	RS Means, Year 2016 Quarter 1	310513100200	Soils for earthwork, common borrow, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	12.0	100%	-	0.8	-	32.5	$ 12.63	$ 3.02	$ -	$ 5.76	$ -	$ 21.41	$ -	$ 5,891	$ -	$ 125,308	-	767	-	11,505
FFS 1000 DRAFT 189			Additional delivery distance	-	7,251	Common Borrow (per hauling increment)	C.Y.	RS Means, Year 2016 Quarter 1	310513100900	Soils for earthwork, borrow, spread with 200 HP dozer, includes load at pit and haul, round trip, excludes compaction, for 5 mile haul, add	B34B	200	1.0	23.6	100%	-	1.5	-	36.3	$ -	$ 2.50	$ -	$ 4.29	$ -	$ 6.79	$ -	$ -	$ -	$ 49,233				
FFS 1000 DRAFT 190			Compact material	-	5,578	Common Borrow	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235720	Compaction, 4 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	2,600	1.5	2.0	100%	-	1.1	-	3.2	$ -	$ 0.31	$ -	$ 0.58	$ -	$ 0.89	$ -	$ -	$ -	$ 4,964				
FFS 1000 DRAFT 191	Final Cover	Starter Berms	Purchase and deliver material	-	55,516	Riprap	Ton	RS Means, Year 2016 Quarter 1	313713100350	Rip-rap and rock lining, random, broken stone, 100 lb. average, dumped	B11A	700	2.0	8.0	100%	-	9.9	-	158.6	$ 27.87	$ 1.47	$ -	$ 2.49	$ -	$ 31.83	$ -	$ 129,395	$ -	$ 1,896,467	-	2,776	-	111,040
FFS 1000 DRAFT 192			Spread loose lift before compaction	-	33,310	Riprap	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	4.0	100%	-	8.3	-	50.0	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 84,606				
FFS 1000 DRAFT 193			Special grading for steep slopes	-	12,791	Riprap	S.Y.	RS Means, Year 2016 Quarter 1	312216103310	Fine grading, slopes, steep, finish grading	B11L	7,100	2.0	1.0	100%	-	1.8	-	3.6	$ -	$ 0.14	$ -	$ 0.12	$ -	$ 0.26	$ -	$ -	$ -	$ 3,326				
FFS 1000 DRAFT 194			Compact starter berms	-	27,758	Riprap	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235060	Compaction, riding, vibrating roller, 2 passes, 12" lifts	B10Y	5,200	1.5	2.0	100%	-	2.7	-	8.0	$ -	$ 0.15	$ -	$ 0.14	$ -	$ 0.29	$ -	$ -	$ -	$ 8,050				
FFS 1000 DRAFT 195		Bio-Intrusion	Purchase and Spread Bio-Intrusion Layer Material	137,749	241,775	4-in Minus Aggregate	L.C.Y.	RS Means, Year 2016 Quarter 1	310516100300	Aggregate for earthwork, crushed stone, 1.40 tons per C.Y., 1-1/2", spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	12.0	100%	19.1	33.6	803.5	1,410.4	$ 24.51	$ 3.02	$ -	$ 5.76	$ -	$ 33.29	$ 282,354	$ 495,583	$ 4,868,023	$ 8,544,264	11,480	20,148	172,200	302,220
FFS 1000 DRAFT 196			Deliver Bio-Intrusion Layer Material	179,074	314,307	4-in Minus Aggregate (per Hauling Increment)	L.C.Y.	RS Means, Year 2016 Quarter 1	310516100900	Aggregate for earthwork, aggregate or sand, spread with 200 HP dozer, includes load at pit and haul, round trip, for 5 mile haul add	B34B	200	1.0	23.6	100%	37.9	66.6	895.4	1,571.5	$ -	$ 2.50	$ -	$ 4.29	$ -	$ 6.79	$ -	$ -	$ 1,215,912	$ 2,134,146				
FFS 1000 DRAFT 197			Compact Bio-Intrusion Layer Material	83,484	146,530	4-in Minus Aggregate	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235060	Compaction, riding, vibrating roller, 2 passes, 12" lifts	B10Y	5,200	1.5	2.0	100%	8.0	14.1	24.1	42.3	$ -	$ 0.15	$ -	$ 0.14	$ -	$ 0.29	$ -	$ -	$ 24,210	$ 42,494				
FFS 1000 DRAFT 198		Clay	Purchase and deliver clay material	122,444	214,911	Clay Material	L.C.Y.	RS Means, Year 2016 Quarter 1	354113200040	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	41.4	100%	51.0	89.5	2,111.1	3,705.4	$ 26.69	$ -	$ -	$ -	$ -	$ 26.69	$ 273,305	$ 479,699	$ 3,541,327	$ 6,215,671	10,204	17,910	408,160	716,400
FFS 1000 DRAFT 199			Spread loose lift before compaction	122,444	214,911	Clay Material	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	12.0	100%	10.2	17.9	183.7	322.4	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ 311,007	$ 545,874				
FFS 1000 DRAFT 200			Compact Clay (Final Cover)	87,460	153,508	Clay Material	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235640	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	1,300	1.5	2.0	100%	33.6	59.0	100.9	177.1	$ -	$ 0.62	$ -	$ 1.15	$ -	$ 1.77	$ -	$ -	$ 154,804	$ 271,709				

Construction Cost Worksheet - FFS 1000 DRAFT

Step #	Category	Sub-Category	Task	Quantity Area 1	Quantity Area 2	Type of Material Handled	Units	Estimate Source	RS Means Ref #	RS Means Description	Crew Type	Daily Construction Rate	Crew Size	Number of Crews	Efficiency Factor	Construction Days Area 1	Construction Days Area 2	Crew Man-days Area 1	Crew Man-days Area 2	Unit Costs Ext. Mat, O&P	Ext. Labor, O&P	Ext. Labor, O&P Ineff.	Ext. Equip, O&P	Ext. Equip, O&P Ineff.	Ext. Total, O&P	Bridgeton Taxes Area 1	Bridgeton Taxes Area 2	Total Cost Area 1	Total Cost Area 2	Delivery Truckloads Area 1	Delivery Truckloads Area 2	Total Delivery Miles Area 1	Total Delivery Miles Area 2
FFS 1000 DRAFT 201		Top Soil	Purchase and place Topsoil	39,754	69,776	Topsoil	C.Y.	RS Means, Year 2016 Quarter 1	310513100800	Soils for earthwork, topsoil borrow, weed free, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	12.0	100%	5.5	9.7	231.9	407.0	$ 24.98	$ 3.02	$ -	$ 5.76	$ -	$ 33.76	$ 83,050	$ 145,768	$ 1,425,160	$ 2,501,415	4,142	7,269	62,130	109,035
FFS 1000 DRAFT 202		Top Soil	Addition for Topsoil Delivery	51,681	90,709	Topsoil (per Hauling Increment)	C.Y.	RS Means, Year 2016 Quarter 1	310513100900	Soils for earthwork, borrow, spread with 200 HP dozer, includes load at pit and haul, round trip, excludes compaction, for 5 mile haul, add	B34B	200	1.0	23.6	100%	10.9	19.2	258.4	453.5	$ -	$ 2.50	$ -	$ 4.29	$ -	$ 6.79	$ -	$ -	$ 350,912	$ 615,915				
FFS 1000 DRAFT 203	Stormwater Controls (for stormwater after cover is constructed)	Terraces	Purchase and place Topsoil	3,929	4,634	Topsoil	C.Y.	RS Means, Year 2016 Quarter 1	310513100800	Soils for earthwork, topsoil borrow, weed free, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	B15	600	3.5	2.0	100%	3.3	3.9	22.9	27.0	$ 24.98	$ 3.02	$ -	$ 5.76	$ -	$ 33.76	$ 8,208	$ 9,681	$ 140,847	$ 166,127	410	483	6,150	7,245
FFS 1000 DRAFT 204		Terraces	Addition for Topsoil Delivery	5,108	6,024	Topsoil (per Hauling Increment)	C.Y.	RS Means, Year 2016 Quarter 1	310513100900	Soils for earthwork, borrow, spread with 200 HP dozer, includes load at pit and haul, round trip, excludes compaction, for 5 mile haul, add	B34B	200	1.0	23.6	100%	1.1	1.3	25.5	30.1	$ -	$ 2.50	$ -	$ 4.29	$ -	$ 6.79	$ -	$ -	$ 34,680	$ 40,905				
FFS 1000 DRAFT 205		Pond	Purchase and deliver liner & berm material	-	13,760	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	354113200040	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	41.4	100%	-	5.7	-	237.2	$ 26.69	$ -	$ -	$ -	$ -	$ 26.69	$ -	$ 30,713	$ -	$ 397,963	-	1,147	-	45,880
FFS 1000 DRAFT 206		Pond	Spread loose lift before compaction (Pond)	-	13,760	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	2.1	100%	-	6.6	-	20.6	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ -	$ 34,950				
FFS 1000 DRAFT 207		Pond	Compact Liner & Berm (Pond)	-	9,828	Structural Fill / Clay	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235640	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	B10G	1,300	1.5	2.0	100%	-	3.8	-	11.3	$ -	$ 0.62	$ -	$ 1.15	$ -	$ 1.77	$ -	$ -	$ -	$ 17,396				
FFS 1000 DRAFT 208		Pond	Pond Perimeter Berm Structural Rock	-	1,130	Structural Rock	L.C.Y.	RS Means, Year 2016 Quarter 1	313713100100	Rip-rap and rock lining, random, broken stone, machine placed for slope protection	B12G	62	2.0	1.0	100%	-	18.2	-	36.5	$ 31.59	$ 16.76	$ -	$ 14.69	$ -	$ 63.04	$ -	$ 2,986	$ -	$ 74,241				
FFS 1000 DRAFT 209		Diversion Berms	Purchase and deliver berm material	1,425	724	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	354113200040	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.	B34B	58	1.0	41.4	100%	0.6	0.3	24.6	12.5	$ 26.69	$ -	$ -	$ -	$ -	$ 26.69	$ 3,180	$ 1,616	$ 41,200	$ 20,934	119	61	4,760	2,440
FFS 1000 DRAFT 210		Diversion Berms	Spread loose lift before compaction	1,425	724	Structural Fill / Clay	L.C.Y.	RS Means, Year 2016 Quarter 1	312323170020	Fill, dumped material, spread, by dozer, excludes compaction	B10B	1,000	1.5	2.1	100%	0.7	0.3	2.1	1.1	$ -	$ 0.80	$ -	$ 1.74	$ -	$ 2.54	$ -	$ -	$ 3,618	$ 1,838				
FFS 1000 DRAFT 211		Diversion Berms	Compact Berms	1,018	517	Structural Fill / Clay	E.C.Y.	RS Means, Year 2016 Quarter 1	312323235060	Compaction, riding, vibrating roller, 2 passes, 12" lifts	B10Y	5,200	1.5	2.0	100%	0.1	0.0	0.3	0.1	$ -	$ 0.15	$ -	$ 0.14	$ -	$ 0.29	$ -	$ -	$ 295	$ 150				
FFS 1000 DRAFT 212			Perimeter Road Stormwater Crossings	-	123	Riprap	L.C.Y.	RS Means, Year 2016 Quarter 1	313713100100	Rip-rap and rock lining, random, broken stone, machine placed for slope protection	B12G	62	2.0	1.0	100%	-	2.0	-	4.0	$ 31.59	$ 16.76	$ -	$ 14.69	$ -	$ 63.04	$ -	$ 325	$ -	$ 8,092				
FFS 1000 DRAFT 213			Final Stormwater Controls (letdowns, swales, etc.)	889	2,111	Riprap	S.Y.	RS Means, Year 2016 Quarter 1	313713100110	Rip-rap and rock lining, random, broken stone, 3/8 to 1/4 C.Y. pieces, machine placed for slope protection, grouted	B13	80	7.0	3.0	100%	3.7	8.8	77.8	184.7	$ 65.49	$ 42.14	$ -	$ 11.64	$ -	$ 119.27	$ 4,868	$ 11,562	$ 110,886	$ 263,355				
FFS 1000 DRAFT 214	Site Completion		Apply seeding to cover	1,288	2,261	Seeding	M.S.F.	RS Means, Year 2016 Quarter 1	329219142400	Seeding athletic fields, seeding fescue, tall with mulch and fertilizer, 5.5 lb. per M.S.F., hydro/air seeding	B81	80	3.0	1.0	100%	16.1	28.3	48.3	84.8	$ 26.26	$ 19.04	$ -	$ 10.79	$ -	$ 56.09	$ 2,829	$ 4,965	$ 75,075	$ 131,770				
FFS 1000 DRAFT 215			Install temporary irrigation system	107,337	188,396	Irrigation System	S.F.	RS Means, Year 2016 Quarter 1	328423100800	Underground sprinklers irrigation system, for lawns, residential system, custom, 1" supply	B20	2,000	3.0	10.0	100%	5.4	9.4	161.0	282.6	$ 0.27	$ 0.75	$ -	$ -	$ -	$ 1.02	$ 2,424	$ 4,254	$ 111,907	$ 196,418				
FFS 1000 DRAFT 216			Install Fencing	5,770	6,726	Fencing	L.F.	RS Means, Year 2016 Quarter 1	323113200920	Fence, chain link industrial, galvanized steel, 6 ga. wire, 2-1/2" posts @ 10' OC, 8' high, includes excavation, in concrete, excludes barbed wire	B80C	180	3.0	2.0	100%	16.0	18.7	96.2	112.1	$ 37.00	$ 8.06	$ -	$ 1.77	$ -	$ 46.83	$ 17,854	$ 20,812	$ 288,063	$ 335,791				

Overall Crew Man-days: 36,300 | 37,500 — 73,800

	Area 1	Area 2	Combined
Bridgeton Taxes *Totals*	$ 1,890,000	$1,950,000	$3,840,000
Total Cost *Totals*	$ 57,000,000	$ 80,700,000	$ 138,000,000
Delivery Truckloads *Totals*	44,200	88,600	133,000
Total Delivery Miles *Totals*	1,190,000	2,100,000	3,290,000
RIM Transporation & Disposal	$ 2,690,000	$ 11,800,000	$ 14,400,000
RIM Loading Operation	$ 1,830,000	$ 1,420,000	$ 3,260,000
On-Site Costs	$ 52,500,000	$ 67,500,000	$ 120,000,000

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Radiological Survey and Health and Safety Costs
1,000 pCi/g

Total Estimated Costs for Radiological Survey and Health & Safety Support

Total Labor Cost	$18,688,000
Professional Services	$1,299,000
Equipment	$2,090,000
Materials/PPE	$10,874,000
Travel	$2,636,000
Off-Site Laboratory	$534,000
Total	**$36,121,000**

Estimate of Labor Costs

Estimated Labor Costs	Team	Personnel Description	Cost/day*	Notes:		
$1,924,000	Team 1	Sr Rad Tech	$1,070	Supervise field activities; Collect samples and deliver to outside lab; Maintain records; Surveys	$489,000	Perdiem Weekend days
$1,565,000		Rad Tech	$870	Run personal air sampling program; Available for decon, distributing protective clothing, assist with survey vehicle moving on-site		
$1,565,000		Rad Tech	$870	Control entry/exit for contaminated areas		
$1,565,000		Rad Tech	$870	Control entry/exit for contaminated areas		
$408,000	Team 2	Sr Rad Tech	$1,070	Survey while moving RIM Area 1; Conduct Final Survey	$367,000	Perdiem Weekend days
$332,000		Rad Tech	$870	Survey while moving RIM Area 1; Conduct Final Survey		
$332,000		Rad Tech	$870	Survey while moving RIM Area 1; Conduct Final Survey		
$685,000	Team 3	Sr Rad Tech	$1,070	Survey while moving RIM Area 2; Conduct Final Survey	$367,000	Perdiem Weekend days
$557,000		Rad Tech	$870	Survey while moving RIM Area 2; Conduct Final Survey		
$557,000		Rad Tech	$870	Survey while moving RIM Area 2; Conduct Final Survey		
$15,000.00	Team 4	Sr Rad Tech	$1,070	Final Survey for Buffer/Crossroads property after RIM relocated	$245,000	Perdiem Weekend days
$12,000.00		Rad Tech	$870	Final Survey for Buffer/Crossroads property after RIM relocated		
$1,234,000.00	Team 5	Sr Rad Tech	$1,070	RIM transfer station	$245,000	Perdiem Weekend days
$1,004,000.00		Rad Tech	$870	RIM transfer station		
$3,675,050.00	Team 6	Lab Supervisor	$2,170	Run On-site Laboratory includes 3 months set-up and training	$245,000	Perdiem Weekend days
$1,300,000.00		Lab Tech	$1,070	Conduct detailed activities at On-site laboratory includes 3 months set-up and training		

$16,730,000 Total Estimated Labor Costs during Construction

* Includes per diem at $170/day

Team 1

3/15/2018	Estimated Start Date	Road construction
2/4/2025	Estimated End Date	Clean-up
2518	No. of calendar days	
6.9	No. years	
83	No. Months	
28	No. of quarters	
360	No. of weeks	
1799	No. of working days	
719	No. of weekend days	
143	No. of field personnel requiring badges	
49	No. of field personnel in PPE	

Team 2

8/8/2018	Estimated Start Date	Start Exc Area 1
1/24/2020	Estimated End Date	FSS Area 1
534	No. of calendar days	
1.5	No. years	
17	No. Months	
6	No. of quarters	
76	No. of weeks	
381	No. of working days	
153	No. of weekend days	

Team 3

4/17/2020	Estimated Start Date	Start Exc Area 2
9/30/2022	Estimated End Date	FSS Area 2
896	No. of calendar days	
2.5	No. years	
29	No. Months	
10	No. of quarters	
128	No. of weeks	
640	No. of working days	
256	No. of weekend days	

Team 4

9/30/2022	Estimated Start Date	Start Exc BZ
10/20/2022	Estimated End Date	FSS BZ
20	No. of calendar days	
0.1	No. years	
1	No. Months	
0	No. of quarters	
3	No. of weeks	
14	No. of working days	
6	No. of weekend days	

Team 5

7/6/2018	Estimated Start Date	RIM Xfer Station-1m
12/7/2022	Estimated End Date	
1615	No. of calendar days	
4.4	No. years	
53	No. Months	
18	No. of quarters	
231	No. of weeks	
1154	No. of working days	
461	No. of weekend days	

Team 6

5/6/2018	Estimated Start Date	Start of Excavations minus 3 months
12/30/2022	Estimated End Date	End of Exc plus 2 month
1699	No. of calendar days	
4.7	No. years	
55	No. Months	
18	No. of quarters	
243	No. of weeks	
1214	No. of working days	
485	No. of weekend days	

Estimate of Non-Labor Costs

ITEM NO.	DESCRIPTION		UNIT	QUANTITY	RATE	COSTS	
1	**PROFESSIONAL SERVICES**					**$ 1,299,000**	
1.1	Oversight						
		CHP	hourly	899	$ 170	152,879	
		Sr. Health Physicist	hourly	7,194	$ 115	937,743	includes 6 months to recruit staff and set up the on-site laboratory
		Project Coordinator	hourly	1,799	$ 85	152,879	
1.3	Training						
		Sr. Health Physicist	hourly	138	$ 115	15,867	
		**Estimated 2 trips for 6 years for GERT training courses.					
1.4	Report Assistance						
		CHP	hourly	80	$ 170	13,600	
		Graphics Support	hourly	80	$ 120	9,600	
		Sr. Health Physicist	hourly	80	$ 115	9,200	
		Project Coordinator	hourly	80	$ 85	6,800	
2	**EQUIPMENT**					**$ 2,090,000**	
2.1	Equipment						
		Model 2929 w/ 43-10-1 (3)	/month	249	$ 320	79,680	
		Model 2360 w/ 43-93 (7)	/month	581	$ 825	479,325	
		Extra Mylars for 43-93	/unit	8	$ 40	320	
		Model 2221 w/44-20 (3)	/month	0	$ -	0	
		Th-230 source (3)	/month	249	$ 75	18,675	
		Cs-137 source (3)	/month	249	$ 75	18,675	
		Tc-99 source (3)	/month	249	$ 75	18,675	
		PID (3)	/month	249	$ 750	186,750	
		PID 5 gas (3)	/month	249	$ 725	180,525	
		Air Monitors (6)	/month	498	$ 165	82,170	
		Trimble GPS Unit + Model 2221 w/ 44-10 (2)	/month	166	$ 3,000	498,000	
		Model 2221 w/44-10 (5)	/month	415	$ 500	207,500	
		Field Computer (4)	/month	332	$ 250	83,000	
		Model 19 (4)	/month	332	$ 400	132,800	
		Model 2221 w/ 44-2 (2)	/month	0	$ -	0	
		Tax on outside rentals		9.5%	$ 963,950	91,575	
2.2	Shipping						
		FedEx Charges	/shipment	166	$ 75	12,450	
		**Estimate of 2 shipments per month					
3	**MATERIALS/PPE**					**$ 10,874,000**	
3.1	Training						
		Rad Training packets	/unit	100	$ 25	2,500	
3.2	Health and Safety Monitoring & PPE						
		Mirion TLDs	/unit, /quarter	3,956	$ 50	197,817	
	50/ case	Boot Covers	/case	41,151	$ 150	6,172,697	
	25/case	Tyvek Coveralls	/case	41,151	$ 100	4,115,131	
	1000/case	Gloves	/case	3,086	$ 125	385,794	

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Estimate of Non-Labor Costs (continued)

ITEM NO.	DESCRIPTION		UNIT	QUANTITY	RATE	COSTS	
4	**TRAVEL**					**$ 2,636,000**	
4.1	Training/Audits						
		Travel Time	1 person/Quarter	443	$ 115	$ 50,907	
		Per Diem	2 days per trip	55	$ 170	$ 9,407	
		Air Fare	1 person/Quarter	28	$ 850	$ 23,517	
		Car Rental	2 person/Quarter	28	$ 300	$ 8,300	
		Gas	3 person/Quarter	28	$ 50	$ 1,383	
4.2	HP Technicians		Team 1				
		Travel Time	staff * 29 trips	1856	$ 300	$ 556,800	
		Per Diem	staff * 29 trips	232	$ 170	$ 39,440	
		Air Fare	staff * 29 trips	116	$ 850	$ 98,600	29
		Mileage	vehicles * project duration	719	$ 70	$ 50,360	
		Car Rental	# vehicles * project duration	719	$ 400	$ 287,771	
		Supplies	/month	83	$ 500	$ 41,500	
		Gas	/month	83	$ 400	$ 33,200	
		Misc Items	/month	83	$ 500	$ 41,500	
4.3	HP Technicians		Team 2				
		Travel Time	staff * 7 trips	336	$ 300	$ 100,800	
		Per Diem	staff * 7 trips	42	$ 170	$ 7,140	
		Air Fare	staff * 7 trips	21	$ 850	$ 17,850	7
		Mileage	vehicles * project duration	114	$ 70	$ 8,010	
		Car Rental	# vehicles * project duration	114	$ 400	$ 45,771	
		Supplies	/month	17	$ 500	$ 8,500	
		Gas	/month	17	$ 400	$ 6,800	
		Misc Items	/month	17	$ 500	$ 8,500	
4.4	HP Technicians		Team 3				
		Travel Time	staff * 11 trips	528	$ 300	$ 158,400	
		Per Diem	staff * 11 trips	66	$ 170	$ 11,220	
		Air Fare	staff * 11 trips	33	$ 850	$ 28,050	11
		Mileage	vehicles * project duration	192	$ 70	$ 13,440	
		Car Rental	# vehicles * project duration	192	$ 400	$ 76,800	
		Supplies	/month	29	$ 500	$ 14,500	
		Gas	/month	29	$ 400	$ 11,600	
		Misc Items	/month	29	$ 500	$ 14,500	
4.5	HP Technicians		Team 4				
		Travel Time	staff * 2 trips	64	$ 300	$ 19,200	
		Per Diem	staff * 2 trips	8	$ 170	$ 1,360	
		Air Fare	staff * 2 trips	4	$ 850	$ 3,400	2
		Mileage	vehicles * project duration	3	$ 70	$ 200	
		Car Rental	# vehicles * project duration	3	$ 400	$ 1,143	
		Supplies	/month	1	$ 500	$ 500	
		Gas	/month	1	$ 400	$ 400	
		Misc Items	/month	1	$ 500	$ 500	
4.6	HP Technicians		Team 5				
		Travel Time	staff * 19 trips	608	$ 300	$ 182,400	
		Per Diem	staff * 19 trips	76	$ 170	$ 12,920	
		Air Fare	staff * 19 trips	38	$ 850	$ 32,300	19
		Mileage	vehicles * project duration	231	$ 70	$ 16,150	
		Car Rental	# vehicles * project duration	231	$ 400	$ 92,286	
		Supplies	/month	53	$ 500	$ 26,500	
		Gas	/month	53	$ 400	$ 21,200	
		Misc Items	/month	53	$ 500	$ 26,500	
4.7	Lab Staff		Team 6				
		Travel Time	staff * 20 trips	640	$ 290	$ 185,600	
		Per Diem	staff * 20 trips	80	$ 170	$ 13,600	
		Air Fare	staff * 20 trips	40	$ 850	$ 34,000	20
		Mileage	vehicles * project duration	243	$ 70	$ 16,990	
		Car Rental	# vehicles * project duration	243	$ 400	$ 97,086	
		Supplies	/month	55	$ 500	$ 27,500	
		Gas	/month	55	$ 400	$ 22,000	
		Misc Items	/month	55	$ 500	$ 27,500	

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Estimate of Non-Labor Costs (continued)

ITEM NO.	DESCRIPTION		UNIT	QUANTITY	RATE	COSTS	
5	**LABORATORY**					**$ 534,000**	
5.1	Air Filter Analysis						start exc Area 1 end exc Area 2
		Gross Alpha Beta	1 air filter * 5 days * weeks	1799	$ 65	$ 116,907	8/6/2018 8/16/2026 2932 418.857143 weeks
		Isotopic Thorium	1 air filter * 5 days * weeks	1799	$ 100	$ 179,857	
5.2	Water Sample Analysis						
		Gross Alpha Beta	Estimated 30 samples	30	$ 65	$ 1,950	
		Isotopic Thorium	Estimated 30 samples	30	$ 100	$ 3,000	
		Isotopic Uranium	Estimated 30 samples	30	$ 100	$ 3,000	
		Radium-226	Estimated 30 samples	30	$ 85	$ 2,550	
5.3	Soil Sample Analysis						
		Gamma Spec	Estimated 730 samples	730	$ 85	$ 62,050	7300 103 2000m2 SU in Area 2 and 43 SR in Area 1. Estimate 50 samples per SU.
		Isotopic Thorium	Estimated 730 samples	730	$ 100	$ 73,000	10% of those go to off-site laboratory. 50 from reference area but those will be analyzed at the on-site lab.
		Isotopic Uranium	Estimated 730 samples	730	$ 100	$ 73,000	
5.4	Vegetation						
		Gamma Spec	Estimated 0 samples	0	$ 85	$ -	
		Isotopic Thorium	Estimated 0 samples	0	$ 100	$ -	
		Isotopic Uranium	Estimated 0 samples	0	$ 100	$ -	
		Radium-226	Estimated 0 samples	0	$ 85	$ -	
		Radium-228	Estimated 0 samples	0	$ 85	$ -	
5.5	Shipping						
		FedEx Charges	/shipment	249	$ 75	18,675	
		Estimate of 3 shipments per month					

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On-Site Radiological Laboratory
1,000 pCi/g Remedy Alternative

Equipment Price List

Item Description	Vendor(s)	Unit Cost	Quantity	Total Cost	Total Shipping Cost	Taxes	Extended Price
Modular Analytical Lab (MAL):							
Cost of MAL	CPM LabFab	$ 3,800	55.2	$ 209,760	$ 21,576	$ 19,445	$ 250,781
MAL Analytical Equipment							
Discover SPD 80 system (microwave digestion)							
SPD 80 System	CEM Corporation	$ 20,351	1	$ 20,351	$ 2,035	$ 1,887	$ 24,273
Scrubber Option (mandtory for HF application)		$ 2,691	1	$ 2,691	$ 269	$ 249	$ 3,210
Synergy External Controller Optior		$ 2,714	1	$ 2,714	$ 271	$ 252	$ 3,237
80-ml quartz vial (set of twelve)		$ 1,751	1	$ 1,751	$ 175	$ 162	$ 2,088
35ml/80ml Vial Caps (100)		$ 99	1	$ 99	$ 10	$ 9	$ 118
Installation and Training		$ 837	1	$ 837	$ 84	$ 78	$ 998
Maintence Contract		$ 3,095	5	$ 15,475	$ 1,548	$ 1,435	$ 18,457
SUB-TOTAL MAL Microwave				**$ 31,538**			**$ 4,392**
Nuclear Instrumentation for Sample Analysis							
Computer to run APEX software for 2 gamma and 12 alpha diodes	DELL	$ 2,700	1	$ 2,700	$ 270	$ 250	$ 3,220
Alpha Spectroscopy							
Alpha Analyst	Canberra	$ 36,540	1	$ 36,540	$ 3,654	$ 3,387	$ 43,581
PIPS Detectors		$ 1,026	60	$ 61,560	$ 6,156	$ 5,707	$ 73,423
Chassis and Hardware		$ 5,857	2	$ 11,714	$ 1,171	$ 1,086	$ 13,971
Vacuum Pump		$ 1,868	1	$ 1,868	$ 187	$ 173	$ 2,228
Alpha Spec Installation Kit		$ 518	1	$ 518	$ 52	$ 48	$ 618
Training		$ 2,250	2	$ 4,500	$ 450	$ 417	$ 5,367
Apex-Alpha Desktop Package		$ 7,430	1	$ 7,430	$ 743	$ 689	$ 8,862
Mixed Alpha Standard		$ 1,850	6	$ 11,100	$ 1,110	$ 1,029	$ 13,239
Maintence Contract		$ 1,000	5	$ 5,000	$ 500	$ 464	$ 5,964
SUB-TOTAL MAL Alpha Spec				**$ 135,230**			**$ 161,289**
Gamma Spectroscopy							
SAGE Well Detector	Canberra	$ 114,993	1	$ 114,993	$ 11,499	$ 10,660	$ 137,152
Ultra low background shield		$ 27,000	1	$ 27,000	$ 2,700	$ 2,503	$ 32,203
Solid Side Plug		$ 390	1	$ 390	$ 39	$ 36	$ 465
Detector Lift		$ 3,087	1	$ 3,087	$ 309	$ 286	$ 3,682
Genie 2000 Basic		$ 1,316	1	$ 1,316	$ 132	$ 122	$ 1,570
Genie 2000 Gamma Option		$ 4,336	1	$ 4,336	$ 434	$ 402	$ 5,172
LABSOCS Efficiency Calibration Software		$ 6,990	1	$ 6,990	$ 699	$ 648	$ 8,337
ISOXCAL		$ 5,040	1	$ 5,040	$ 504	$ 467	$ 6,011
LYNX-Digital Signal Analyzei		$ 15,887	1	$ 15,887	$ 1,589	$ 1,473	$ 18,948
Maintence Contract		$ 1,000	5	$ 5,000	$ 500	$ 464	$ 5,964
SUB-TOTAL MAL LB4200				**$ 179,039**			**$ 213,540**
LB4200 System							
Base Platform	Canberra	$ 7,339	2	$ 14,678	$ 1,468	$ 1,361	$ 17,506
Drawer		$ 20,920	8	$ 167,360	$ 16,736	$ 15,514	$ 199,610
Apex Software		$ 3,827	1	$ 3,827	$ 383	$ 355	$ 4,564
Mounting Table		$ 1,584	2	$ 3,168	$ 317	$ 294	$ 3,778
Multi Core CPU		$ 2,700	1	$ 2,700	$ 270	$ 250	$ 3,220
Maintence Contract		$ 1,000	5	$ 5,000	$ 500	$ 464	$ 5,964
SUB-TOTAL MAL LB4200				**$ 58,297**			**$ 21,766**
Eichrom Resin System							
24 Hole Vacuum Box with Rack	EiChrom	$ 1,315	1	$ 1,315	$ 132	$ 122	$ 1,568
Inner Liner		$ 215	1	$ 215	$ 22	$ 20	$ 256
White Inner Support Tube-PE 1000/box		$ 118	58	$ 6,797	$ 680	$ 630	$ 8,107
Yellow Outer Tips 1000/box		$ 89	58	$ 5,126	$ 513	$ 475	$ 6,114
20ml Cartridge Reservoir 25/box		$ 28	2,400	$ 67,200	$ 6,720	$ 6,229	$ 80,149
Resolve Filters in Funnel 25/box		$ 47	2,400	$ 112,800	$ 11,280	$ 10,457	$ 134,537
Pump	Fisher	$ 1,005	1	$ 1,005	$ 101	$ 93	$ 1,199
SUB-TOTAL MAL LB4200				**$ 7,049**			**$ 9,152**
MAL Other Equipment							
Bench-top drying ovens (2)		$ 2,500	2	$ 5,000	$ 500	$ 464	$ 5,964
Muffle Furnace		$ 2,600	1	$ 2,600	$ 260	$ 241	$ 3,101
Analytical Balance (0.0001g)		$ 2,000	1	$ 2,000	$ 200	$ 185	$ 2,385
Top loading balance (1 kg)		$ 1,000	1	$ 1,000	$ 100	$ 93	$ 1,193
Centrifuge		$ 1,000	2	$ 2,000	$ 200	$ 185	$ 2,385
Heat Lamps		$ 1,000	2	$ 2,000	$ 200	$ 185	$ 2,385
Hot Plates		$ 500	4	$ 2,000	$ 200	$ 185	$ 2,385
Zirconium crudibles		$ 200	24	$ 4,800	$ 480	$ 445	$ 5,725
Labware		$ 15,000	1	$ 15,000	$ 1,500	$ 1,391	$ 17,891
Acids, Reagents, and standards		$ 20,000	5	$ 100,000	$ 10,000	$ 9,270	$ 119,270
SUB-TOTAL MAL Other Equipment				**$ 33,901**			**$ 162,684**
MAL Support Equipment							
Copier		$ 15,000	1	$ 15,000	$ 1,500	$ 1,391	$ 17,891
Printer		$ 5,000	1	$ 5,000	$ 500	$ 464	$ 5,964
Desks		$ 500	2	$ 1,000	$ 100	$ 93	$ 1,193
Chairs		$ 300	5	$ 1,500	$ 150	$ 139	$ 1,789
Tables		$ 200	2	$ 400	$ 40	$ 37	$ 477
Filing Cabinets		$ 1,000	2	$ 2,000	$ 200	$ 185	$ 2,385
Storage Cabinets		$ 1,000	4	$ 4,000	$ 400	$ 371	$ 4,771
Initial office supply setup		$ 2,500	1	$ 2,500	$ 250	$ 232	$ 2,982
Stools for lab area		$ 100	6	$ 600	$ 60	$ 56	$ 716
Safety shower / eyewash		$ 1,000	1	$ 1,000	$ 100	$ 93	$ 1,193
Cellular phones for lab employees		$ 150	2	$ 300	$ 30	$ 28	$ 358
SUB-TOTAL MAL Support				**$ 6,750**			**$ 39,717**
GRAND TOTAL EQUIPMENT				**$ 657,000**			**$ 857,000**

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Capital Cost Estimate - Long-Term Monitoring
1,000 pCi/g Remedy Alternative

Description	Quantity	Units	Unit Rate	Estimated Cost ($)
Secure easements	1	LS	5,000	5,000
Landfill Gas:				
Driller: Install radon/landfill gas monitoring probes, MDNR "Code Wells"; 10' deep	31	each	2,000	62,000
Misc. wellhead sampling fittings and locks	31	each	40	1,200
Field technician observation during drilling and construction of probes (4/day)	64	hour	90	5,800
Mileage for field technician during probe construction	400	mile	0.54	200
Multi-gas detector (e.g., Industrial Scientific iBrid™ MX6), incl regulator, tubing, calbrtn gas	1	LS	4,806	4,800
Portable radon gas monitor and detector (e.g., Pylon AB6 monitor w/ 300A detector)	1	LS	9,075	9,100
Groundwater:				
Construction of new groundwater monitoring wells	12	each	10,000	120,000
Flat-bottom polyethylene tank to store purge water prior to disposal	1,500	gallon	2	3,000
Estimated Long-term Monitoring Capital Costs - Total				**211,000**

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Post-Construction Radon Flux Monitoring Cost Estimate
1,000 pCi/g Remedy Alternative

Description	Quantity	Units	Unit Rate	Estimated Cost ($)
Radon Flux (once after cover construction is complete):				
Number of Monitoring Locatons (assume same as post-NCC program):	*130*			
Surveying of locations	1	day	1,500	1,500
Auxier labor	1	LS	6,345	6,350
Per diem	2	each	1,190	2,380
Airfare and vehicle rental	2	each	1,000	2,000
Overnight shipping to lab	1	LS	1,200	1,200
Lab analysis (Eberline)	1	LS	11,050	11,050
Data validation and management	1	each	1,000	1,000
Reporting	4	hour	150	600
Estimated Post-Construction Radon Flux Monitoring Costs - Total				**26,000**

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Stormwater and Air Monitoring During Construction Cost Estimates
1,000 pCi/g Remedy Alternative

Description	Analytical Method	Quantity	Units	Unit Rate ($)	Estimated Cost ($)
Stormwater Monitoring and Inspection (Quarterly - only during remedy construction)					
4 sampling locations					
1 field duplicate					
5 total samples					
Sampling and Inspection (Feezor Engineering estimate)		1	LS	5,000	5,000
Laboratory Analysis:					
Eberline (T-uranium, iso-uranium, iso-thorium, gross alpha/beta, Ra-226, Ra-228)		1	LS	2,325	2,330
TekLab (all other parameters)		1	LS	2,743	2,740
Data validation and management		1	LS	1,500	1,500
Reporting		4	hour	150	600
Estimated Quarterly Stormwater Monitoring and Inspection Costs - Total					**12,000**
Air Monitoring during Construction					
13 air monitoring stations and one MET station					
Auxier & Associates FY2016 Air Monitoring Program Estimate (minus contingency)		1	LS	172,852	172,900
Data validation		1	LS	6,800	6,800
Power costs (13 stations plus one MET station; $10/month per station)		12	months	140	1,700
Estimated Air Monitoring during Construction Costs - Annual Total					181,000
Estimated Quarterly Air Monitoring Costs during Construction (assuming annual costs divided by 4)					**45,000**

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Capital Cost Estimate - Amend Existing/Additional Institutional Controls
1,000 pCi/g Remedy Alternative

Description	Quantity	Units	Unit Rate	Estimated Cost
Prepare Institutional Controls planning documents	1	LS	10,000	10,000
Attorney labor: prepare draft amended existing and additional ICs	1	LS	20,000	20,000
Review of draft documents	1	LS	5,000	5,000
Revise amended and additional Institutional Controls documents	1	LS	10,000	10,000
Filings and registrations	1	LS	5,000	5,000
Estimated Institutional Controls Capital Costs - Total				**50,000**

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Long-Term Post-Construction Monitoring (per event) Cost Estimate
1,000 pCi/g Remedy Alternative

(Landfill Gas/Radon, Groundwater Monitoring and Annual Post-Construction Site Inspections)

Description	Analytical Method	Quantity	Units	Unit Rate ($)	Estimated Cost ($)
Landfill Gas/Radon (quarterly after contruction complete):					
Number of Landfill Gas/Radon Monitoring Wells		*31*			
Labor - field technician		9	hour	90	810
Field vehicle		1	day	120	120
Replacement radon detector (Pylon 300A)		1	each	550	550
Calibration gas for multi-gas detector		1	each	449	450
Data management		2	hour	100	200
Reporting		8	hour	150	1,200
Estimated Landfill Gas/Radon Monitoring Costs - Subtotal					3,300
Contingency			*%*	*20*	*700*
Estimated Landfill Gas/Radon Monitoring Costs - Total (per Event)					**4,000**

Description	Analytical Method	Quantity	Units	Unit Rate ($)	Estimated Cost ($)
Groundwater (semi-annual first 5 years after construction; annually thereafter):					
Number of Samples:			*For VOCs*		
Investigative Groundwater (5, 3-wells clusters in Area 2; 3, 3-well clusters in Area 1)		*24*	*24*		
Field Duplicates (one per every 10 investigative samples)		*3*	*3*		
Trip blank (one per day per cooler)			*15*		
Matrix Spike			*1*		
Matrix Spike Duplicate			*1*		
Sub-total number of unfiltered samples:		*27*	*44*		
Sub-total number of filtered samples for radionuclide and metals analyses:		*27*			
Total number of samples:		*54*	*44*		
Labor:					
Labor - field technicians (assume 2 people, 5 days, 10-hr days)		100	hour	90	9,000
Materials and equipment:					
Sample kits, incl. filters		24	each	50	1,200
Field instrumentation and flowcell rental - groundwater		5	day	100	500
Field Vehicle		5	day	120	600
Overnight shipping of sample coolers (assume 1 per day to rad lab)		5	coolers	100	500
Delivery of sample coolers to local lab (2 to 3 coolers per day)		5	hour	90	450
Disposal of purge water (assumes PE tank previously purchased is onsite):					
Vacuum truck		4	hour	200	800
Transportation and disposal (assumes approx 25 gal per well per event)		600	gallon	2.00	1,200
Laboratory Sample Analysis:	*Analytical Method:*				
Gross alpha and beta	EPA 900.0	54	each	50	2,700
Total Uranium		54	each	65	3,510
Iso-Uranium-234, 235, 238	EML U-02 Mod	54	each	100	5,400
Iso-Thorium-228, 230, 232	EML Th-01 Mod	54	each	100	5,400
Radium 228	EPA 904.0	54	each	75	4,050
Radium 226	EPA 903.0 Mod	54	each	75	4,050
Radon 222 - 72 hr hold time	SM 20th ED 7500-Rn B	54	each	85	4,590
Volatile Organic Compounds [VOCs] (GC/MS)	8260B	44	each	110	4,840
Semivolatile Organic Compounds [SVOCs] (GC/MS)	8270C	54	each	220	11,880
22 Metals Target Analyte List (ICP/AES)	6010B	54	each	115	6,210
Mercury (CVAA)	7470A	54	each	35	1,890
4 Anions (IC) - Bromide, Chloride, Fluoride, Sulfate	300.0	54	each	72	3,890
2 Anions (IC) - Nitrate, Nitrite - 48 hr hold time	300.0	54	each	36	1,940
Sulfide, Total	SM 4500 S2 D	54	each	35	1,890
Phosphorus, Total	365.1	54	each	40	2,160
Organic carbon, Total (TOC)	SM 5310B	54	each	40	2,160
Total Alkalinity, Carbonate, Bicarbonate	SM 2320B	54	each	20	1,080
Nitrogen, Ammonia	350.1	54	each	25	1,350
Level IV data deliverable		$ 68,990	%	10%	6,900
Data validation (assumes validation of 100% of Level IV data will be required)		1	LS	6,600	6,600
Data management		7	SDG	100	700
Reporting		40	hour	150	6,000
Estimated Groundwater Monitoring Costs - Subtotal					103,400
Contingency			*%*	*20*	*20,700*
Estimated Groundwater Monitoring Costs - Total (per Event)					**124,000**

DVR = data validation report
SDG = sample delivery group

Description	Analytical Method	Quantity	Units	Unit Rate ($)	Estimated Cost ($)
Annual Post-Construction Site Inspections					
Labor - Engineer		9	hour	130	1,170
Field vehicle		1	day	120	120
Site Inspection Report		4	hour	130	520
Estimated Annual Post-Construction Site Inspections Costs - Subtotal					1,800
Contingency			*%*	*20*	*400*
Estimated Annual Post-Construction Site Inspections Costs - Total					**2,200**

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Operation and Maintenance Cost Estimate - Annual Cover System Maintenance
1,000 pCi/g Remedy Alternative

Description	Quantity	Units	Unit Rate	Estimated Cost
Mowing; tractor w/ rotary mower (once/year)	55.3	acre	40.00	2,200
Fill depressions in cover w/ topsoil, assume 1% of area; 6 inches deep	446	bcy	37.53	16,700
Seeding of filled area	24.1	M.S.F.	66.04	1,600
Estimated Cover System O&M Costs - Subtotal				20,500
Contingency		*%*	*20*	*4,100*
Estimated Annual Cover Maintenance O&M Costs - Total				**25,000**

M.S.F. = 1,000 square feet

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Periodic Cost Estimate - 5 year Review
1,000 pCi/g Remedy Alternative

Description	Quantity	Units	Unit Rate	Estimated Cost ($)
Access Restrictions (inspect/repair fencing and signage)	16	hours	150	2,400
Institutional Controls verification	8	hours	150	1,200
Document that landfill cover is effective	8	hours	150	1,200
Assemble Monitoring Data (landfill gas/radon, groundwater, surface water)	40	hours	150	6,000
Summarize Annual Post-Construction Site Inspections	8	hours	150	1,200
Summarize Annual Cover Maintenance Documentation	8	hours	150	1,200
Water supply well inventory review	8	hours	150	1,200
Document any changes in Land Use at and around West Lake Landfill	16	hours	150	2,400
Prepare Summary Report	80	hours	150	12,000
Estimated 5-year Maint/Review O&M Costs - Subtotal				**29,000**
Contingency		*%*	*20*	*6,000*
Estimated 5-year Maintenance O&M Costs - Total				**35,000**

Present Worth Cost Estimate
1,000 pCi/g Remedy Alternative

Year	*n*	P/F(*i* =7%)	Capital Costs ($): Remediation	Capital Costs ($): Subtotal Capital Costs	Operation, Maintenance, Monitoring, and Periodic Costs ($/yr): Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000	14,120,000	14,120,000					0	14,120,000	14,120,000	14,120,000
2018	1	0.93458	48,700,000	48,700,000					0	48,700,000	45,514,000	59,634,000
2019	2	0.87344	32,280,000	32,280,000					0	32,280,000	28,195,000	87,829,000
2020	3	0.81630	44,850,000	44,850,000					0	44,850,000	36,611,000	124,440,000
2021	4	0.76290	63,170,000	63,170,000					0	63,170,000	48,192,000	172,632,000
2022	5	0.71299	39,000,000	39,000,000					0	39,000,000	27,806,000	200,438,000
2023	6	0.66634	30,690,000	30,690,000					0	30,690,000	20,450,000	220,888,000
2024	7	0.62275	49,120,000	49,120,000					0	49,120,000	30,589,000	251,477,000
2025	8	0.58201	38,830,000	38,830,000	4,000				4,000	38,834,000	22,602,000	274,079,000
2026	9	0.54393			16,000	248,000	27,000		291,000	291,000	158,000	274,237,000
2027	10	0.50835			16,000	248,000	27,000		291,000	291,000	148,000	274,385,000
2028	11	0.47509			16,000	248,000	27,000		291,000	291,000	138,000	274,523,000
2029	12	0.44401			16,000	248,000	27,000		291,000	291,000	129,000	274,652,000
2030	13	0.41496			16,000	248,000	27,000	35,000	326,000	326,000	135,000	274,787,000
2031	14	0.38782			16,000	124,000	27,000		167,000	167,000	65,000	274,852,000
2032	15	0.36245			16,000	124,000	27,000		167,000	167,000	61,000	274,913,000
2033	16	0.33873			16,000	124,000	27,000		167,000	167,000	57,000	274,970,000
2034	17	0.31657			16,000	124,000	27,000		167,000	167,000	53,000	275,023,000
2035	18	0.29586			16,000	124,000	27,000	35,000	202,000	202,000	60,000	275,083,000
2036	19	0.27651			16,000	124,000	27,000		167,000	167,000	46,000	275,129,000
2037	20	0.25842			16,000	124,000	27,000		167,000	167,000	43,000	275,172,000
2038	21	0.24151			16,000	124,000	27,000		167,000	167,000	40,000	275,212,000
2039	22	0.22571			16,000	124,000	27,000		167,000	167,000	38,000	275,250,000
2040	23	0.21095			16,000	124,000	27,000	35,000	202,000	202,000	43,000	275,293,000
2041	24	0.19715			16,000	124,000	27,000		167,000	167,000	33,000	275,326,000
2042	25	0.18425			16,000	124,000	27,000		167,000	167,000	31,000	275,357,000
2043	26	0.17220			16,000	124,000	27,000		167,000	167,000	29,000	275,386,000
2044	27	0.16093			16,000	124,000	27,000		167,000	167,000	27,000	275,413,000
2045	28	0.15040			16,000	124,000	27,000	35,000	202,000	202,000	30,000	275,443,000
2046	29	0.14056			16,000	124,000	27,000		167,000	167,000	23,000	275,466,000
2047	30	0.13137			16,000	124,000	27,000		167,000	167,000	22,000	275,488,000

Estimated Non-discounted Capital Costs: 361,000,000

Estimated Non-discounted Total Costs: 365,000,000

Estimated 30-year Present Worth Costs: 275,000,000

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. In accordance with USEPA Guidance, this is an order-of-magnitude engineering estimate that is expected to be within -30 to +50 percent of the actual project cost.

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Present Worth Cost Estimate
1,000 pCi/g Remedy Alternative

Year	*n*	P/F(*i* =1.5%)	Capital Costs ($): Remediation	Capital Costs ($): Subtotal Capital Costs	Operation, Maintenance, Monitoring, and Periodic Costs ($/yr): Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000	14,120,000	14,120,000					0	14,120,000	14,120,000	14,120,000
2018	1	0.98522	48,700,000	48,700,000					0	48,700,000	47,980,000	62,100,000
2019	2	0.97066	32,280,000	32,280,000					0	32,280,000	31,333,000	93,433,000
2020	3	0.95632	44,850,000	44,850,000					0	44,850,000	42,891,000	136,324,000
2021	4	0.94218	63,170,000	63,170,000					0	63,170,000	59,518,000	195,842,000
2022	5	0.92826	39,000,000	39,000,000					0	39,000,000	36,202,000	232,044,000
2023	6	0.91454	30,690,000	30,690,000					0	30,690,000	28,067,000	260,111,000
2024	7	0.90103	49,120,000	49,120,000					0	49,120,000	44,258,000	304,369,000
2025	8	0.88771	38,830,000	38,830,000	4,000				4,000	38,834,000	34,473,000	338,842,000
2026	9	0.87459			16,000	248,000	27,000		291,000	291,000	255,000	339,097,000
2027	10	0.86167			16,000	248,000	27,000		291,000	291,000	251,000	339,348,000
2028	11	0.84893			16,000	248,000	27,000		291,000	291,000	247,000	339,595,000
2029	12	0.83639			16,000	248,000	27,000		291,000	291,000	243,000	339,838,000
2030	13	0.82403			16,000	248,000	27,000	35,000	326,000	326,000	269,000	340,107,000
2031	14	0.81185			16,000	124,000	27,000		167,000	167,000	136,000	340,243,000
2032	15	0.79985			16,000	124,000	27,000		167,000	167,000	134,000	340,377,000
2033	16	0.78803			16,000	124,000	27,000		167,000	167,000	132,000	340,509,000
2034	17	0.77639			16,000	124,000	27,000		167,000	167,000	130,000	340,639,000
2035	18	0.76491			16,000	124,000	27,000	35,000	202,000	202,000	155,000	340,794,000
2036	19	0.75361			16,000	124,000	27,000		167,000	167,000	126,000	340,920,000
2037	20	0.74247			16,000	124,000	27,000		167,000	167,000	124,000	341,044,000
2038	21	0.73150			16,000	124,000	27,000		167,000	167,000	122,000	341,166,000
2039	22	0.72069			16,000	124,000	27,000		167,000	167,000	120,000	341,286,000
2040	23	0.71004			16,000	124,000	27,000	35,000	202,000	202,000	143,000	341,429,000
2041	24	0.69954			16,000	124,000	27,000		167,000	167,000	117,000	341,546,000
2042	25	0.68921			16,000	124,000	27,000		167,000	167,000	115,000	341,661,000
2043	26	0.67902			16,000	124,000	27,000		167,000	167,000	113,000	341,774,000
2044	27	0.66899			16,000	124,000	27,000		167,000	167,000	112,000	341,886,000
2045	28	0.65910			16,000	124,000	27,000	35,000	202,000	202,000	133,000	342,019,000
2046	29	0.64936			16,000	124,000	27,000		167,000	167,000	108,000	342,127,000
2047	30	0.63976			16,000	124,000	27,000		167,000	167,000	107,000	342,234,000

Estimated Non-discounted Capital Costs: 361,000,000

Estimated Non-discounted Total Costs: 365,000,000

Estimated 30-year Present Worth Costs: 342,000,000

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. In accordance with USEPA Guidance, this is an order-of-magnitude engineering estimate that is expected to be within -30 to +50 percent of the actual project cost.

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Present Worth Cost Estimate
1,000 pCi/g Remedy Alternative

Year	*n*	P/F(*i* =7%)	Capital Costs ($): Remediation	Capital Costs ($): Subtotal Capital Costs	Operation, Maintenance, Monitoring, and Periodic Costs ($/yr): Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000	14,120,000	14,120,000					0	14,120,000	14,120,000	14,120,000
2018	1	0.93458	48,700,000	48,700,000					0	48,700,000	45,514,000	59,634,000
2019	2	0.87344	32,280,000	32,280,000					0	32,280,000	28,195,000	87,829,000
2020	3	0.81630	44,850,000	44,850,000					0	44,850,000	36,611,000	124,440,000
2021	4	0.76290	63,170,000	63,170,000					0	63,170,000	48,192,000	172,632,000
2022	5	0.71299	39,000,000	39,000,000					0	39,000,000	27,806,000	200,438,000
2023	6	0.66634	30,690,000	30,690,000					0	30,690,000	20,450,000	220,888,000
2024	7	0.62275	49,120,000	49,120,000					0	49,120,000	30,589,000	251,477,000
2025	8	0.58201	38,830,000	38,830,000	4,000				4,000	38,834,000	22,602,000	274,079,000
2026	9	0.54393			16,000	248,000	27,000		291,000	291,000	158,000	274,237,000
2027	10	0.50835			16,000	248,000	27,000		291,000	291,000	148,000	274,385,000
2028	11	0.47509			16,000	248,000	27,000		291,000	291,000	138,000	274,523,000
2029	12	0.44401			16,000	248,000	27,000		291,000	291,000	129,000	274,652,000
2030	13	0.41496			16,000	248,000	27,000	35,000	326,000	326,000	135,000	274,787,000
2031	14	0.38782			16,000	124,000	27,000		167,000	167,000	65,000	274,852,000
2032	15	0.36245			16,000	124,000	27,000		167,000	167,000	61,000	274,913,000
2033	16	0.33873			16,000	124,000	27,000		167,000	167,000	57,000	274,970,000
2034	17	0.31657			16,000	124,000	27,000		167,000	167,000	53,000	275,023,000
2035	18	0.29586			16,000	124,000	27,000	35,000	202,000	202,000	60,000	275,083,000
2036	19	0.27651			16,000	124,000	27,000		167,000	167,000	46,000	275,129,000
2037	20	0.25842			16,000	124,000	27,000		167,000	167,000	43,000	275,172,000
2038	21	0.24151			16,000	124,000	27,000		167,000	167,000	40,000	275,212,000
2039	22	0.22571			16,000	124,000	27,000		167,000	167,000	38,000	275,250,000
2040	23	0.21095			16,000	124,000	27,000	35,000	202,000	202,000	43,000	275,293,000
2041	24	0.19715			16,000	124,000	27,000		167,000	167,000	33,000	275,326,000
2042	25	0.18425			16,000	124,000	27,000		167,000	167,000	31,000	275,357,000
2043	26	0.17220			16,000	124,000	27,000		167,000	167,000	29,000	275,386,000
2044	27	0.16093			16,000	124,000	27,000		167,000	167,000	27,000	275,413,000
2045	28	0.15040			16,000	124,000	27,000	35,000	202,000	202,000	30,000	275,443,000
2046	29	0.14056			16,000	124,000	27,000		167,000	167,000	23,000	275,466,000
2047	30	0.13137			16,000	124,000	27,000		167,000	167,000	22,000	275,488,000
2216	199	0.0000014			16,000	124,000	27,000		167,000	167,000	0	275,812,000
2217	200	0.0000013			16,000	124,000	27,000		167,000	167,000	0	275,812,000

Estimated Non-discounted Capital Costs: 361,000,000

Estimated Non-discounted Total Costs: 395,000,000

Estimated 200-year Present Worth Costs: 276,000,000

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. In accordance with USEPA Guidance, this is an order-of-magnitude engineering estimate that is expected to be within -30 to +50 percent of the actual project cost.

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Present Worth Cost Estimate
1,000 pCi/g Remedy Alternative

			Capital Costs ($)		Operation, Maintenance, Monitoring, and Periodic Costs ($/yr)							
Year	*n*	P/F(*i* =1.5%)	Remediation	Subtotal Capital Costs	Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000	14,120,000	14,120,000					0	14,120,000	14,120,000	14,120,000
2018	1	0.98522	48,700,000	48,700,000					0	48,700,000	47,980,000	62,100,000
2019	2	0.97066	32,280,000	32,280,000					0	32,280,000	31,333,000	93,433,000
2020	3	0.95632	44,850,000	44,850,000					0	44,850,000	42,891,000	136,324,000
2021	4	0.94218	63,170,000	63,170,000					0	63,170,000	59,518,000	195,842,000
2022	5	0.92826	39,000,000	39,000,000					0	39,000,000	36,202,000	232,044,000
2023	6	0.91454	30,690,000	30,690,000					0	30,690,000	28,067,000	260,111,000
2024	7	0.90103	49,120,000	49,120,000					0	49,120,000	44,258,000	304,369,000
2025	8	0.88771	38,830,000	38,830,000	4,000				4,000	38,834,000	34,473,000	338,842,000
2026	9	0.87459			16,000	248,000	27,000		291,000	291,000	255,000	339,097,000
2027	10	0.86167			16,000	248,000	27,000		291,000	291,000	251,000	339,348,000
2028	11	0.84893			16,000	248,000	27,000		291,000	291,000	247,000	339,595,000
2029	12	0.83639			16,000	248,000	27,000		291,000	291,000	243,000	339,838,000
2030	13	0.82403			16,000	248,000	27,000	35,000	326,000	326,000	269,000	340,107,000
2031	14	0.81185			16,000	124,000	27,000	0	167,000	167,000	136,000	340,243,000
2032	15	0.79985			16,000	124,000	27,000		167,000	167,000	134,000	340,377,000
2033	16	0.78803			16,000	124,000	27,000		167,000	167,000	132,000	340,509,000
2034	17	0.77639			16,000	124,000	27,000		167,000	167,000	130,000	340,639,000
2035	18	0.76491			16,000	124,000	27,000	35,000	202,000	202,000	155,000	340,794,000
2036	19	0.75361			16,000	124,000	27,000		167,000	167,000	126,000	340,920,000
2037	20	0.74247			16,000	124,000	27,000		167,000	167,000	124,000	341,044,000
2038	21	0.73150			16,000	124,000	27,000		167,000	167,000	122,000	341,166,000
2039	22	0.72069			16,000	124,000	27,000		167,000	167,000	120,000	341,286,000
2040	23	0.71004			16,000	124,000	27,000	35,000	202,000	202,000	143,000	341,429,000
2041	24	0.69954			16,000	124,000	27,000		167,000	167,000	117,000	341,546,000
2042	25	0.68921			16,000	124,000	27,000		167,000	167,000	115,000	341,661,000
2043	26	0.67902			16,000	124,000	27,000		167,000	167,000	113,000	341,774,000
2044	27	0.66899			16,000	124,000	27,000		167,000	167,000	112,000	341,886,000
2045	28	0.65910			16,000	124,000	27,000	35,000	202,000	202,000	133,000	342,019,000
2046	29	0.64936			16,000	124,000	27,000		167,000	167,000	108,000	342,127,000
2047	30	0.63976			16,000	124,000	27,000		167,000	167,000	107,000	342,234,000
2216	199	0.05167			16,000	124,000	27,000	0	167,000	167,000	9,000	349,053,000
2217	200	0.05091			16,000	124,000	27,000	0	167,000	167,000	9,000	349,062,000

Estimated Non-discounted Capital Costs: 361,000,000

Estimated Non-discounted Total Costs: 395,000,000

Estimated 200-year Present Worth Costs: 349,000,000

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. In accordance with USEPA Guidance, this is an order-of-magnitude engineering estimate that is expected to be within -30 to +50 percent of the actual project cost.

Present Worth Cost Estimate
1,000 pCi/g Remedy Alternative

			Capital Costs ($)		Operation, Maintenance, Monitoring, and Periodic Costs ($/yr)							
Year	*n*	P/F(*i* =7%)	Remediation	Subtotal Capital Costs	Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000	14,120,000	14,120,000					0	14,120,000	14,120,000	14,120,000
2018	1	0.93458	48,700,000	48,700,000					0	48,700,000	45,514,000	59,634,000
2019	2	0.87344	32,280,000	32,280,000					0	32,280,000	28,195,000	87,829,000
2020	3	0.81630	44,850,000	44,850,000					0	44,850,000	36,611,000	124,440,000
2021	4	0.76290	63,170,000	63,170,000					0	63,170,000	48,192,000	172,632,000
2022	5	0.71299	39,000,000	39,000,000					0	39,000,000	27,806,000	200,438,000
2023	6	0.66634	30,690,000	30,690,000					0	30,690,000	20,450,000	220,888,000
2024	7	0.62275	49,120,000	49,120,000					0	49,120,000	30,589,000	251,477,000
2025	8	0.58201	38,830,000	38,830,000	4,000				4,000	38,834,000	22,602,000	274,079,000
2026	9	0.54393			16,000	248,000	27,000		291,000	291,000	158,000	274,237,000
2027	10	0.50835			16,000	248,000	27,000		291,000	291,000	148,000	274,385,000
2028	11	0.47509			16,000	248,000	27,000		291,000	291,000	138,000	274,523,000
2029	12	0.44401			16,000	248,000	27,000		291,000	291,000	129,000	274,652,000
2030	13	0.41496			16,000	248,000	27,000	35,000	326,000	326,000	135,000	274,787,000
2031	14	0.38782			16,000	124,000	27,000		167,000	167,000	65,000	274,852,000
2032	15	0.36245			16,000	124,000	27,000		167,000	167,000	61,000	274,913,000
2033	16	0.33873			16,000	124,000	27,000		167,000	167,000	57,000	274,970,000
2034	17	0.31657			16,000	124,000	27,000		167,000	167,000	53,000	275,023,000
2035	18	0.29586			16,000	124,000	27,000	35,000	202,000	202,000	60,000	275,083,000
2036	19	0.27651			16,000	124,000	27,000		167,000	167,000	46,000	275,129,000
2037	20	0.25842			16,000	124,000	27,000		167,000	167,000	43,000	275,172,000
2038	21	0.24151			16,000	124,000	27,000		167,000	167,000	40,000	275,212,000
2039	22	0.22571			16,000	124,000	27,000		167,000	167,000	38,000	275,250,000
2040	23	0.21095			16,000	124,000	27,000	35,000	202,000	202,000	43,000	275,293,000
2041	24	0.19715			16,000	124,000	27,000		167,000	167,000	33,000	275,326,000
2042	25	0.18425			16,000	124,000	27,000		167,000	167,000	31,000	275,357,000
2043	26	0.17220			16,000	124,000	27,000		167,000	167,000	29,000	275,386,000
2044	27	0.16093			16,000	124,000	27,000		167,000	167,000	27,000	275,413,000
2045	28	0.15040			16,000	124,000	27,000	35,000	202,000	202,000	30,000	275,443,000
2046	29	0.14056			16,000	124,000	27,000		167,000	167,000	23,000	275,466,000
2047	30	0.13137			16,000	124,000	27,000		167,000	167,000	22,000	275,488,000
3016	999	4.422E-30			16,000	124,000	27,000		167,000	167,000	0	275,812,000
3017	1000	4.133E-30			16,000	124,000	27,000		167,000	167,000	0	275,812,000

Estimated Non-discounted Capital Costs: 361,000,000

Estimated Non-discounted Total Costs: 534,000,000

Estimated 1,000-year Present Worth Costs: 276,000,000

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. In accordance with USEPA Guidance, this is an order-of-magnitude engineering estimate that is expected to be within -30 to +50 percent of the actual project cost.

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Present Worth Cost Estimate
1,000 pCi/g Remedy Alternative

			Capital Costs ($)		Operation, Maintenance, Monitoring, and Periodic Costs ($/yr)							
Year	*n*	P/F(*i* =1.5%)	Remediation	Subtotal Capital Costs	Landfill Gas and Radon Monitoring	Groundwater Monitoring	Annual Site Inspection/Cover Maintenance	5 year Review	Subtotal OM&M and Periodic Costs	Total Costs ($)	Present Worth of Costs ($)	Cumulative Present Worth ($)
2017	0	1.00000	14,120,000	14,120,000					0	14,120,000	14,120,000	14,120,000
2018	1	0.98522	48,700,000	48,700,000					0	48,700,000	47,980,000	62,100,000
2019	2	0.97066	32,280,000	32,280,000					0	32,280,000	31,333,000	93,433,000
2020	3	0.95632	44,850,000	44,850,000					0	44,850,000	42,891,000	136,324,000
2021	4	0.94218	63,170,000	63,170,000					0	63,170,000	59,518,000	195,842,000
2022	5	0.92826	39,000,000	39,000,000					0	39,000,000	36,202,000	232,044,000
2023	6	0.91454	30,690,000	30,690,000					0	30,690,000	28,067,000	260,111,000
2024	7	0.90103	49,120,000	49,120,000					0	49,120,000	44,258,000	304,369,000
2025	8	0.88771	38,830,000	38,830,000	4,000				4,000	38,834,000	34,473,000	338,842,000
2026	9	0.87459			16,000	248,000	27,000		291,000	291,000	255,000	339,097,000
2027	10	0.86167			16,000	248,000	27,000		291,000	291,000	251,000	339,348,000
2028	11	0.84893			16,000	248,000	27,000		291,000	291,000	247,000	339,595,000
2029	12	0.83639			16,000	248,000	27,000		291,000	291,000	243,000	339,838,000
2030	13	0.82403			16,000	248,000	27,000	35,000	326,000	326,000	269,000	340,107,000
2031	14	0.81185			16,000	124,000	27,000		167,000	167,000	136,000	340,243,000
2032	15	0.79985			16,000	124,000	27,000		167,000	167,000	134,000	340,377,000
2033	16	0.78803			16,000	124,000	27,000		167,000	167,000	132,000	340,509,000
2034	17	0.77639			16,000	124,000	27,000		167,000	167,000	130,000	340,639,000
2035	18	0.76491			16,000	124,000	27,000	35,000	202,000	202,000	155,000	340,794,000
2036	19	0.75361			16,000	124,000	27,000		167,000	167,000	126,000	340,920,000
2037	20	0.74247			16,000	124,000	27,000		167,000	167,000	124,000	341,044,000
2038	21	0.73150			16,000	124,000	27,000		167,000	167,000	122,000	341,166,000
2039	22	0.72069			16,000	124,000	27,000		167,000	167,000	120,000	341,286,000
2040	23	0.71004			16,000	124,000	27,000	35,000	202,000	202,000	143,000	341,429,000
2041	24	0.69954			16,000	124,000	27,000		167,000	167,000	117,000	341,546,000
2042	25	0.68921			16,000	124,000	27,000		167,000	167,000	115,000	341,661,000
2043	26	0.67902			16,000	124,000	27,000		167,000	167,000	113,000	341,774,000
2044	27	0.66899			16,000	124,000	27,000		167,000	167,000	112,000	341,886,000
2045	28	0.65910			16,000	124,000	27,000	35,000	202,000	202,000	133,000	342,019,000
2046	29	0.64936			16,000	124,000	27,000		167,000	167,000	108,000	342,127,000
2047	30	0.63976			16,000	124,000	27,000		167,000	167,000	107,000	342,234,000
3016	999	3.471E-07			16,000	124,000	27,000		167,000	167,000	0	349,629,000
3017	1000	3.419E-07			16,000	124,000	27,000		167,000	167,000	0	349,629,000

Estimated Non-discounted Capital Costs: 361,000,000

Estimated Non-discounted Total Costs: 534,000,000

Estimated 1,000-year Present Worth Costs: 350,000,000

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. In accordance with USEPA Guidance, this is an order-of-magnitude engineering estimate that is expected to be within -30 to +50 percent of the actual project cost.

Appendix L:

RIM Average Activity Levels

Prepared by:

S.S. PAPADOPULOS & ASSOCIATES, INC.
7944 Wisconsin Avenue
Bethesda, MD 20814-3620

S.S. PAPADOPULOS & ASSOCIATES, INC.
Environmental & Water-Resource Consultants

Memorandum

Date: December 15, 2016

From: Matthew J. Tonkin, SSP&A

To: Paul Rosasco, EMSI

Subject: Estimates of Average Combined Radium and Combined Thorium Concentrations

In support of the risk assessment (FFS Appendix H) and comparison of radiologically impacted material (RIM) activity levels to the Waste Acceptance Criteria (WAC) of the various off-site disposal facilities, estimates were required of the average concentrations of combined Radium and of combined Thorium in landfilled material in OU-1 Areas 1 and 2 that would need to be handled or disposed of under the various remedy alternatives considered. These averages were estimated by post-processing the results of the previously-completed three-dimensional (3D) indicator kriging (IK) that is detailed in the report "*Estimated Three-Dimensional Extent of Radiologically Impacted Material, West Lake Landfill, Operable Unit 1, Bridgeton, Missouri*" ("RIM mapping report", SSP&A, September 2016: FFS Appendix B). The materials that would need to be handled under the various remedy alternatives include RIM and any associated landfill material together with overburden and any additional material removed as required for safe setback during excavation. Estimates of average concentrations were required for:

1. All materials that would be handled (*i.e.*, RIM with associated landfill materials, vertical overburden and setback), in consideration of the risk posed to workers during remedy implementation ("all material").
2. RIM only, to evaluate estimated activity levels relative to the WAC of the various disposal facilities ("RIM only").

The 3D IK calculations described in the RIM mapping report were completed to estimate the extent of landfill material that would exceed four concentration thresholds (*i.e.*, 7.9, 52.9, 500 and 1,000 pCi/g) for combined Thorium *or* combined Radium. Calculations of "all material" and "RIM only" averages presented here were made for the following five potential remedy alternatives:

1. Excavation of Areas 1 and 2 to remove RIM exhibiting combined Radium *or* combined Thorium concentrations greater than 7.9 pCi/g (the "complete rad removal" alternative);
2. Partial excavation of Areas 1 and 2 to remove RIM exhibiting combined Radium *or* combined Thorium concentrations greater than 52.9 pCi/g present within 16 feet of the 2005 ground surface;
3. Partial excavation of Areas 1 and 2 to remove RIM exhibiting combined Radium *or* combined Thorium concentrations greater than 500 pCi/g;
4. Partial excavation of Areas 1 and 2 to remove RIM exhibiting combined Radium *or* combined Thorium concentrations greater than 1,000 pCi/g; and

5. The ROD-selected remedy, which would involve regrading of Areas 1 and 2, thus necessitating handling of some RIM and some non-RIM.

Alternative (3) is an intermediate between (2) and (4) that was not specifically evaluated in the FFS or risk assessment, but is included here for completeness and consistency with the results presented in the RIM mapping report.

Output files from the 3D IK calculations do not specifically list concentrations of combined Thorium or combined Radium; rather, they list probabilities as to whether the concentration thresholds are or are not exceeded, from which concentrations can be estimated. For each OU-1 Area, two sets of outputs from the 3D IK RIM mapping were used to estimate average concentrations for the potential alternatives listed above. The first group of outputs comprises two files: one file for combined Radium and one file for combined Thorium. Each of these files lists, for each location in the 3D grid, a conditional cumulative density function (CCDF) describing the probability of non-exceedance for each concentration threshold. An example CCDF is shown below:

Threshold (pCi/g)	Non-Exceedance Probability
7.9	0.49
52.9	0.96
500	0.98
1,000	0.99

The interpolated values between 0 and 1 can be interpreted as probabilities. In the simplest case of a single concentration threshold, the value of 0.50 is then often used distinguish between regions that likely exceed the concentration threshold of interest (i.e., the interpolated probability is >0.50) or fall below that threshold (i.e., the interpolated probability is <0.50). In the case of multiple concentration thresholds, if the 0.50 probability lies between two thresholds, the likely concentration is constrained and can be estimated using the non-exceedance probabilities for the two thresholds that bound the 0.50 probability. In this example, the concentration likely lies above 7.9 and below 52.9 pCi/g, and can be estimated assuming a linear or a semi-logarithmic relation between concentration and probability. In this case, the difference in the concentration estimates is small (8.6 pCi/g, assuming a linear relation versus 8.2 pCi/g assuming a semi-logarithmic relation), because one of the two non-exceedance probabilities is very close to 0.50. If the 0.50 probability lies below the lowest threshold or above the highest threshold, the likely concentration lies outside these thresholds and estimation requires interpolation bounds at these "tails" (*e.g.*, Goovaerts, 1997; Pyrcz and Deutsch, 2014). In all calculations here, the lower interpolation bound was set at 0.1 pCi/g and the upper interpolation bound was set at the median value of the sample concentrations that exceed the upper threshold, which reduces the leverage of the small number of very high concentration sample results when estimating averages. In all cases, concentration was assumed to vary linearly with probability between concentration thresholds or interpolation bounds.

The above calculations provide estimates of the combined Radium and combined Thorium concentrations for each 3D IK grid block. To obtain the average concentration for "all material" that would be handled and for the "RIM only" material that would be handled under each of the five potential alternatives, each 3D IK grid block must be identified as either RIM, vertical overburden or setback. This was accomplished using the second group of 3D IK output files, comprising four files - one for each concentration threshold. This set of files contains integers (i.e., numeric flags) that identify whether each grid block is (a) RIM, (b) vertical overburden or (c) setback material assuming excavation of RIM at the corresponding concentration threshold. Any non-zero entry in any of these integer files represents a 3D IK block that would need to be removed under the corresponding alternative. For the first four potential remedy alternatives, the average concentration of combined Radium and combined Thorium was determined for each area by summing the concentrations estimated for all non-zero IK 3D blocks and dividing by the number of non-zero blocks. For the ROD remedy alternative, the average concentration of combined Radium and combined Thorium was determined for each Area by making the same calculation using only 3D IK blocks that lie above the corresponding ROD remedy top-of-waste elevation surface (provided by Feezor Engineering, Inc., in files "*SRF_ROD A1 top of waste.tif*" and "*SRF_ROD A2 top of waste.tif*" for Areas 1 and 2, respectively).

The average concentrations of combined Radium and combined Thorium estimated using this procedure for each of Area 1 and Area 2 for the five potential remedial alternatives are provided in Table L-1 ("All Material") and Table L-2 ("RIM Only"). The estimates obtained for the ROD remedy alternative – in particular for the "RIM only" scenario listed in Table L-2 – are subject to greater uncertainty than the estimates obtained for the other potential alternatives, because the ROD remedy alternative requires the handling of substantially (orders of magnitude) less material, much of which is at or close to the land surface and for which relatively few samples were available when the 3D IK RIM mapping was undertaken.

Table L-1 Summary of Average Concentrations (pCi/g): "All Material"

OU-1 Area	Constituent	*Linear Averages using Median Value for Upper Tail*				
		>7.9	**>52.9**	**>500**	**>1,000**	**ROD Remedy**
Area 1	Combined Thorium	52	250	65	76	5
Area 2	Combined Thorium	300	529	574	694	150
Area 1	Combined Radium	33	157	41	43	5
Area 2	Combined Radium	129	229	232	241	60

Table L-2 Summary of Average Concentrations (pCi/g): "RIM Only"

OU-1 Area	Constituent	*Linear Averages using Median Value for Upper Tail*				
		>7.9	**>52.9**	**>500**	**>1,000**	**ROD Remedy[1]**
Area 1	Combined Thorium	662	847	1,487	2,661	100
Area 2	Combined Thorium	856	1,184	2,191	4,111	750
Area 1	Combined Radium	401	526	841	1,192	100
Area 2	Combined Radium	362	507	807	1,025	310

Notes:

1 Estimates of the average concentration of combined Radium and combined Thorium for the ROD remedy alternative are subject to substantial uncertainty. See text for explanation.

References:

Goovaerts, P., 1997. Geostatistics for Natural Resources Evaluation (Applied Geostatistics Series), Oxford University Press, ISBN: 9780195115383, pp 483.

Pyrcz, M.J and C.V. Deutsch, 2014. Geostatistical Reservoir Modeling, Second Edition, Oxford University Press, ISBN: 9780199731442, pp 448.

Appendix M:

Excavation and Final Grading Plans

Prepared by:

Feezor Engineering, Inc.
406 E. Walnut Street
Chatham, Illinois 62629

DESIGN DRAWINGS FOR THE

RADIOLOGICALLY IMPACTED MATERIAL REMEDIATION FINAL FEASIBILITY STUDY

LOCATION MAP

N

SEPTEMBER 2016
PREPARED FOR:

BRIDGETON LANDFILL, LLC

13570 ST. CHARLES ROCK ROAD
BRIDGETON, MISSOURI 63044

Engineering for a Better World
FEEZOR ENGINEERING, INC.

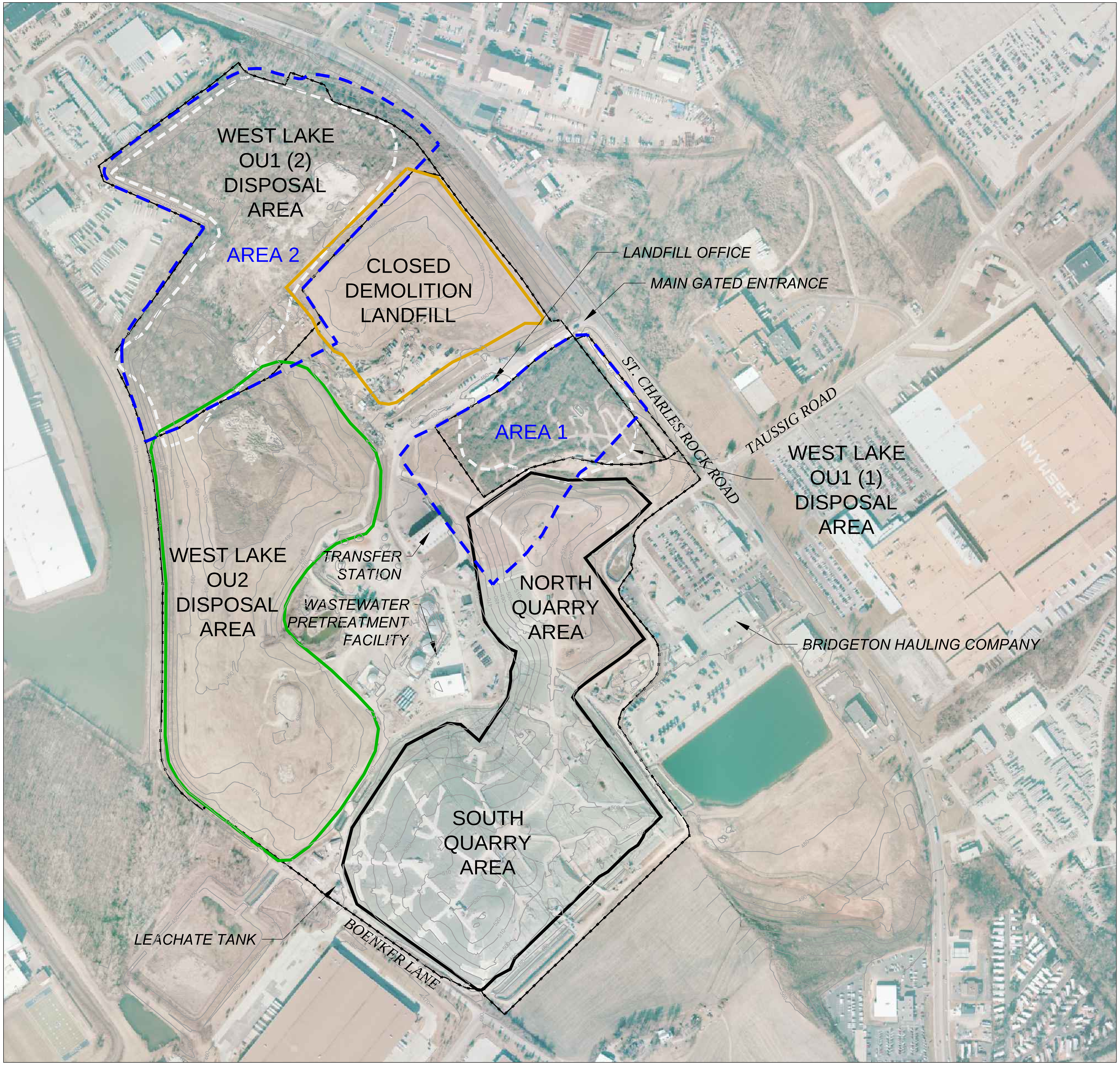
406 EAST WALNUT STREET
CHATHAM, IL 62629
TEL. (217) 483-3118
FAX. (217) 483-2356

INDEX OF DRAWINGS

DRAFT

CHANGES TO THIS PLAN/DRAWING SET REQUIRE WRITTEN APPROVAL BY FEI.

Daniel R. Feezor, P.E.
IL P.E. No: 062-048889 Date



0 200 400 Feet

DRAFT

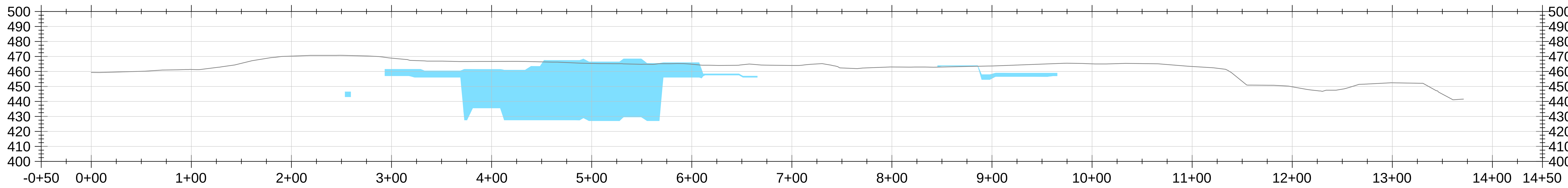
NOTES:

- AERIAL TOPOGRAPHY PROVIDED BY COOPER AERIAL SURVEYS, INC. AND IS DATED MARCH 10, 2015
- ALL ELEVATIONS ARE ABOVE MEAN SEA LEVEL (AMSL)

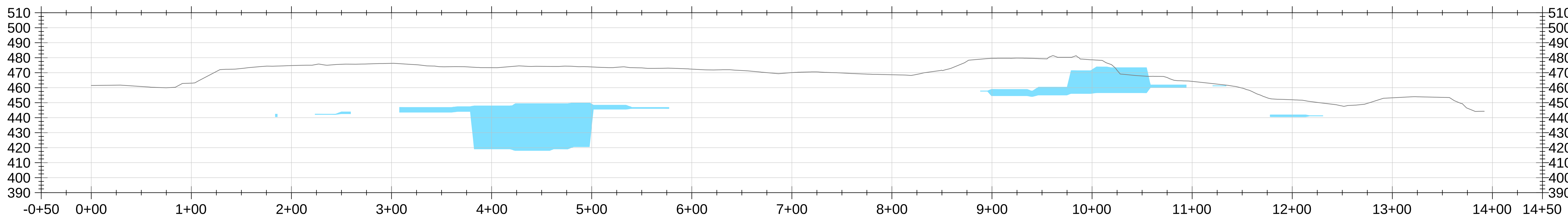
THE DRAWINGS INCLUDED WITHIN THIS PLAN SET ARE NOT DESIGN NOR CONSTRUCTION LEVEL DRAWINGS. THEY ARE INTENDED FOR ILLUSTRATIVE PURPOSES ONLY.

BRIDGETON LANDFILL 13570 ST. CHARLES ROCK ROAD BRIDGETON, MISSOURI 63044	BRIDGETON LANDFILL FINAL FEASIBILITY STUDY	Engineering for a Better World FEEZOR ENGINEERING, INC.	JULY 2016 DESIGNED BY: PML APPROVED BY: ---	DRAWING NO.: 002
SITE FACILITY MAP			REVISION / DATE	
PROJECT NUMBER: BT-106	FILE PATH: E:\Dropbox (Feezor Engineering)\Bridgeton\BT-106 West Lake Final Feasibility Study\Step 1 - Design\ALLL OPTIONS\site Map.dwg			

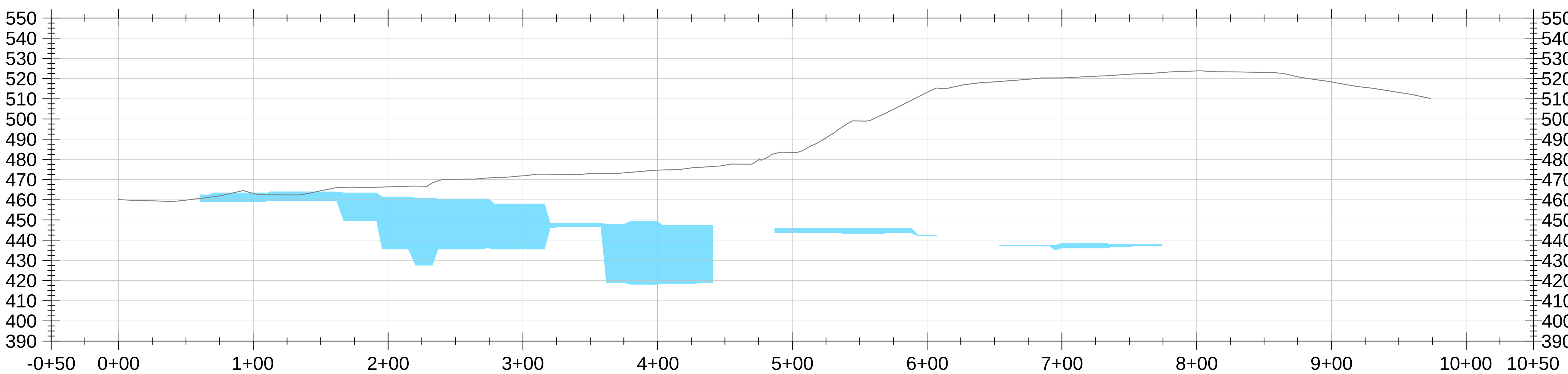
Profile View of Alignment A Vertical Exaggeration x 1.5



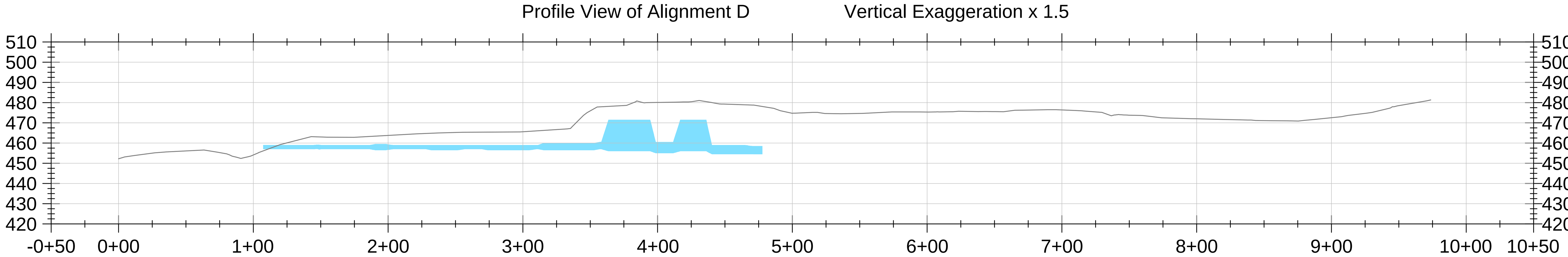
Profile View of Alignment B Vertical Exaggeration x 1.5



Profile View of Alignment C Vertical Exaggeration x 1.5



Profile View of Alignment D Vertical Exaggeration x 1.5



LEGEND

- 2015 TOPOGRAPHY (2' CONTOUR)
- 500 — 2015 TOPOGRAPHY (10' CONTOUR)
- AREA 1 BOUNDARY
- RIM

DRAFT

NOTES:

- AERIAL TOPOGRAPHY PROVIDED BY COOPER AERIAL SURVEYS, INC. AND IS DATED MARCH 10, 2015
- ALL 3 DIMENSIONAL EXTENTS OF RADIOLOGICALLY IMPACTED MATERIAL (RIM) AND ALL INITIAL EXCAVATION SURFACES WERE PROVIDED BY S.S. PAPADOPULOS & ASSOC., INC.
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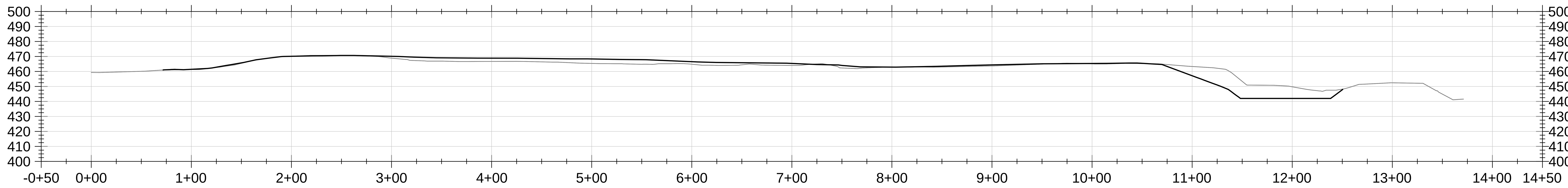
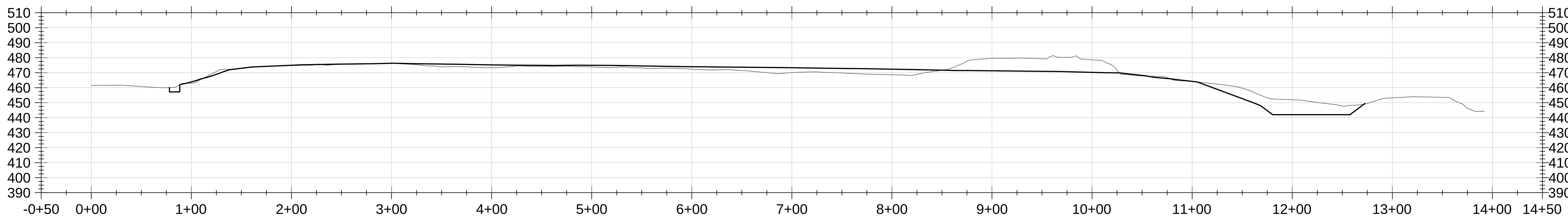
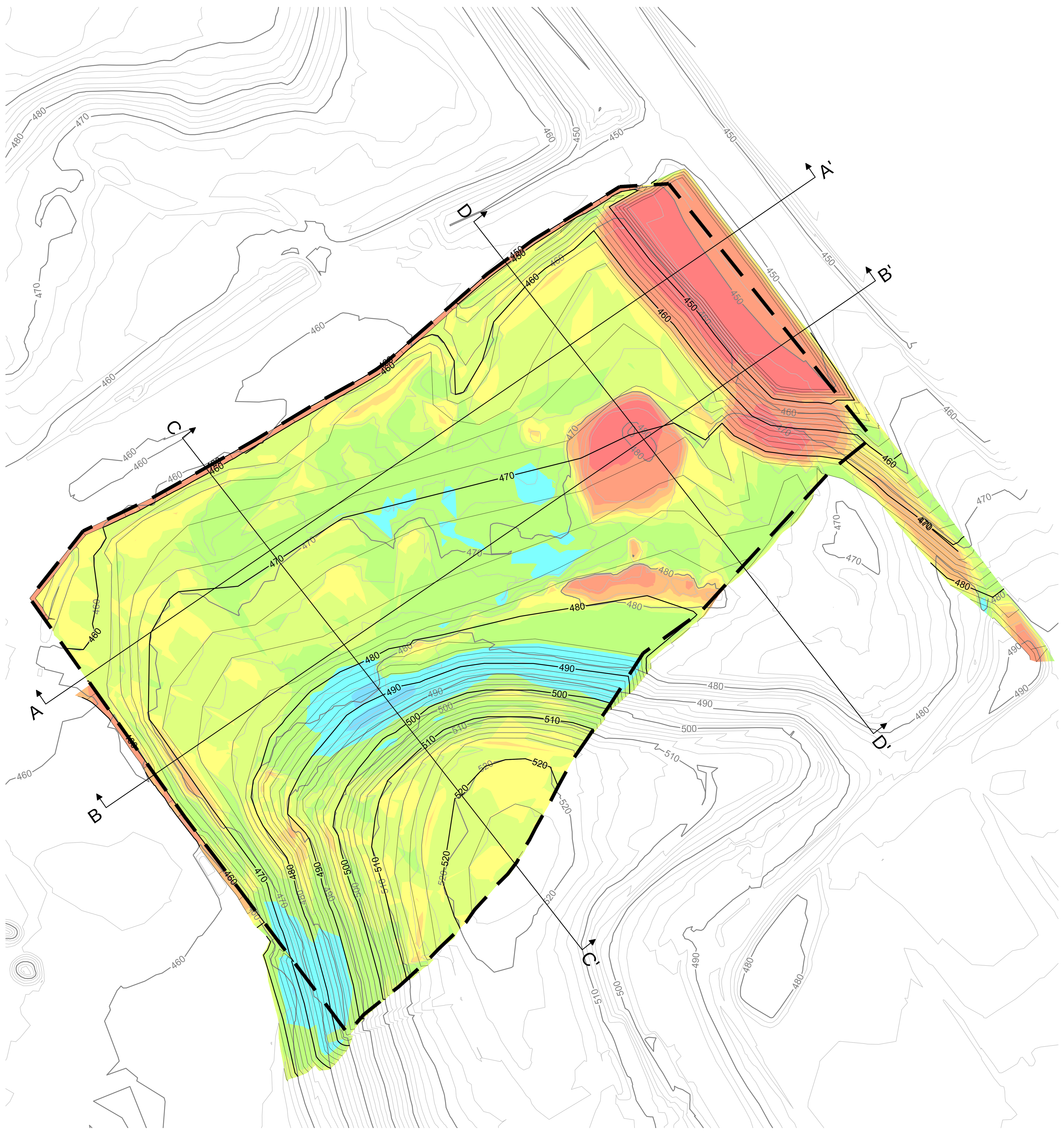
BRIDGETON LANDFILL 13570 ST. CHARLES ROCK ROAD BRIDGETON, MISSOURI 63044	BRIDGETON LANDFILL FINAL FEASIBILITY STUDY	Engineering for a Better World FEEZOR ENGINEERING, INC.	SEPTEMBER 2016 DESIGNED BY: PML APPROVED BY: ---	DRAWING NO.: 003
ROD REMEDY - AREA 1 **RIM EXTENTS**			REVISION / DATE	
PROJECT NUMBER: BT-106	FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\ROD Remedy\working\Draft Drawings\BT-106 (ROD) 003-010.dwg			

Profile View of Alignment A Vertical Exaggeration x 1.5

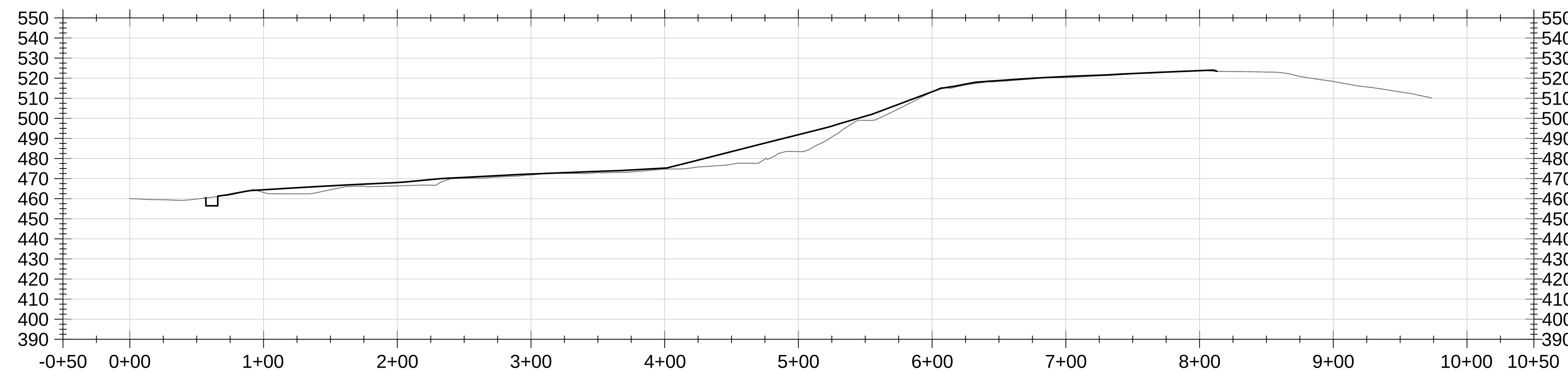


Profile View of Alignment B Vertical Exaggeration x 1.5

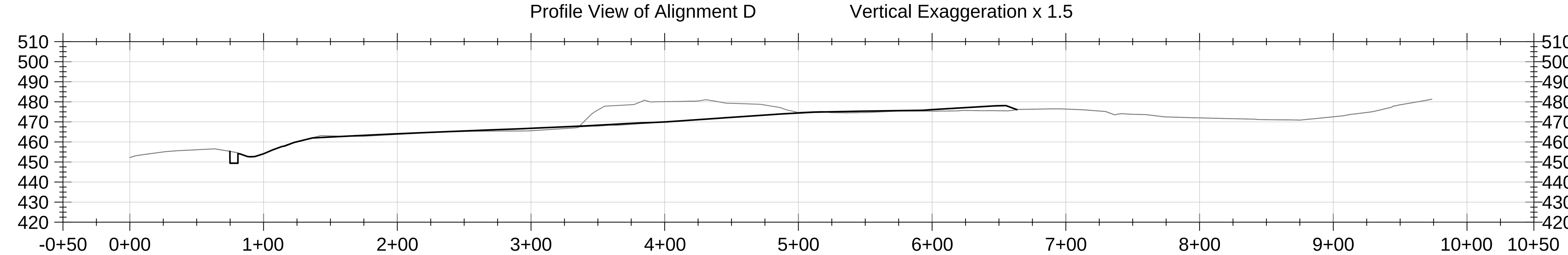


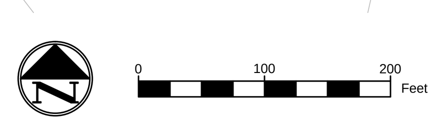


Profile View of Alignment C Vertical Exaggeration x 1.5



Profile View of Alignment D Vertical Exaggeration x 1.5





Thickness Map

Range	Minimum Depth	Maximum Depth	Color
1	-14	-8	
2	-8	-4	
3	-4	-2	
4	-2	-1	
5	-1	0	
6	0	1	
7	1	2	
8	2	4	
9	4	8	
10	8	10	

WASTE REGRADING VOLUME ANALYSIS:

CUT: 33,222 CY

FILL: 35,506 CY

NET: 2,284 CY (FILL)

LEGEND

- 2015 TOPOGRAPHY (2' CONTOUR)
- 500 — 2015 TOPOGRAPHY (10' CONTOUR)
- BOTTOM OF FINAL COVER GRADING (2' CONTOUR)
- 500 — BOTTOM OF FINAL COVER GRADING (10' CONTOUR)
- AREA 1 BOUNDARY

DRAFT

NOTES:

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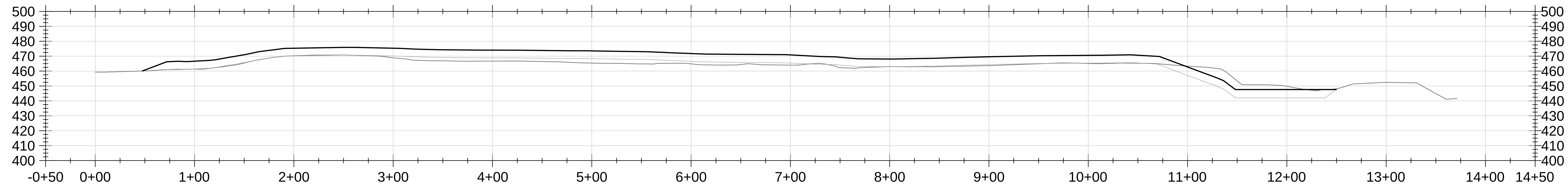
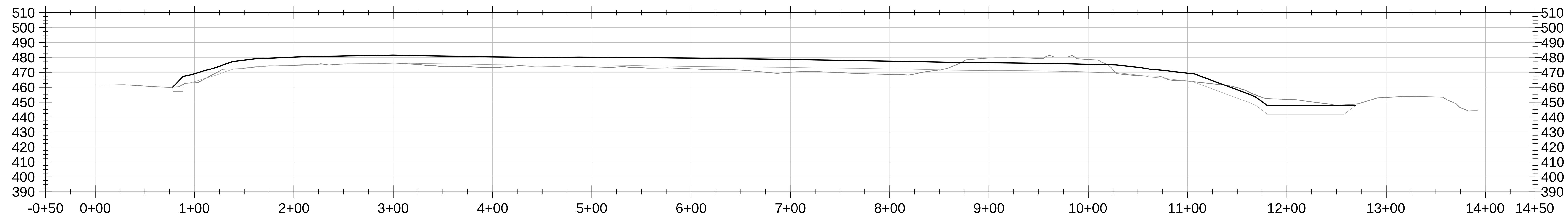
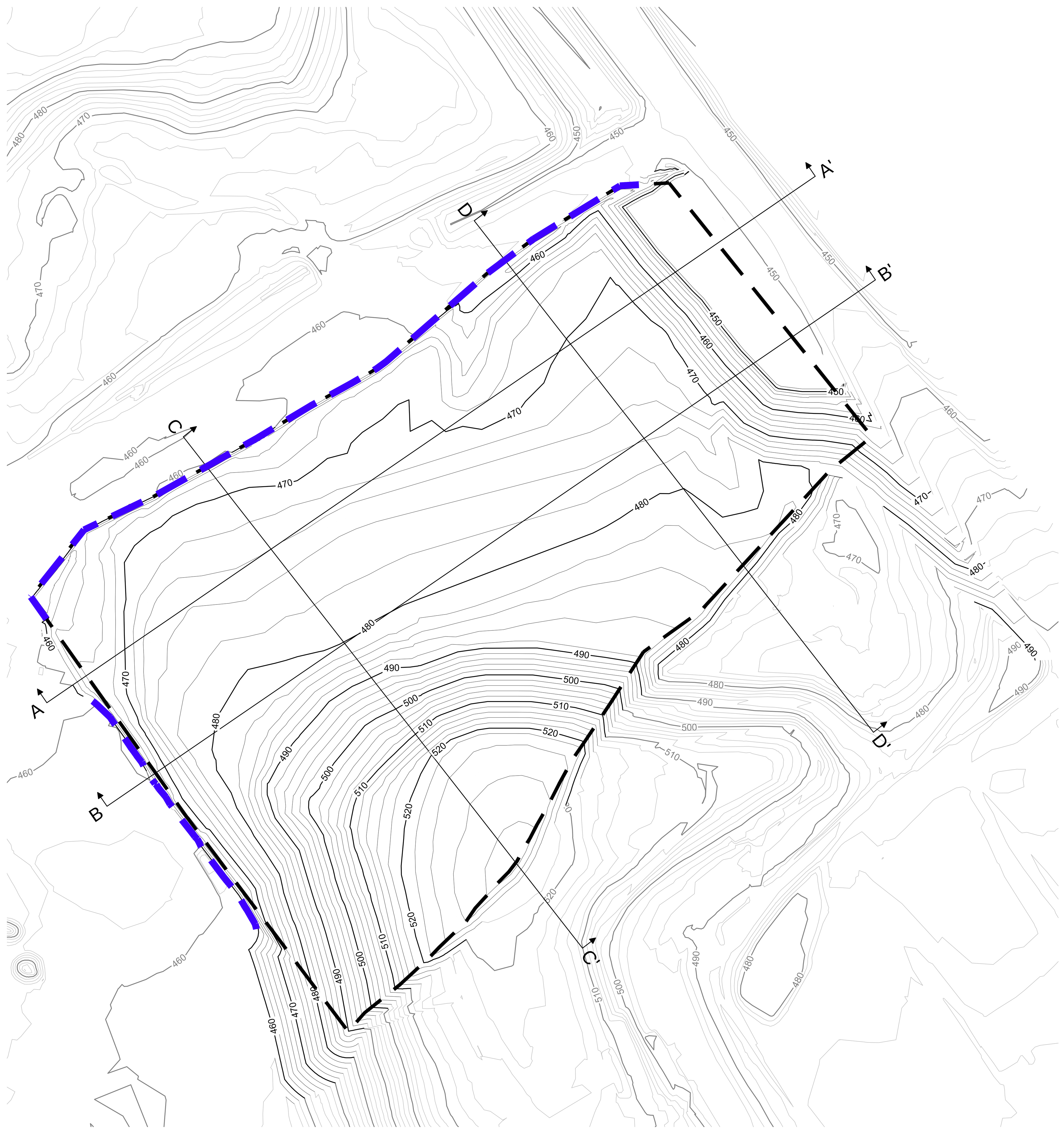
BRIDGETON LANDFILL 13570 ST. CHARLES ROCK ROAD BRIDGETON, MISSOURI 63044	BRIDGETON LANDFILL FINAL FEASIBILITY STUDY	Engineering for a Better World FEEZOR ENGINEERING, INC.	SEPTEMBER 2016 DESIGNED BY: PML APPROVED BY: ---	DRAWING NO.:
ROD REMEDY - AREA 1 BOTTOM OF FINAL COVER GRADING			REVISION / DATE	**004**
PROJECT NUMBER: BT-106	FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\ROD Remedy\working\Draft Drawings\BT-106 (ROD) 003-010.dwg			

Profile View of Alignment A Vertical Exaggeration x 1.5

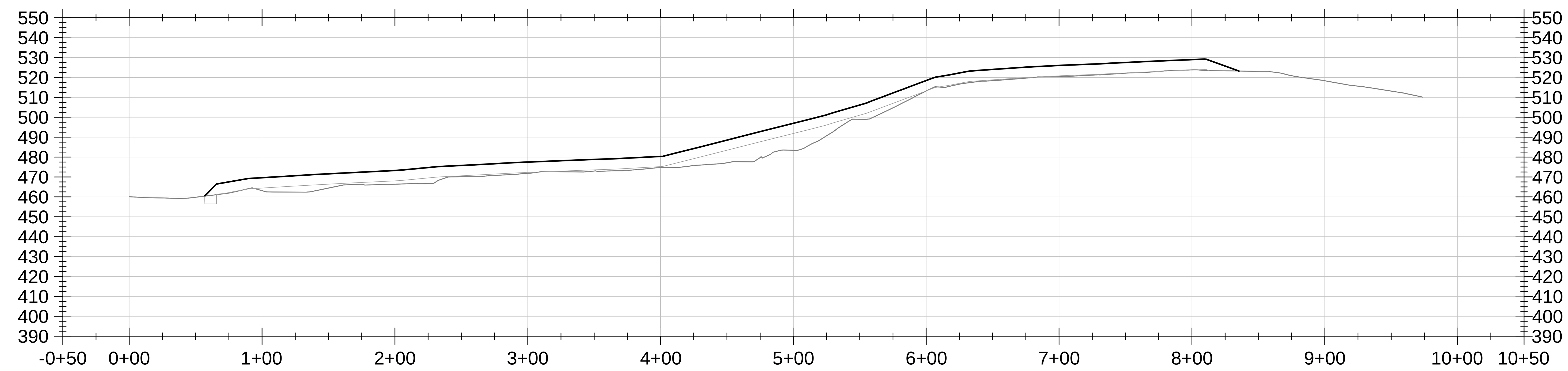


Profile View of Alignment B Vertical Exaggeration x 1.5

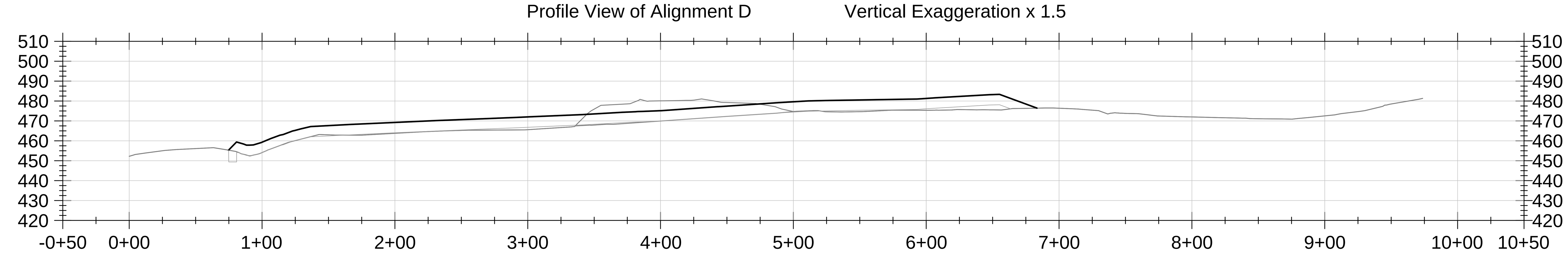


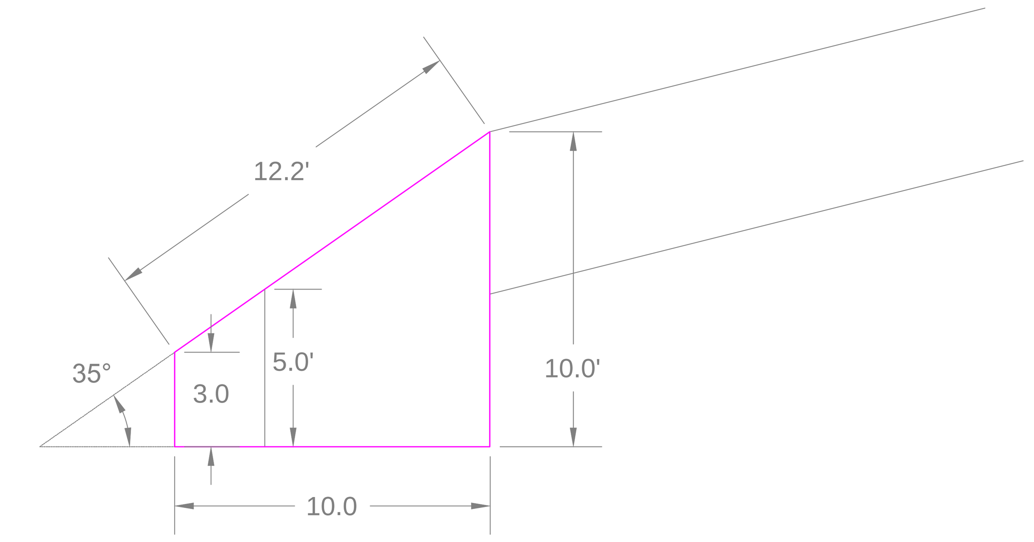


Profile View of Alignment C Vertical Exaggeration x 1.5



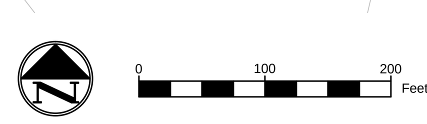
Profile View of Alignment D Vertical Exaggeration x 1.5





Area 1 Starter Berm Detail

Not to scale



LEGEND

- 2015 TOPOGRAPHY (2' CONTOUR)
- 500 — 2015 TOPOGRAPHY (10' CONTOUR)
- TOP OF FINAL COVER GRADING (2' CONTOUR)
- 500 — TOP OF FINAL COVER GRADING (10' CONTOUR)
- AREA 1 BOUNDARY
- STARTER BERM LOCATION
- STARTER BERM DETAIL DESIGN

DRAFT

NOTES:

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BRIDGETON LANDFILL
13570 ST. CHARLES ROCK ROAD
BRIDGETON, MISSOURI 63044

BRIDGETON LANDFILL
FINAL FEASIBILITY STUDY

ROD REMEDY - AREA 1
TOP OF FINAL COVER GRADING

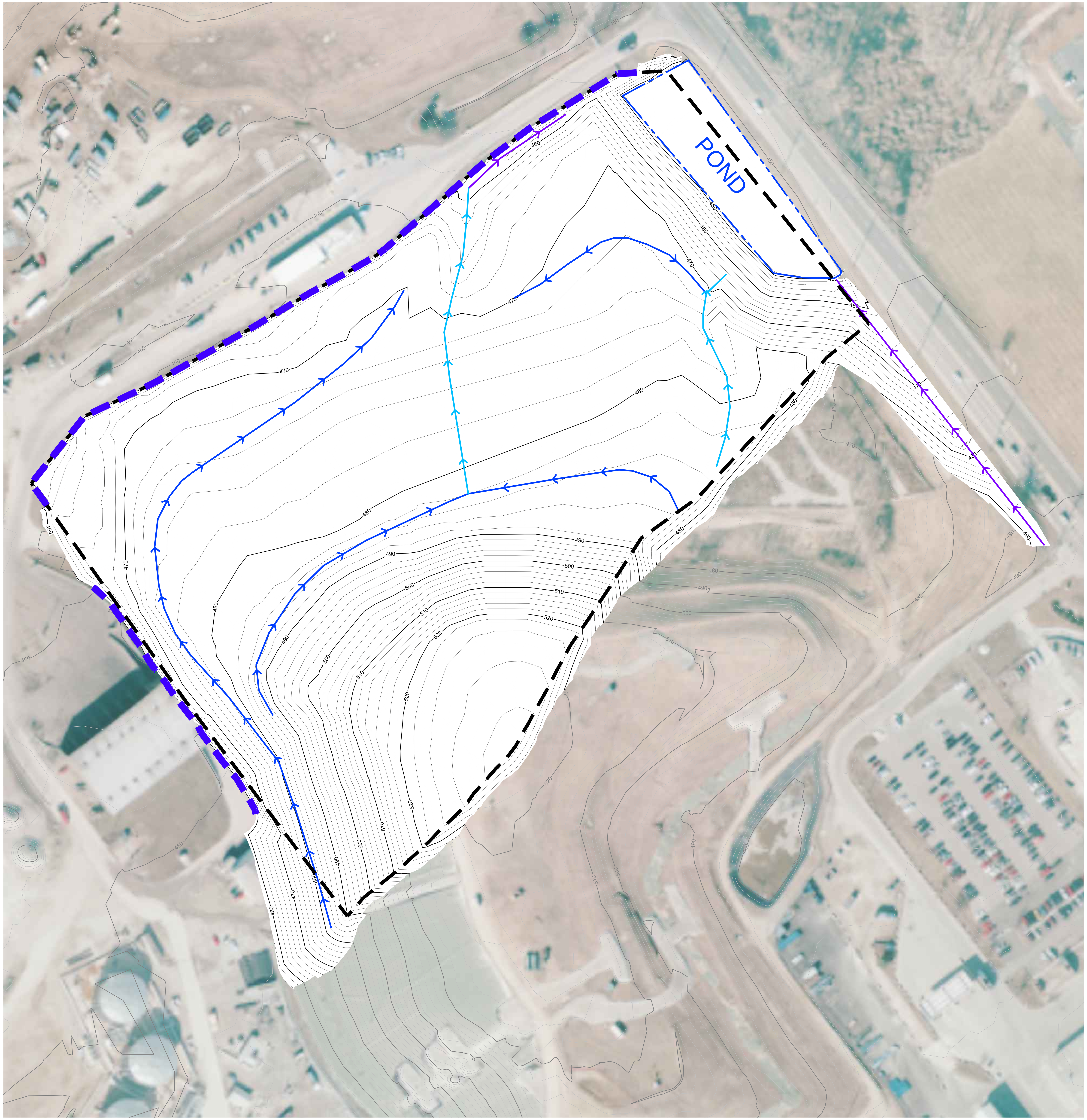
Engineering for a Better World
FEEZOR ENGINEERING, INC.

SEPTEMBER 2016
DESIGNED BY: PML
APPROVED BY: ---

REVISION	DATE

DRAWING NO.: **005**

PROJECT NUMBER: BT-106 FILE PATH: C:\Users\FEI User\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\ROD Remedy\working\Draft Drawings\BT-106 (ROD) 003-010.dwg



N

0 60 120
Feet

LEGEND

(2015 topography, 2' contour line)	2015 TOPOGRAPHY (2' CONTOUR)
500	2015 TOPOGRAPHY (10' CONTOUR)
(final cover grading, 2' contour line)	TOP OF FINAL COVER GRADING (2' CONTOUR)
500	TOP OF FINAL COVER GRADING (10' CONTOUR)
(dashed black line)	AREA 1 BOUNDARY
(dashed blue line)	STARTER BERM LOCATION
(blue arrow)	DRAINAGE TERRACE
(light blue arrow)	DOWNCHUTE SWALE
(purple arrow)	PERIMETER DITCH

DRAFT

NOTES:
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BRIDGETON LANDFILL
13570 ST. CHARLES ROCK ROAD
BRIDGETON, MISSOURI 63044

BRIDGETON LANDFILL
FINAL FEASIBILITY STUDY

ROD REMEDY - AREA 1
STORM WATER CONTROLS

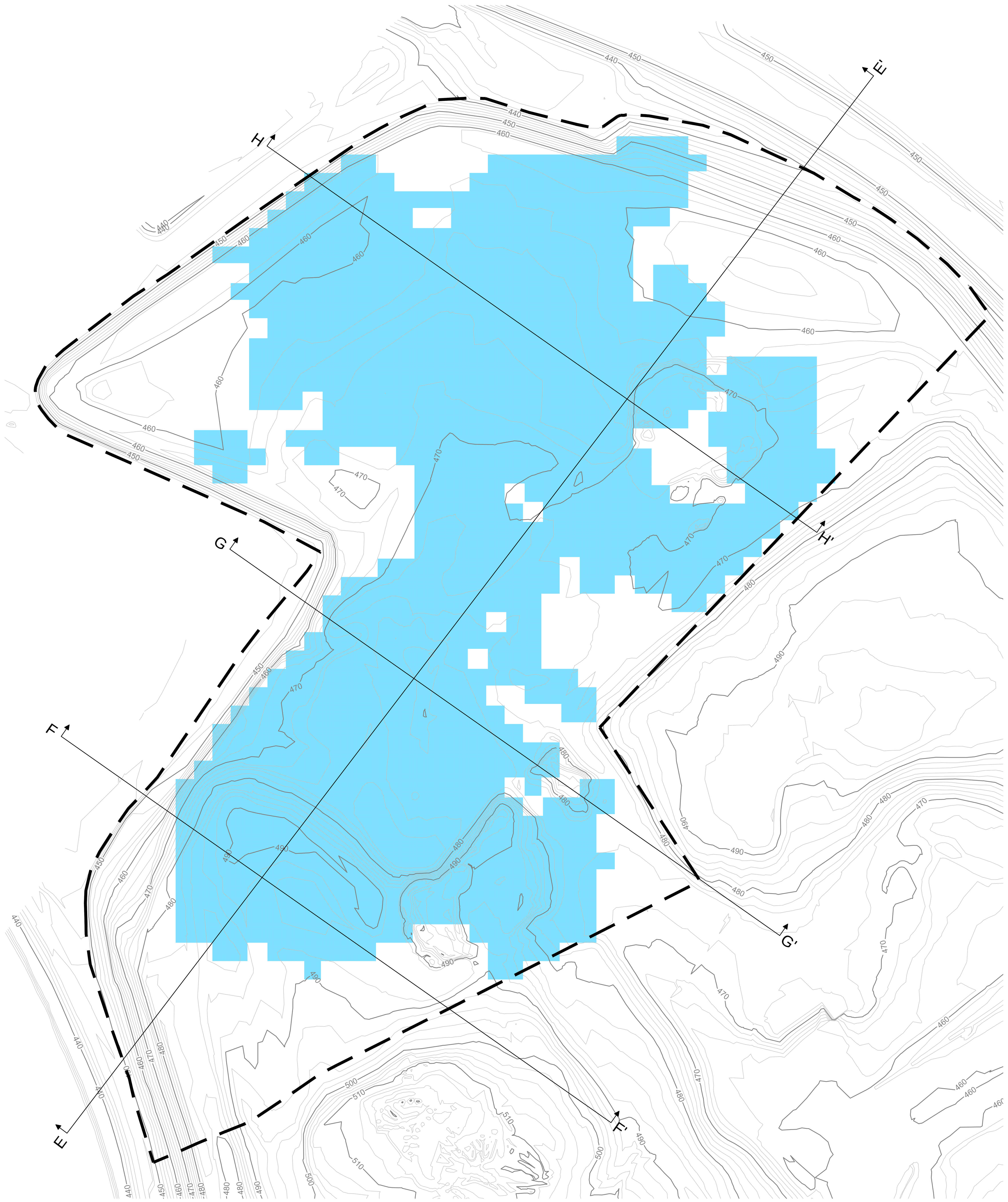
Engineering for a Better World
FEEZOR ENGINEERING, INC.

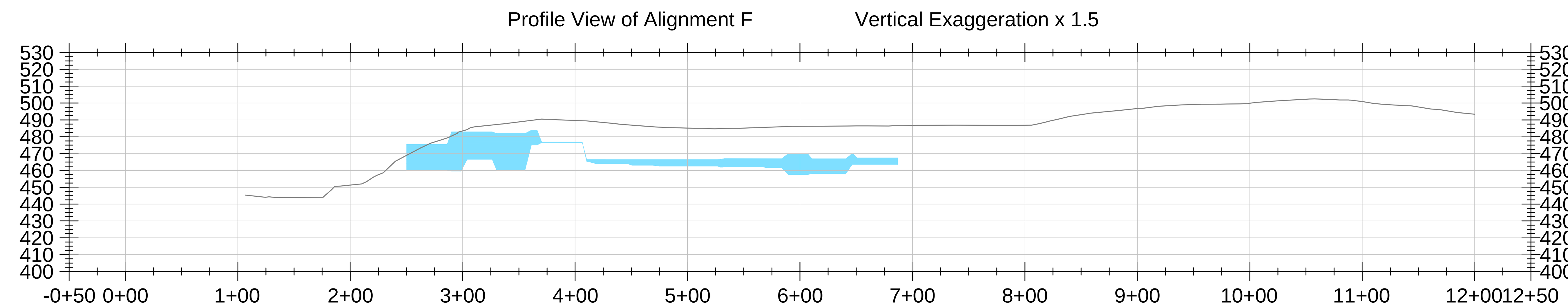
SEPTEMBER 2016
DESIGNED BY: PML
APPROVED BY: ---

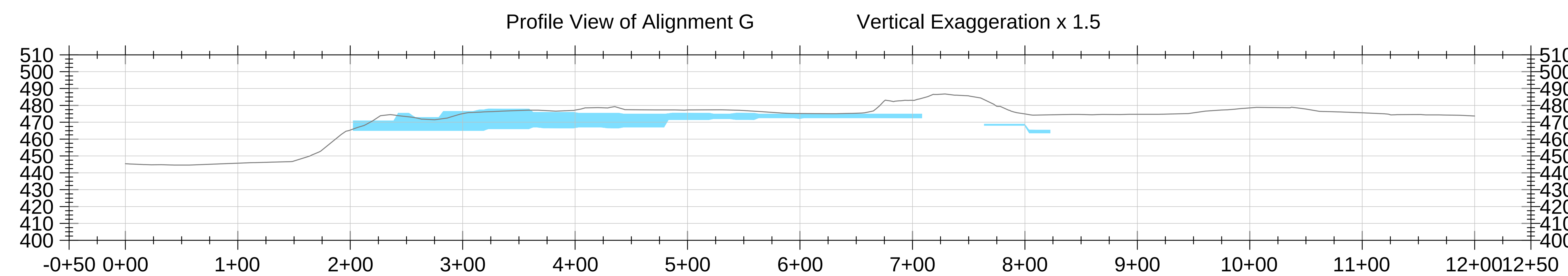
REVISION	DATE

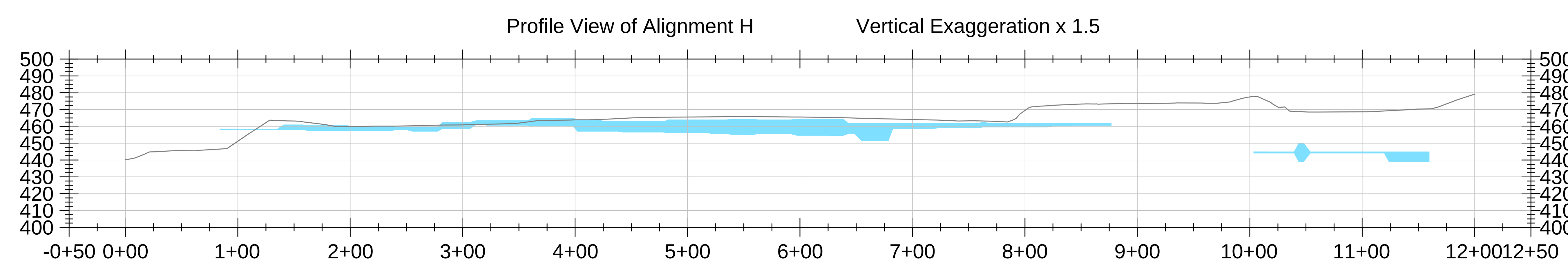
DRAWING NO.: **006**

PROJECT NUMBER: BT-106 | FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\ROD Remedy\working\Draft Drawings\BT-106 (ROD) 003-010.dwg









LEGEND

- 2015 TOPOGRAPHY (2' CONTOUR)
- 2015 TOPOGRAPHY (10' CONTOUR)
- AREA 2 BOUNDARY
- RIM

DRAFT

NOTES:

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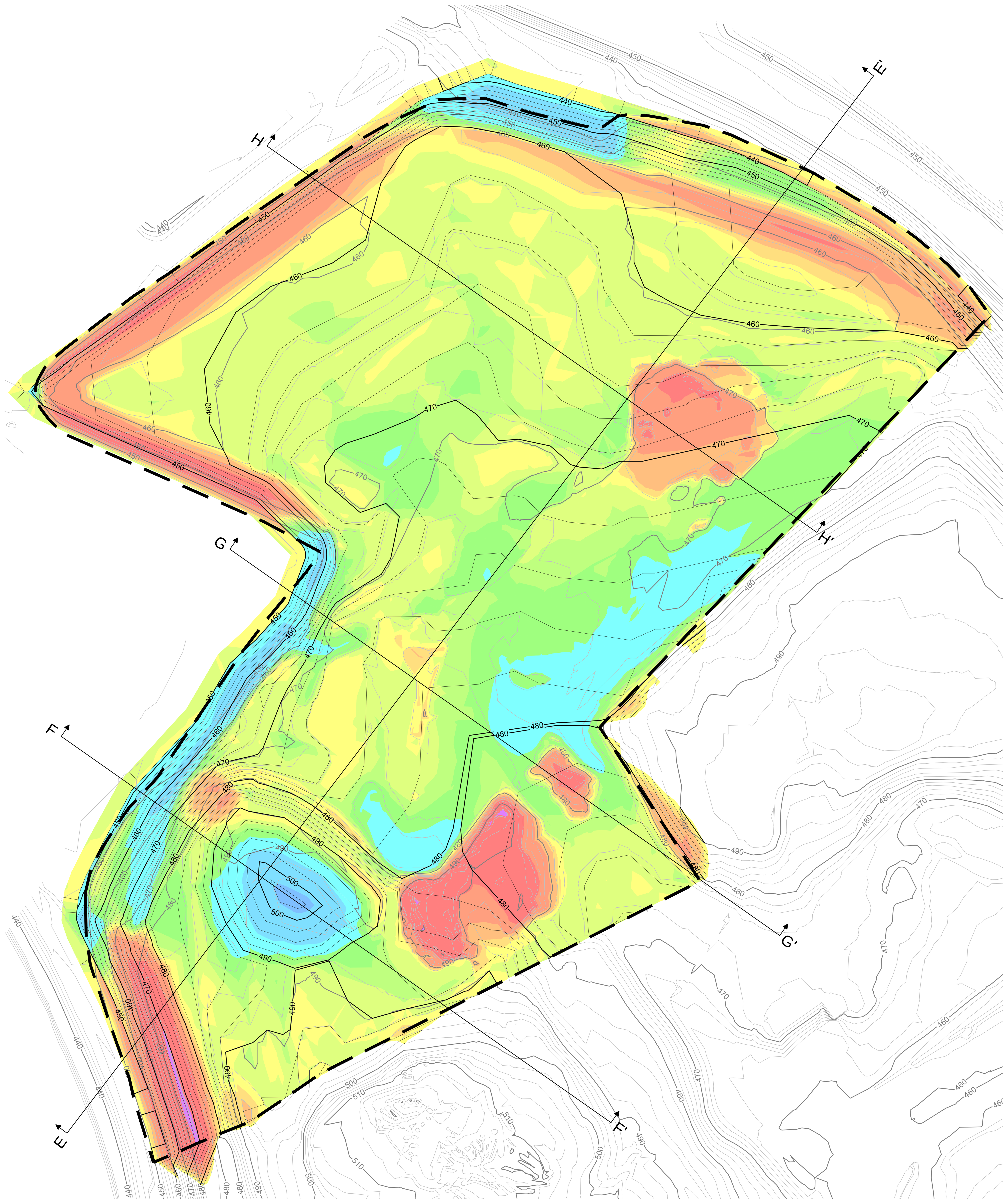
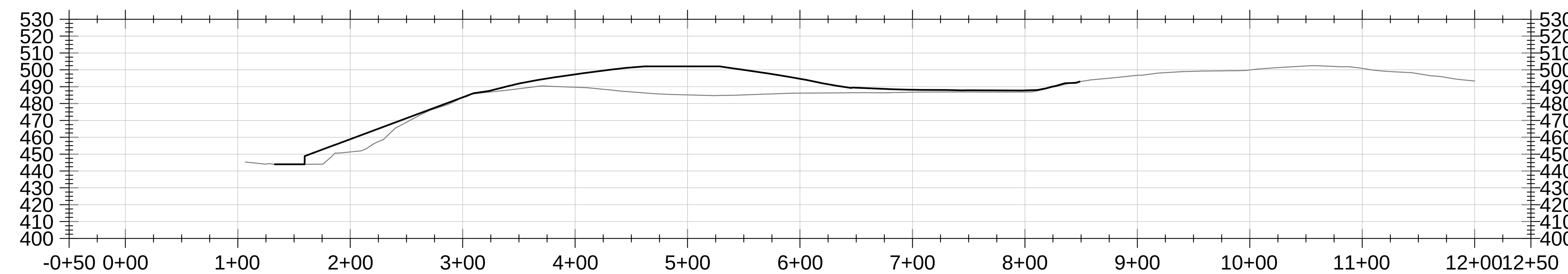
BRIDGETON LANDFILL 13570 ST. CHARLES ROCK ROAD BRIDGETON, MISSOURI 63044	BRIDGETON LANDFILL FINAL FEASIBILITY STUDY	Engineering for a Better World FEEZOR ENGINEERING, INC.	SEPTEMBER 2016 DESIGNED BY: PML APPROVED BY: ---	DRAWING NO.: 007
ROD REMEDY - AREA 2 **RIM EXTENTS**			REVISION / DATE	
PROJECT NUMBER: BT-106	FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\ROD Remedy\working\Draft Drawings\BT-106 (ROD) 003-010.dwg			

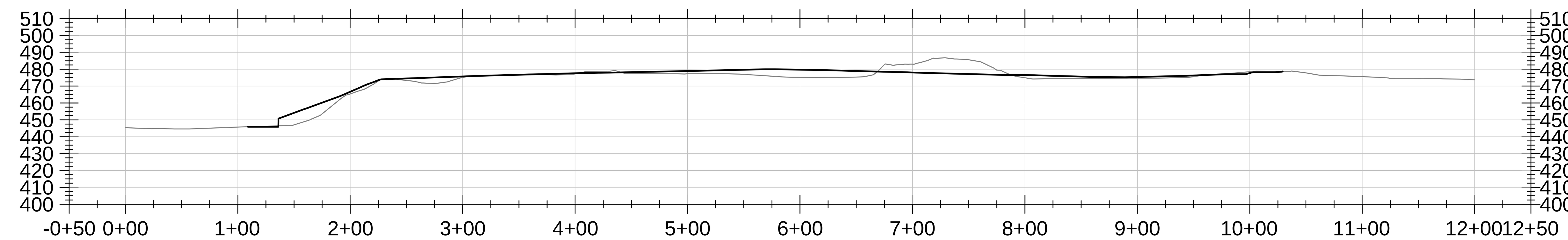
Profile View of Alignment E Vertical Exaggeration x 1.5



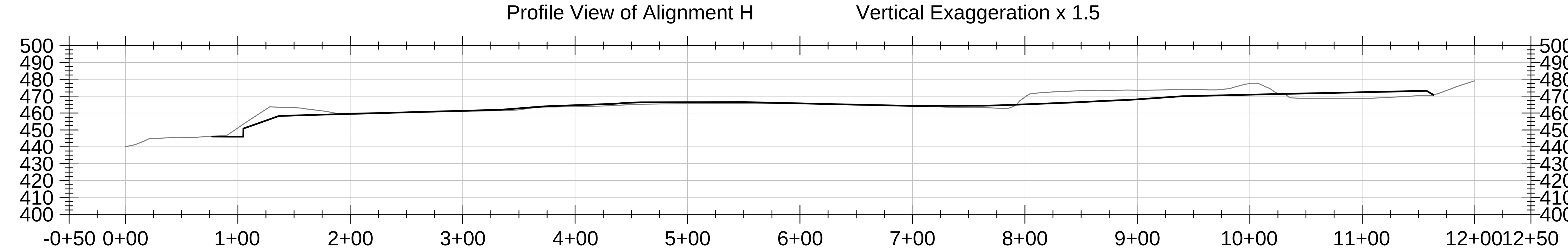
Profile View of Alignment F Vertical Exaggeration x 1.5



Profile View of Alignment G Vertical Exaggeration x 1.5



Profile View of Alignment H Vertical Exaggeration x 1.5



Thickness Map

Range	Minimum Depth	Maximum Depth	Color
1	-18	-16	
2	-16	-8	
3	-8	-4	
4	-4	-2	
5	-2	-1	
6	-1	0	
7	0	1	
8	1	2	
9	2	4	
10	4	8	
11	8	16	
12	16	17	

WASTE REGRADING VOLUME ANALYSIS:
CUT: 78,435 CY
FILL: 92,932 CY
NET: 14,497 CY (Fill)

LEGEND

- 2015 TOPOGRAPHY (2' CONTOUR)
- 500 — 2015 TOPOGRAPHY (10' CONTOUR)
- BOTTOM OF FINAL COVER GRADING (2' CONTOUR)
- 500 — BOTTOM OF FINAL COVER GRADING (10' CONTOUR)
- AREA 2 BOUNDARY

DRAFT

NOTES:
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BRIDGETON LANDFILL
13570 ST. CHARLES ROCK ROAD
BRIDGETON, MISSOURI 63044

BRIDGETON LANDFILL
FINAL FEASIBILITY STUDY

ROD REMEDY - AREA 2
BOTTOM OF FINAL COVER GRADING

Engineering for a Better World
FEEZOR ENGINEERING, INC.

SEPTEMBER 2016
DESIGNED BY: PML
APPROVED BY: ---

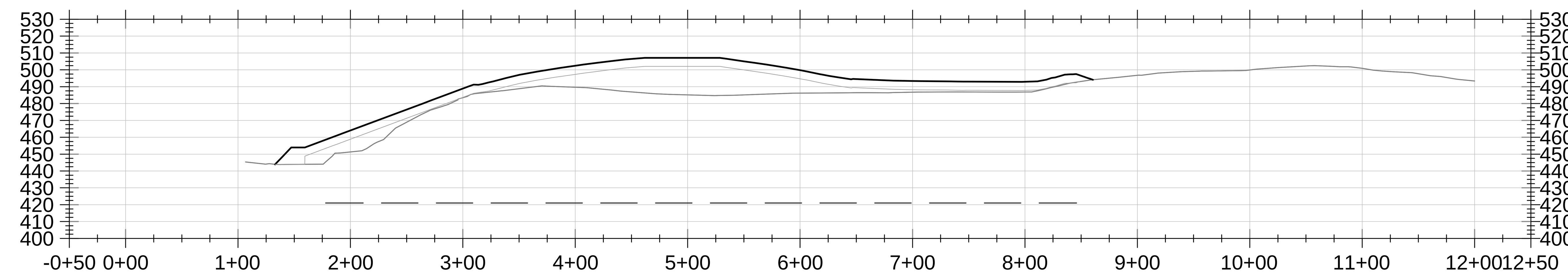
REVISION | DATE

DRAWING NO.: **008**

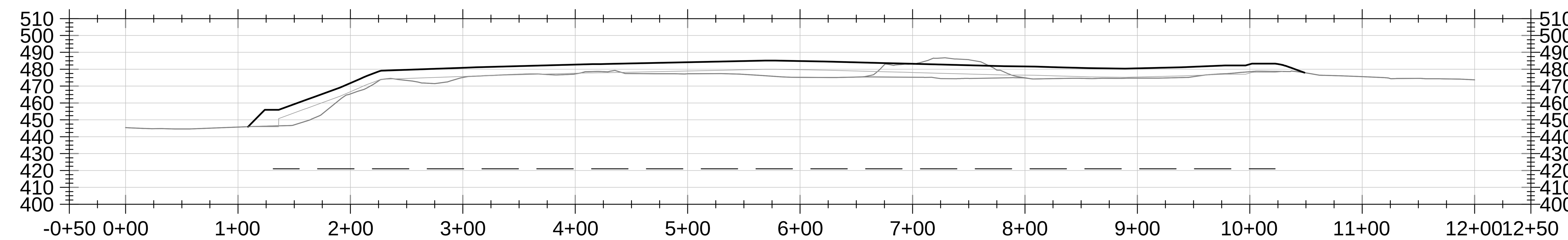
PROJECT NUMBER: BT-106 FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\ROD Remedy\working\Draft Drawings\BT-106 (ROD) 003-010.dwg

Profile View of Alignment E Vertical Exaggeration x 1.5

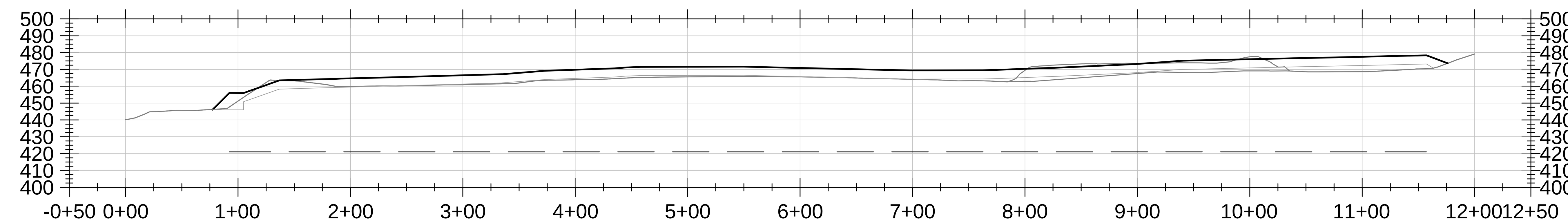
Profile View of Alignment F Vertical Exaggeration x 1.5

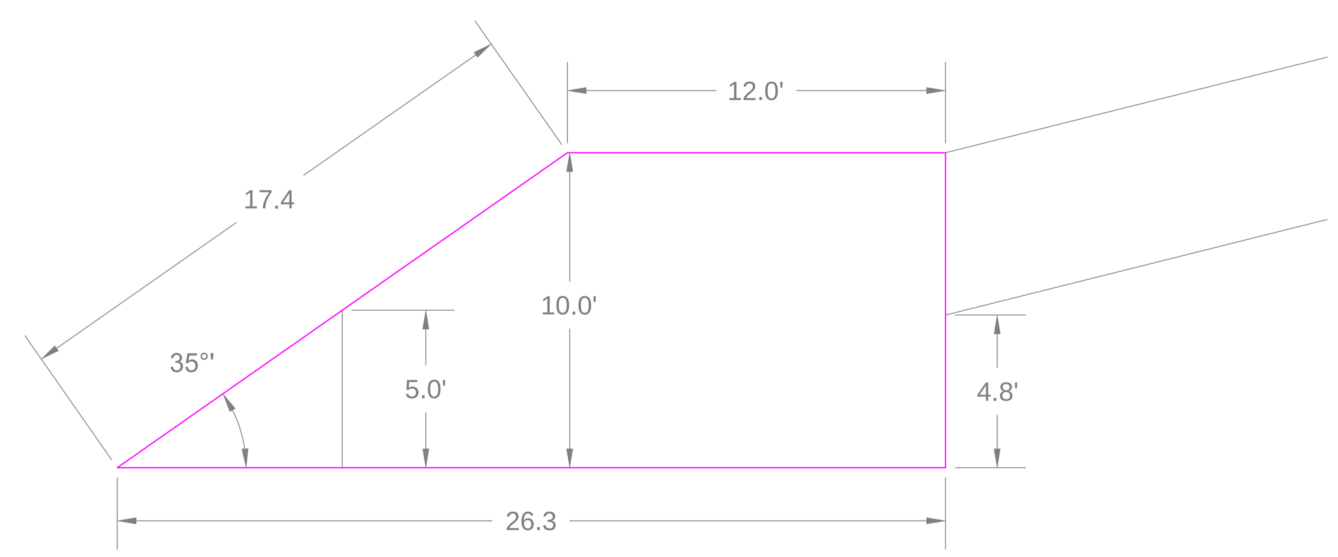


Profile View of Alignment G Vertical Exaggeration x 1.5



Profile View of Alignment H Vertical Exaggeration x 1.5





Area 2 Starter Berm Detail

Not to scale

LEGEND

- 2015 TOPOGRAPHY (2' CONTOUR)
- 2015 TOPOGRAPHY (10' CONTOUR)
- TOP OF FINAL COVER GRADING (2' CONTOUR)
- TOP OF FINAL COVER GRADING (10' CONTOUR)
- AREA 2 BOUNDARY
- STARTER BERM LOCATION
- STARTER BERM DETAIL DESIGN

DRAFT

NOTES:

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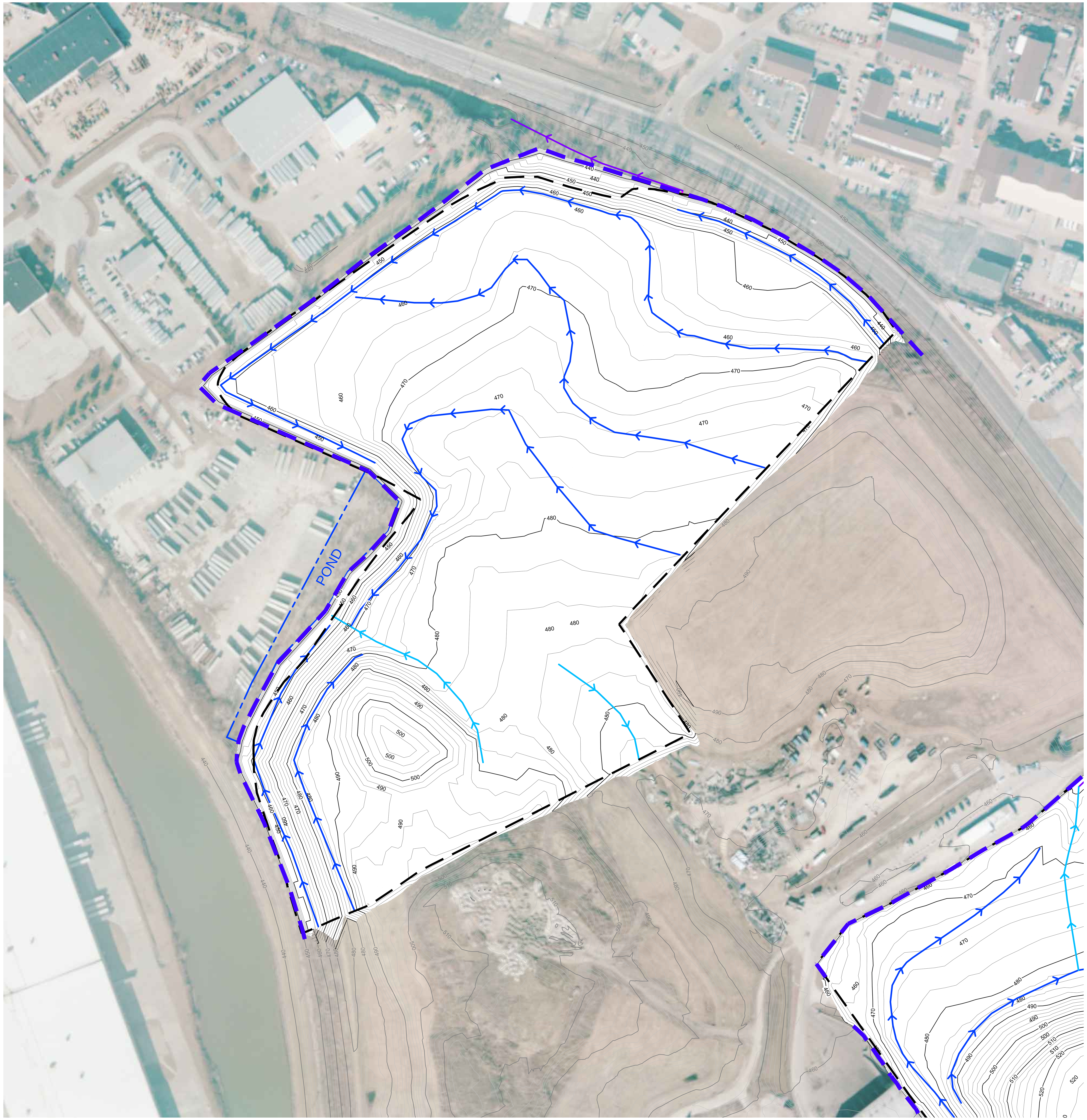
BRIDGETON LANDFILL 13570 ST. CHARLES ROCK ROAD BRIDGETON, MISSOURI 63044	BRIDGETON LANDFILL FINAL FEASIBILITY STUDY	Engineering for a Better World FEEZOR ENGINEERING, INC.	SEPTEMBER 2016 DESIGNED BY: PML APPROVED BY: ---	DRAWING NO.:
ROD REMEDY - AREA 2 TOP OF FINAL COVER GRADING			REVISION / DATE	**009**
PROJECT NUMBER: BT-106	FILE PATH: C:\Users\FEI User\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\ROD Remedy\working\Draft Drawings\BT-106 (ROD) 003-010.dwg			



LEGEND

- 2015 TOPOGRAPHY WITH EXCAVATION GRADING (2' CONTOUR)
- 500 — 2015 TOPOGRAPHY WITH EXCAVATION GRADING (10' CONTOUR)
- FINAL COVER GRADING (2' CONTOUR)
- 500 — FINAL COVER GRADING (10' CONTOUR)
- AREA 2 BOUNDARY
- STARTER BERM LOCATION
- DRAINAGE TERRACE
- DOWNCHUTE SWALE
- PERIMETER ROAD CROSSING
- PERIMETER DITCH

DRAFT

NOTES:

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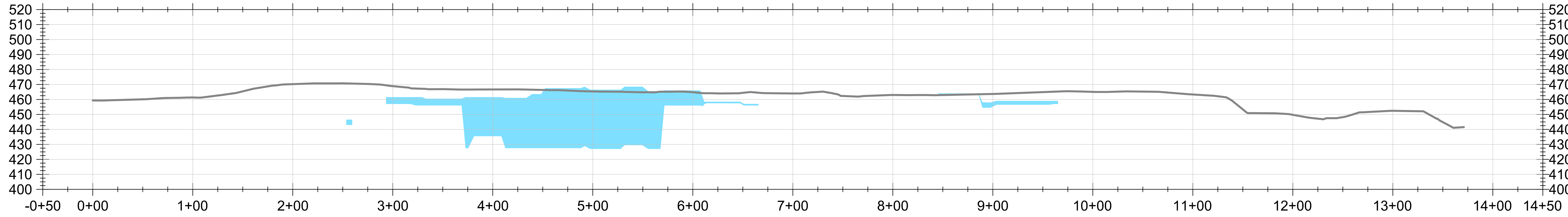
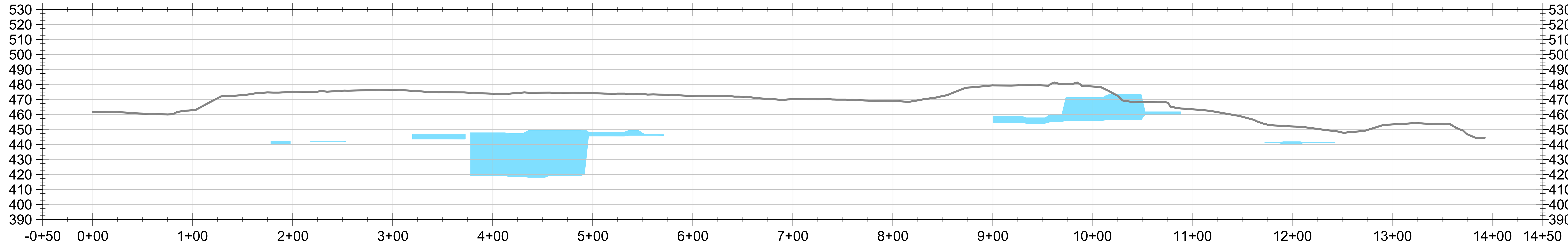
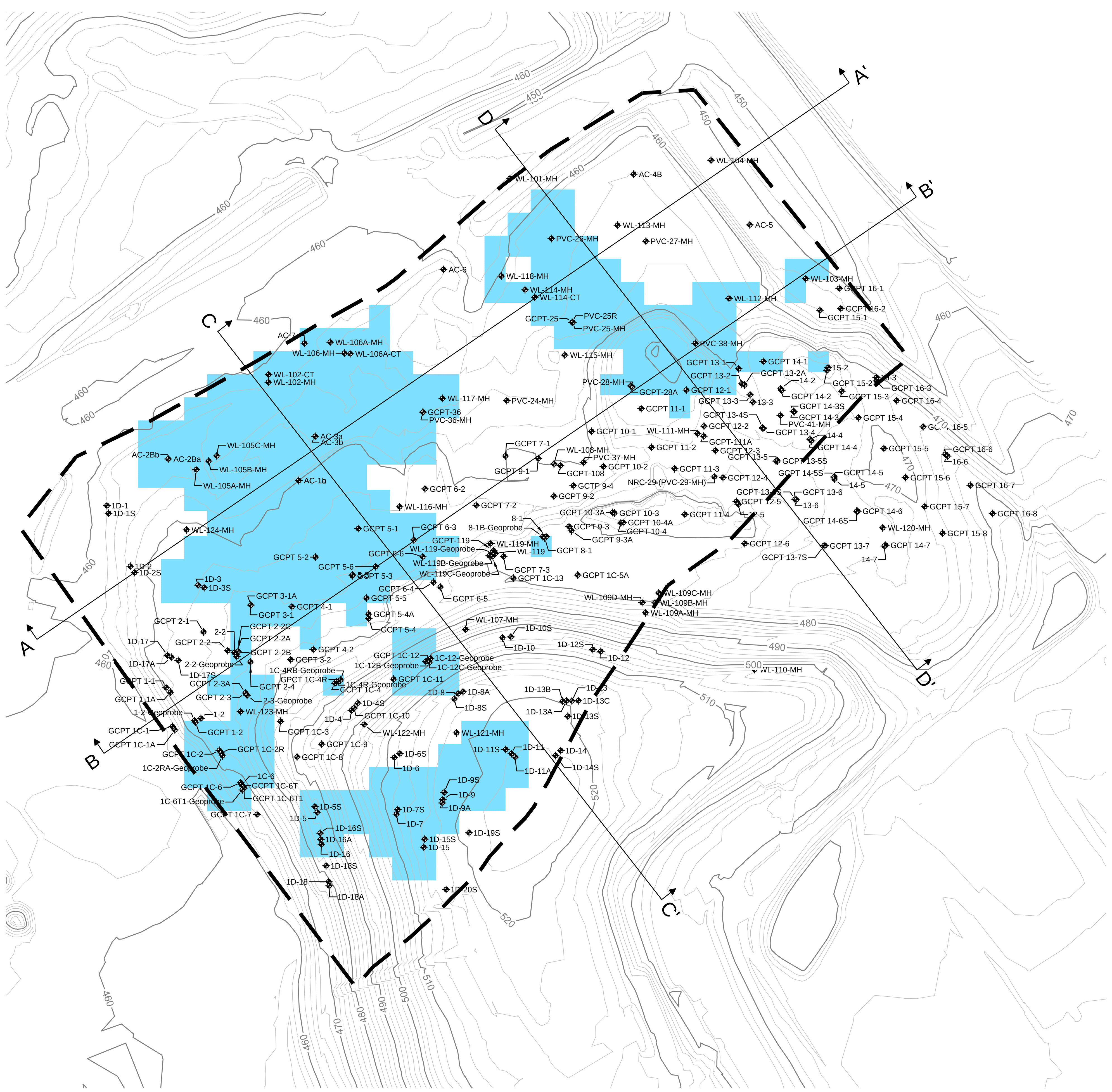
BRIDGETON LANDFILL 13570 ST. CHARLES ROCK ROAD BRIDGETON, MISSOURI 63044	BRIDGETON LANDFILL FINAL FEASIBILITY STUDY	Engineering for a Better World FEEZOR ENGINEERING, INC.	SEPTEMBER 2016 DESIGNED BY: PML APPROVED BY: ---	DRAWING NO.:
ROD REMEDY - AREA 2 **STORM WATER CONTROLS**			REVISION / DATE	**010**
PROJECT NUMBER: BT-106	FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\ROD Remedy\working\Draft Drawings\BT-106 (ROD) 003-010.dwg			

Profile View of Alignment A — Vertical Exaggeration x 1.5

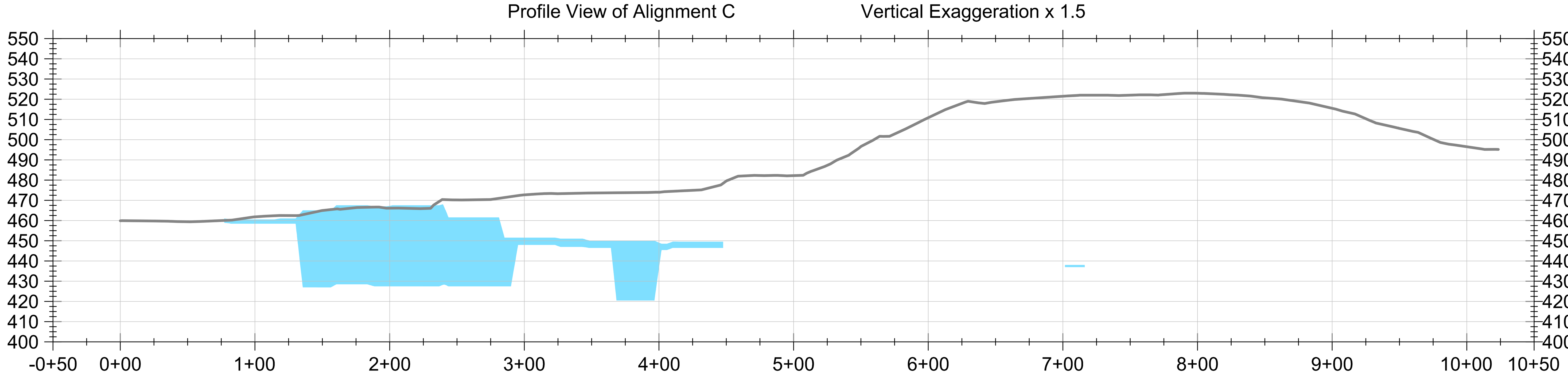


Profile View of Alignment B — Vertical Exaggeration x 1.5

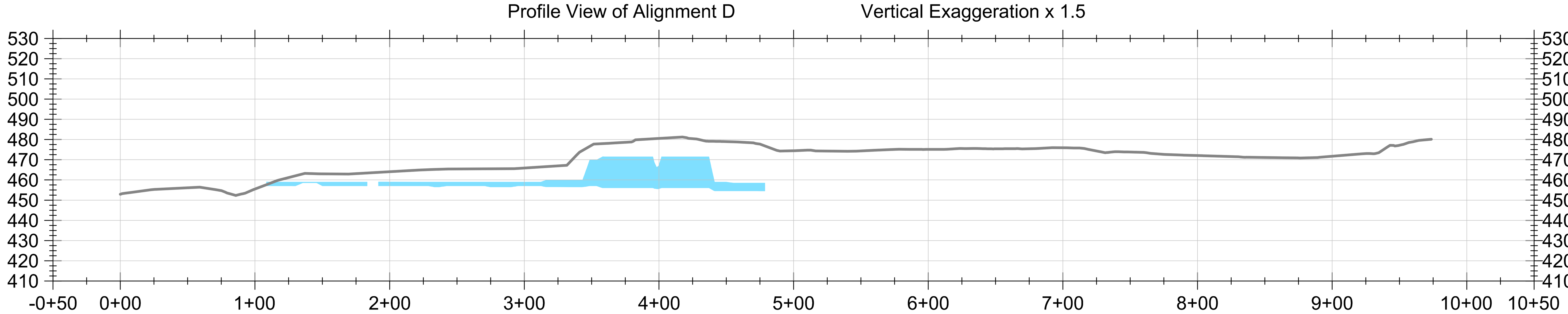




Profile View of Alignment C — Vertical Exaggeration x 1.5



Profile View of Alignment D — Vertical Exaggeration x 1.5



LEGEND

- 2015 TOPOGRAPHY (2' CONTOUR)
- 2015 TOPOGRAPHY (10' CONTOUR)
- AREA 1 BOUNDARY
- RIM (PROFILE VIEW)
- BORING LOCATION

DRAFT

NOTES:
- AERIAL TOPOGRAPHY PROVIDED BY COOPER AERIAL SURVEYS, INC. AND IS DATED MARCH 10, 2015
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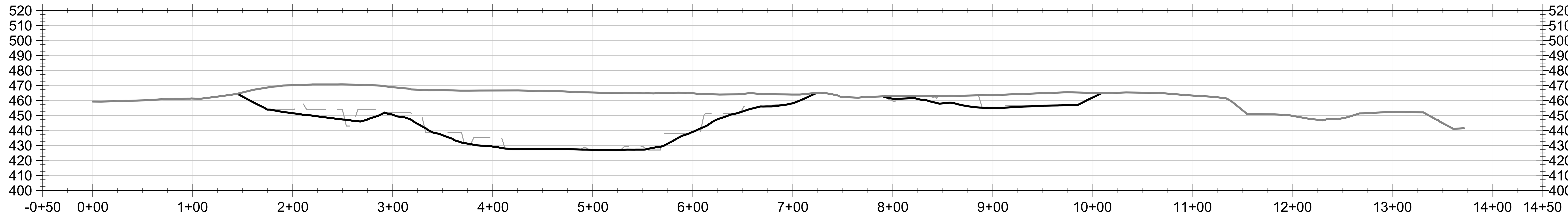
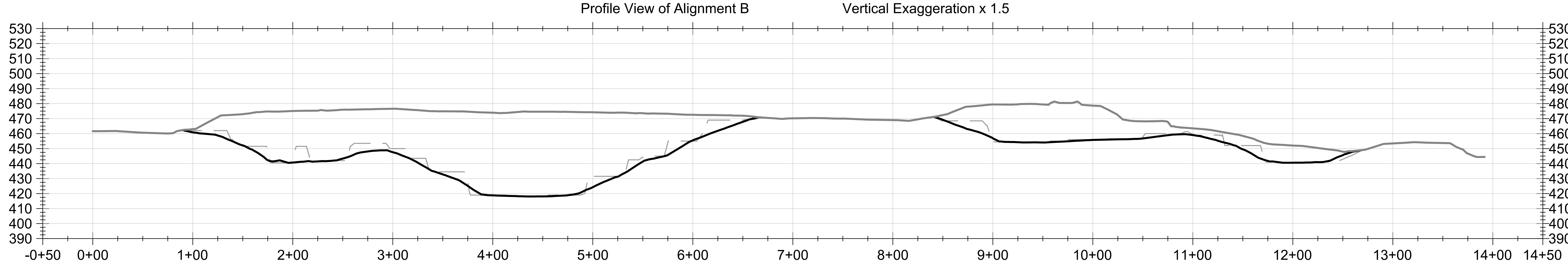
BRIDGETON LANDFILL 13570 ST. CHARLES ROCK ROAD BRIDGETON, MISSOURI 63044	BRIDGETON LANDFILL FINAL FEASIBILITY STUDY	Engineering for a Better World FEEZOR ENGINEERING, INC.	SEPTEMBER 2016 DESIGNED BY: IN APPROVED BY: ---	DRAWING NO.: 011
7.9 (CRR) REMEDY - AREA 1 RIM EXTENTS			REVISION / DATE	

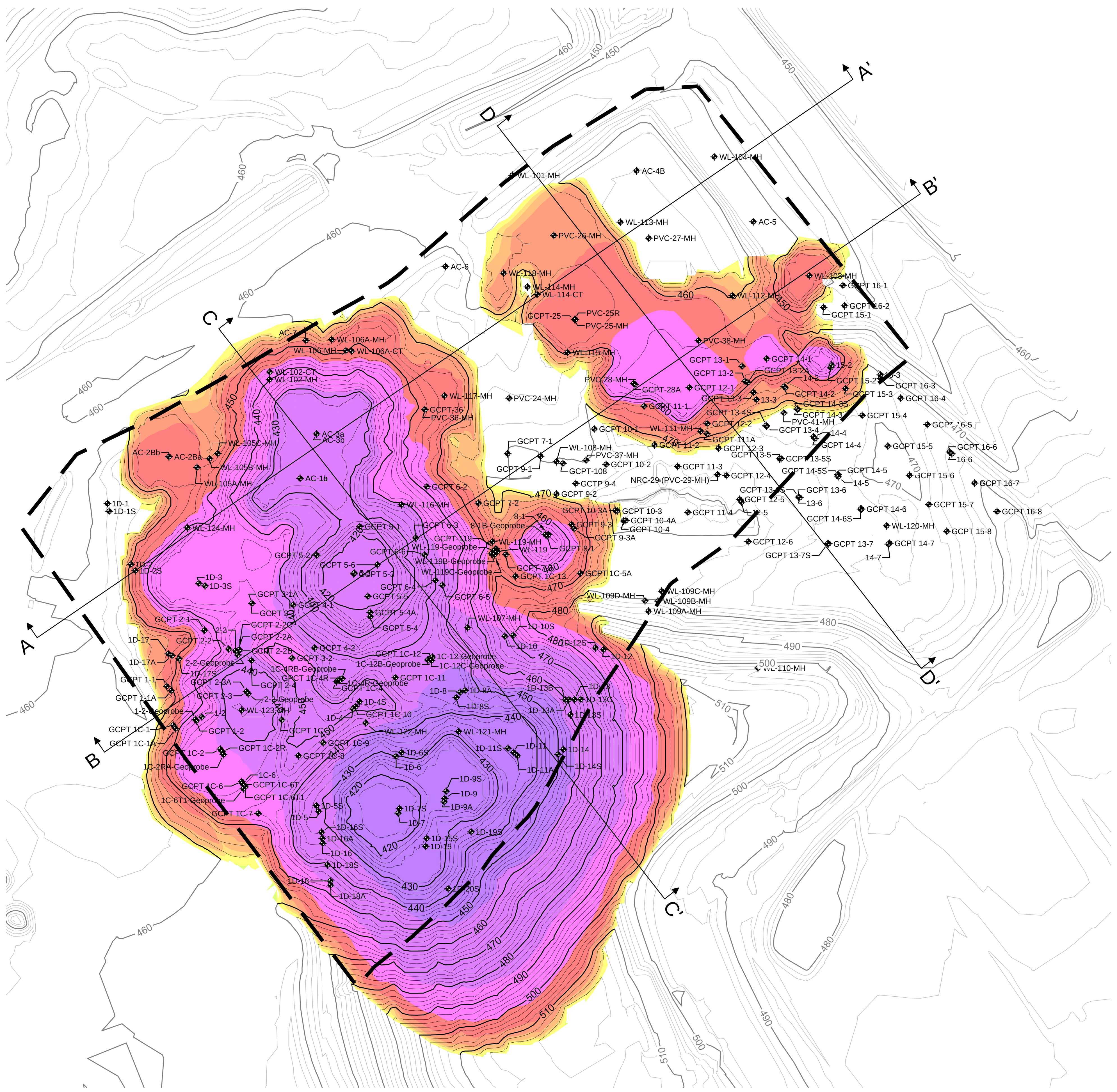
PROJECT NUMBER: BT-106 FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\7.9 (CRR)\working\Draft Drawings\BT-106 A1 (7.9 CRR) 5% Criteria.dwg

Profile View of Alignment A — Vertical Exaggeration x 1.5

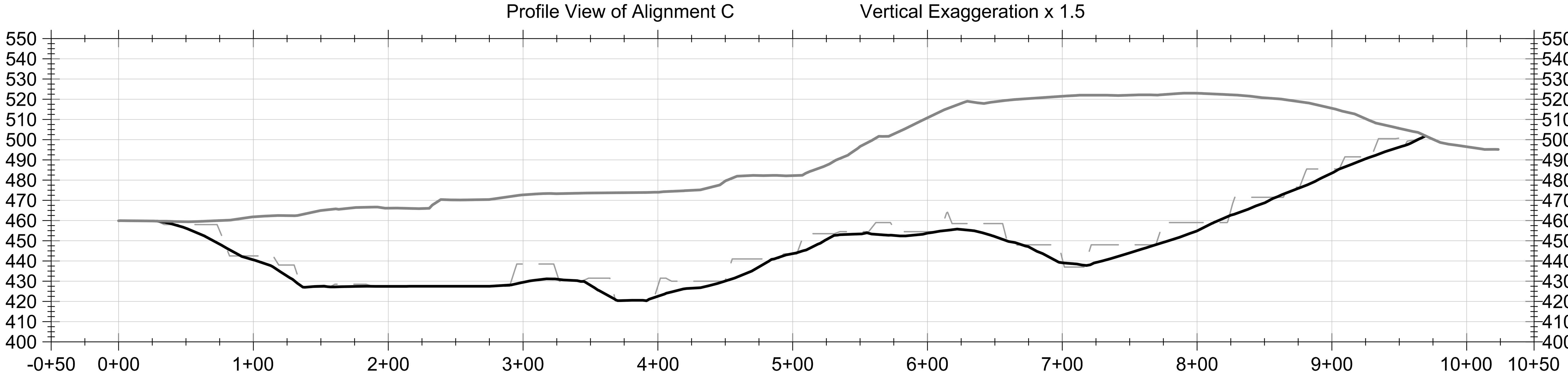


Profile View of Alignment B — Vertical Exaggeration x 1.5

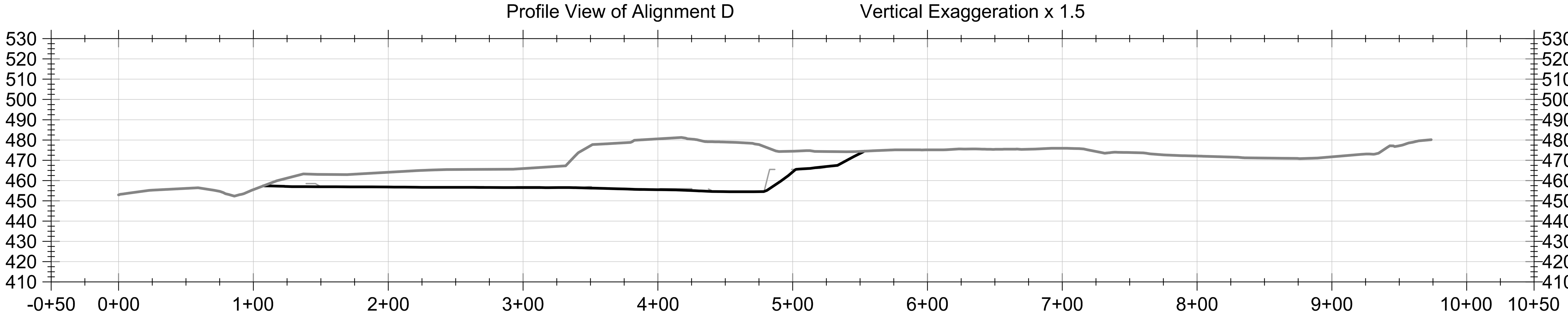


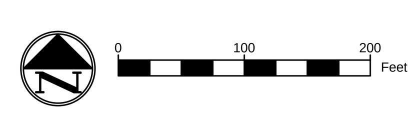


Profile View of Alignment C — Vertical Exaggeration x 1.5



Profile View of Alignment D — Vertical Exaggeration x 1.5





Thickness Map			
Range	Minimum Depth	Maximum Depth	Color
1	-98	-64	
2	-64	-32	
3	-32	-16	
4	-16	-8	
5	-8	-4	
6	-4	-2	
7	-2	-1	
8	-1	0	
9	0	0	

EXCAVATION VOLUME: 790,432 CY

LEGEND

- 2015 TOPOGRAPHY (2' CONTOUR)
- 500 — 2015 TOPOGRAPHY (10' CONTOUR)
- EXCAVATION GRADING (2' CONTOUR)
- 500 — EXCAVATION GRADING (10' CONTOUR)
- INITIAL EXCAVATION GRADING (PROFILE)
- AREA 1 BOUNDARY
- BORING LOCATION

DRAFT

NOTES:
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BRIDGETON LANDFILL
13570 ST. CHARLES ROCK ROAD
BRIDGETON, MISSOURI 63044

BRIDGETON LANDFILL
FINAL FEASIBILITY STUDY

7.9 (CRR) REMEDY - AREA 1
EXCAVATION GRADING

Engineering for a Better World
FEEZOR ENGINEERING, INC.

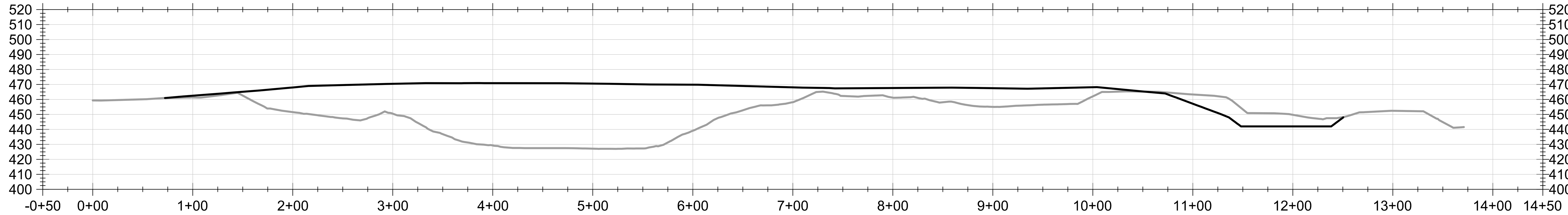
SEPTEMBER 2016
DESIGNED BY: IN
APPROVED BY: ---

REVISION	DATE

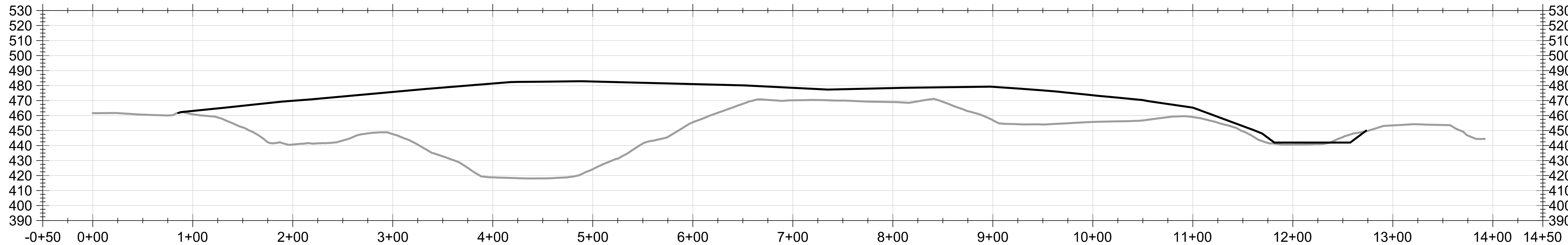
DRAWING NO.: **012**

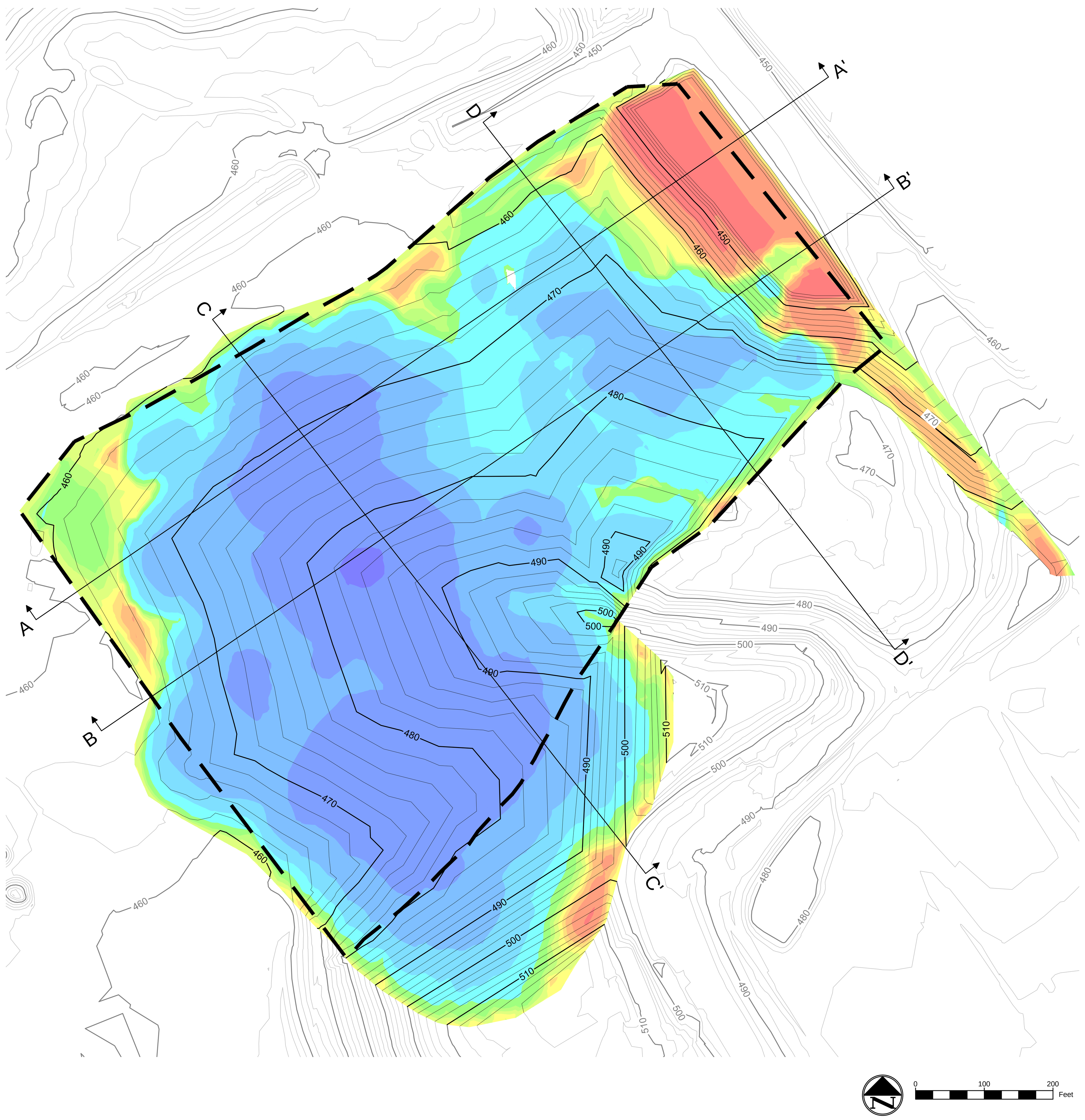
PROJECT NUMBER: BT-106 | FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\7.9 (CRR)\working\Draft Drawings\BT-106 A1 (7.9 CRR) 5% Criteria.dwg

Profile View of Alignment A Vertical Exaggeration x 1.5

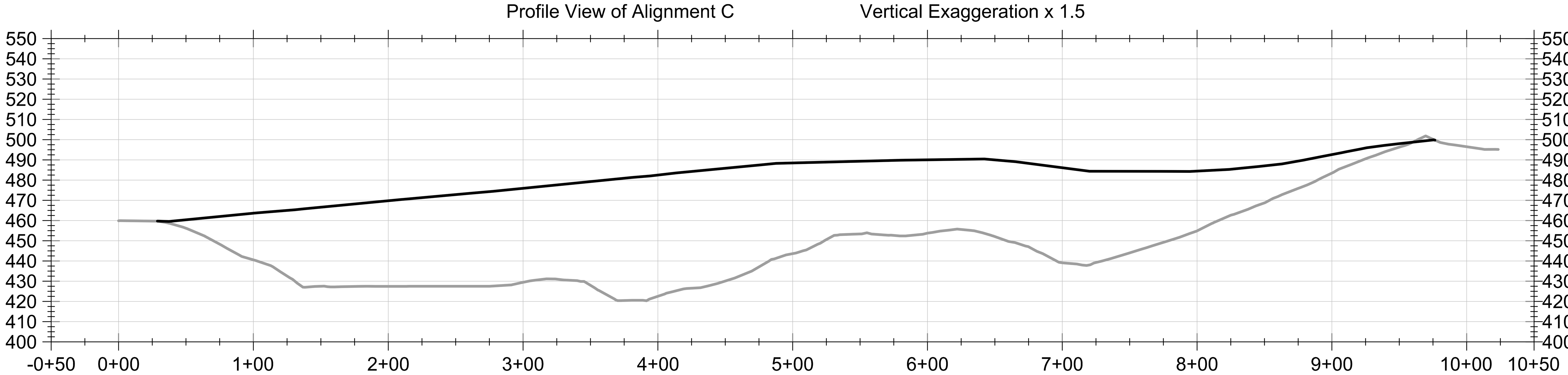


Profile View of Alignment B Vertical Exaggeration x 1.5

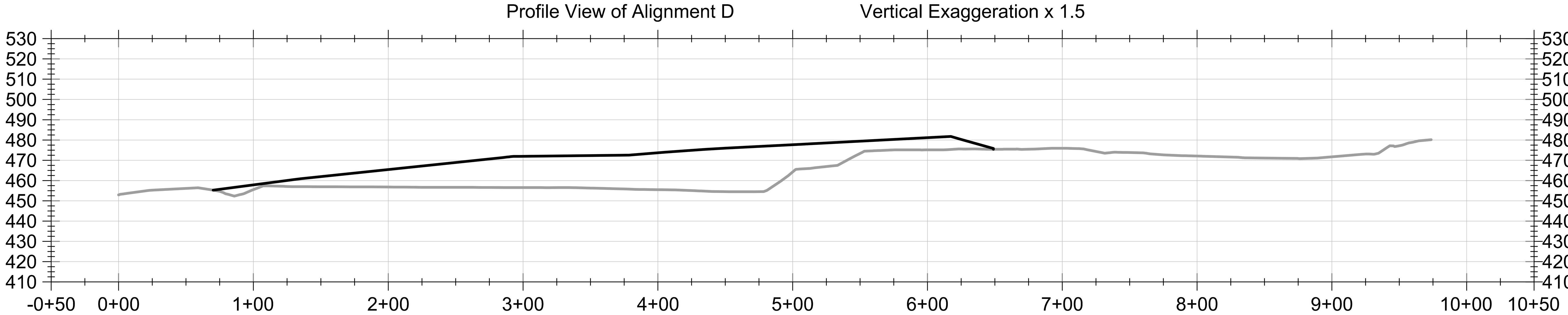




Profile View of Alignment C Vertical Exaggeration x 1.5



Profile View of Alignment D Vertical Exaggeration x 1.5



Thickness Map			
Range	Minimum Depth	Maximum Depth	Color
1	-14	-8	
2	-8	-4	
3	-4	-2	
4	-2	-1	
5	-1	0	
6	0	1	
7	1	2	
8	2	4	
9	4	8	
10	8	16	
11	16	32	
12	32	64	
13	64	66	

BACKFILL GRADING VOLUME
CUT: 19,516 CY
FILL: 614,681 CY

LEGEND

- 2015 TOPOGRAPHY WITH EXCAVATION GRADING (2' CONTOUR)
- 500 — 2015 TOPOGRAPHY WITH EXCAVATION GRADING (10' CONTOUR)
- BOTTOM OF FINAL COVER / BACKFILL GRADING (2' CONTOUR)
- 500 — BOTTOM OF FINAL COVER / BACKFILL GRADING (10' CONTOUR)
- AREA 1 BOUNDARY

DRAFT

NOTES:
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BRIDGETON LANDFILL
13570 ST. CHARLES ROCK ROAD
BRIDGETON, MISSOURI 63044

BRIDGETON LANDFILL
FINAL FEASIBILITY STUDY

7.9 (CRR) REMEDY - AREA 1
BOTTOM OF FINAL COVER / BACKFILL GRADING

Engineering for a Better World
FEEZOR ENGINEERING, INC.

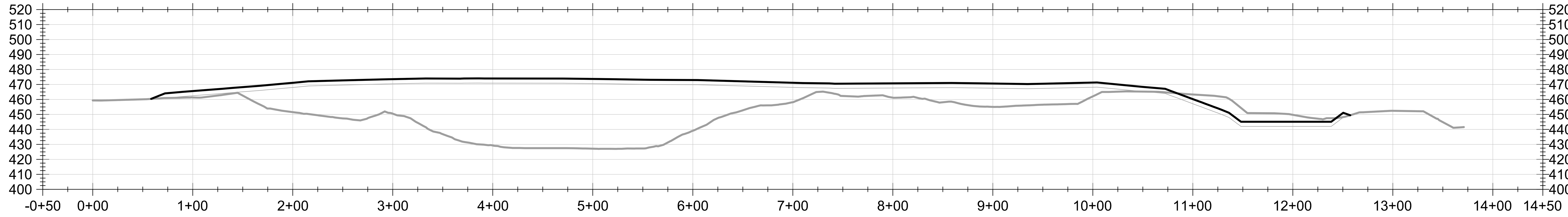
SEPTEMBER 2016
DESIGNED BY: IN
APPROVED BY: ---

REVISION | DATE

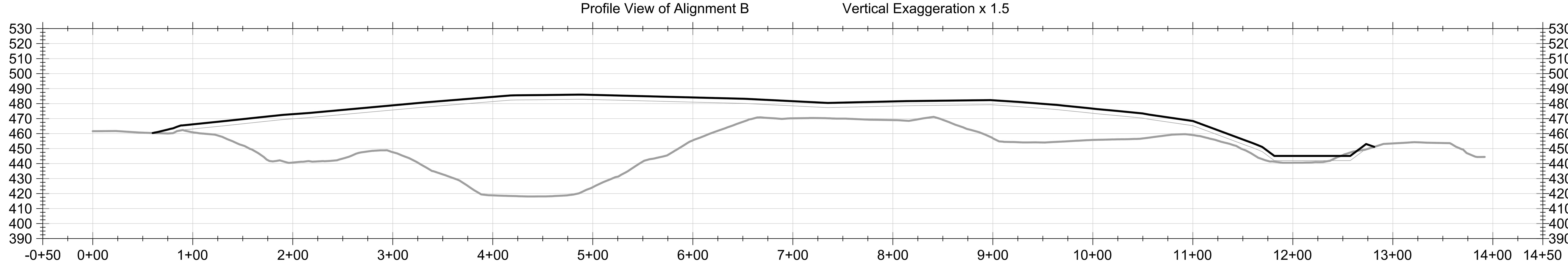
DRAWING NO.: **013**

PROJECT NUMBER: BT-106 | FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\7.9 (CRR)\working\Draft Drawings\BT-106 A1 (7.9 CRR) 5% Criteria.dwg

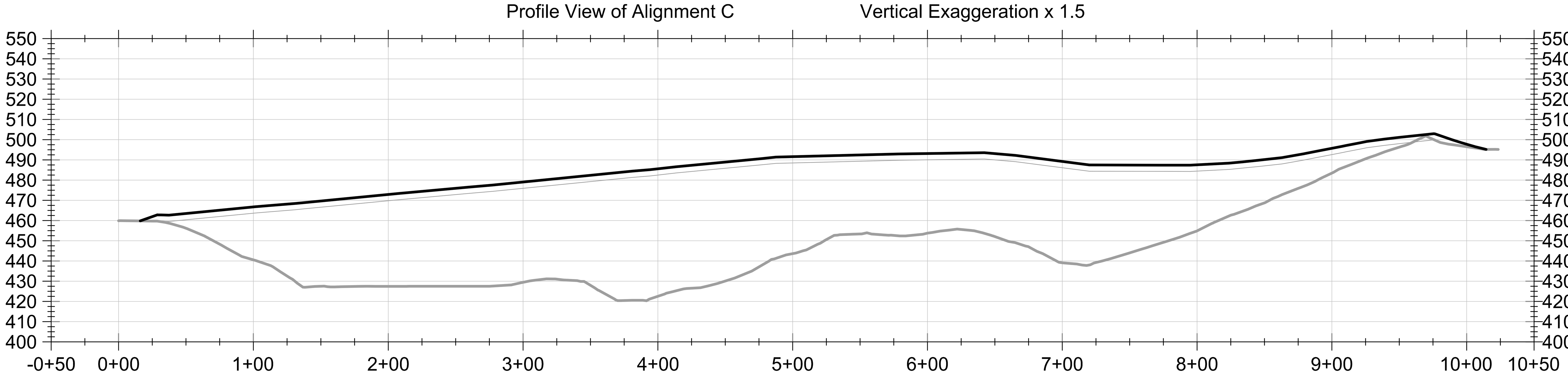
Profile View of Alignment A — Vertical Exaggeration x 1.5



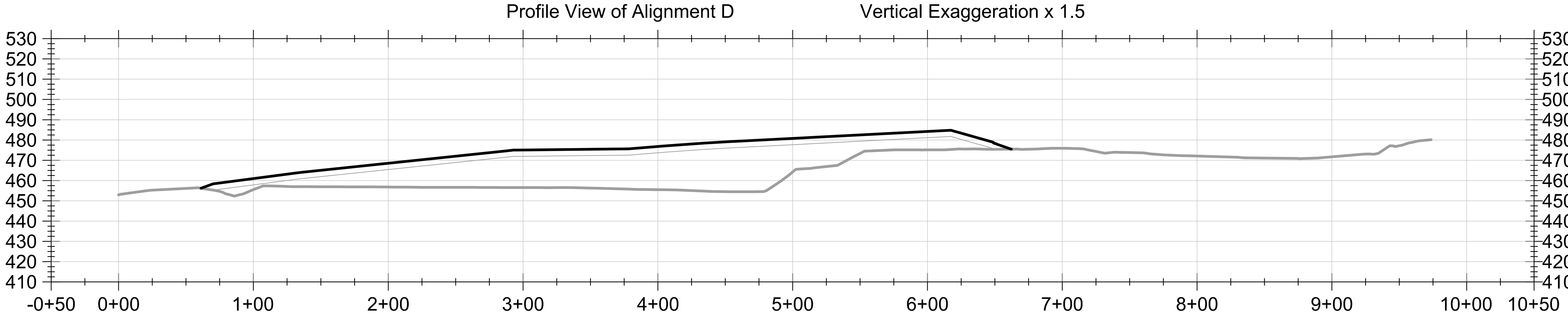
Profile View of Alignment B — Vertical Exaggeration x 1.5



Profile View of Alignment C — Vertical Exaggeration x 1.5



Profile View of Alignment D — Vertical Exaggeration x 1.5



LEGEND

- 2015 TOPOGRAPHY WITH EXCAVATION GRADING (2' CONTOUR)
- —500— 2015 TOPOGRAPHY WITH EXCAVATION GRADING (10' CONTOUR)
- TOP OF FINAL COVER GRADING (2' CONTOUR)
- —500— TOP OF FINAL COVER GRADING (10' CONTOUR)
- AREA 1 BOUNDARY

DRAFT

NOTES:

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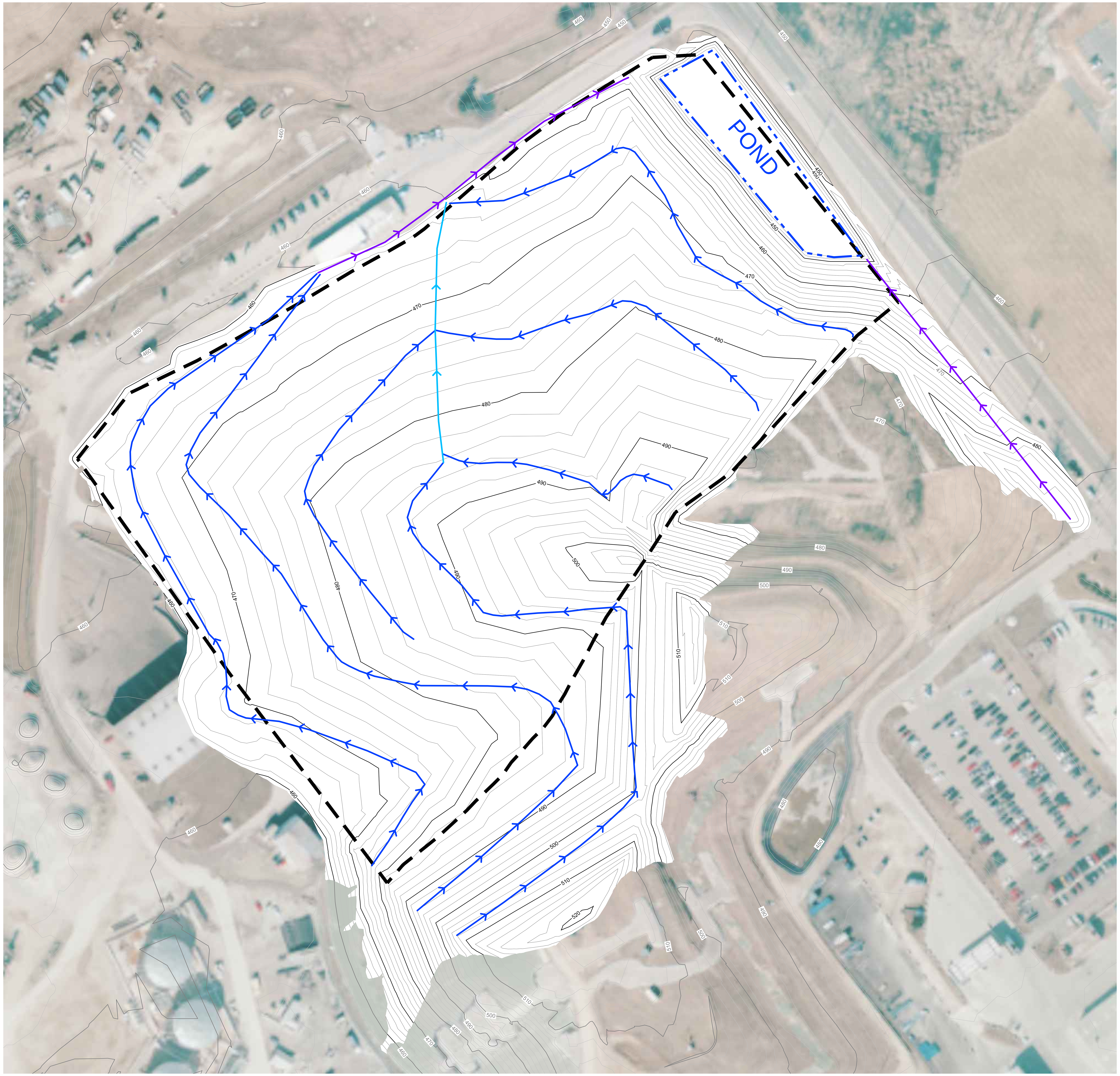
BRIDGETON LANDFILL 13570 ST. CHARLES ROCK ROAD BRIDGETON, MISSOURI 63044	BRIDGETON LANDFILL FINAL FEASIBILITY STUDY	Engineering for a Better World FEEZOR ENGINEERING, INC.	SEPTEMBER 2016 DESIGNED BY: IN APPROVED BY: ---	DRAWING NO.: 014
7.9 (CRR) REMEDY - AREA 1 TOP OF FINAL COVER GRADING			REVISION / DATE	
PROJECT NUMBER: BT-106	FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\7.9 (CRR)\working\Draft Drawings\BT-106 A1 (7.9 CRR) 5% Criteria.dwg			



0 60 120 Feet

LEGEND

- 2015 TOPOGRAPHY (2' CONTOUR)
- 500 — 2015 TOPOGRAPHY (10' CONTOUR)
- FINAL COVER GRADING (2' CONTOUR)
- 500 — FINAL COVER GRADING (10' CONTOUR)
- AREA 1 BOUNDARY
- DRAINAGE TERRACE
- DOWNCHUTE SWALE
- PERIMETER DITCH

DRAFT

NOTES:

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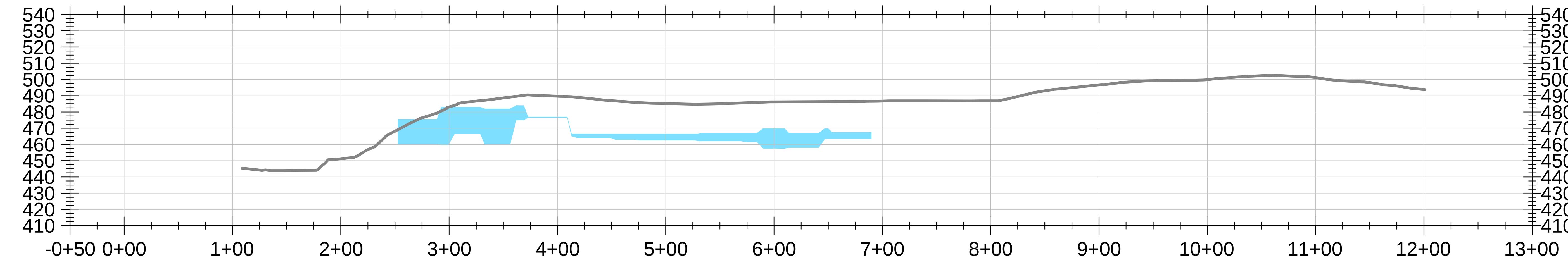
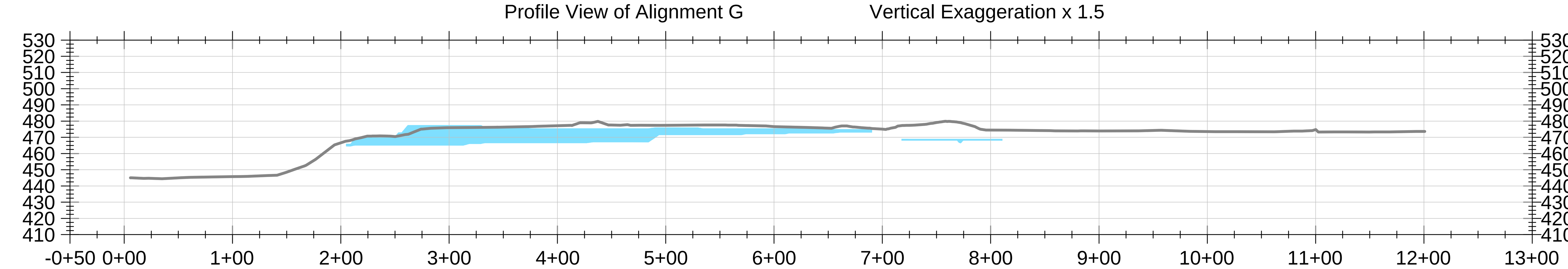
BRIDGETON LANDFILL 13570 ST. CHARLES ROCK ROAD BRIDGETON, MISSOURI 63044	BRIDGETON LANDFILL FINAL FEASIBILITY STUDY	Engineering for a Better World FEEZOR ENGINEERING, INC.	SEPTEMBER 2016 DESIGNED BY: IN APPROVED BY: ---	DRAWING NO.: 015
7.9 (CRR) REMEDY - AREA 1 STORM WATER CONTROLS			REVISION / DATE	
PROJECT NUMBER: BT-106	FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\7.9 (CRR)\working\Draft Drawings\BT-106 A1 (7.9 CRR) 5% Criteria.dwg			

Profile View of Alignment E Vertical Exaggeration x 1.5

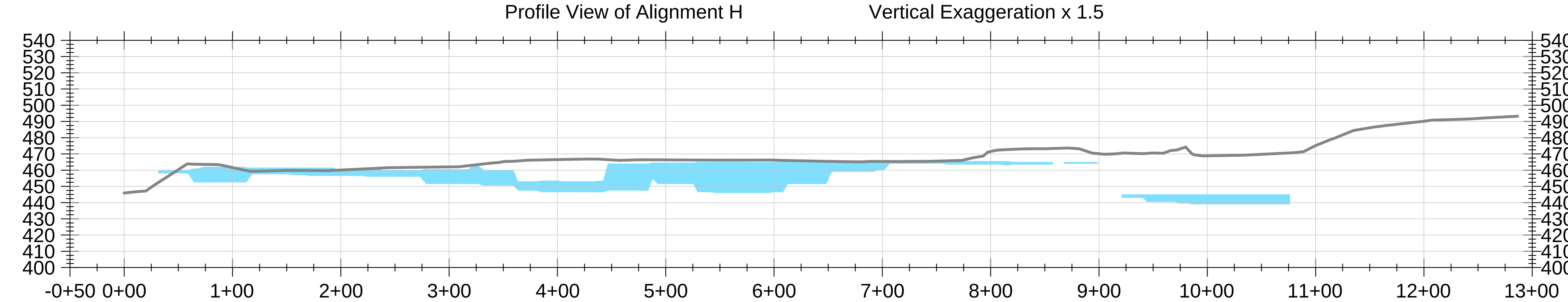
Profile View of Alignment F Vertical Exaggeration x 1.5

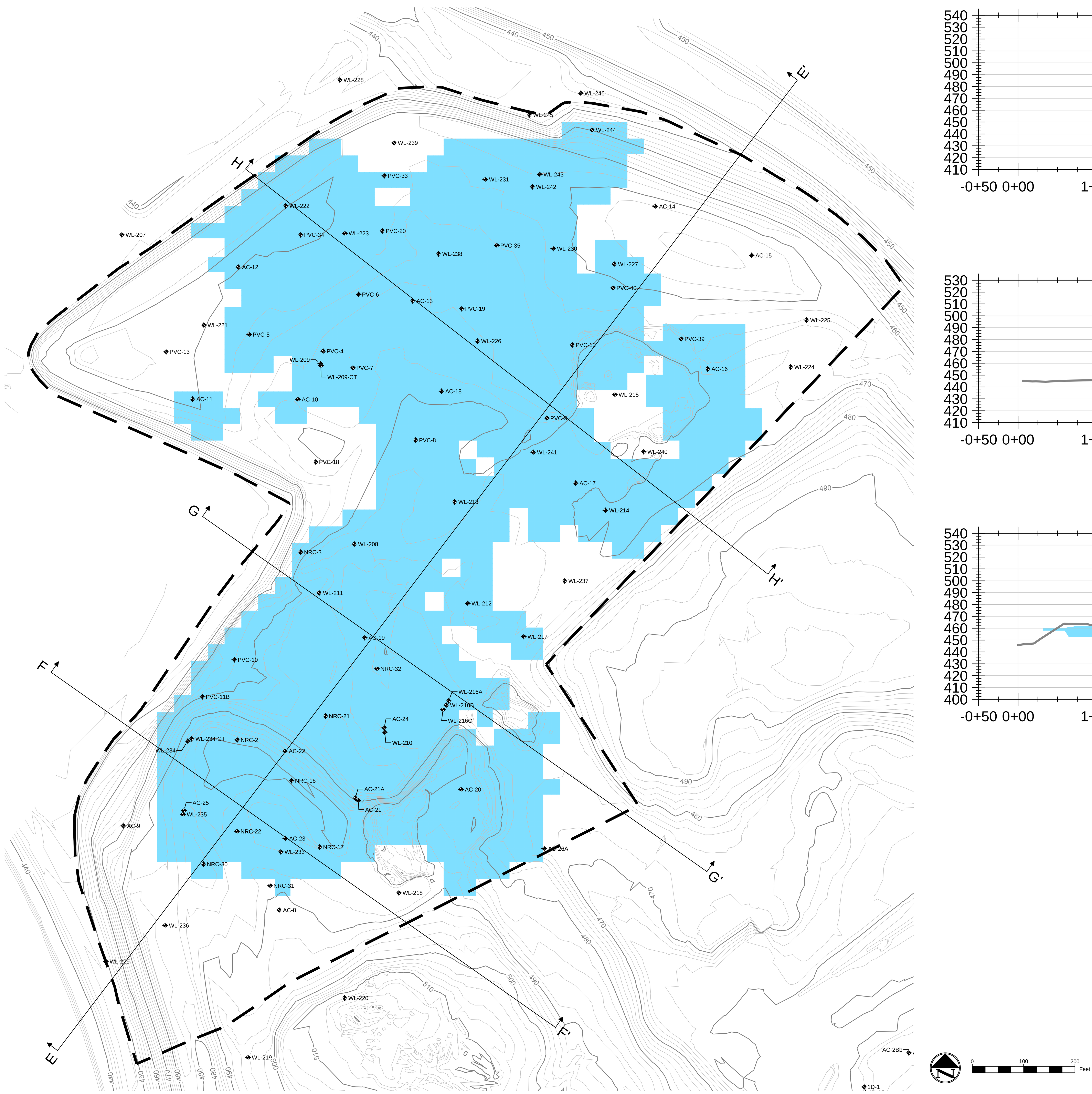


Profile View of Alignment G Vertical Exaggeration x 1.5



Profile View of Alignment H Vertical Exaggeration x 1.5





LEGEND

- 2015 TOPOGRAPHY (2' CONTOUR)
- 500 — 2015 TOPOGRAPHY (10' CONTOUR)
- AREA 2 BOUNDARY
- RIM (PROFILE VIEW)
- BORING LOCATION

DRAFT

NOTES:

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BRIDGETON LANDFILL
13570 ST. CHARLES ROCK ROAD
BRIDGETON, MISSOURI 63044

BRIDGETON LANDFILL
FINAL FEASIBILITY STUDY

7.9 (CRR) REMEDY - AREA 2
RIM EXTENTS

Engineering for a Better World
FEEZOR ENGINEERING, INC.

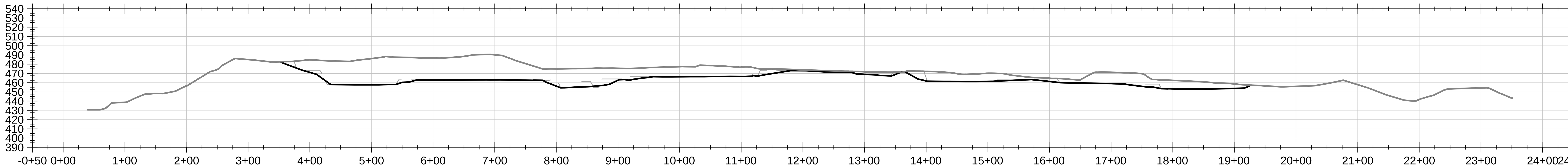
SEPTEMBER 2016
DESIGNED BY: IN
APPROVED BY: ---

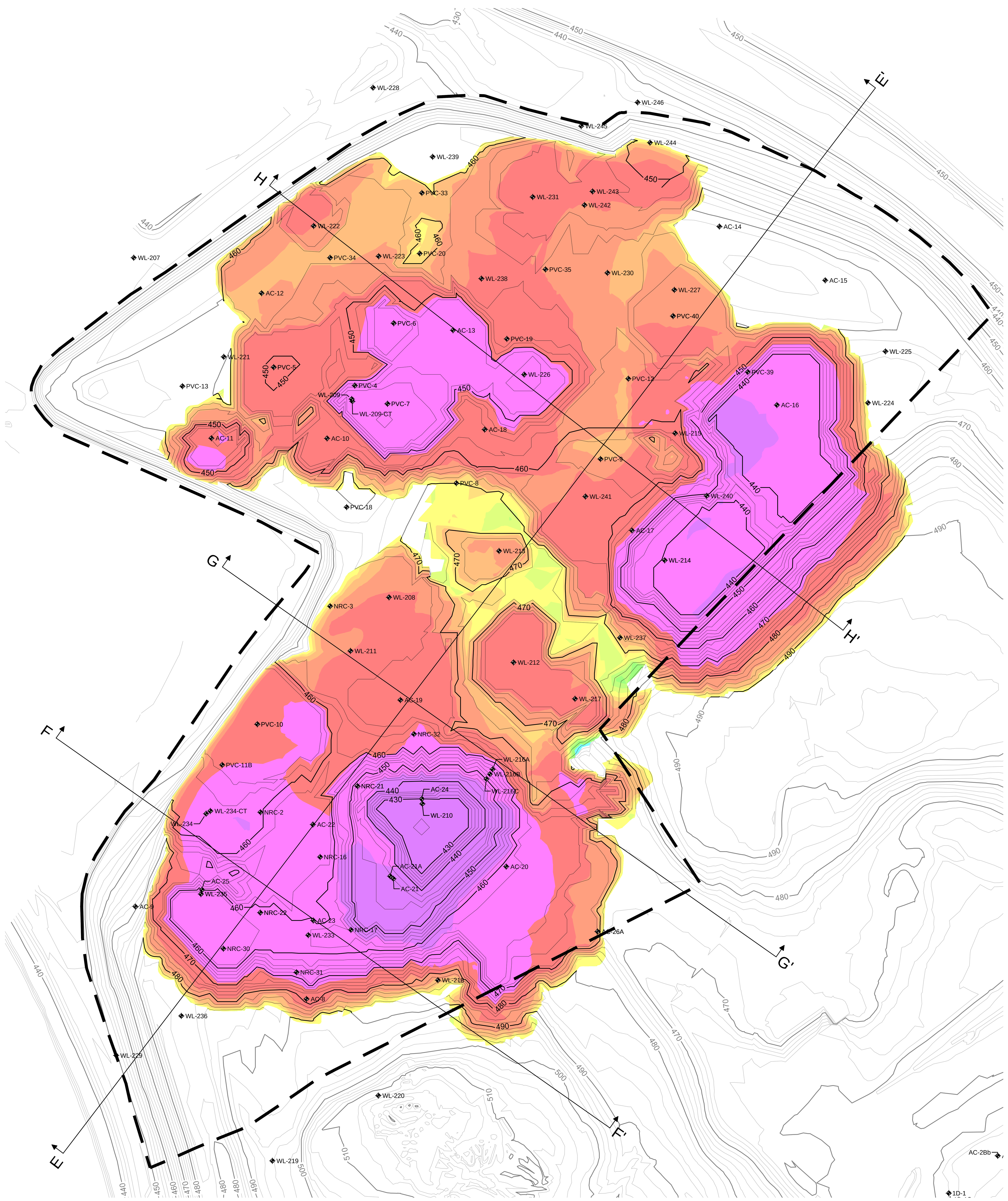
REVISION	DATE

DRAWING NO.: **016**

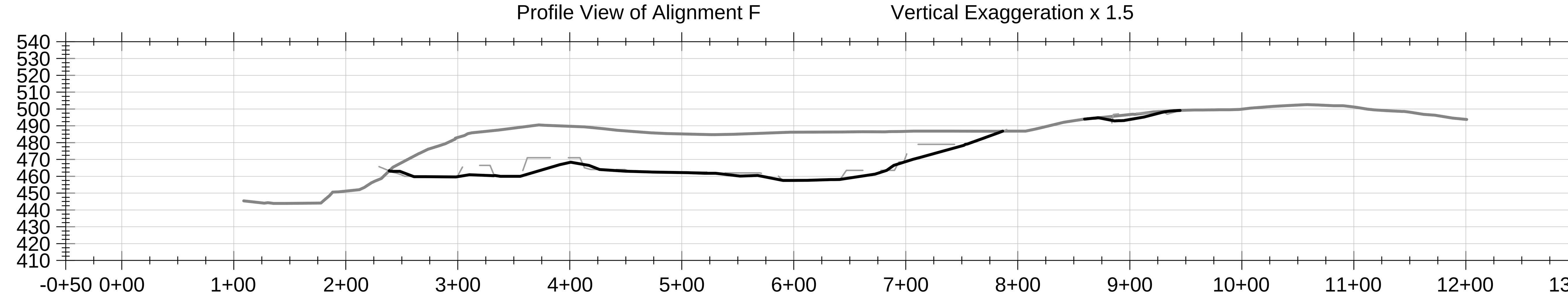
PROJECT NUMBER: BT-106 FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\7.9 (CRR)\working\Draft Drawings\BT-106 A2 (7.9 CRR) 5% Criteria.dwg

Profile View of Alignment E Vertical Exaggeration x 1.5

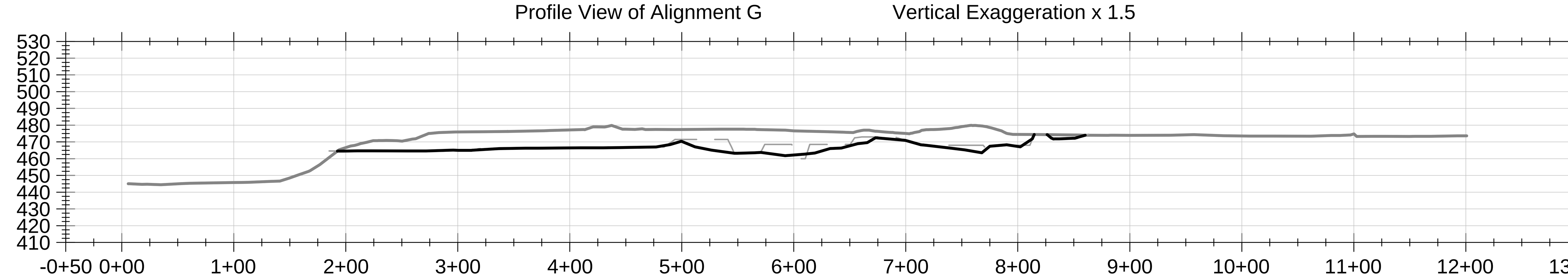




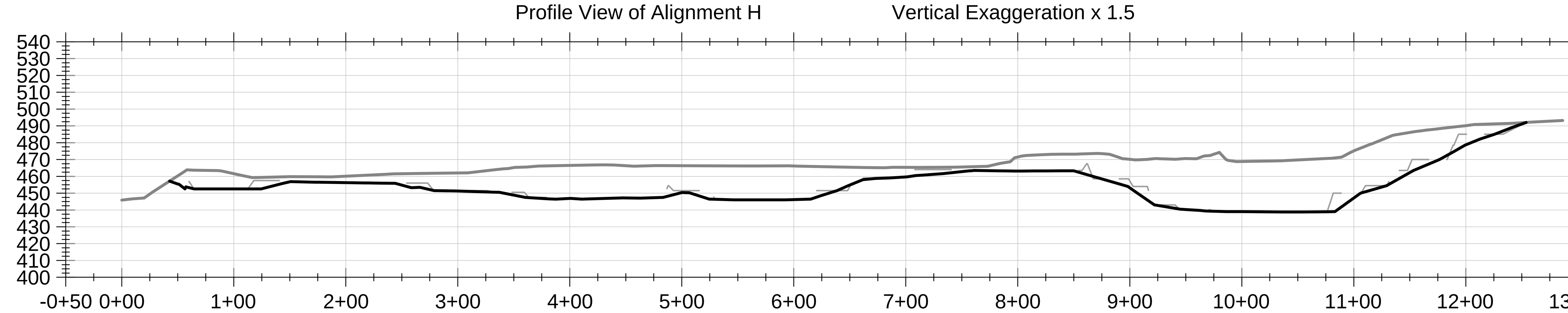
Profile View of Alignment F Vertical Exaggeration x 1.5



Profile View of Alignment G Vertical Exaggeration x 1.5



Profile View of Alignment H Vertical Exaggeration x 1.5



Thickness Map			
Range	Minimum Depth	Maximum Depth	Color
1	-57	-32	
2	-32	-16	
3	-16	-8	
4	-8	-4	
5	-4	-2	
6	-2	-1	
7	-1	0	
8	0	1	
9	1	2	
10	2	4	
11	4	6	

EXCAVATION VOLUME: 706,573 CY

0 100 200 Feet

LEGEND

- 2015 TOPOGRAPHY (2' CONTOUR)
- 2015 TOPOGRAPHY (10' CONTOUR)
- EXCAVATION GRADING (2' CONTOUR)
- EXCAVATION GRADING (10' CONTOUR)
- AREA 2 BOUNDARY
- BORING LOCATION

DRAFT

NOTES:
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BRIDGETON LANDFILL
13570 ST. CHARLES ROCK ROAD
BRIDGETON, MISSOURI 63044

BRIDGETON LANDFILL
FINAL FEASIBILITY STUDY

7.9 (CRR) REMEDY - AREA 2
EXCAVATION GRADING

Engineering for a Better World
FEEZOR ENGINEERING, INC.

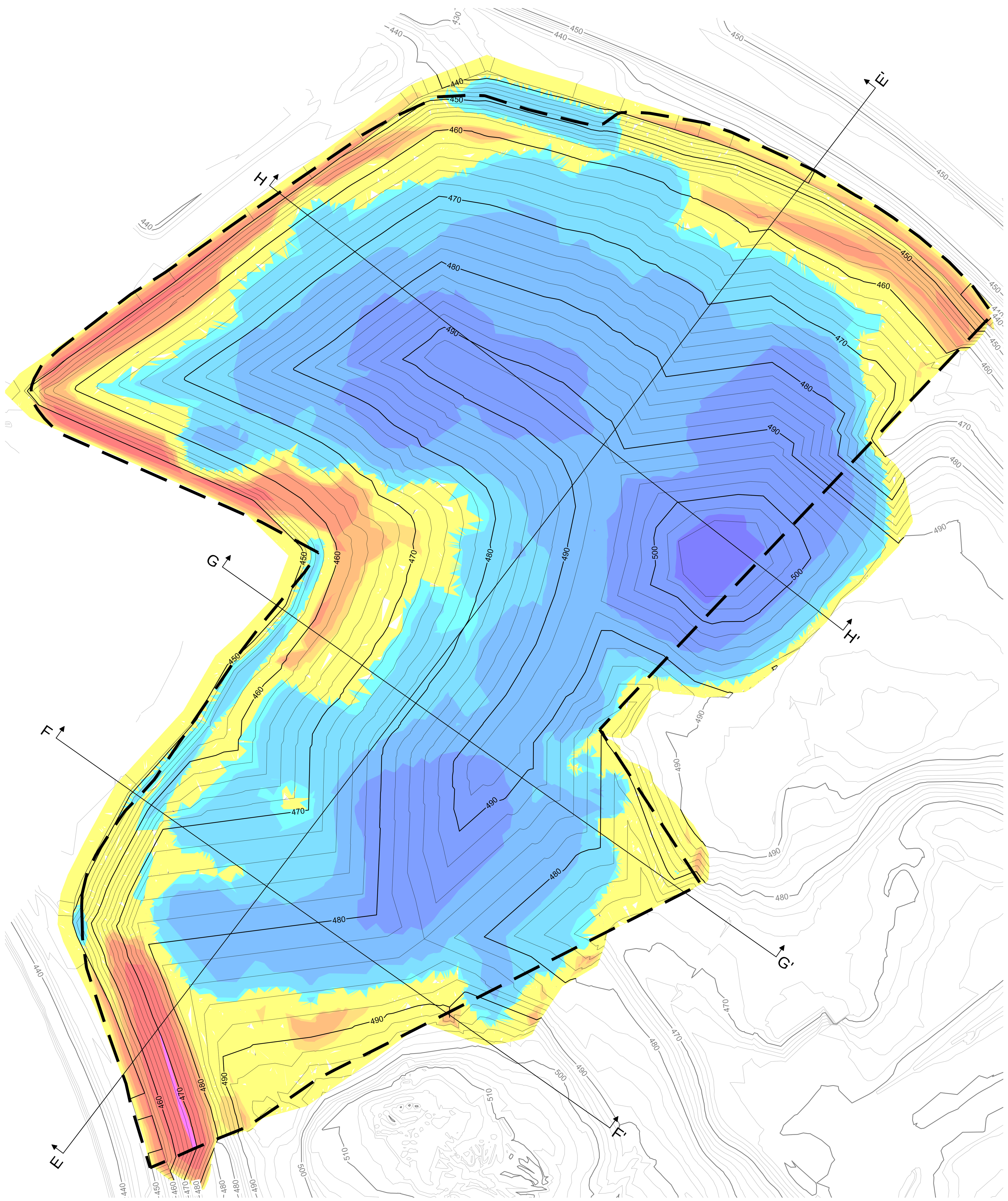
SEPTEMBER 2016
DESIGNED BY: IN
APPROVED BY: ---

REVISION | DATE

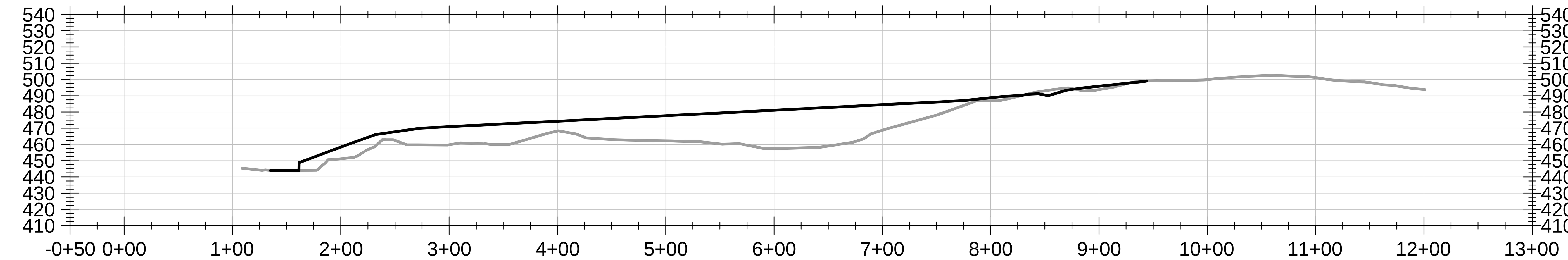
DRAWING NO.: **017**

PROJECT NUMBER: BT-106 FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\7.9 (CRR)\working\Draft Drawings\BT-106 A2 (7.9 CRR) 5% Criteria.dwg

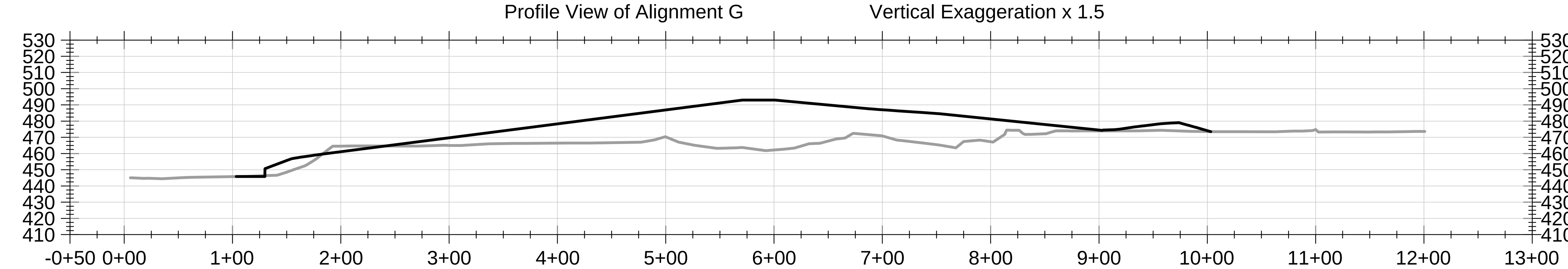
Profile View of Alignment E   Vertical Exaggeration x 1.5



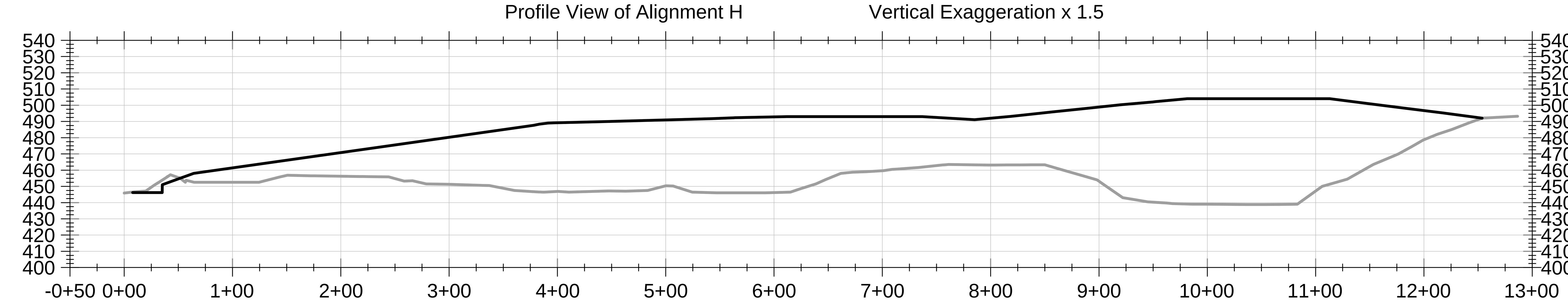
Profile View of Alignment F   Vertical Exaggeration x 1.5



Profile View of Alignment G   Vertical Exaggeration x 1.5

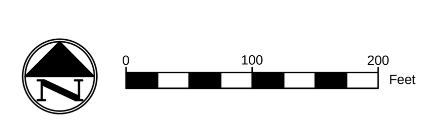


Profile View of Alignment H   Vertical Exaggeration x 1.5



Thickness Map			
Range	Minimum Depth	Maximum Depth	Color
1	-18	-16	
2	-16	-8	
3	-8	-4	
4	-4	-2	
5	-2	-1	
6	-1	6	
7	0	1	
8	1	2	
9	2	4	
10	4	8	
11	8	16	
12	16	32	
13	32	64	
14	64	66	

BACKFILL GRADING VOLUME
CUT: 41,206 CY
FILL: 1,147,152 CY



LEGEND

- 2015 TOPOGRAPHY WITH EXCAVATION GRADING (2' CONTOUR)
- 500 — 2015 TOPOGRAPHY WITH EXCAVATION GRADING (10' CONTOUR)
- BOTTOM OF FINAL COVER / BACKFILL GRADING (2' CONTOUR)
- 500 — BOTTOM OF FINAL COVER / BACKFILL GRADING (10' CONTOUR)
- AREA 2 BOUNDARY

DRAFT

NOTES:
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BRIDGETON LANDFILL
13570 ST. CHARLES ROCK ROAD
BRIDGETON, MISSOURI 63044

BRIDGETON LANDFILL
FINAL FEASIBILITY STUDY

7.9 (CRR) REMEDY - AREA 2
BOTTOM OF FINAL COVER / BACKFILL GRADING

Engineering for a Better World
FEEZOR
ENGINEERING, INC.

SEPTEMBER 2016
DESIGNED BY: IN
APPROVED BY: ---

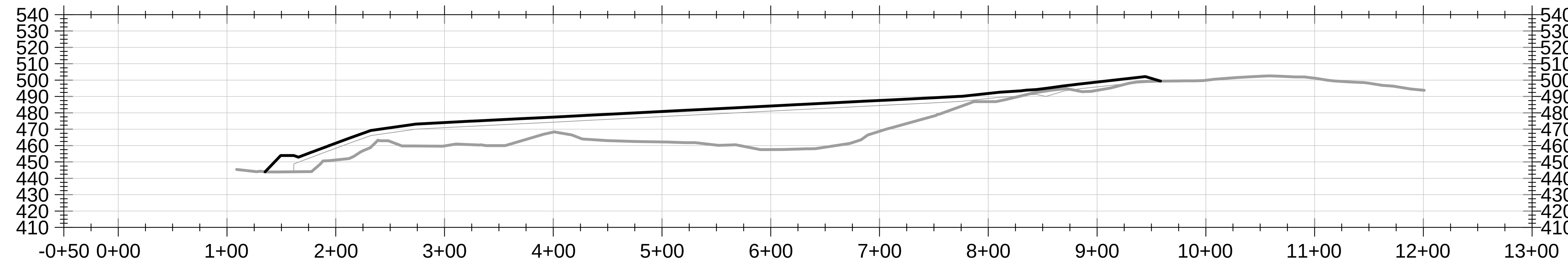
REVISION	DATE

DRAWING NO.: **018**

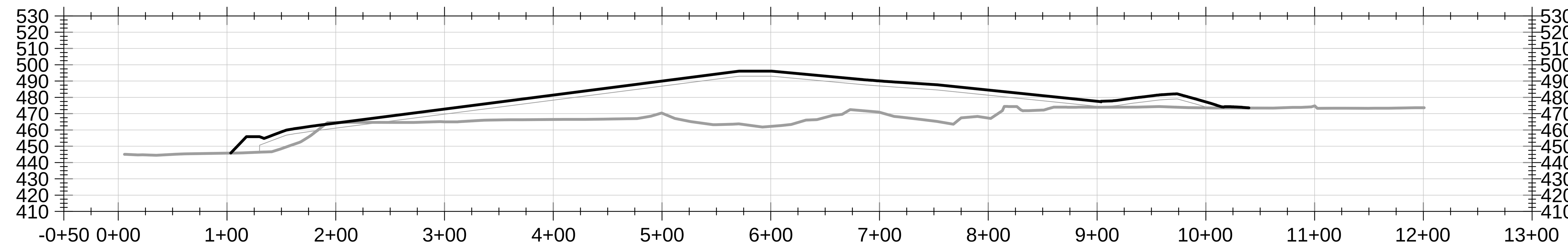
PROJECT NUMBER: BT-106 | FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\7.9 (CRR)\working\Draft Drawings\BT-106 A2 (7.9 CRR) 5% Criteria.dwg

Profile View of Alignment E   Vertical Exaggeration x 1.5

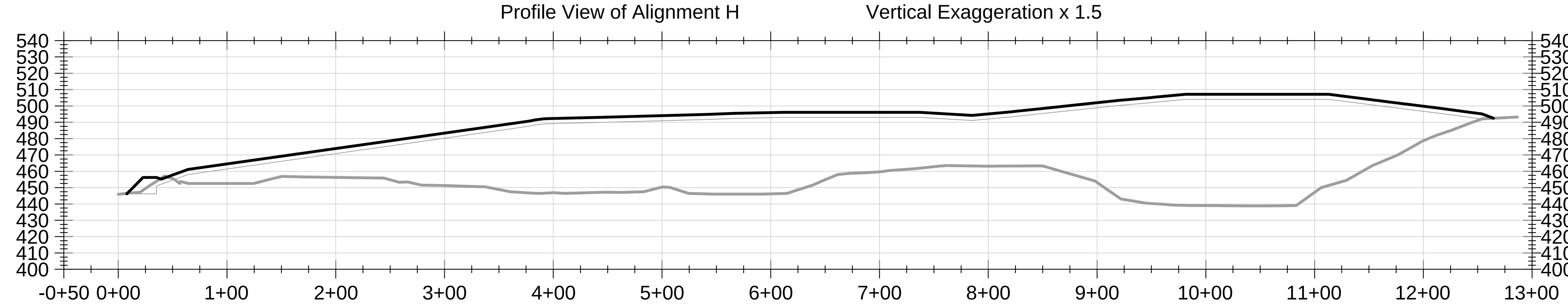
Profile View of Alignment F   Vertical Exaggeration x 1.5

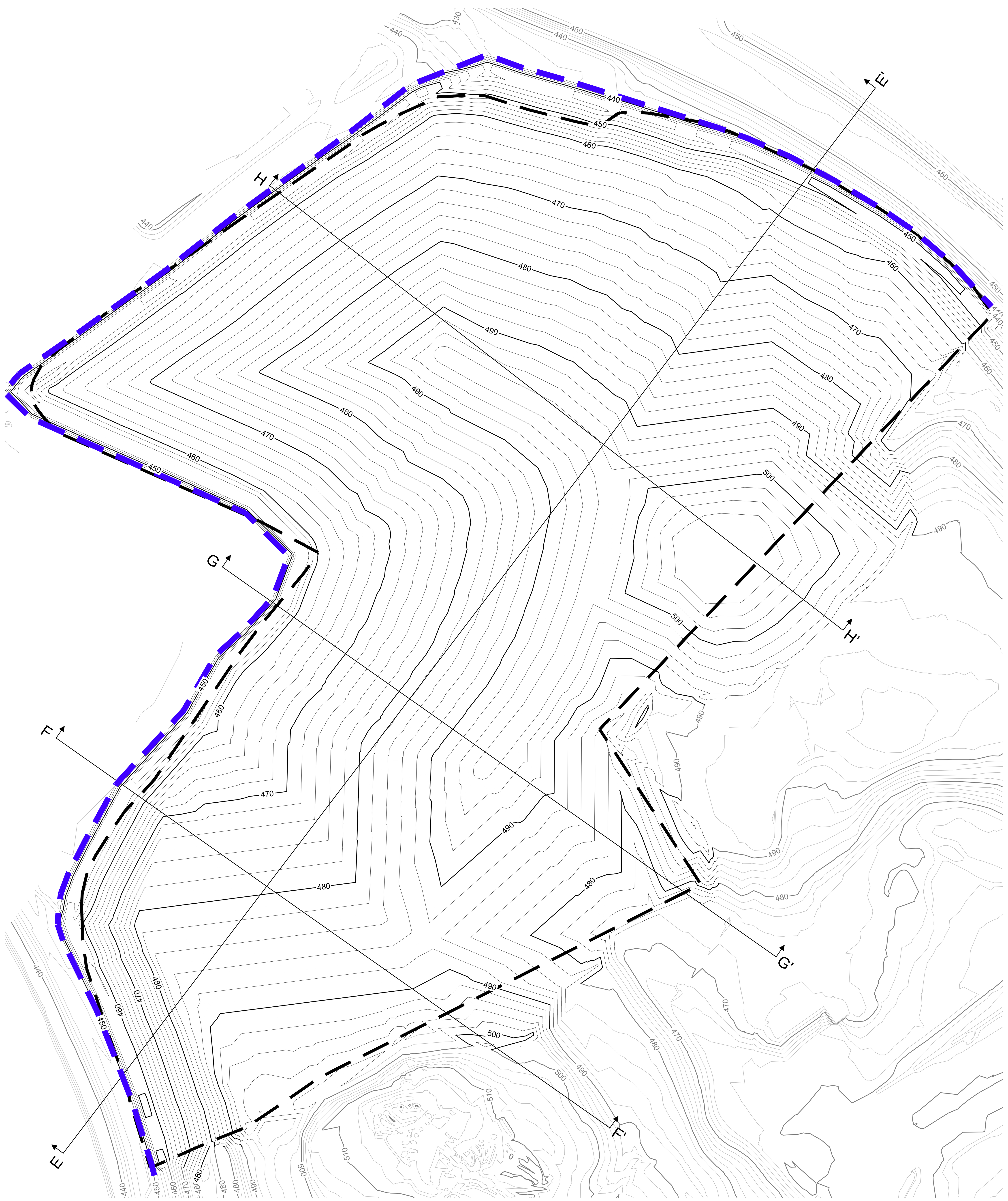


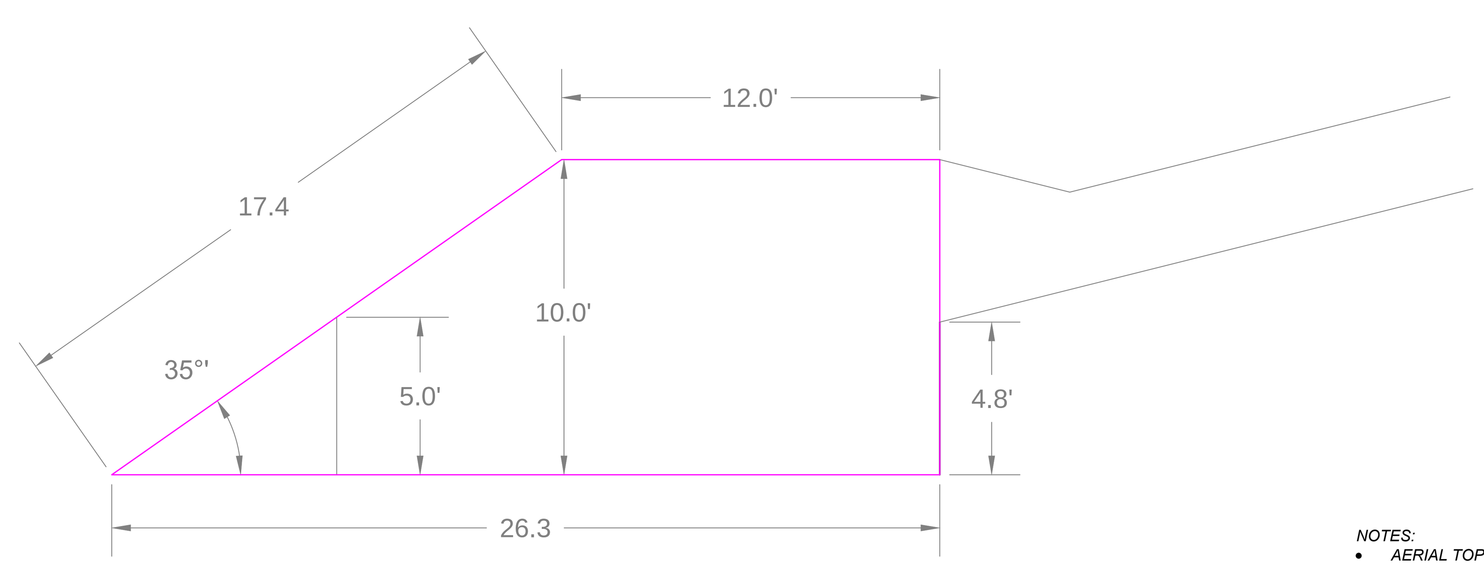
Profile View of Alignment G   Vertical Exaggeration x 1.5



Profile View of Alignment H   Vertical Exaggeration x 1.5







Area 2 Starter Berm Detail
Not to Scale

LEGEND

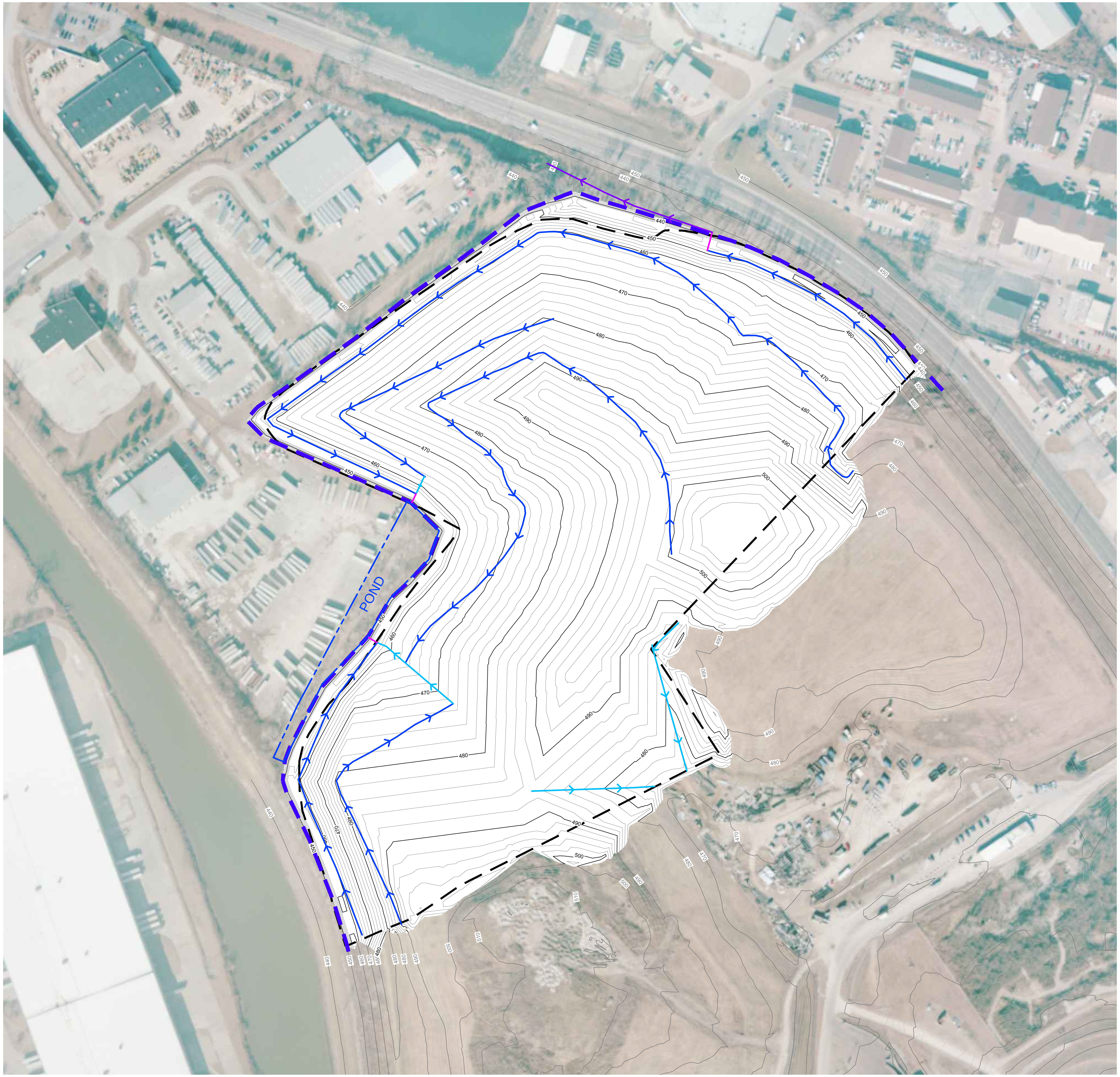
- 2015 TOPOGRAPHY (2' CONTOUR)
- 2015 TOPOGRAPHY (10' CONTOUR)
- TOP OF FINAL COVER GRADING (2' CONTOUR)
- TOP OF FINAL COVER GRADING (10' CONTOUR)
- AREA 2 BOUNDARY
- STARTER BERM LOCATION
- STARTER BERM DETAIL DESIGN

DRAFT

NOTES:
- *AERIAL TOPOGRAPHY PROVIDED BY COOPER AERIAL SURVEYS, INC. AND IS DATED MARCH 10, 2015*
- *ALL 3 DIMENSIONAL EXTENTS OF RADIOLOGICALLY IMPACTED MATERIAL (RIM) AND ALL INITIAL EXCAVATION SURFACES WERE PROVIDED BY S.S. PAPADOPULOS & ASSOC., INC.*
- *THE DRAWINGS INCLUDED WITHIN THIS PLAN SET ARE NOT DESIGN NOR CONSTRUCTION LEVEL DRAWINGS. THEY ARE INTENDED FOR ILLUSTRATIVE PURPOSES ONLY.*

BRIDGETON LANDFILL 13570 ST. CHARLES ROCK ROAD BRIDGETON, MISSOURI 63044	BRIDGETON LANDFILL FINAL FEASIBILITY STUDY	FEEZOR ENGINEERING, INC. Engineering for a Better World	SEPTEMBER 2016 DESIGNED BY: IN APPROVED BY: ---	DRAWING NO.: 019
7.9 (CRR) REMEDY - AREA 2 **TOP OF FINAL COVER GRADING**			REVISION / DATE	

PROJECT NUMBER: BT-106 FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\7.9 (CRR)\working\Draft Drawings\BT-106 A2 (7.9 CRR) 5% Criteria.dwg



LEGEND

- 2015 TOPOGRAPHY (2' CONTOUR)
- 500 — 2015 TOPOGRAPHY (10' CONTOUR)
- FINAL COVER GRADING (2' CONTOUR)
- 500 — FINAL COVER GRADING (10' CONTOUR)
- AREA 2 BOUNDARY
- STARTER BERM LOCATION
- DRAINAGE TERRACE
- DOWNCHUTE SWALE
- PERIMETER DITCH
- PERIMETER ROAD CROSSING

0 100 200 Feet

DRAFT

NOTES:

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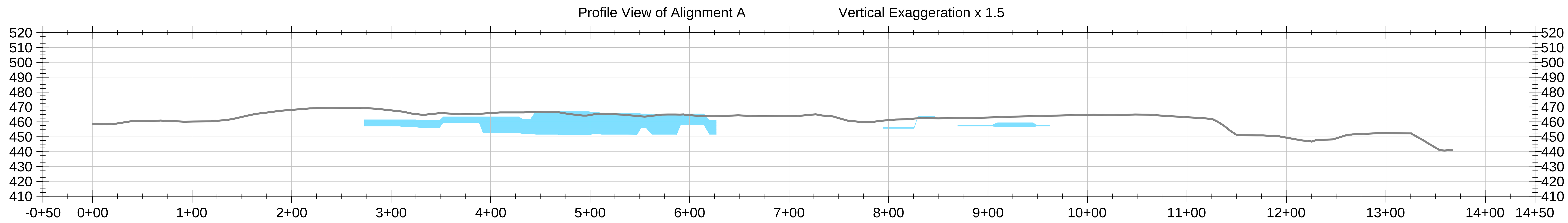
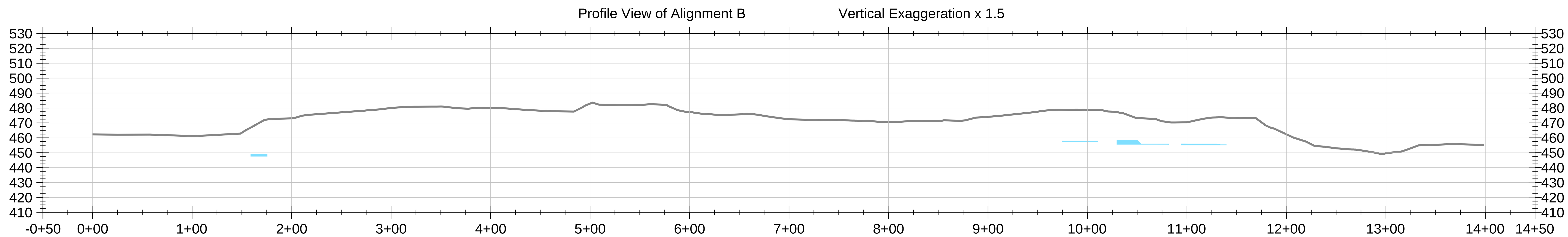
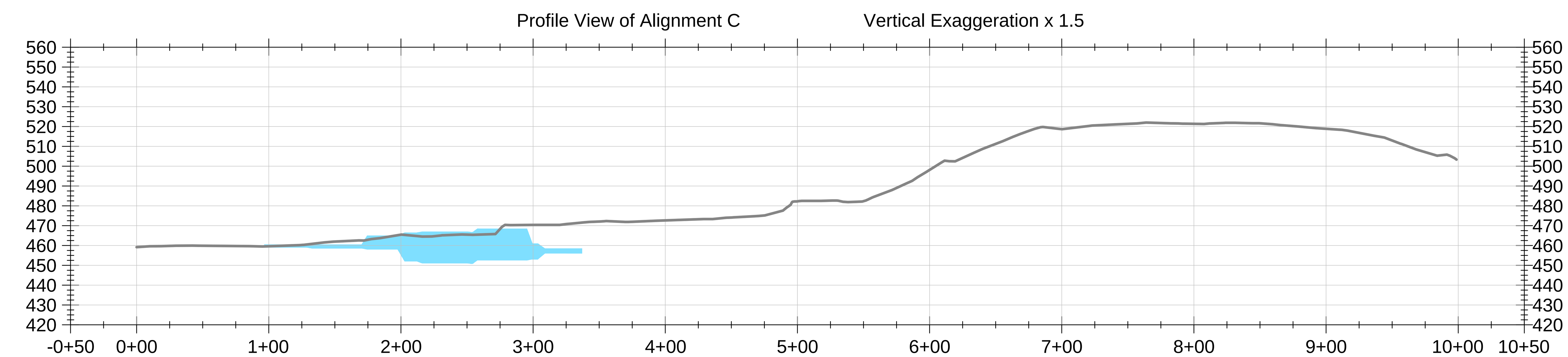
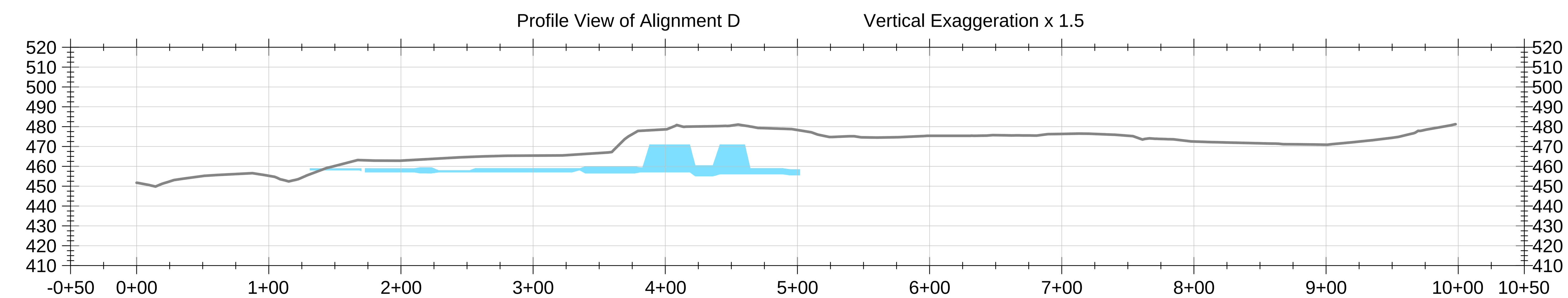
BRIDGETON LANDFILL 13570 ST. CHARLES ROCK ROAD BRIDGETON, MISSOURI 63044	BRIDGETON LANDFILL FINAL FEASIBILITY STUDY	Engineering for a Better World FEEZOR ENGINEERING, INC.	SEPTEMBER 2016 DESIGNED BY: IN APPROVED BY: ---	DRAWING NO.: 020
7.9 (CRR) REMEDY - AREA 2 STORM WATER CONTROLS			REVISION / DATE	
PROJECT NUMBER: BT-106	FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\7.9 (CRR)\working\Draft Drawings\BT-106 A2 (7.9 CRR) 5% Criteria.dwg			









LEGEND

- 2015 TOPOGRAPHY (2' CONTOUR)
- 500 — 2015 TOPOGRAPHY (10' CONTOUR)
- AREA 1 BOUNDARY
- RIM (PROFILE VIEW)
- BORING LOCATION

DRAFT

NOTES:

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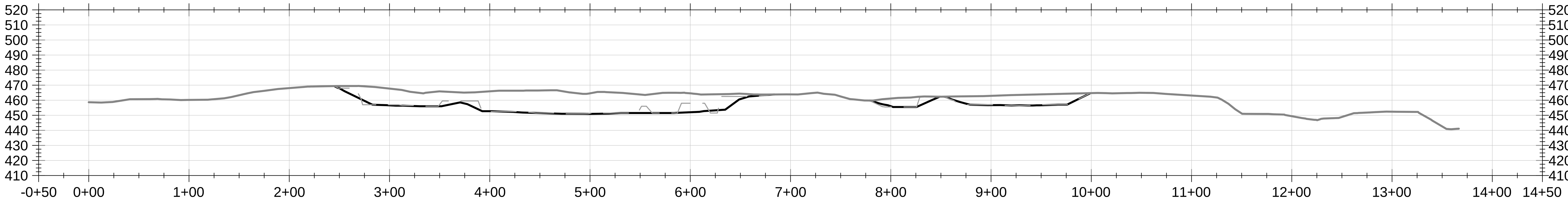
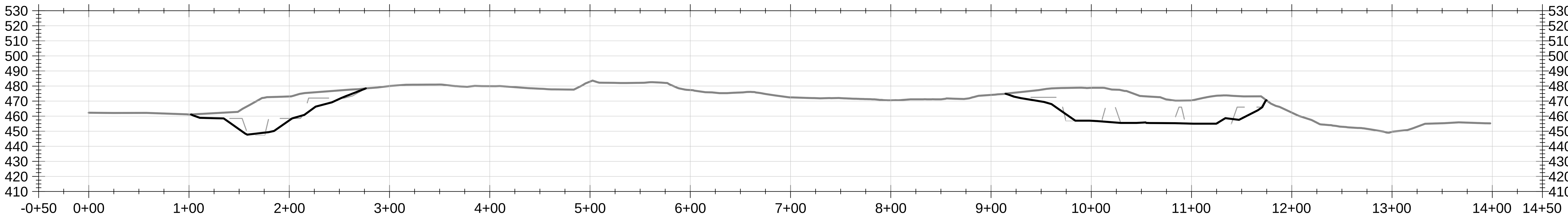
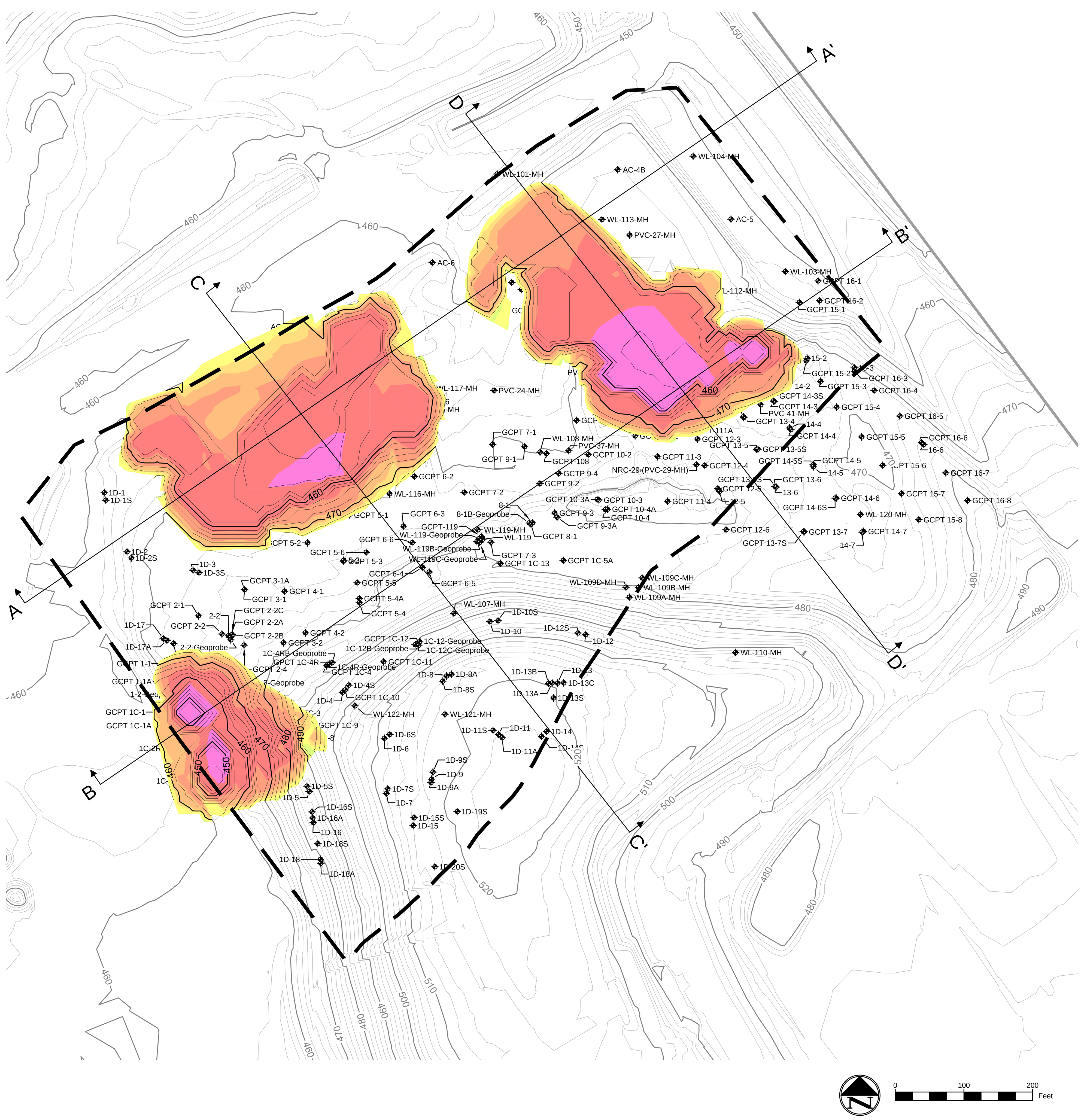
BRIDGETON LANDFILL 13570 ST. CHARLES ROCK ROAD BRIDGETON, MISSOURI 63044	BRIDGETON LANDFILL FINAL FEASIBILITY STUDY	Engineering for a Better World FEEZOR ENGINEERING, INC.	SEPTEMBER 2016 DESIGNED BY: IN APPROVED BY: ---	DRAWING NO.: 021
52.9 (16' OFFSET) REMEDY - AREA 1 **RIM EXTENTS**			REVISION / DATE	
PROJECT NUMBER: BT-106	FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\52.9 (16 Ft Offset)\working\draft Drawings\BT-106 A1 (52.9 16' Offset) 5% Criteria.dwg			

Profile View of Alignment A   Vertical Exaggeration x 1.5

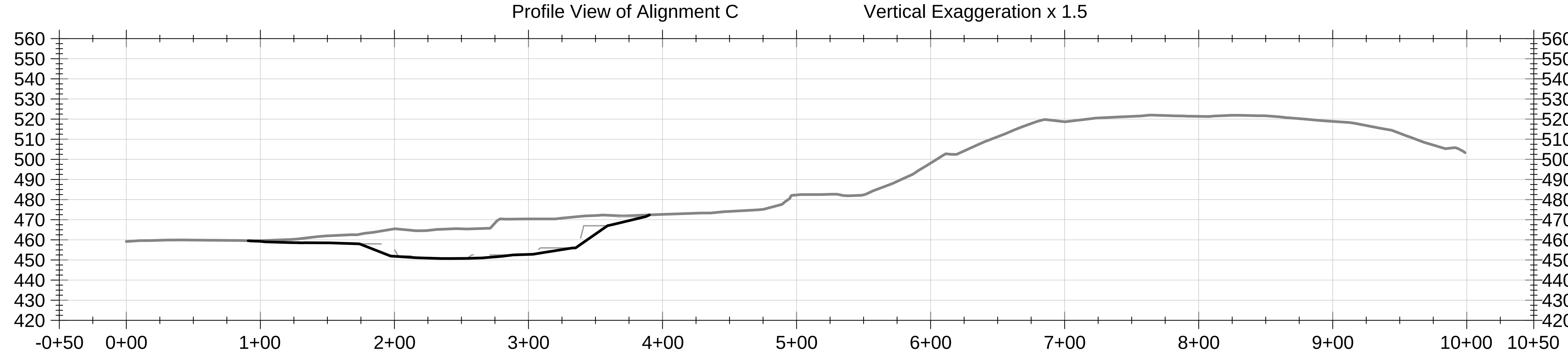


Profile View of Alignment B   Vertical Exaggeration x 1.5

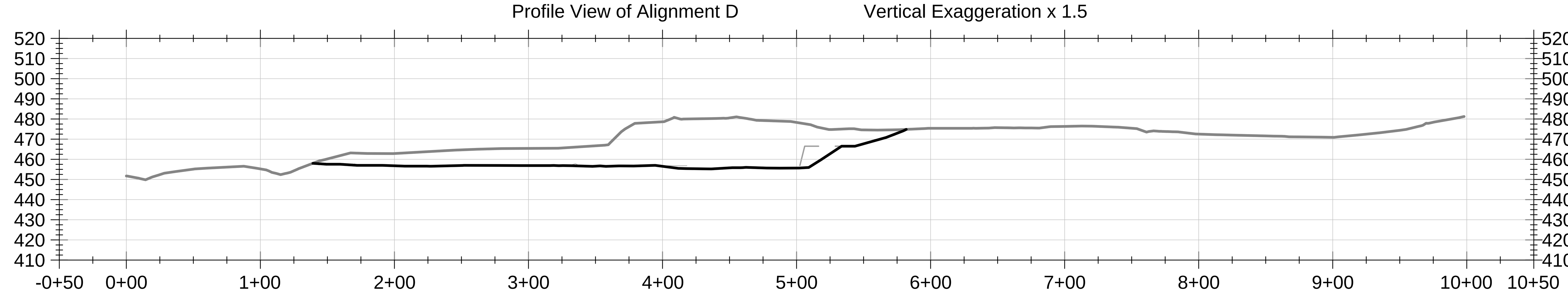




Profile View of Alignment C   Vertical Exaggeration x 1.5



Profile View of Alignment D   Vertical Exaggeration x 1.5



Thickness Map			
Range	Minimum Depth	Maximum Depth	Color
1	-26	-16	
2	-16	-8	
3	-8	-4	
4	-4	-2	
5	-2	-1	
6	-1	0	
7	0	1	

EXCAVATION VOLUME: 81,399 CY

LEGEND

- 2015 TOPOGRAPHY (2' CONTOUR)
- 2015 TOPOGRAPHY (10' CONTOUR)
- EXCAVATION GRADING (2' CONTOUR)
- EXCAVATION GRADING (10' CONTOUR)
- INITIAL EXCAVATION GRADING (PROFILE)
- AREA 1 BOUNDARY
- BORING LOCATION

DRAFT

NOTES:
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BRIDGETON LANDFILL
13570 ST. CHARLES ROCK ROAD
BRIDGETON, MISSOURI 63044

BRIDGETON LANDFILL
FINAL FEASIBILITY STUDY

52.9 (16' OFFSET) REMEDY - AREA 1
EXCAVATION GRADING

Engineering for a Better World
FEEZOR
ENGINEERING, INC.

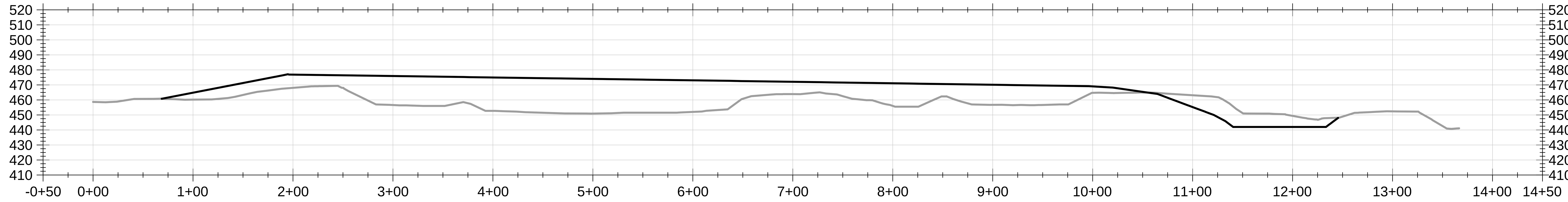
SEPTEMBER 2016
DESIGNED BY: IN
APPROVED BY: ---

REVISION	DATE

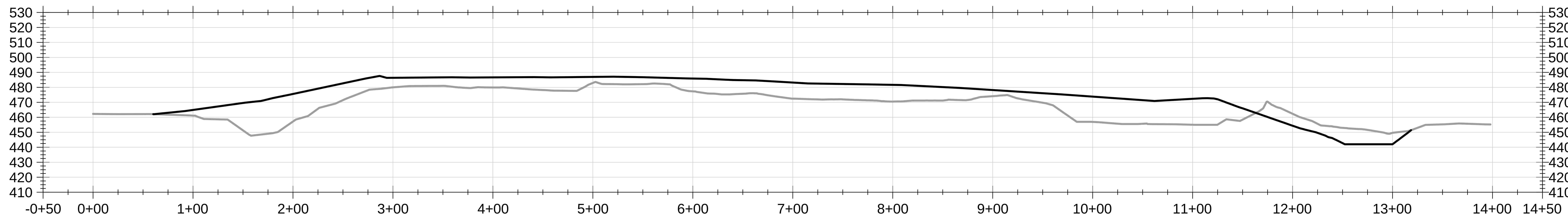
DRAWING NO.: **022**

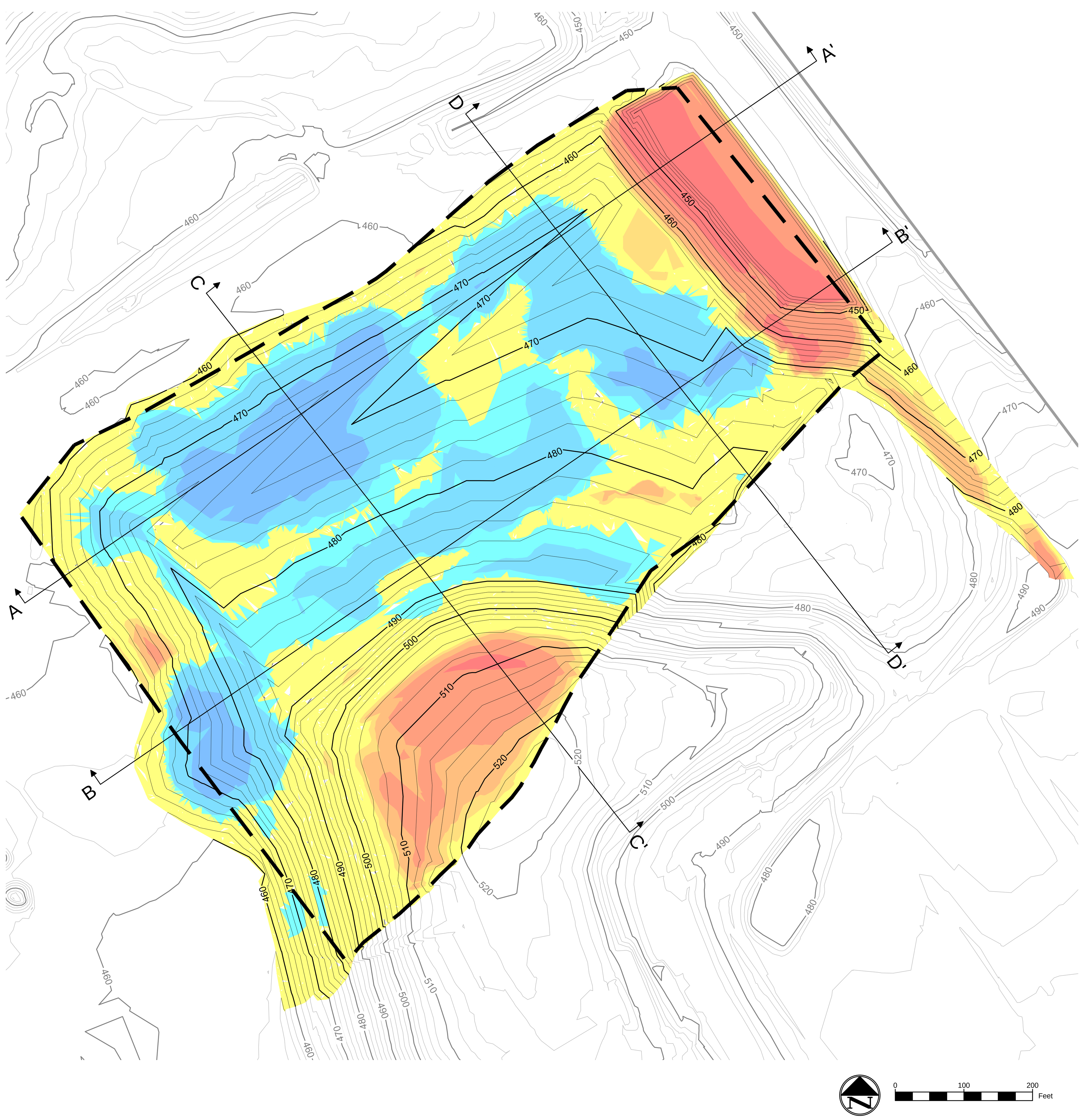
PROJECT NUMBER: BT-106 | FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\52.9 (16 Ft Offset)\working\draft Drawings\BT-106 A1 (52.9 16' Offset) 5% Criteria.dwg

Profile View of Alignment A Vertical Exaggeration x 1.5

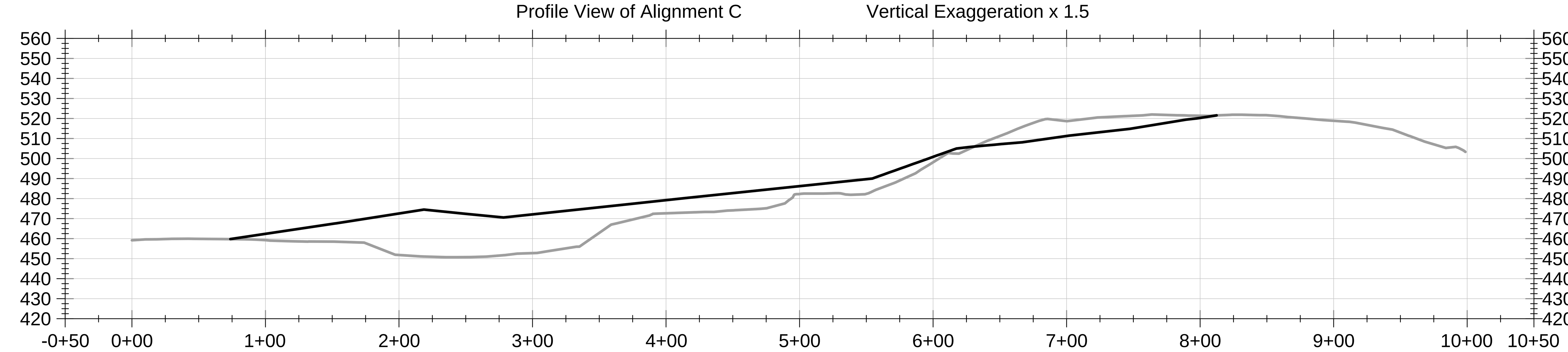


Profile View of Alignment B Vertical Exaggeration x 1.5

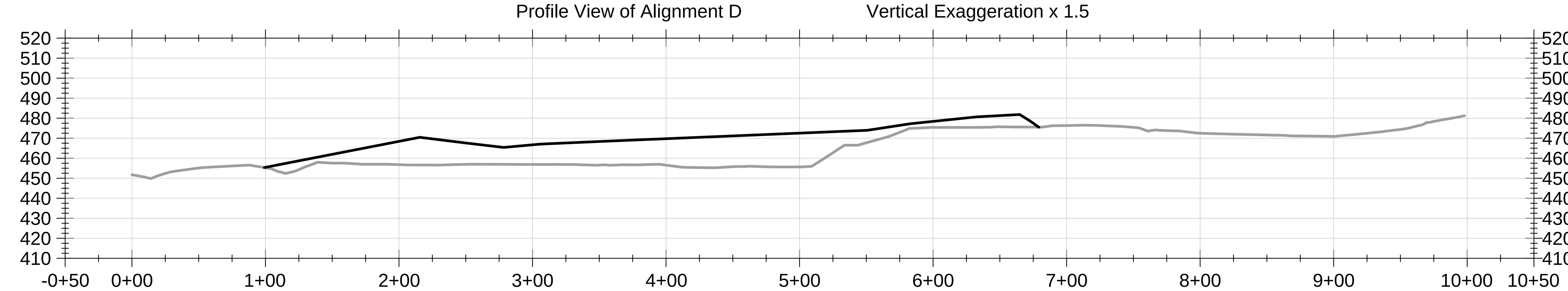




Profile View of Alignment C Vertical Exaggeration x 1.5



Profile View of Alignment D Vertical Exaggeration x 1.5



Thickness Map

Range	Minimum Depth	Maximum Depth	Color
1	-14	-8	
2	-8	-4	
3	-4	-2	
4	-2	-1	
5	-1	6	
6	0	1	
7	1	2	
8	2	4	
9	4	8	
10	8	16	
11	16	29	

BACKFILL GRADING VOLUME
CUT: 33,741 CY
FILL: 177,763 CY

LEGEND

- 2015 TOPOGRAPHY WITH EXCAVATION GRADING(2' CONTOUR)
- 500 — 2015 TOPOGRAPHY WITH EXCAVATION GRADING (10' CONTOUR)
- BOTTOM OF FINAL COVER / BACKFILL GRADING (2' CONTOUR)
- 500 — BOTTOM OF FINAL COVER / BACKFILL GRADING (10' CONTOUR)
- AREA 1 BOUNDARY

DRAFT

NOTES:
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BRIDGETON LANDFILL
13570 ST. CHARLES ROCK ROAD
BRIDGETON, MISSOURI 63044

BRIDGETON LANDFILL
FINAL FEASIBILITY STUDY

52.9 (16' OFFSET) REMEDY - AREA 1
BOTTOM OF FINAL COVER / BACKFILL GRADING

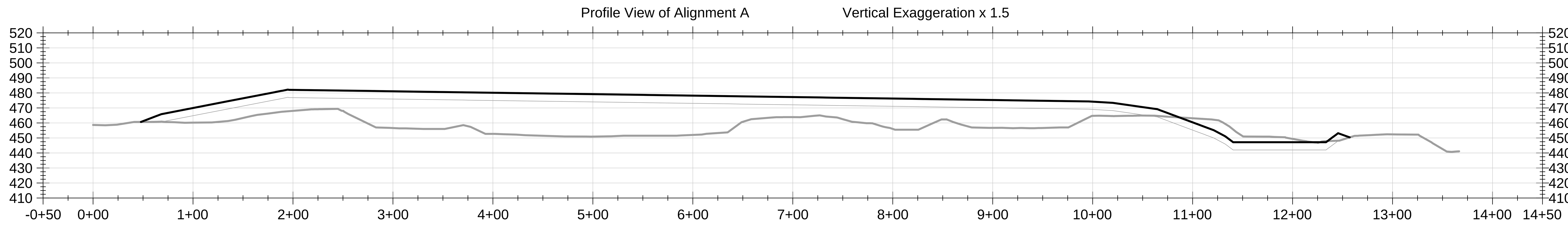
Engineering for a Better World
FEEZOR ENGINEERING, INC.

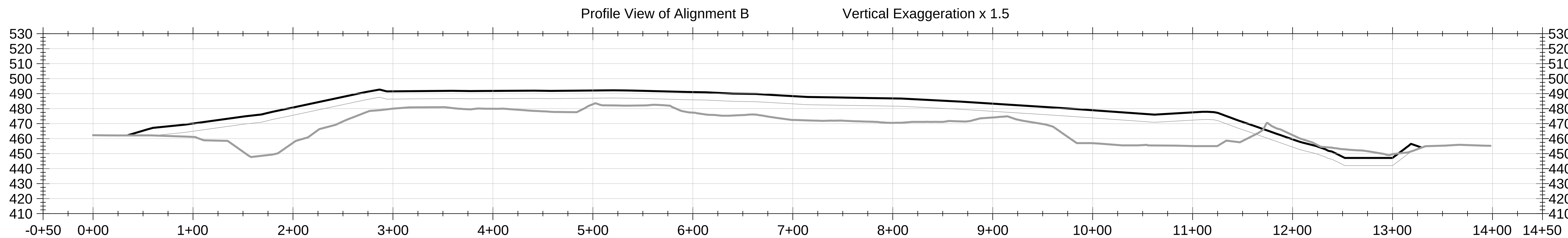
SEPTEMBER 2016
DESIGNED BY: IN
APPROVED BY: ---

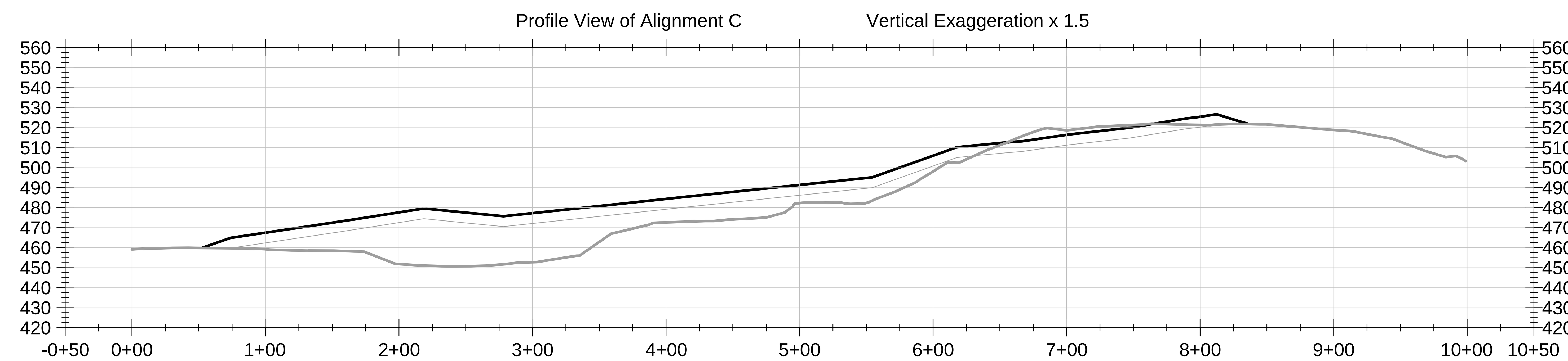
REVISION	DATE

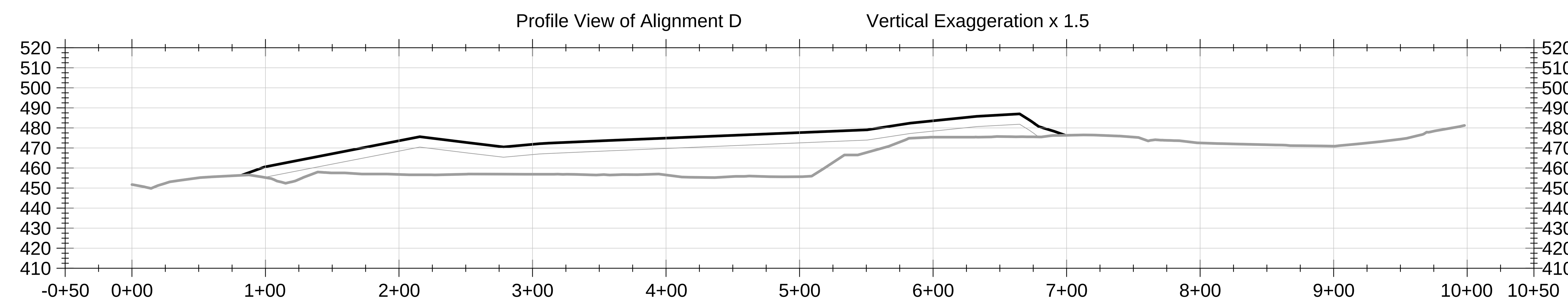
DRAWING NO.: **023**

PROJECT NUMBER: BT-106 FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\52.9 (16 Ft Offset)\working\draft Drawings\BT-106 A1 (52.9 16' Offset) 5% Criteria.dwg









LEGEND

- 2015 TOPOGRAPHY WITH EXCAVATION GRADING (2' CONTOUR)
- 500 — 2015 TOPOGRAPHY WITH EXCAVATION GRADING (10' CONTOUR)
- FINAL COVER GRADING (2' CONTOUR)
- 500 — FINAL COVER GRADING (10' CONTOUR)
- AREA 1 BOUNDARY

DRAFT

NOTES:

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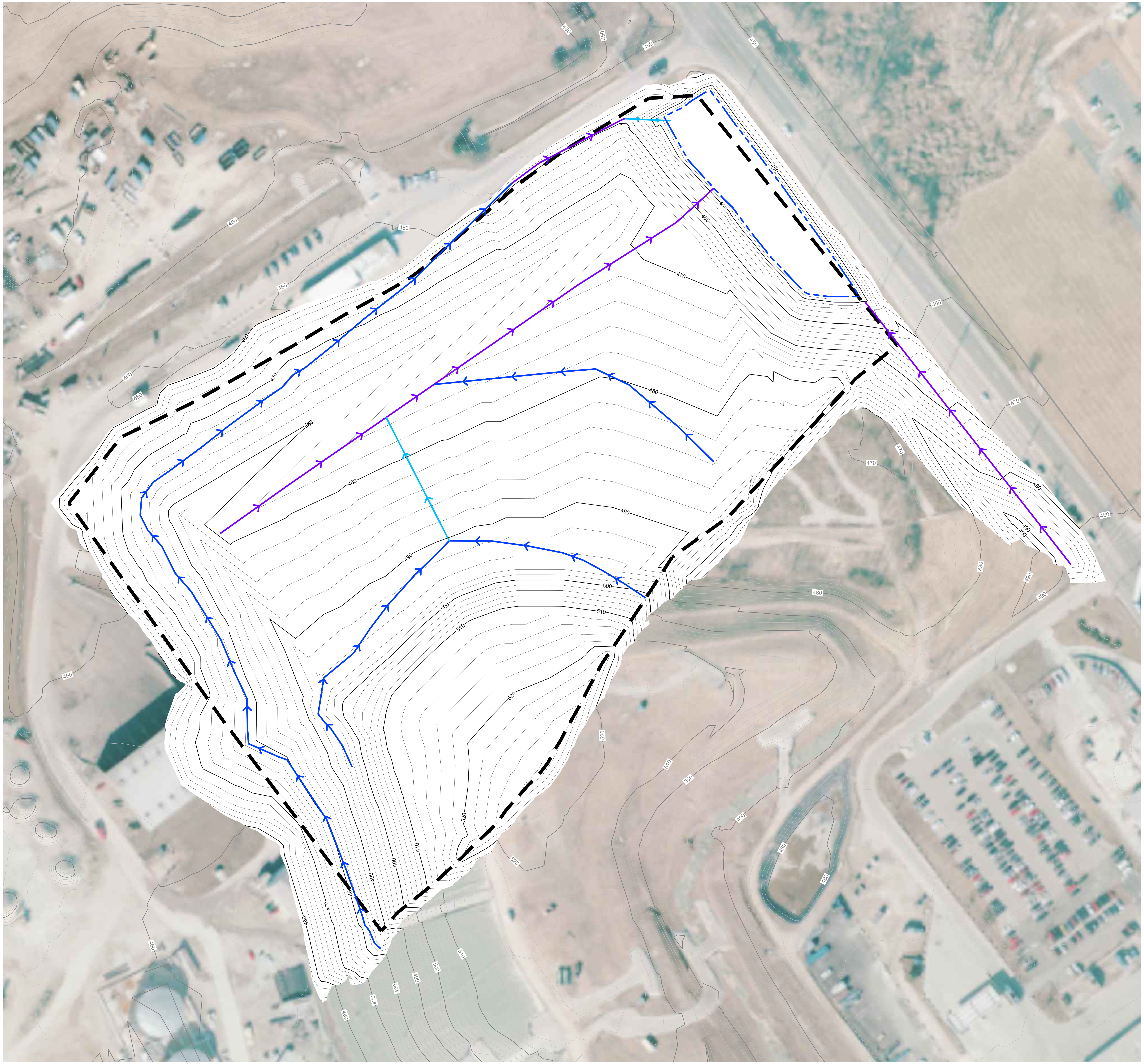
BRIDGETON LANDFILL 13570 ST. CHARLES ROCK ROAD BRIDGETON, MISSOURI 63044	BRIDGETON LANDFILL FINAL FEASIBILITY STUDY	Engineering for a Better World FEEZOR ENGINEERING, INC.	SEPTEMBER 2016 DESIGNED BY: IN APPROVED BY: ---	DRAWING NO.:
52.9 (16' OFFSET) REMEDY - AREA 1 **TOP OF FINAL COVER GRADING**			REVISION / DATE	**024**
PROJECT NUMBER: BT-106	FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\52.9 (16 Ft Offset)\working\draft Drawings\BT-106 A1 (52.9 16' Offset) 5% Criteria.dwg			



LEGEND

- 2015 TOPOGRAPHY GRADING (2' CONTOUR)
- 500 — 2015 TOPOGRAPHY GRADING (10' CONTOUR)
- FINAL COVER GRADING (2' CONTOUR)
- 500 — FINAL COVER GRADING (10' CONTOUR)
- AREA 1 BOUNDARY
- DRAINAGE TERRACE
- DOWNCHUTE SWALE
- PERIMETER DITCH

N

0 60 120 Feet

DRAFT

NOTES:

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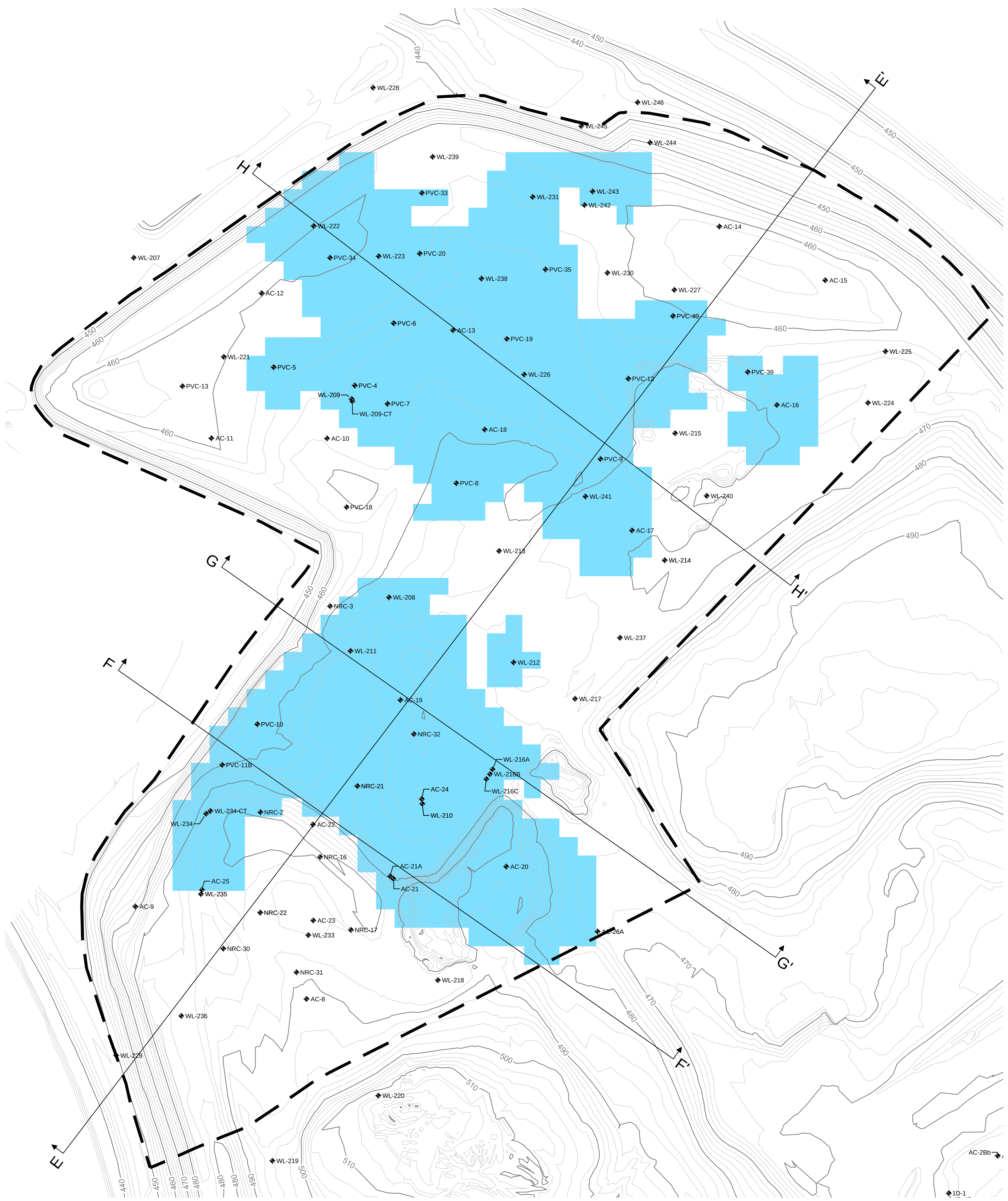
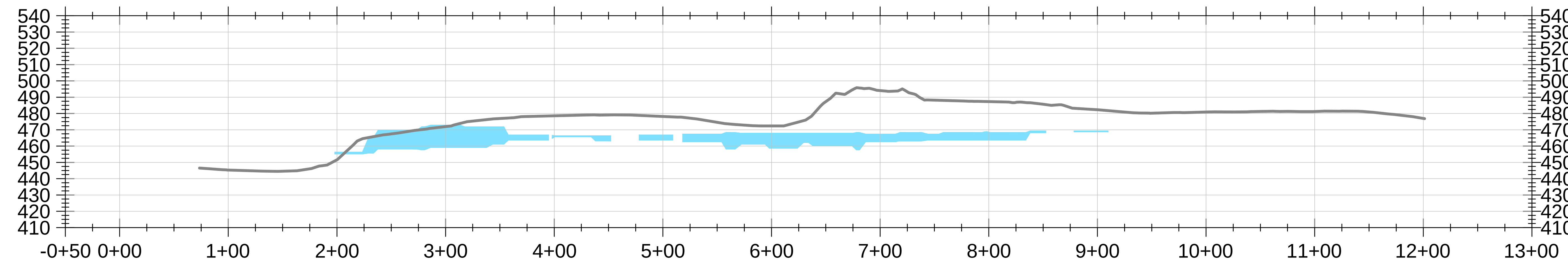
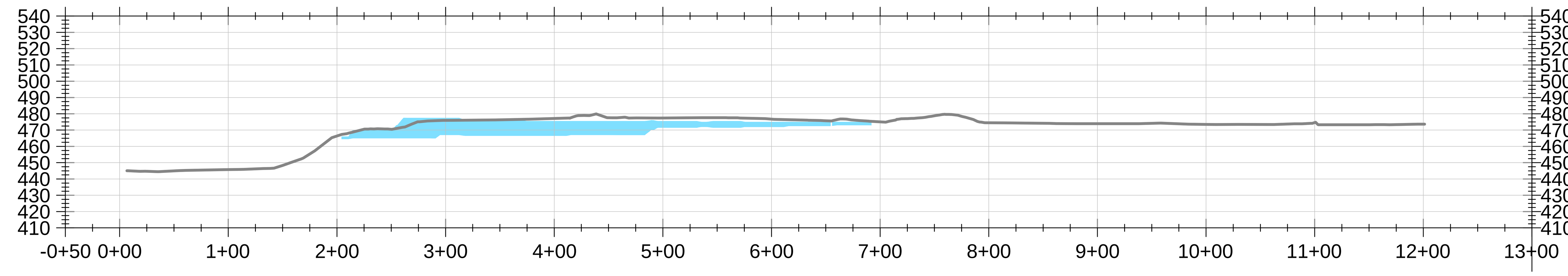
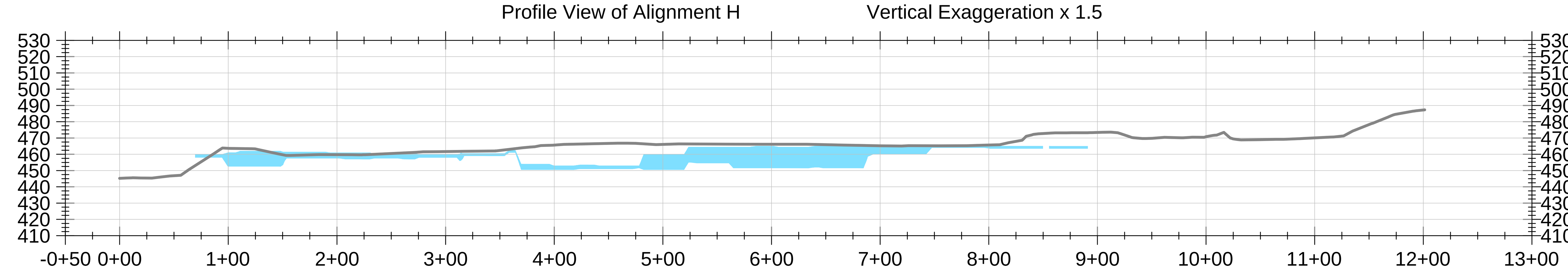
BRIDGETON LANDFILL 13570 ST. CHARLES ROCK ROAD BRIDGETON, MISSOURI 63044	BRIDGETON LANDFILL FINAL FEASIBILITY STUDY	Engineering for a Better World FEEZOR ENGINEERING, INC.	SEPTEMBER 2016 DESIGNED BY: IN APPROVED BY: ---	DRAWING NO.:
52.9 (16' OFFSET) REMEDY - AREA 1 **STORM WATER CONTROLS**			REVISION / DATE	**025**

PROJECT NUMBER: BT-106 | FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\52.9 (16 Ft Offset)\working\draft Drawings\BT-106 A1 (52.9 16' Offset) 5% Criteria.dwg









LEGEND

- 2015 TOPOGRAPHY (2' CONTOUR)
- 2015 TOPOGRAPHY (10' CONTOUR)
- AREA 2 BOUNDARY
- RIM (PROFILE VIEW)
- BORING LOCATION

DRAFT

NOTES:

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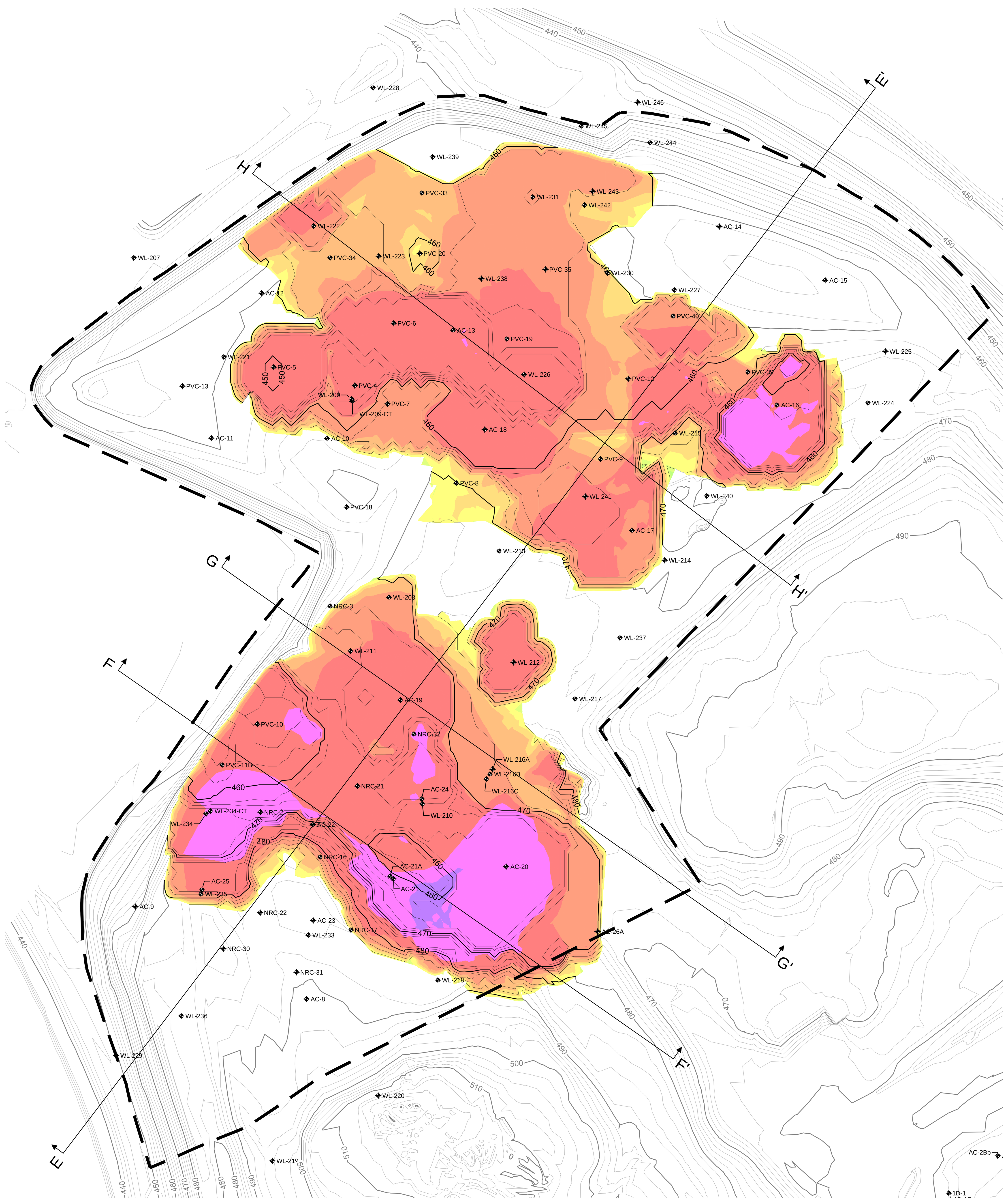
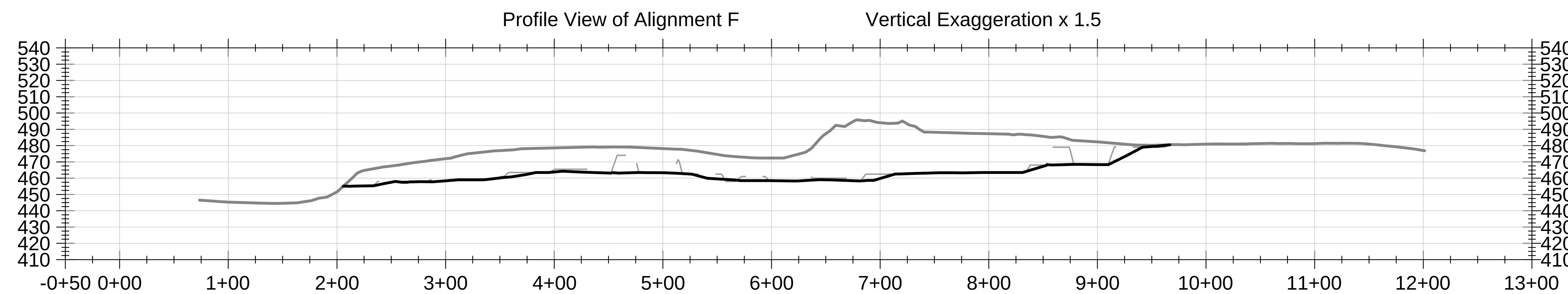
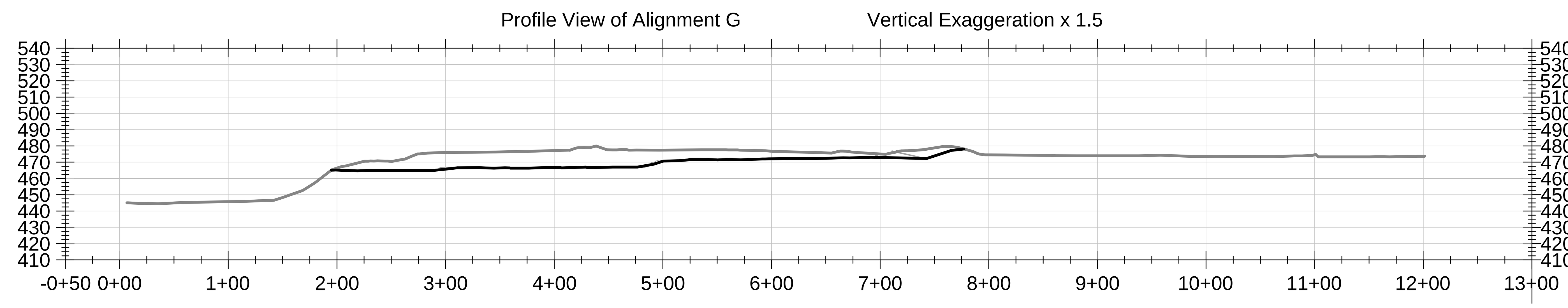
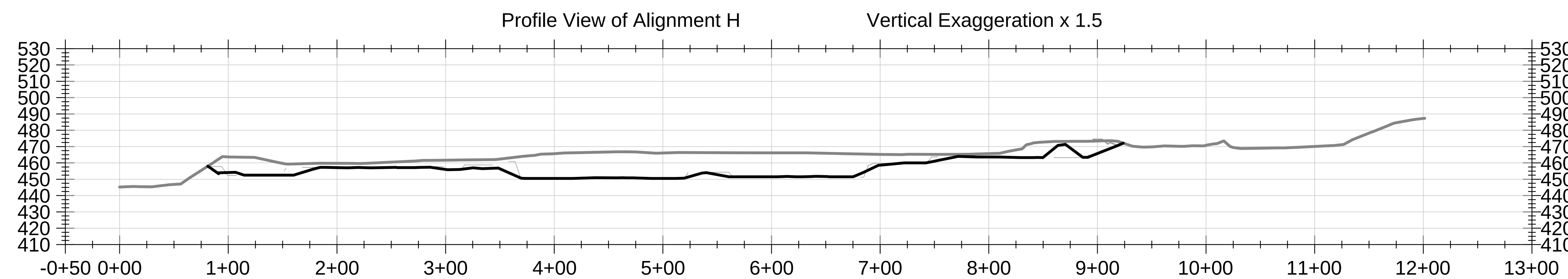
BRIDGETON LANDFILL 13570 ST. CHARLES ROCK ROAD BRIDGETON, MISSOURI 63044	BRIDGETON LANDFILL FINAL FEASIBILITY STUDY	Engineering for a Better World FEEZOR ENGINEERING, INC.	SEPTEMBER 2016 DESIGNED BY: IN APPROVED BY: ---	DRAWING NO.: 026
52.9 (16' OFFSET) REMEDY - AREA 2 RIM EXTENTS			REVISION / DATE	
PROJECT NUMBER: BT-106	FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\52.9 (16 Ft Offset)\working\draft Drawings\BT-106 A2 (52.9 16' Offset) 5% Criteria.dwg			









Thickness Map			
Range	Minimum Depth	Maximum Depth	Color
1	-38	-32	
2	-32	-16	
3	-16	-8	
4	-8	-4	
5	-4	-2	
6	-2	-1	
7	-1	0	
8	0	1	
9	1	2	

EXCAVATION VOLUME: 306,915 CY

LEGEND

- 2015 TOPOGRAPHY (2' CONTOUR)
- 500 — 2015 TOPOGRAPHY (10' CONTOUR)
- EXCAVATION GRADING (2' CONTOUR)
- 500 — EXCAVATION GRADING (10' CONTOUR)
- INITIAL EXCAVATION GRADING (PROFILE)
- AREA 2 BOUNDARY
- BORING LOCATION

DRAFT

NOTES:
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BRIDGETON LANDFILL
13570 ST. CHARLES ROCK ROAD
BRIDGETON, MISSOURI 63044

BRIDGETON LANDFILL
FINAL FEASIBILITY STUDY

52.9 (16' OFFSET) REMEDY - AREA 2
EXCAVATION GRADING

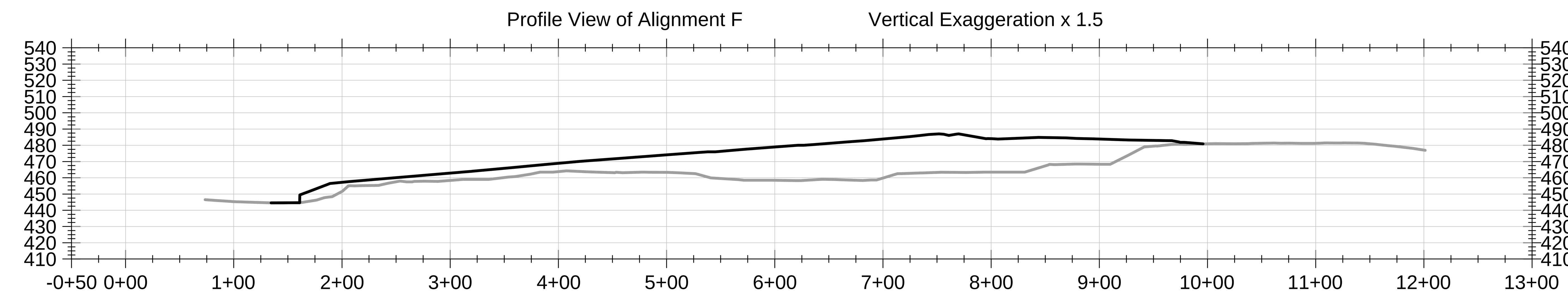
Engineering for a Better World
FEEZOR ENGINEERING, INC.

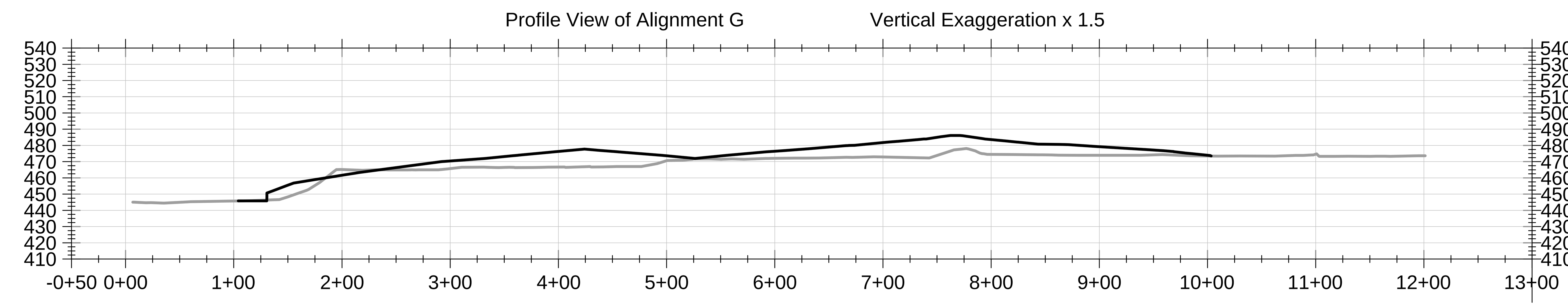
SEPTEMBER 2016
DESIGNED BY: IN
APPROVED BY: ---

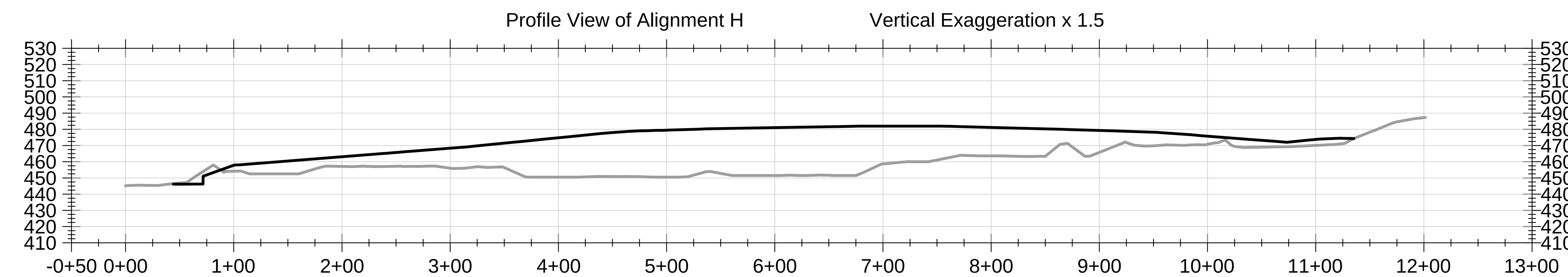
REVISION	DATE

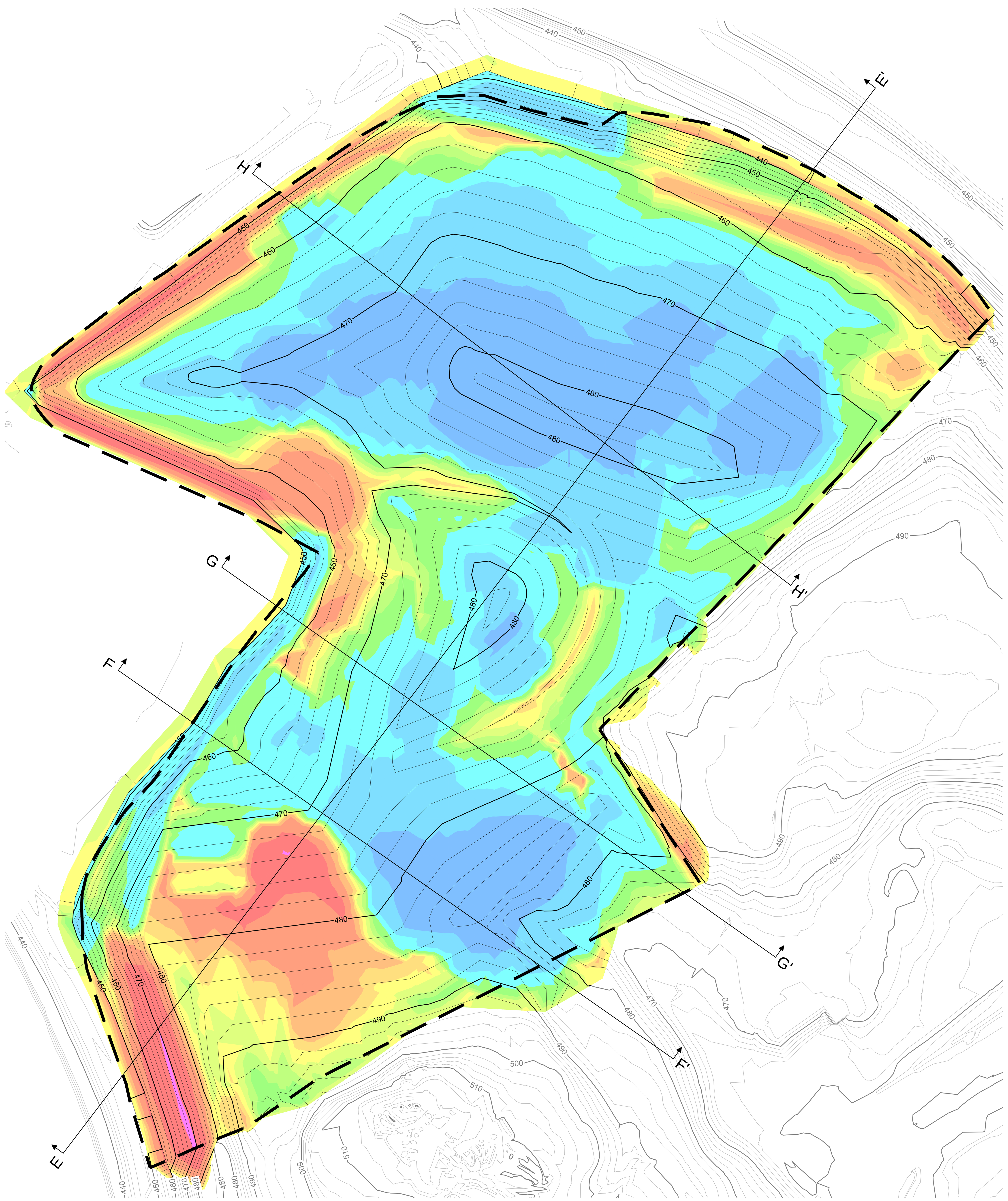
DRAWING NO.: **027**

PROJECT NUMBER: BT-106 FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\52.9 (16 Ft Offset)\working\draft Drawings\BT-106 A2 (52.9 16' Offset) 5% Criteria.dwg









Thickness Map			
Range	Minimum Depth	Maximum Depth	Color
1	-18	-16	
2	-16	-8	
3	-8	-4	
4	-4	-2	
5	-2	-1	
6	-1	0	
7	0	1	
8	1	2	
9	2	4	
10	4	8	
11	8	16	
12	16	31	

BACKFILL GRADING VOLUME
CUT: 64,588 CY
FILL: 463,120 CY

LEGEND

- 2015 TOPOGRAPHY WITH EXCAVATION GRADING (2' CONTOUR)
- 500 — 2015 TOPOGRAPHY WITH EXCAVATION GRADING (10' CONTOUR)
- BOTTOM OF FINAL COVER / BACKFILL REGRADING (2' CONTOUR)
- 500 — BOTTOM OF FINAL COVER / BACKFILL REGRADING (10' CONTOUR)
- AREA 2 BOUNDARY

DRAFT

NOTES:
- *AERIAL TOPOGRAPHY PROVIDED BY COOPER AERIAL SURVEYS, INC. AND IS DATED MARCH 10, 2015*
- *ALL 3 DIMENSIONAL EXTENTS OF RADIOLOGICALLY IMPACTED MATERIAL (RIM) AND ALL INITIAL EXCAVATION SURFACES WERE PROVIDED BY S.S. PAPADOPULOS & ASSOC., INC.*
- *THE DRAWINGS INCLUDED WITHIN THIS PLAN SET ARE NOT DESIGN NOR CONSTRUCTION LEVEL DRAWINGS. THEY ARE INTENDED FOR ILLUSTRATIVE PURPOSES ONLY.*

BRIDGETON LANDFILL
13570 ST. CHARLES ROCK ROAD
BRIDGETON, MISSOURI 63044

BRIDGETON LANDFILL
FINAL FEASIBILITY STUDY

52.9 (16' OFFSET) REMEDY - AREA 2
BOTTOM OF FINAL COVER / BACKFILL GRADING

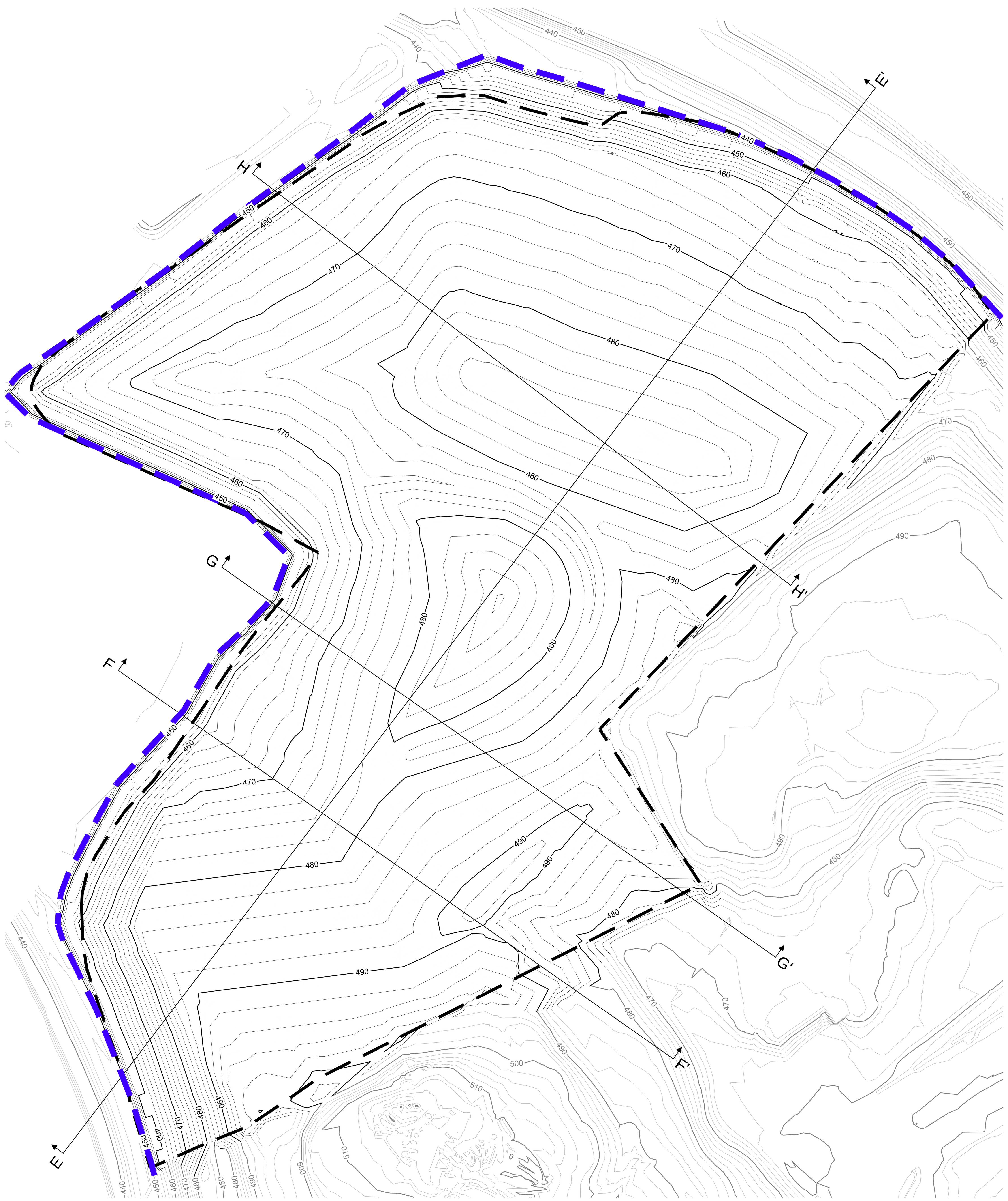
Engineering for a Better World
FEEZOR ENGINEERING, INC.

SEPTEMBER 2016
DESIGNED BY: IN
APPROVED BY: ---
REVISION | DATE

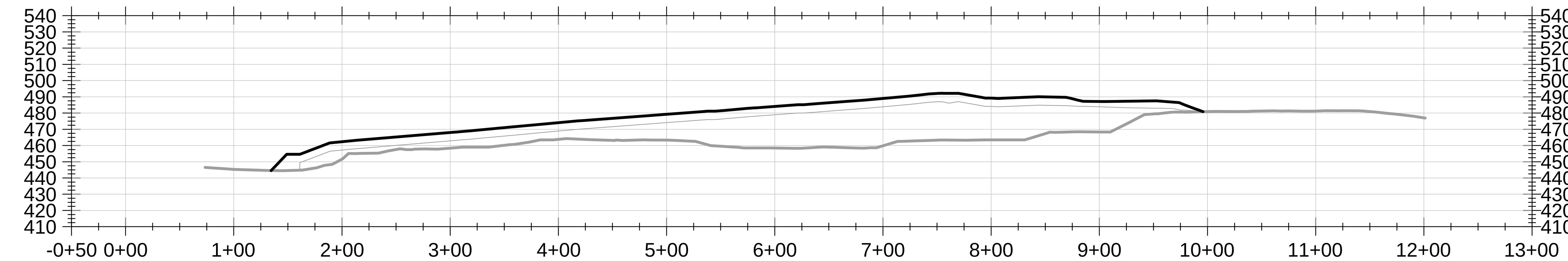
DRAWING NO.: **028**

PROJECT NUMBER: BT-106 | FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\52.9 (16 Ft Offset)\working\draft Drawings\BT-106 A2 (52.9 16' Offset) 5% Criteria.dwg

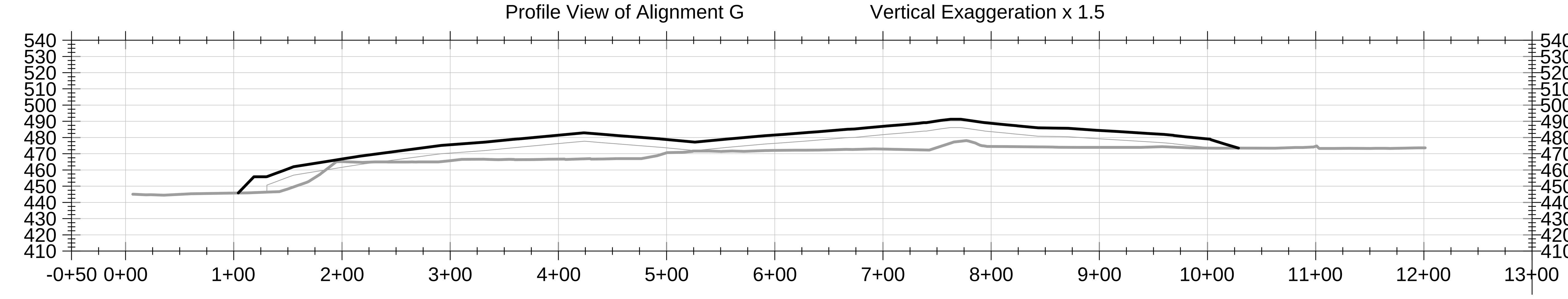
Profile View of Alignment E   Vertical Exaggeration x 1.5



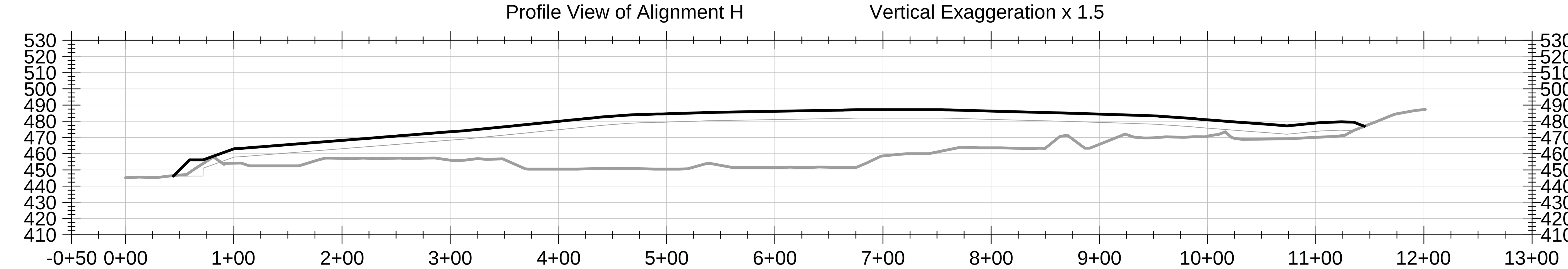
Profile View of Alignment F   Vertical Exaggeration x 1.5

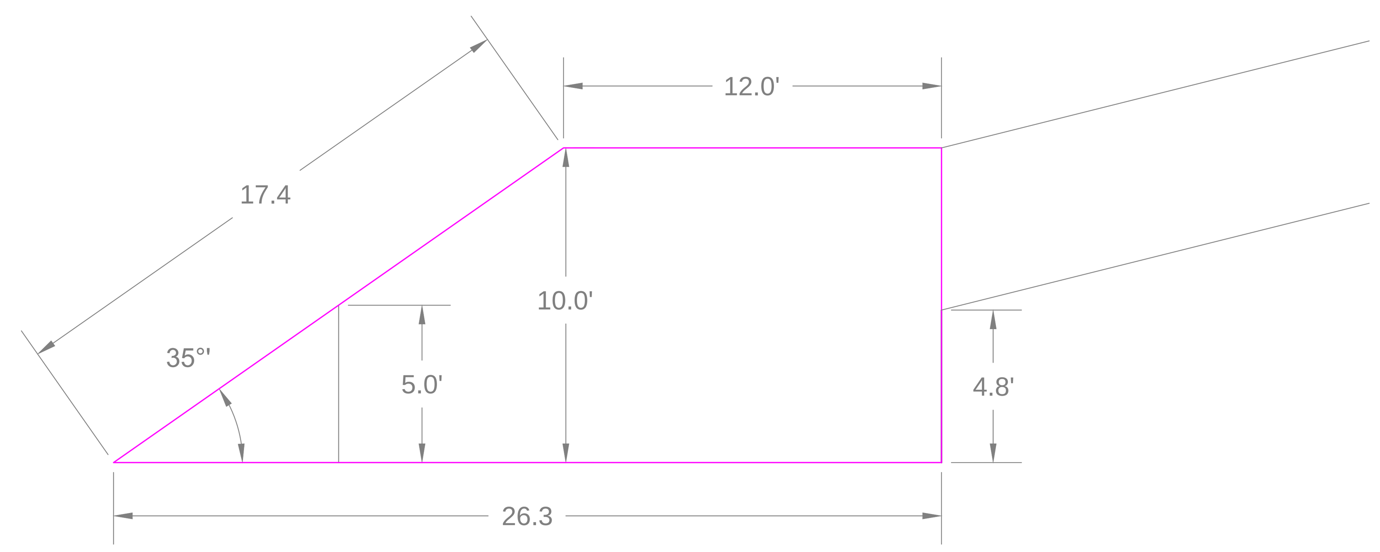


Profile View of Alignment G   Vertical Exaggeration x 1.5



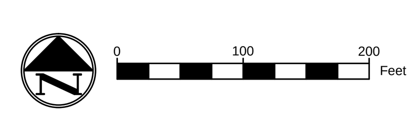
Profile View of Alignment H   Vertical Exaggeration x 1.5





Area 2 Starter Berm Detail

Not to scale



LEGEND

- 2015 TOPOGRAPHY WITH EXCAVATION GRADING (2' CONTOUR)
- 500 — 2015 TOPOGRAPHY WITH EXCAVATION GRADING (10' CONTOUR)
- TOP OF FINAL COVER GRADING (2' CONTOUR)
- 500 — TOP OF FINAL COVER GRADING (10' CONTOUR)
- AREA 2 BOUNDARY
- STARTER BERM LOCATION
- STARTER BERM DETAIL DESIGN

DRAFT

NOTES:

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BRIDGETON LANDFILL 13570 ST. CHARLES ROCK ROAD BRIDGETON, MISSOURI 63044	BRIDGETON LANDFILL FINAL FEASIBILITY STUDY	Engineering for a Better World FEEZOR ENGINEERING, INC.	SEPTEMBER 2016 DESIGNED BY: IN APPROVED BY: ---	DRAWING NO.:
52.9 (16' OFFSET) REMEDY - AREA 2 **TOP OF FINAL COVER GRADING**			REVISION / DATE	**029**
PROJECT NUMBER: BT-106	FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\52.9 (16 Ft Offset)\working\draft Drawings\BT-106 A2 (52.9 16' Offset) 5% Criteria.dwg			

LEGEND

- 2015 TOPOGRAPHY (2' CONTOUR)
- 500 — 2015 TOPOGRAPHY (10' CONTOUR)
- FINAL COVER GRADING (2' CONTOUR)
- 500 — FINAL COVER GRADING (10' CONTOUR)
- AREA 2 BOUNDARY
- STARTER BERM LOCATION
- DRAINAGE TERRACE
- DOWNCHUTE SWALE
- PERIMETER DITCH
- PERIMETER ROAD CROSSING

N

0 100 200 Feet

DRAFT

NOTES:

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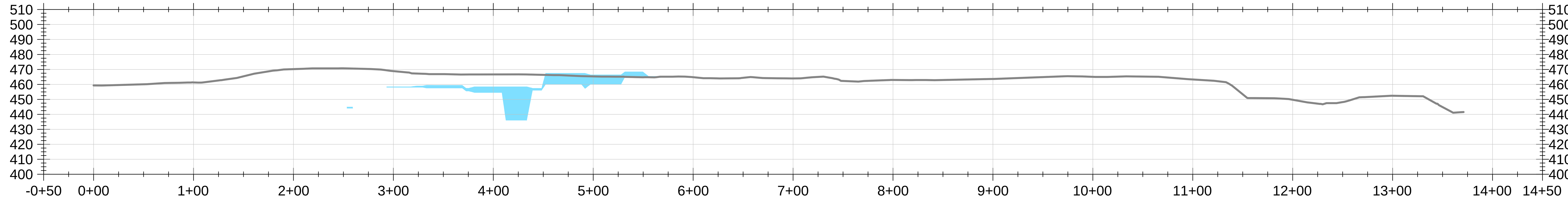
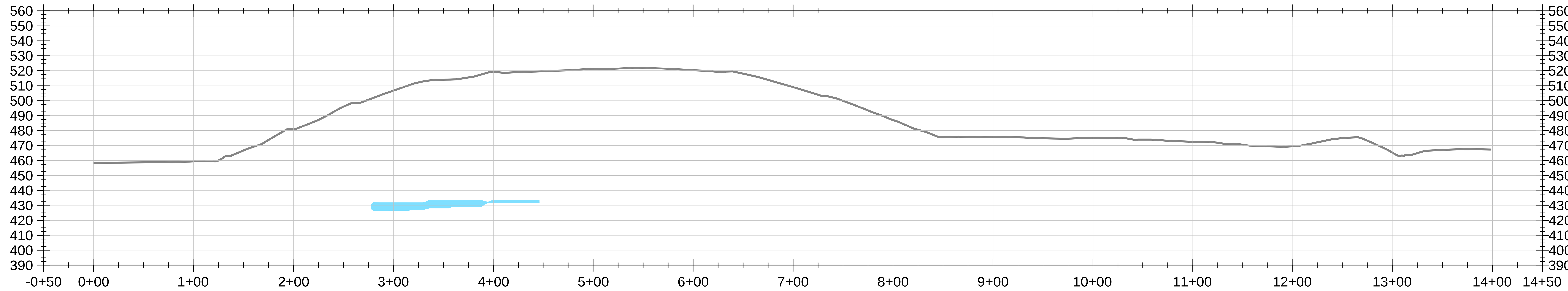
BRIDGETON LANDFILL 13570 ST. CHARLES ROCK ROAD BRIDGETON, MISSOURI 63044	BRIDGETON LANDFILL FINAL FEASIBILITY STUDY	Engineering for a Better World FEEZOR ENGINEERING, INC.	SEPTEMBER 2016 DESIGNED BY: IN APPROVED BY: ---	DRAWING NO.: 030
52.9 (16' OFFSET) REMEDY - AREA 2 STORM WATER CONTROLS			REVISION | DATE	
PROJECT NUMBER: BT-106	FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\52.9 (16 Ft Offset)\working\draft Drawings\BT-106 A2 (52.9 16' Offset) 5% Criteria.dwg			

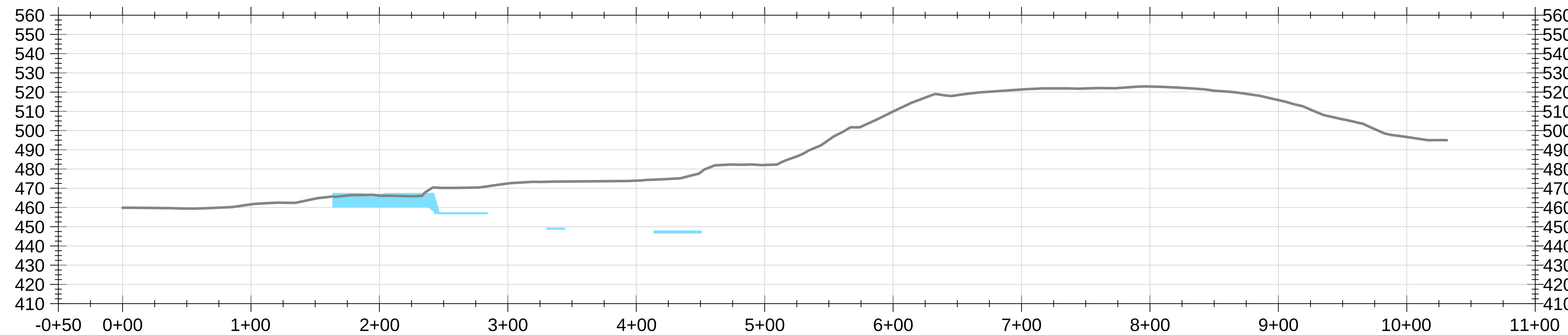
Profile View of Alignment A Vertical Exaggeration x 1.5



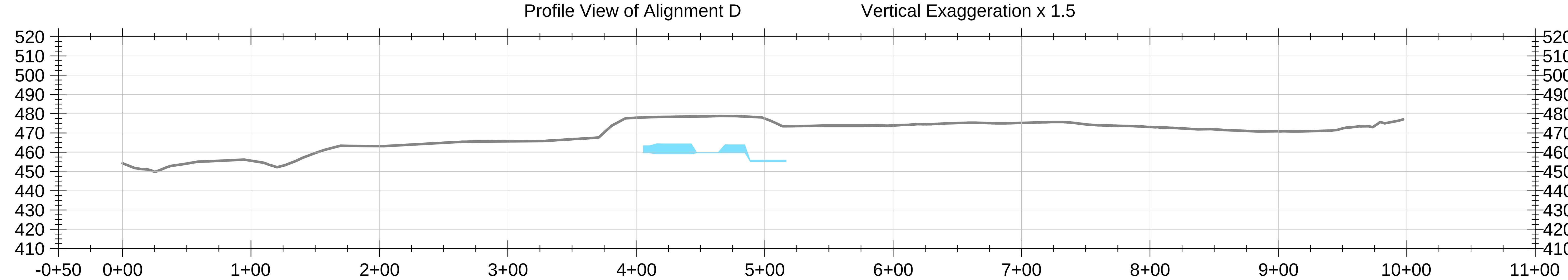
Profile View of Alignment B Vertical Exaggeration x 1.5



Profile View of Alignment C Vertical Exaggeration x 1.5



Profile View of Alignment D Vertical Exaggeration x 1.5



LEGEND

- 2015 TOPOGRAPHY (2' CONTOUR)
- 500 2015 TOPOGRAPHY (10' CONTOUR)
- AREA 1 BOUNDARY
- RIM (PROFILE VIEW)
- BORING LOCATION

DRAFT

NOTES:
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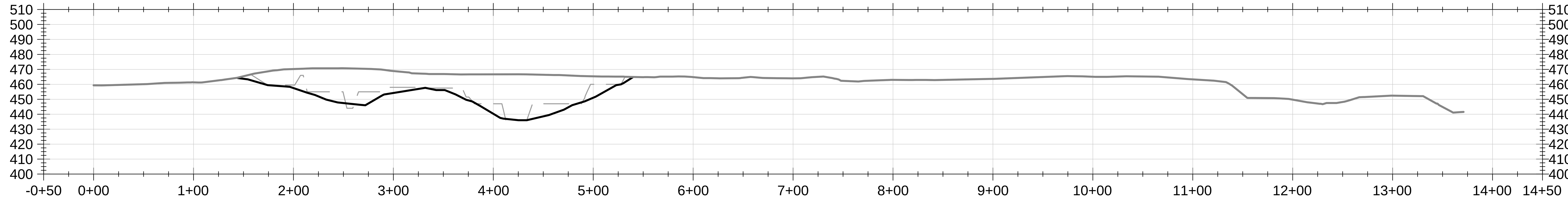
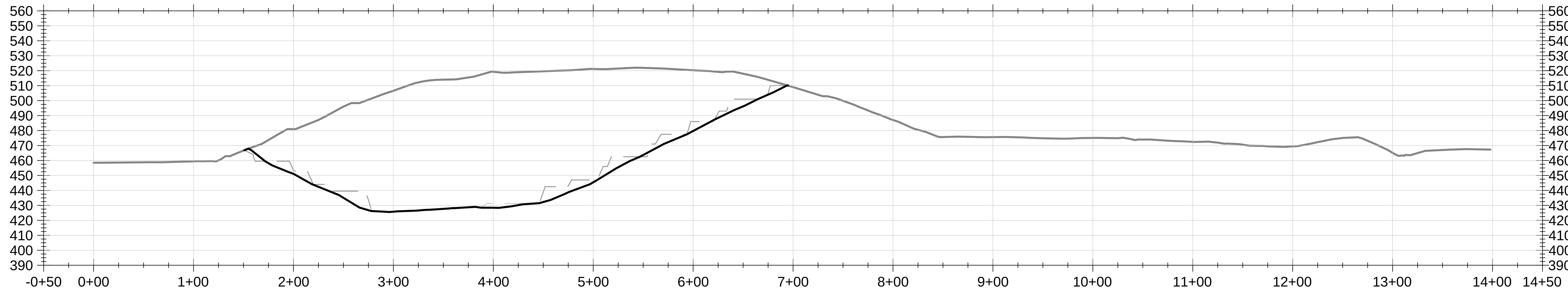
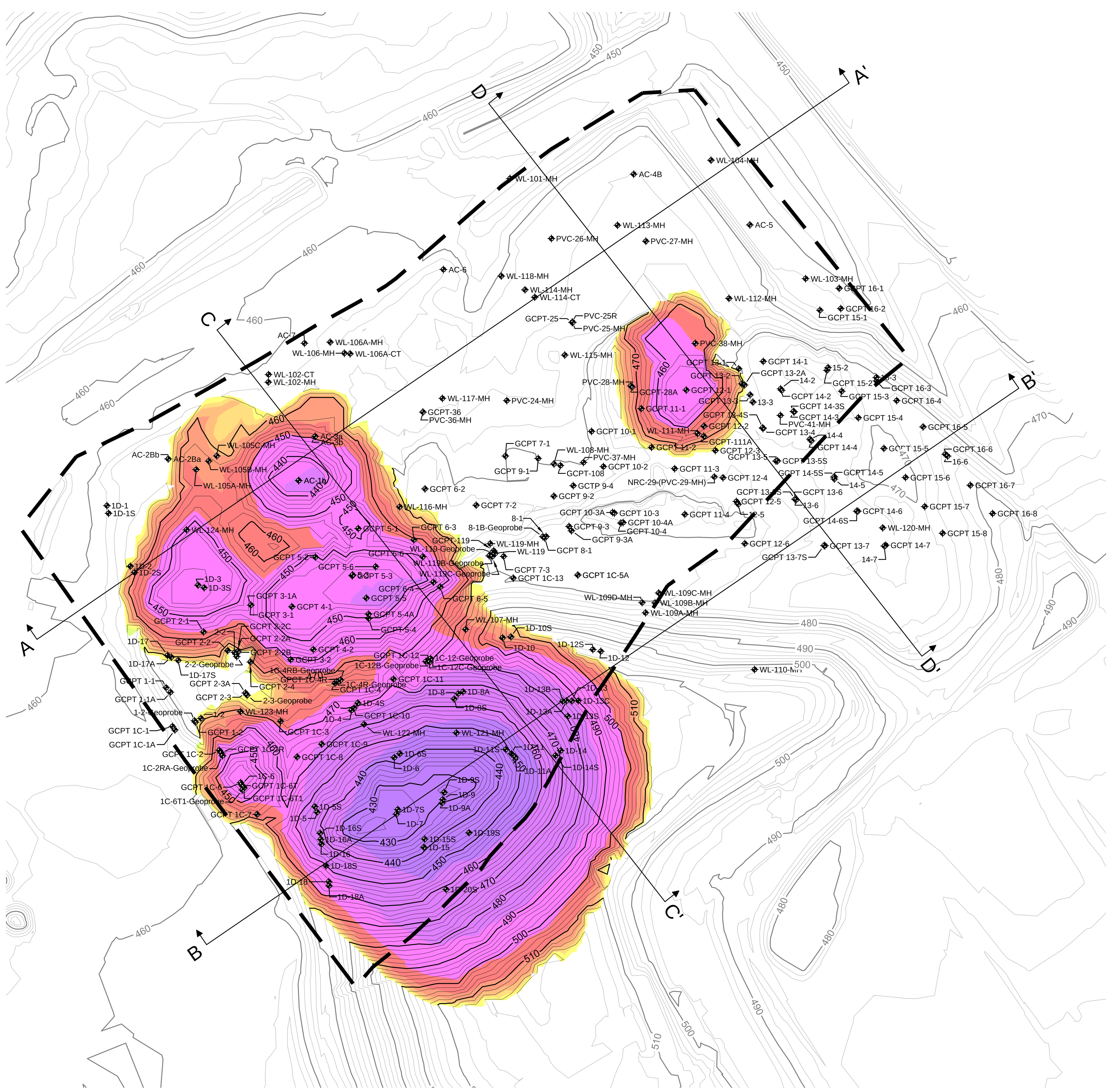
BRIDGETON LANDFILL 13570 ST. CHARLES ROCK ROAD BRIDGETON, MISSOURI 63044	BRIDGETON LANDFILL FINAL FEASIBILITY STUDY	Engineering for a Better World FEEZOR ENGINEERING, INC.	SEPTEMBER 2016 DESIGNED BY: IN APPROVED BY: ---	DRAWING NO.:
1000 REMEDY - AREA 1 RIM EXTENTS			REVISION / DATE	031
PROJECT NUMBER: BT-106	FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\1000\Working\draft Drawings\BT-106 A1 (1000) 5% Criteria.dwg			

Profile View of Alignment A — Vertical Exaggeration x 1.5

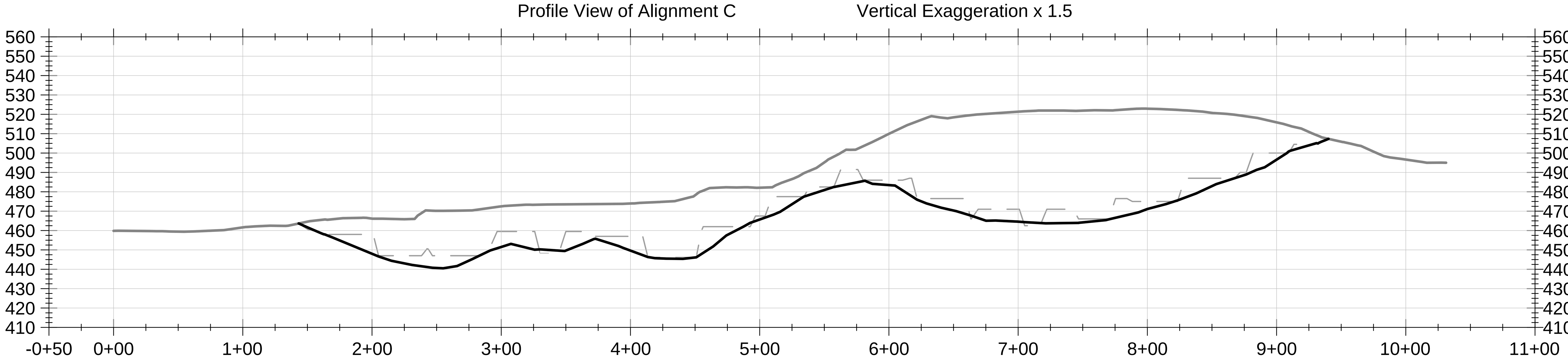


Profile View of Alignment B — Vertical Exaggeration x 1.5

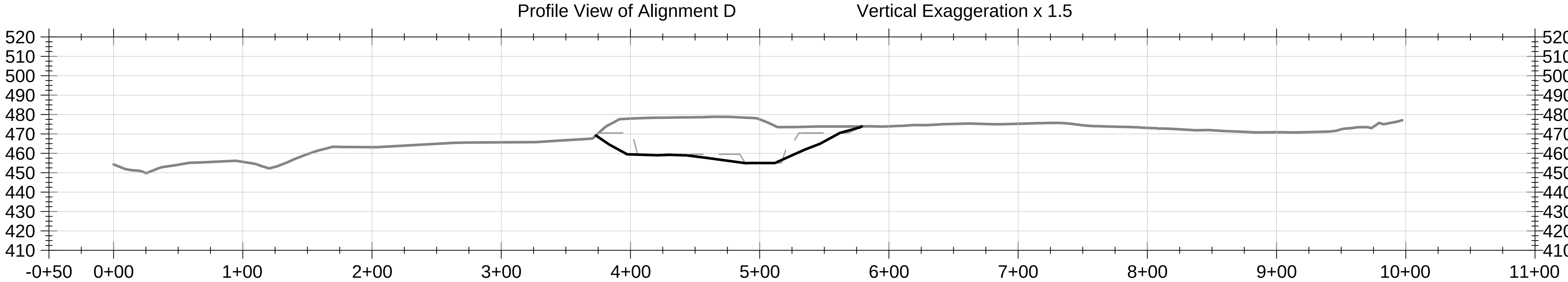




Profile View of Alignment C — Vertical Exaggeration x 1.5



Profile View of Alignment D — Vertical Exaggeration x 1.5



Thickness Map			
Range	Minimum Depth	Maximum Depth	Color
1	-92	-64	
2	-64	-32	
3	-32	-16	
4	-16	-8	
5	-8	-4	
6	-4	-2	
7	-2	-1	
8	-1	0	
9	0	1	

EXCAVATION VOLUME: 437,763 CY

LEGEND

- 2015 TOPOGRAPHY (2' CONTOUR)
- 500 — 2015 TOPOGRAPHY (10' CONTOUR)
- EXCAVATION GRADING (2' CONTOUR)
- 500 — EXCAVATION GRADING (10' CONTOUR)
- INITIAL EXCAVATION GRADING (PROFILE)
- AREA 1 BOUNDARY
- BORING LOCATION

DRAFT

NOTES:

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BRIDGETON LANDFILL
13570 ST. CHARLES ROCK ROAD
BRIDGETON, MISSOURI 63044

BRIDGETON LANDFILL
FINAL FEASIBILITY STUDY

1000 REMEDY - AREA 1
EXCAVATION GRADING

Engineering for a Better World
FEEZOR ENGINEERING, INC.

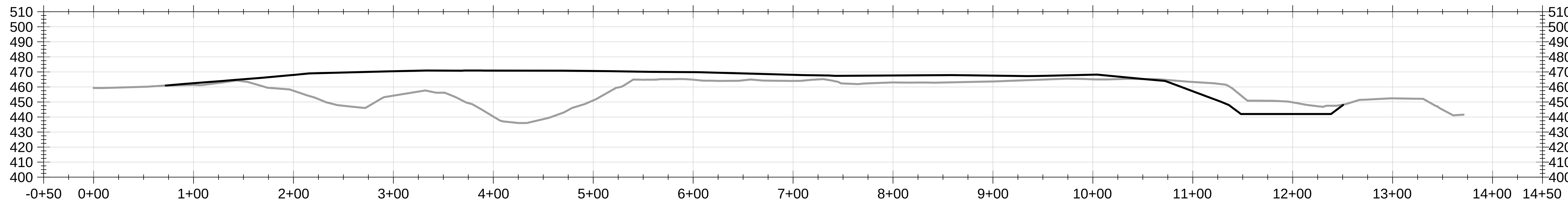
SEPTEMBER 2016
DESIGNED BY: IN
APPROVED BY: ---

REVISION | DATE

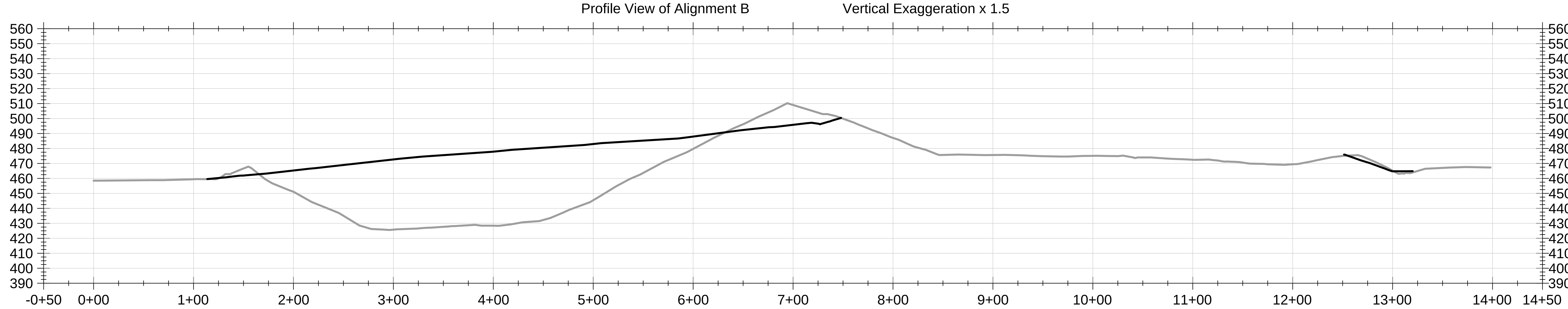
DRAWING NO.: **032**

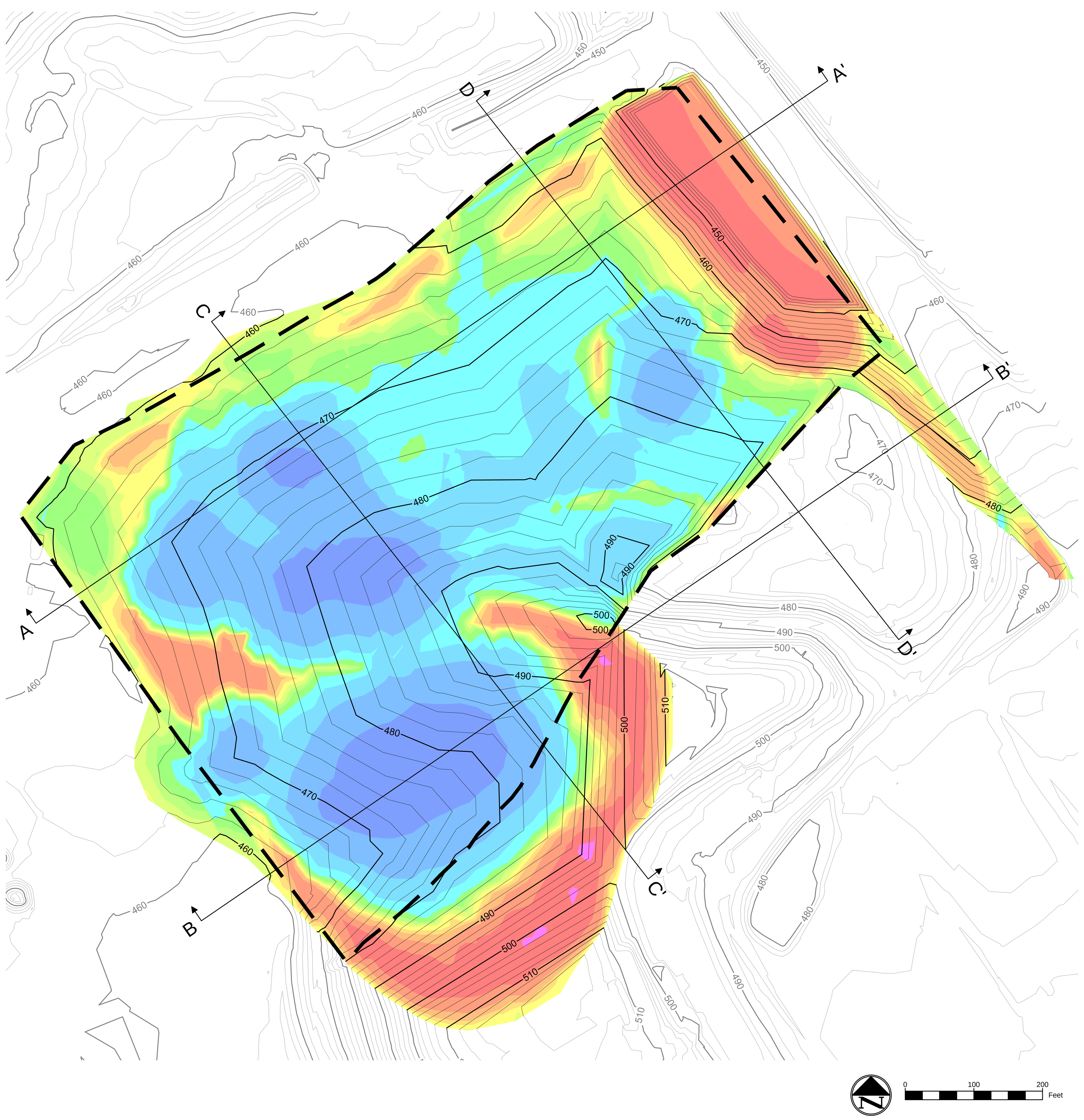
PROJECT NUMBER: BT-106 | FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\1000\Working\draft Drawings\BT-106 A1 (1000) 5% Criteria.dwg

Profile View of Alignment A   Vertical Exaggeration x 1.5

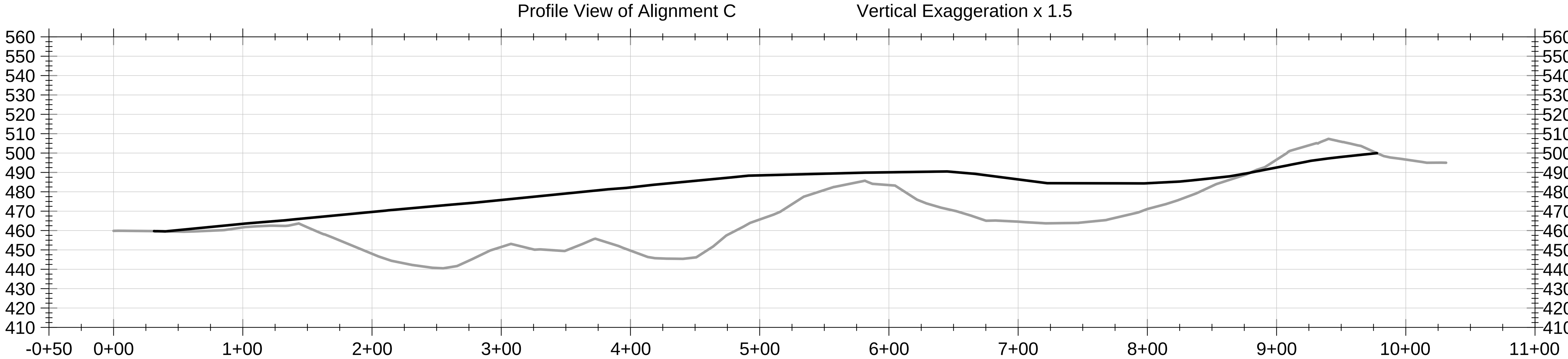


Profile View of Alignment B   Vertical Exaggeration x 1.5

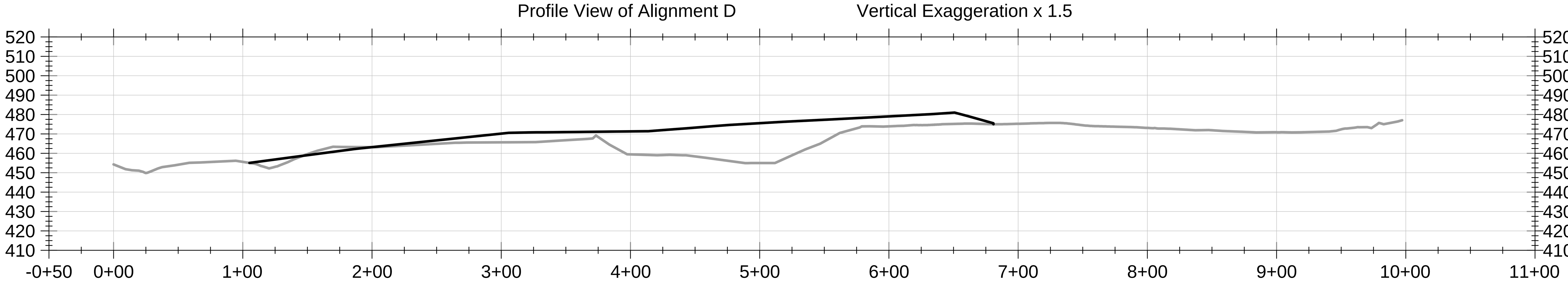




Profile View of Alignment C   Vertical Exaggeration x 1.5



Profile View of Alignment D   Vertical Exaggeration x 1.5



Thickness Map			
Range	Minimum Depth	Maximum Depth	Color
1	-20	-16	
2	-16	-8	
3	-8	-4	
4	-4	-2	
5	-2	-1	
6	-1	0	
7	0	1	
8	1	2	
9	2	4	
10	4	8	
11	8	16	
12	16	32	
13	32	51	

BACKFILL REGRADING VOLUME
CUT: 56,368 CY
FILL: 298,729 CY

LEGEND

- 2015 TOPOGRAPHY WITH EXCAVATION GRADING (2' CONTOUR)
- 500 — 2015 TOPOGRAPHY WITH EXCAVATION GRADING (10' CONTOUR)
- BOTTOM OF FINAL COVER / BACKFILL GRADING (2' CONTOUR)
- 500 — BOTTOM OF FINAL COVER / BACKFILL GRADING (10' CONTOUR)
- AREA 1 BOUNDARY

DRAFT

NOTES:
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BRIDGETON LANDFILL
13570 ST. CHARLES ROCK ROAD
BRIDGETON, MISSOURI 63044

BRIDGETON LANDFILL
FINAL FEASIBILITY STUDY

1000 REMEDY - AREA 1
BOTTOM OF FINAL COVER / BACKFILL GRADING

Engineering for a Better World
FEEZOR ENGINEERING, INC.

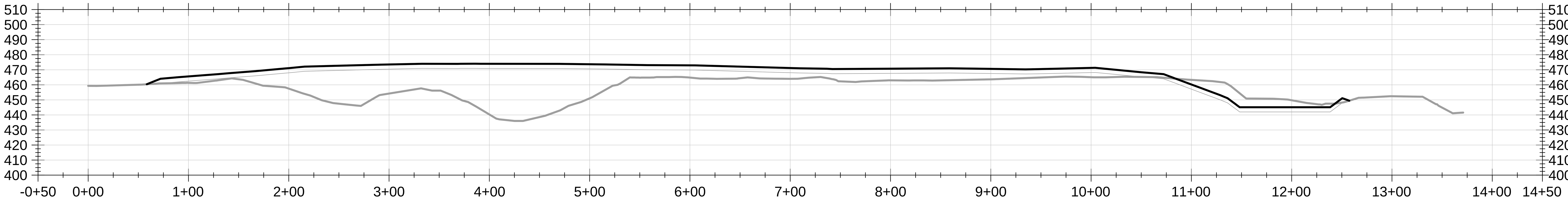
SEPTEMBER 2016
DESIGNED BY: IN
APPROVED BY: ---

REVISION	DATE

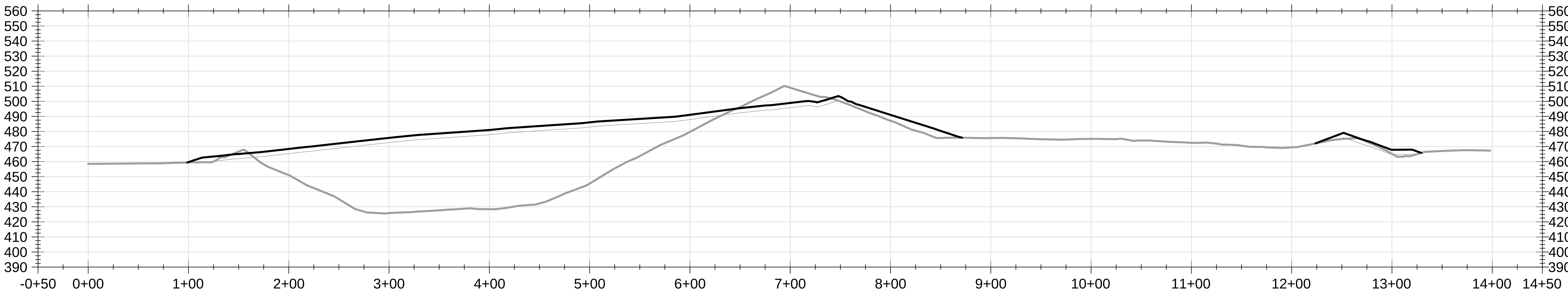
DRAWING NO.: **033**

PROJECT NUMBER: BT-106 | FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\1000\Working\draft Drawings\BT-106 A1 (1000) 5% Criteria.dwg

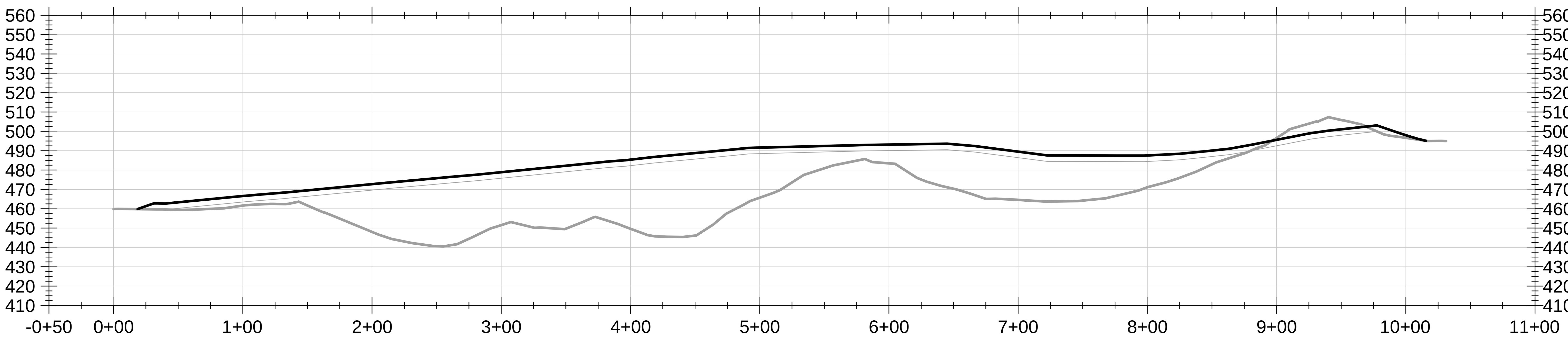
Profile View of Alignment A Vertical Exaggeration x 1.5



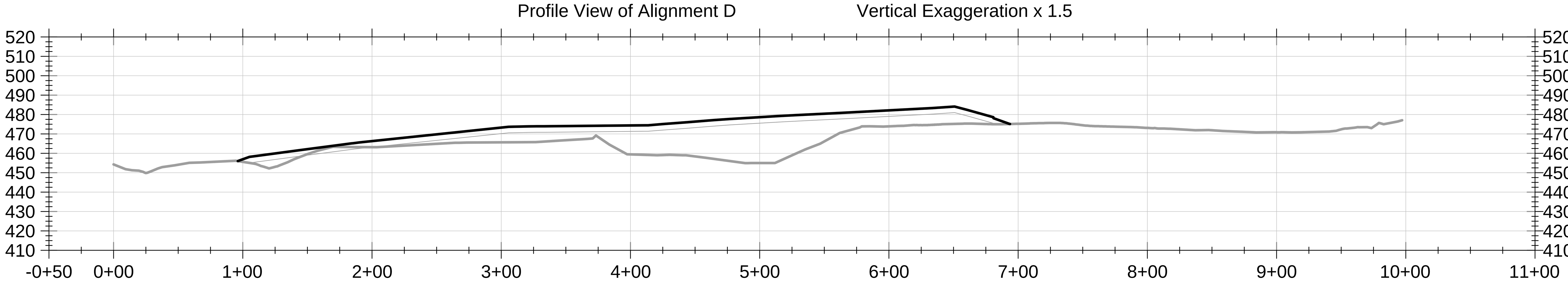
Profile View of Alignment B Vertical Exaggeration x 1.5

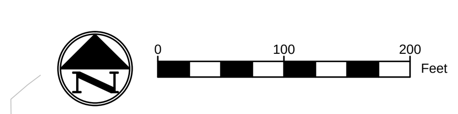


Profile View of Alignment C Vertical Exaggeration x 1.5



Profile View of Alignment D Vertical Exaggeration x 1.5





LEGEND

- 2015 TOPOGRAPHY WITH EXCAVATION GRADING (2' CONTOUR)
- 2015 TOPOGRAPHY WITH EXCAVATION GRADING (10' CONTOUR)
- TOP OF FINAL COVER GRADING (2' CONTOUR)
- TOP OF FINAL COVER GRADING (10' CONTOUR)
- AREA 1 BOUNDARY

DRAFT

NOTES:

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BRIDGETON LANDFILL
13570 ST. CHARLES ROCK ROAD
BRIDGETON, MISSOURI 63044

BRIDGETON LANDFILL
FINAL FEASIBILITY STUDY

1000 REMEDY - AREA 1
TOP OF FINAL COVER GRADING

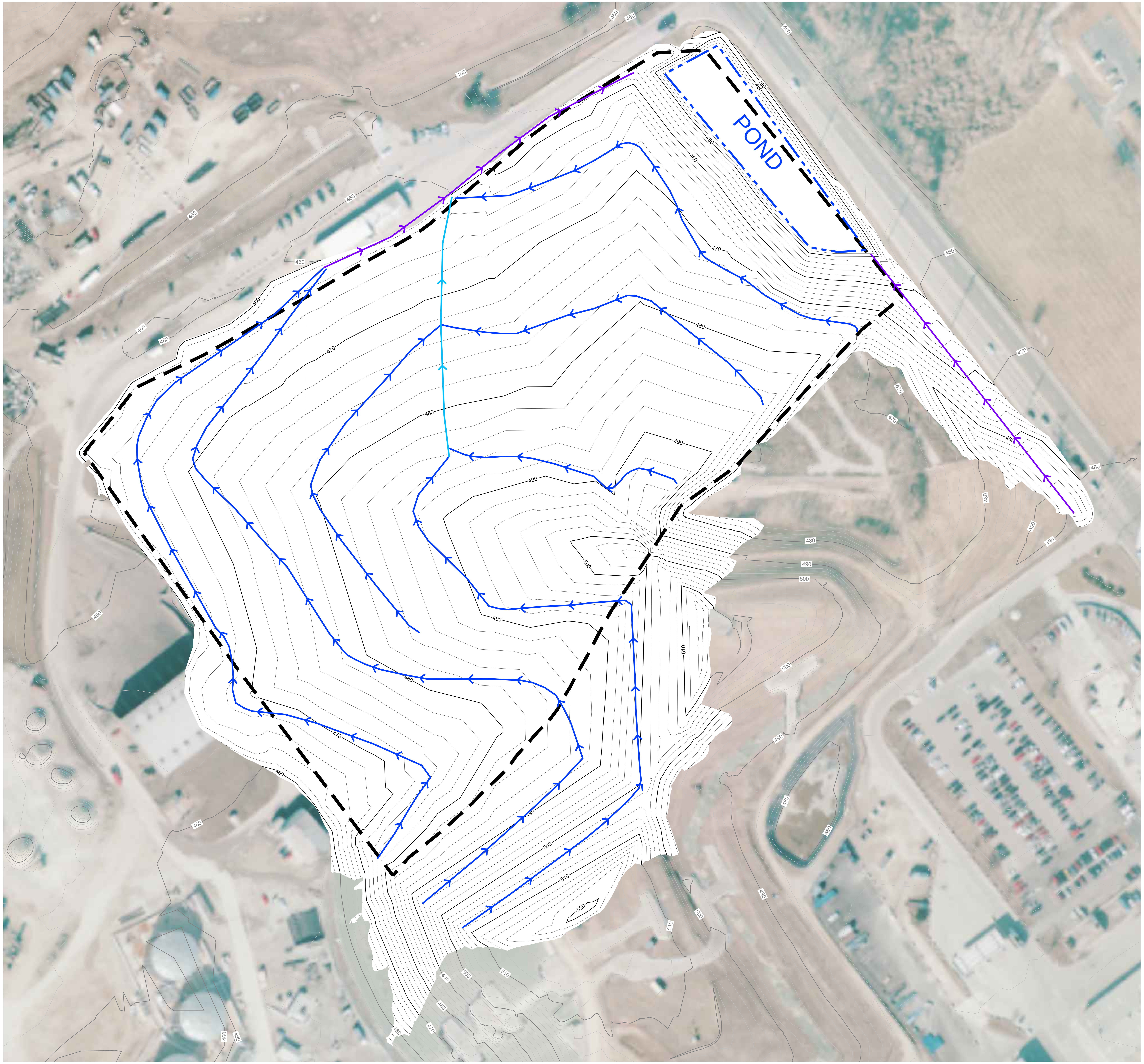
Engineering for a Better World
FEEZOR ENGINEERING, INC.

SEPTEMBER 2016
DESIGNED BY: IN
APPROVED BY: ---

REVISION	DATE

DRAWING NO.: **034**

PROJECT NUMBER: BT-106 | FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\1000\Working\draft Drawings\BT-106 A1 (1000) 5% Criteria.dwg



LEGEND

- 2015 TOPOGRAPHY (2' CONTOUR)
- 500 — 2015 TOPOGRAPHY (10' CONTOUR)
- FINAL COVER GRADING (2' CONTOUR)
- 500 — FINAL COVER GRADING (10' CONTOUR)
- AREA 1 BOUNDARY
- DRAINAGE TERRACE
- DOWNCHUTE SWALE
- PERIMETER DITCH

DRAFT

NOTES:

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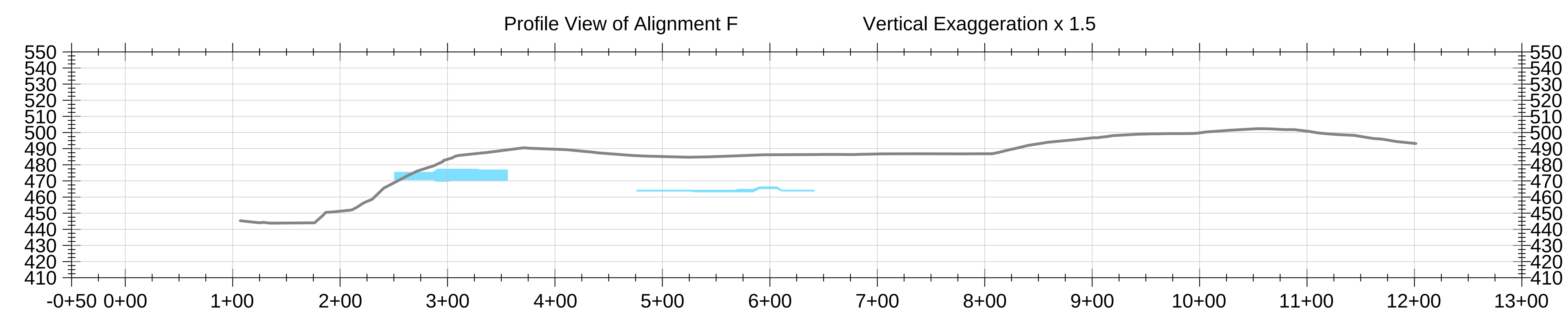
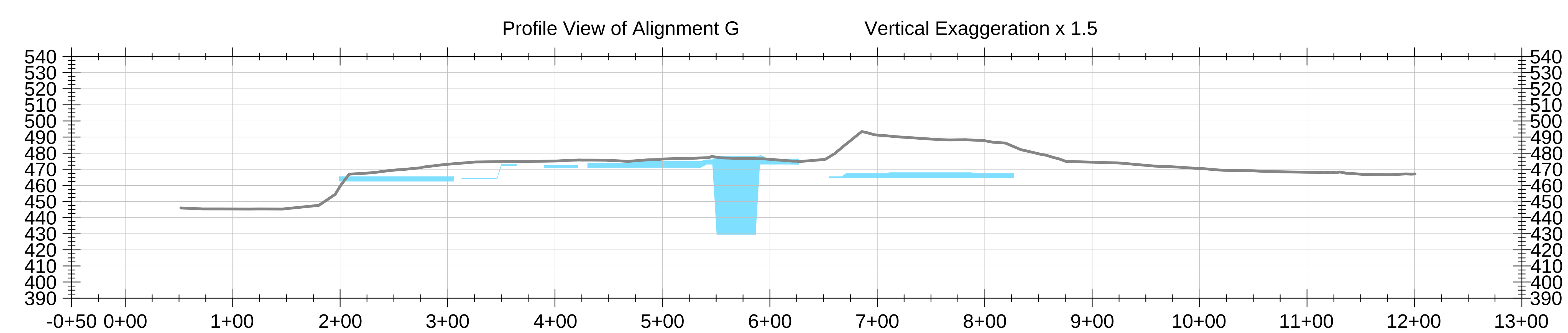
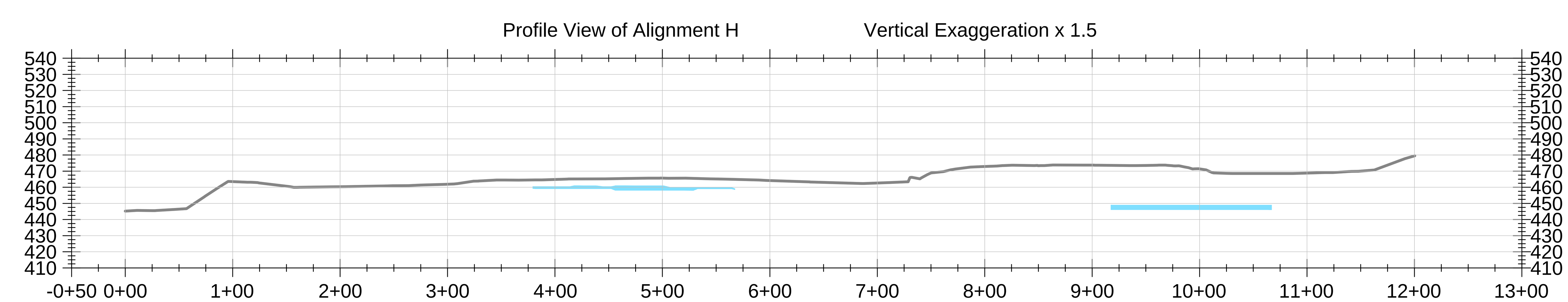
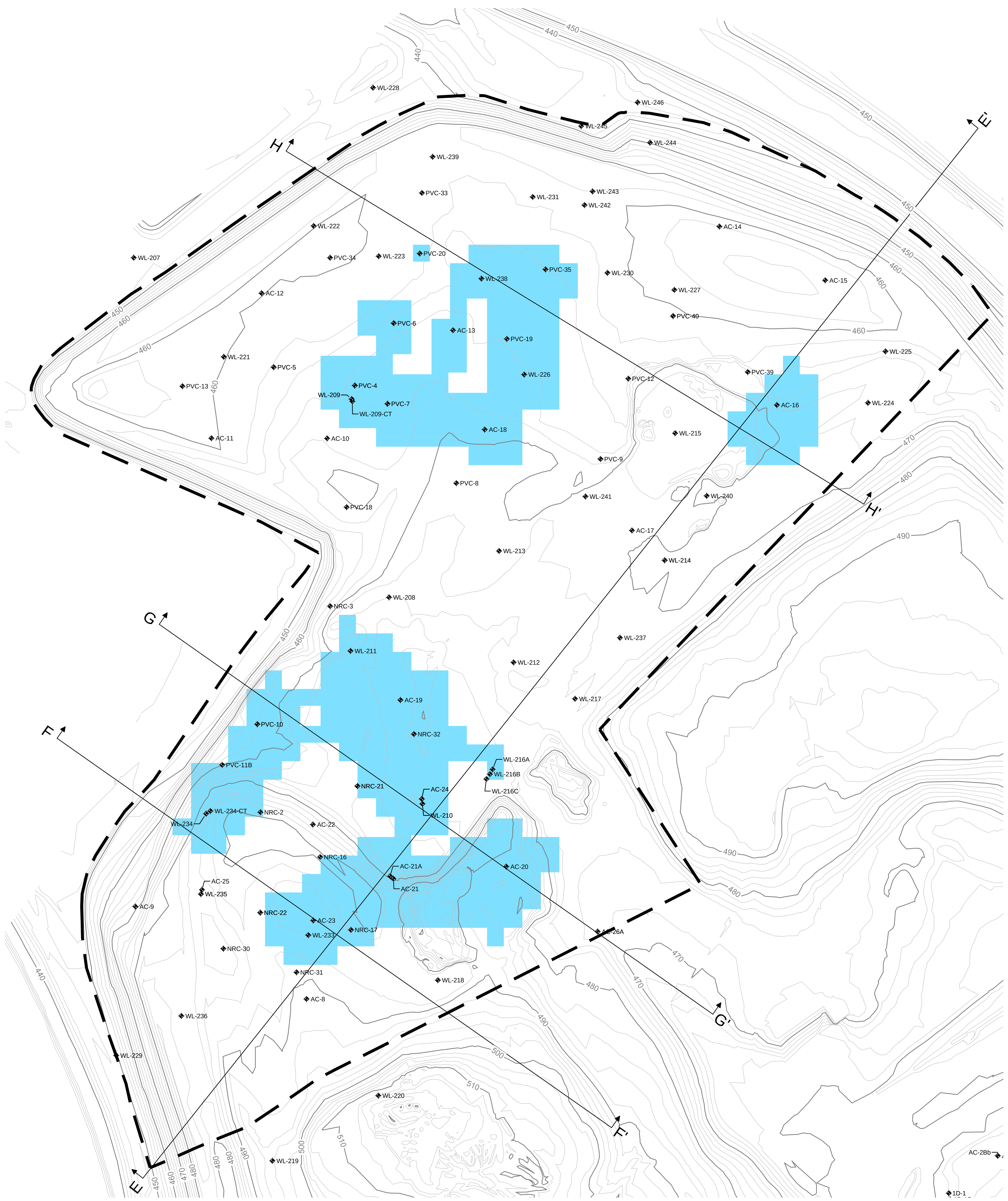
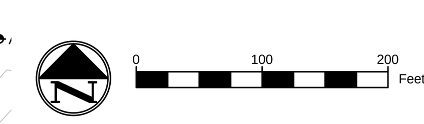
BRIDGETON LANDFILL 13570 ST. CHARLES ROCK ROAD BRIDGETON, MISSOURI 63044	BRIDGETON LANDFILL FINAL FEASIBILITY STUDY	Engineering for a Better World FEEZOR ENGINEERING, INC.	SEPTEMBER 2016 DESIGNED BY: IN APPROVED BY: ---	DRAWING NO.: 035
1000 REMEDY - AREA 1 **STORM WATER CONTROLS**			REVISION / DATE	
PROJECT NUMBER: BT-106	FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\1000\Working\draft Drawings\BT-106 A1 (1000) 5% Criteria.dwg			











LEGEND

- 2015 TOPOGRAPHY (2' CONTOUR)
- 2015 TOPOGRAPHY (10' CONTOUR)
- AREA 2 BOUNDARY
- RIM (PROFILE VIEW)
- BORING LOCATION

DRAFT

NOTES:

- *AERIAL TOPOGRAPHY PROVIDED BY COOPER AERIAL SURVEYS, INC. AND IS DATED MARCH 10, 2015*
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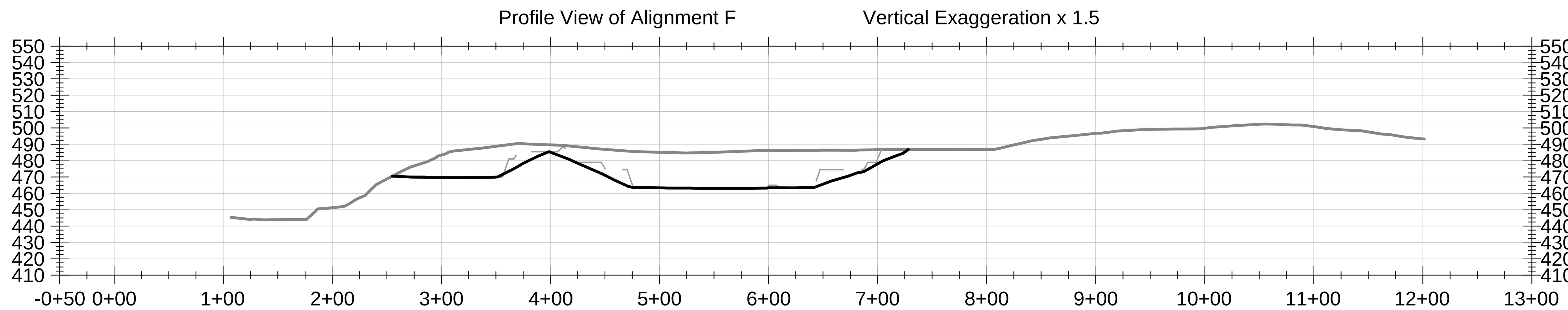
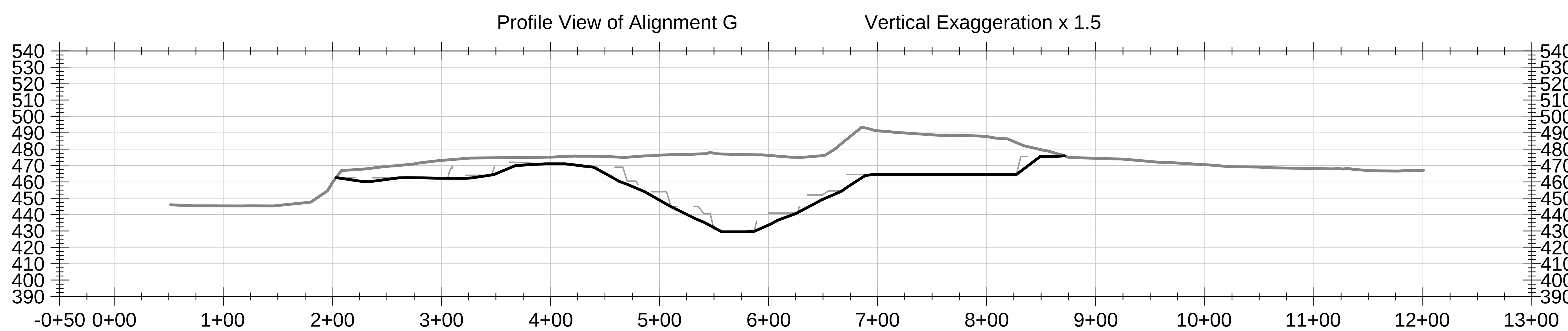
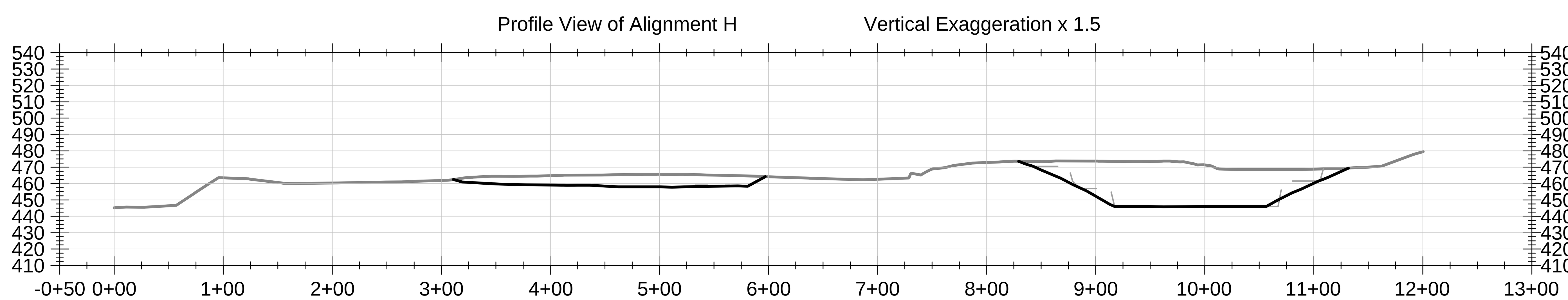
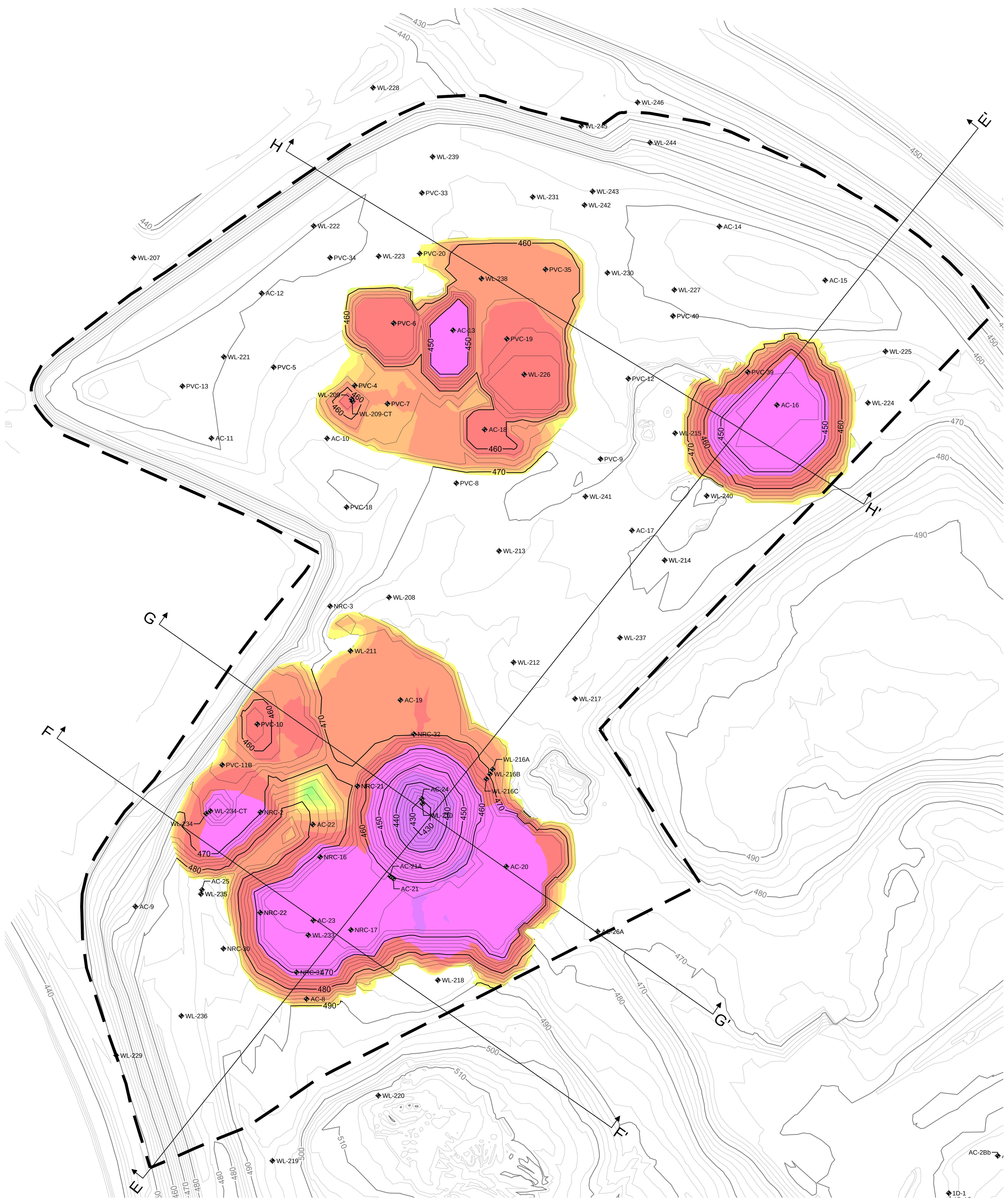
BRIDGETON LANDFILL 13570 ST. CHARLES ROCK ROAD BRIDGETON, MISSOURI 63044	BRIDGETON LANDFILL FINAL FEASIBILITY STUDY	Engineering for a Better World FEEZOR ENGINEERING, INC.	SEPTEMBER 2016 DESIGNED BY: IN APPROVED BY: ---	DRAWING NO.:
1000 REMEDY - AREA 2 **RIM EXTENTS**			REVISION / DATE	**036**
PROJECT NUMBER: BT-106	FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\1000\Working\draft Drawings\BT-106 A2 (1000) 5% Criteria.dwg			









Thickness Map

Range	Minimum Depth	Maximum Depth	Color
1	-48	-32	
2	-32	-16	
3	-16	-8	
4	-8	-4	
5	-4	-2	
6	-2	-1	
7	-1	0	
8	0	1	
9	1	2	
10	2	3	

EXCAVATION VOLUME: 253,250 CY

LEGEND

- 2015 TOPOGRAPHY (2' CONTOUR)
- 2015 TOPOGRAPHY (10' CONTOUR)
- EXCAVATION GRADING (2' CONTOUR)
- EXCAVATION GRADING (10' CONTOUR)
- INITIAL EXCAVATION GRADING (PROFILE)
- AREA 2 BOUNDARY
- BORING LOCATION

DRAFT

NOTES:

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BRIDGETON LANDFILL
13570 ST. CHARLES ROCK ROAD
BRIDGETON, MISSOURI 63044

BRIDGETON LANDFILL
FINAL FEASIBILITY STUDY

1000 REMEDY - AREA 2
EXCAVATION GRADING

Engineering for a Better World
FEEZOR ENGINEERING, INC.

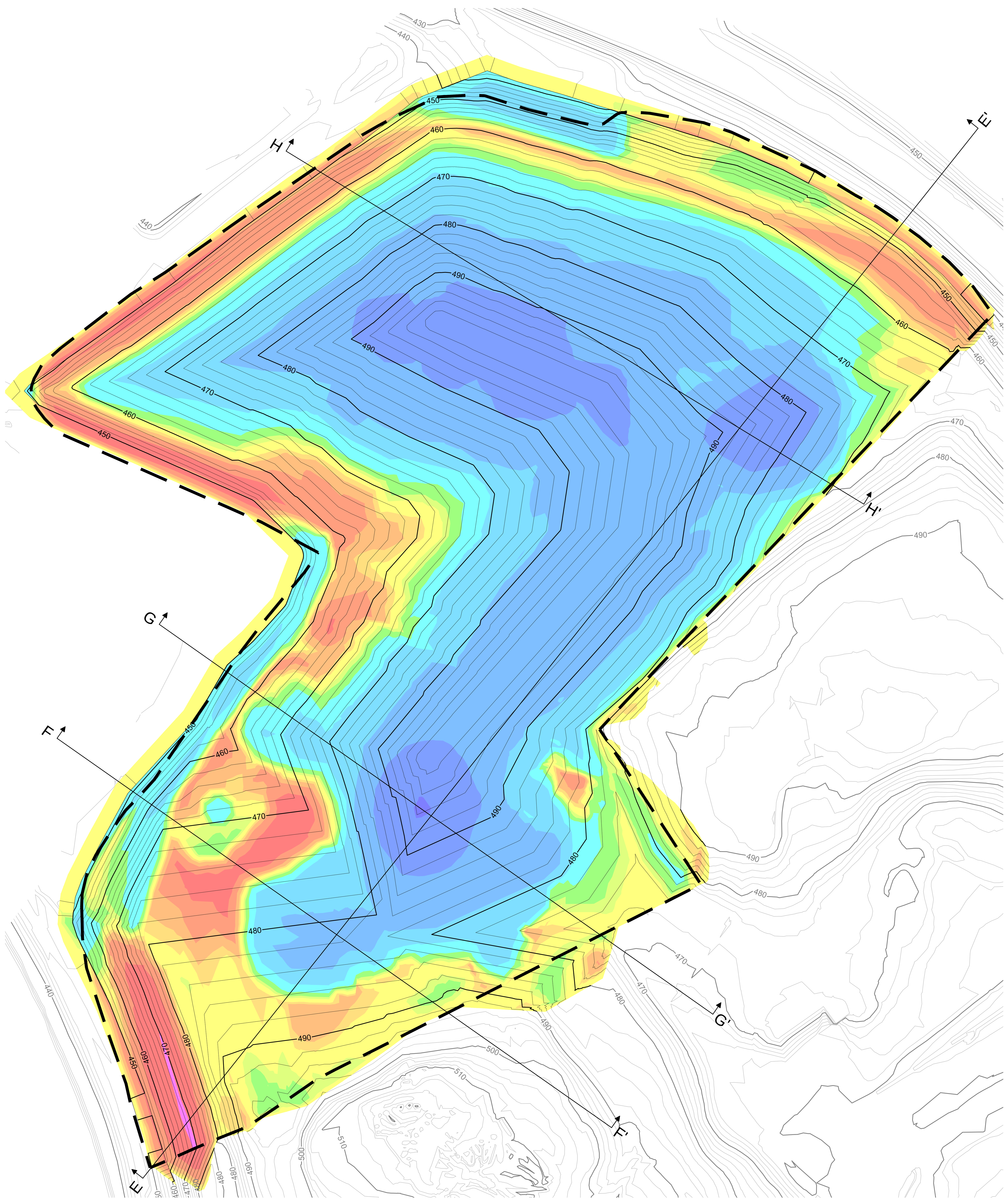
SEPTEMBER 2016
DESIGNED BY: IN
APPROVED BY: ---

REVISION	DATE

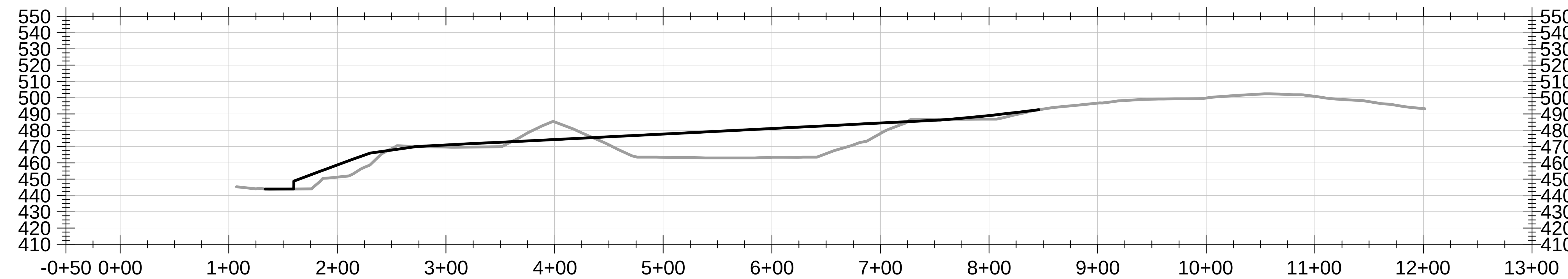
DRAWING NO.: **037**

PROJECT NUMBER: BT-106 FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\1000\Working\draft Drawings\BT-106 A2 (1000) 5% Criteria.dwg

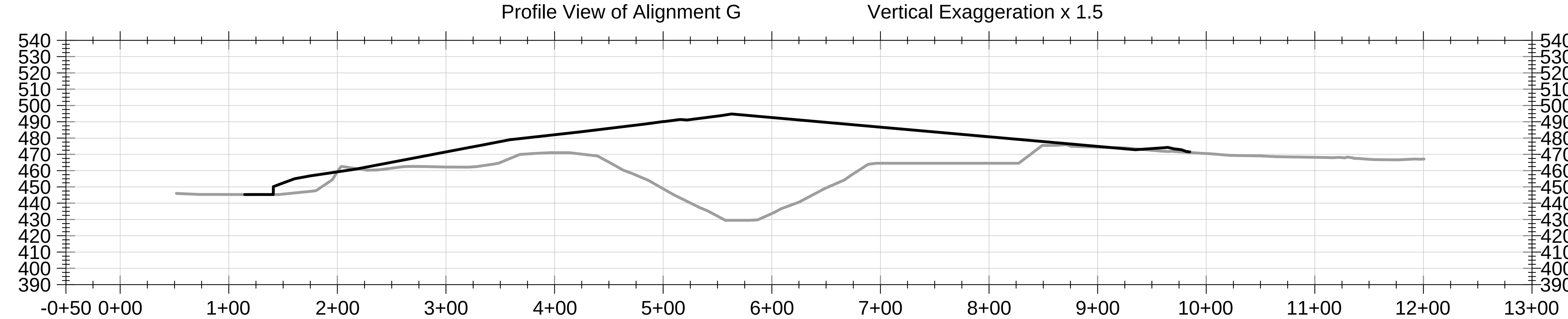
Profile View of Alignment E Vertical Exaggeration x 1.5



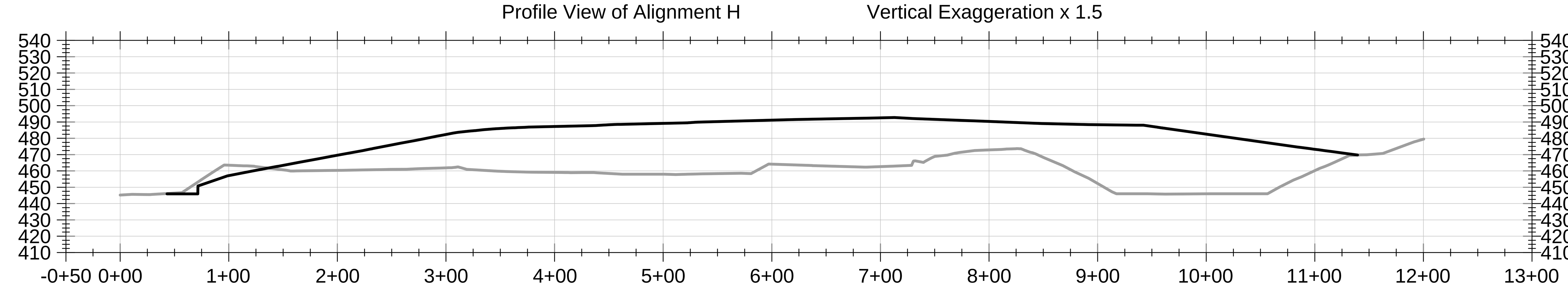
Profile View of Alignment F Vertical Exaggeration x 1.5



Profile View of Alignment G Vertical Exaggeration x 1.5



Profile View of Alignment H Vertical Exaggeration x 1.5



Thickness Map

Range	Minimum Depth	Maximum Depth	Color
1	-18	-16	
2	-16	-8	
3	-8	-4	
4	-4	-2	
5	-2	-1	
6	-1	0	
7	0	1	
8	1	2	
9	2	4	
10	4	8	
11	8	16	
12	16	32	
13	32	64	
14	64	66	

0 100 200 Feet

BACKFILL GRADING VOLUME
CUT: 63,374 CY
FILL: 752,875 CY

LEGEND

- 2015 TOPOGRAPHY WITH EXCAVATION GRADING (2' CONTOUR)
- 500 — 2015 TOPOGRAPHY WITH EXCAVATION GRADING (10' CONTOUR)
- BOTTOM OF FINAL COVER / BACKFILL GRADING (2' CONTOUR)
- 500 — BOTTOM OF FINAL COVER / BACKFILL GRADING (10' CONTOUR)
- AREA 2 BOUNDARY

DRAFT

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BRIDGETON LANDFILL
13570 ST. CHARLES ROCK ROAD
BRIDGETON, MISSOURI 63044

BRIDGETON LANDFILL
FINAL FEASIBILITY STUDY

1000 REMEDY - AREA 2
BOTTOM OF FINAL COVER / BACKFILL GRADING

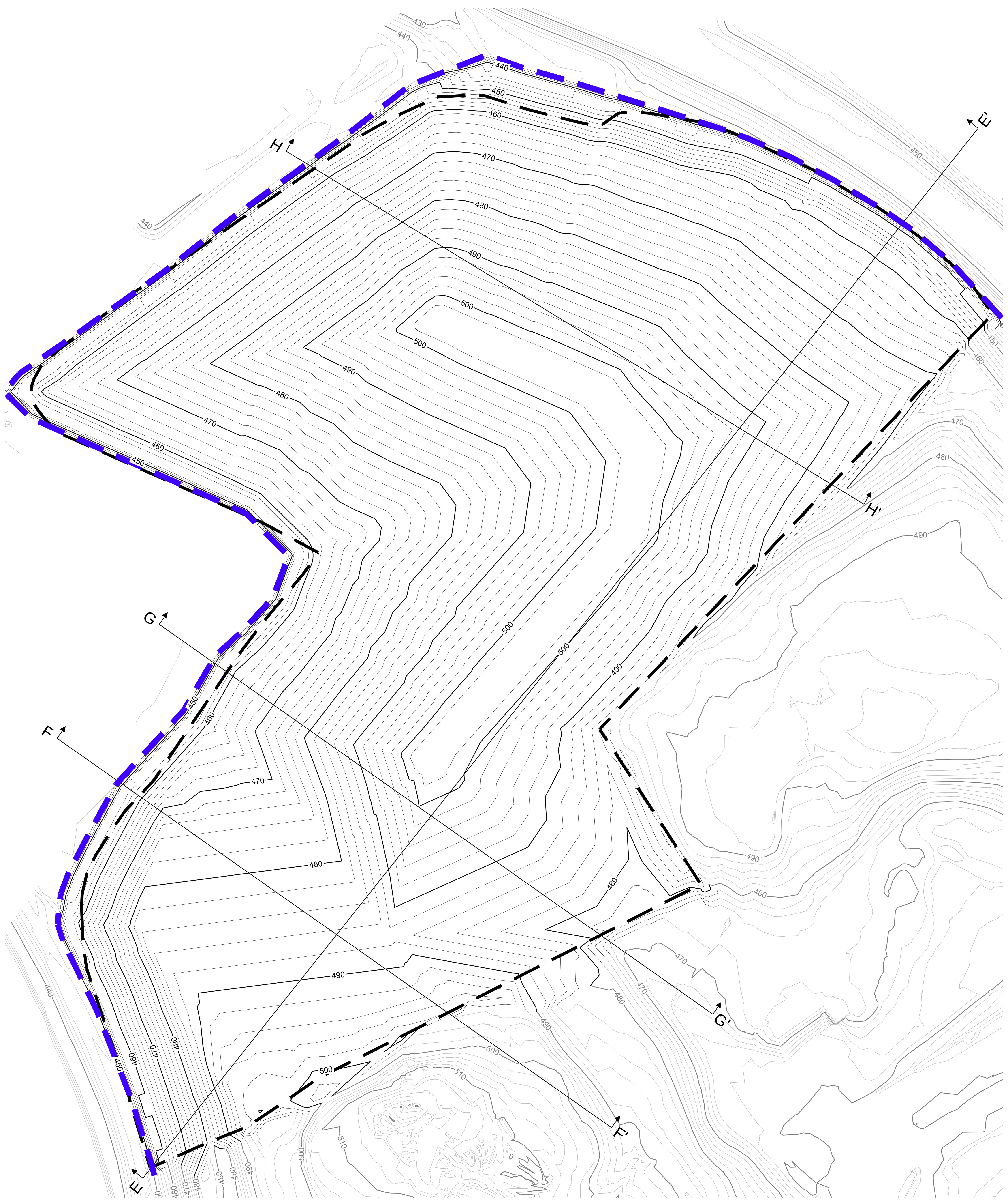
Engineering for a Better World
FEEZOR ENGINEERING, INC.

SEPTEMBER 2016
DESIGNED BY: IN
APPROVED BY: ---
REVISION | DATE

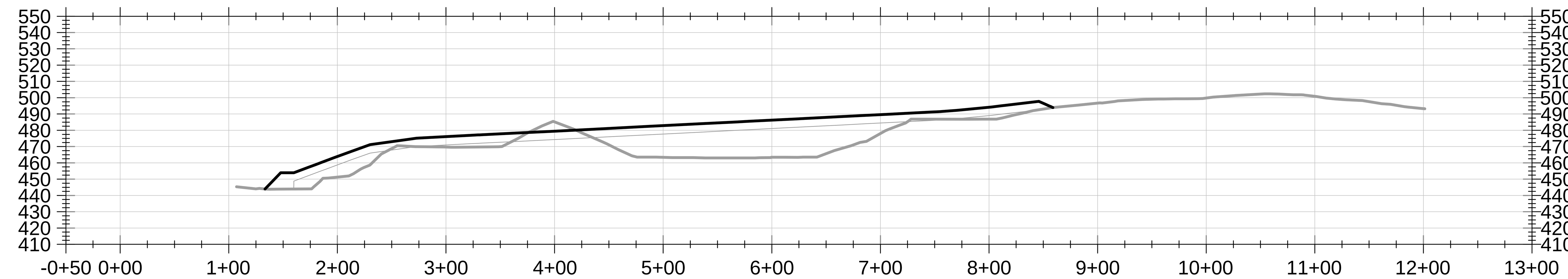
DRAWING NO.: **038**

PROJECT NUMBER: BT-106 | FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\1000\Working\draft Drawings\BT-106 A2 (1000) 5% Criteria.dwg

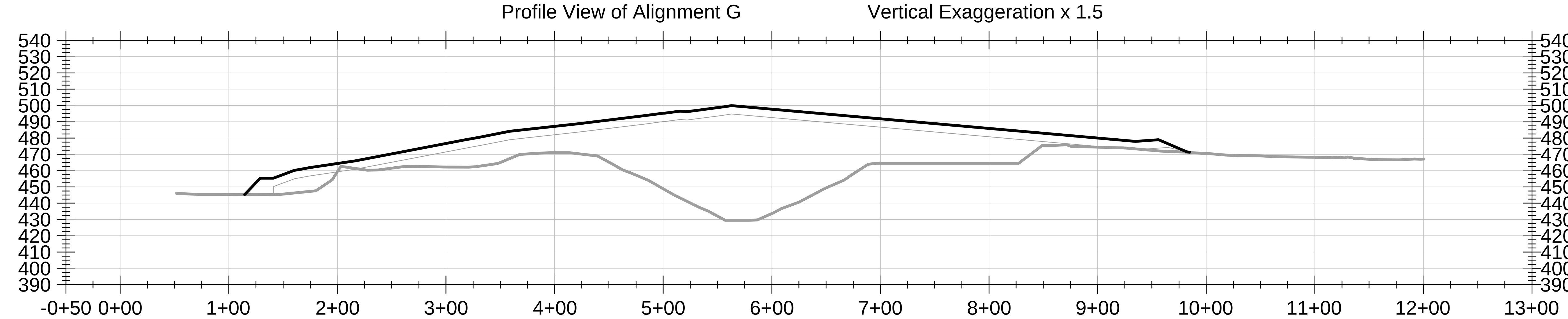
Profile View of Alignment E Vertical Exaggeration x 1.5



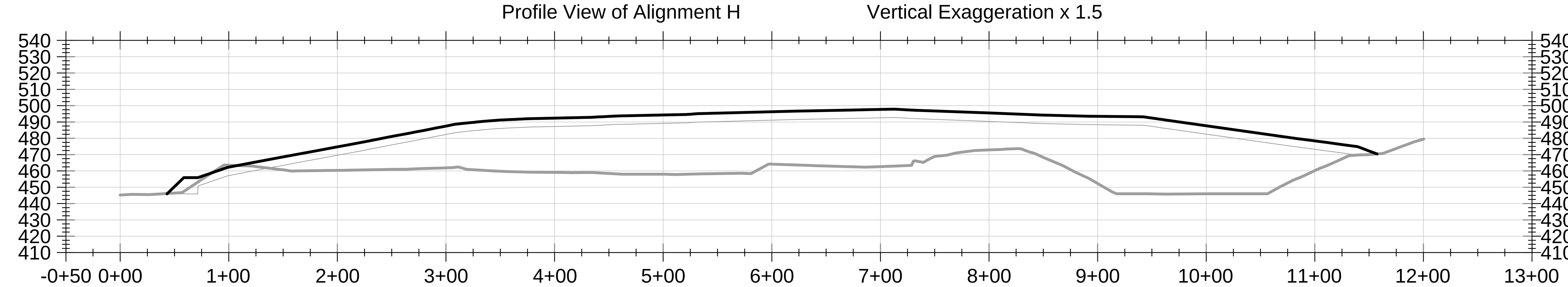
Profile View of Alignment F Vertical Exaggeration x 1.5

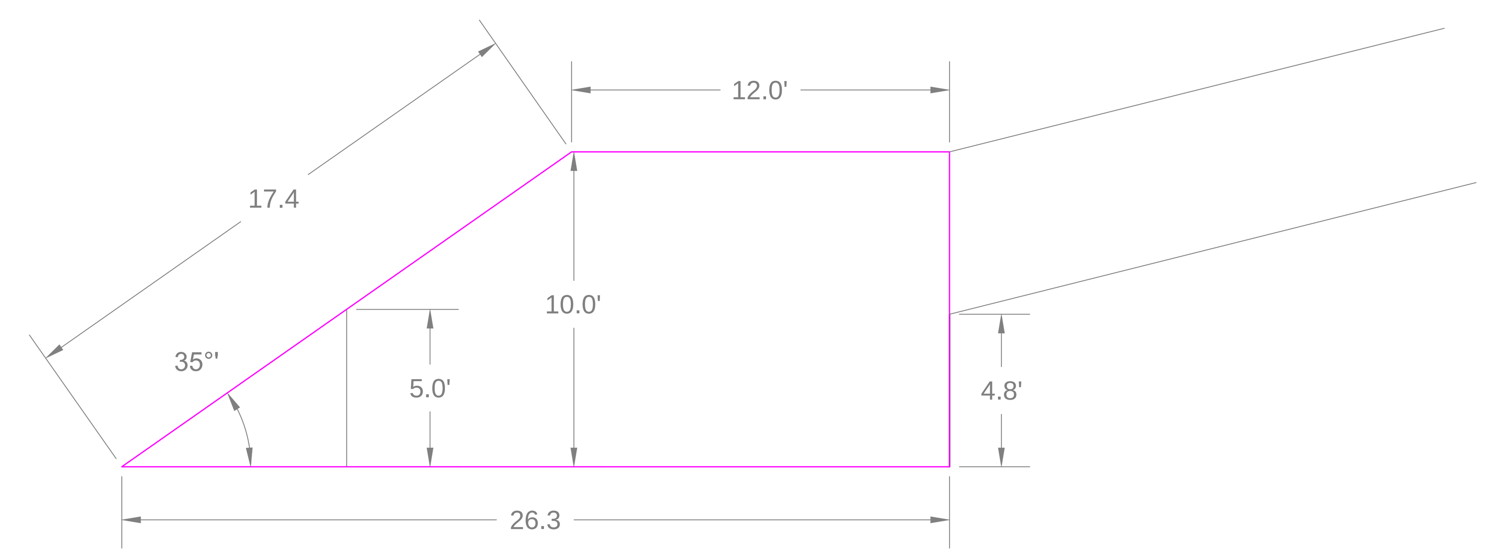


Profile View of Alignment G Vertical Exaggeration x 1.5

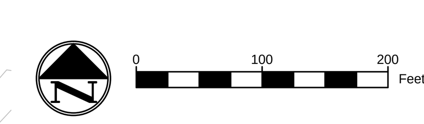


Profile View of Alignment H Vertical Exaggeration x 1.5





Area 2 Starter Berm Detail
Not to scale



LEGEND

- 2015 TOPOGRAPHY WITH EXCAVATION GRADING (2' CONTOUR)
- 500 — 2015 TOPOGRAPHY WITH EXCAVATION GRADING (10' CONTOUR)
- TOP OF FINAL COVER GRADING (2' CONTOUR)
- 500 — TOP OF FINAL COVER GRADING (10' CONTOUR)
- AREA 2 BOUNDARY
- STARTER BERM LOCATION
- STARTER BERM DETAIL DESIGN

DRAFT

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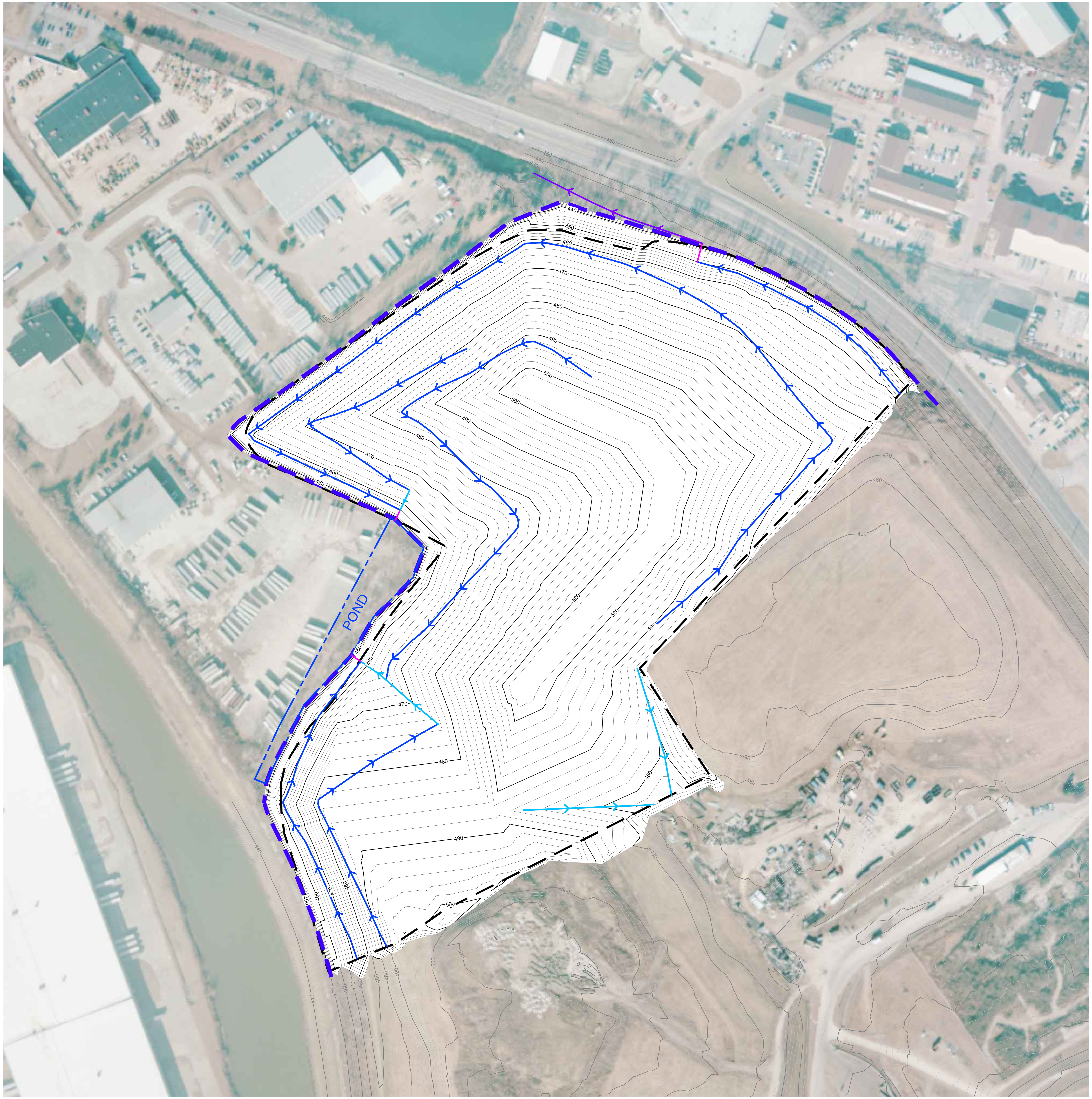
1000 REMEDY - AREA 2 **TOP OF FINAL COVER GRADING**			REVISION / DATE	**039**
PROJECT NUMBER: BT-106	FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\1000\Working\draft Drawings\BT-106 A2 (1000) 5% Criteria.dwg			



LEGEND

- 2015 TOPOGRAPHY GRADING (2' CONTOUR)
- 500 — 2015 TOPOGRAPHY GRADING (10' CONTOUR)
- FINAL COVER GRADING (2' CONTOUR)
- 500 — FINAL COVER GRADING (10' CONTOUR)
- AREA 2 BOUNDARY
- STARTER BERM LOCATION
- DRAINAGE TERRACE
- DOWNCHUTE SWALE
- PERIMETER DITCH
- PERIMETER ROAD CROSSING

N

0 100 200 Feet

DRAFT

NOTES:

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1000 REMEDY - AREA 2 STORM WATER CONTROLS			REVISION / DATE	**040**
PROJECT NUMBER: BT-106	FILE PATH: D:\Dropbox\BT-106 West Lake Final Feasibility Study\step 1 - Design\1000\Working\draft Drawings\BT-106 A2 (1000) 5% Criteria.dwg			