Removal Site Evaluation and Interim Removal Action

Black Jack and Mac Mines

McKinley County, New Mexico

Phase 3 Report:

Removal Site Evaluation

Revision 1

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Table of Contents

FIGURES

TABLES

1. INTRODUCTION

1.1 Background

Investigations conducted by the U.S. Environmental Protection Agency (EPA) in 2009, as part of the "Health and Environmental Impacts of Uranium Contamination in the Navajo Nation-Five Year Plan" (EPA, 2008), indicate that mine-related materials from the Black Jack and Mac mine sites (Sites) in the Mariano Lake and Smith Lake areas of the Navajo Nation within McKinley County, New Mexico may have elevated levels of radium-226, a "hazardous substance" as defined by Section 101(14) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). These Sites may require a Response Action under the CERCLA regulatory framework to protect the public health, welfare, and the environment. The Sites consist of four (4) legacy underground uranium mines owned and formerly operated by Sabre-Pinon Corporation and later by United Nuclear-Homestake Mining Company Partnership, of which Homestake Mining Company of California's (HMC) predecessor, Homestake Mining Company, was a partner. The four Sites include the Black Jack No. 1, Black Jack No. 2, Mac No. 1, and Mac No. 2 mines (Figure 1).

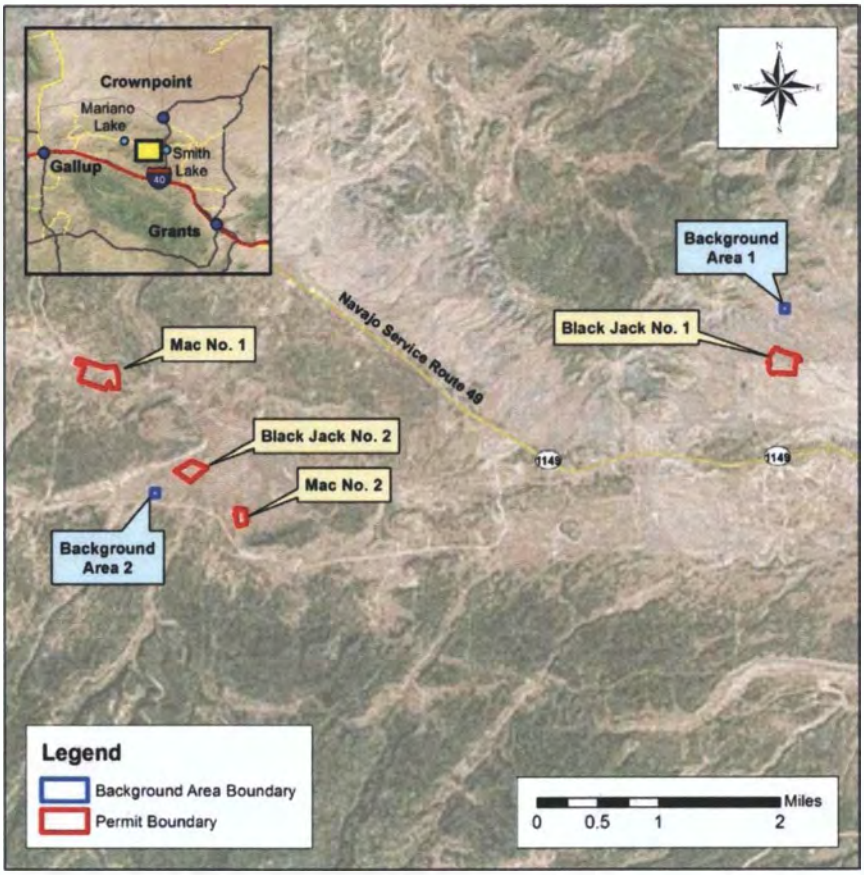


Figure 1: Location of Black Jack and Mac mines and EPA-approved background study areas (adapted from ERG, 2014).

The Black Jack No. 1 mine is located in Township 15 North, Range 13 West (T15N, R13W), Section 12 approximately 2 miles west of Smith Lake, New Mexico. The remaining three mine Sites are located in closer proximity to each other, approximately 6.5 miles west of Smith Lake, with the Black Jack No. 2 and Mac No. 2 sites both in T15N, R13W, Section 18 and the Mac No. 1 site in T15N, R14W, Section 12. These Sites lie within Navajo tribal allotted and/or trust lands administered by the Bureau of Indian Affairs (BIA) on behalf of the Navajo Nation.

1.2 Environmental Setting

The Black Jack and Mac mines are situated at relatively high elevation (approximately 7,450 ft.) on the Colorado Plateau in northwestern New Mexico. The climate is semi-arid with average annual precipitation on the order of 10-12 inches. The regional landscape generally consists of mesas, narrow canyons and relatively wide valleys with sparse desert grassland, sagebrush prairie and pinion/juniper stands. The results of the Phase 1 Geomorphic Study support grazing as the apparent historical land use in the vicinity of the Black Jack and Mac mines.

The geomorphic processes that shaped the landscape at the mine sites are tectonism, mass wasting, and fluvial and eolian erosion and deposition. Tectonism caused the uplift of the Zuni Mountains to the south, which resulted in the tilting of the Chaco Slope where the mines are located. The primary landforms are controlled by the underlying geologic strata and structures. The mine sites are underlain by sedimentary rock of Cretaceous age consisting of shale and sandstone units of the Mancos and Dakota formations. The high ground is formed by mesas and cuestas capped by erosion-resistant sandstone. Low ground consists of dipslopes of sandstone or valleys with shallow alluvial soil over bedrock.

Two relic geologic structures, the Mariano Lake anticline and the Smith Lake syncline with axes running east-west and approximately one-half mile apart, control the terrain and drainage and thus the geomorphology of the mine sites. Mass wasting has caused landslides and rockfalls in the general area, although these features are not present on the Black Jack and Mac mine sites. The present dominant geomorphic process is fluvial erosion and deposition with contribution from and interaction with eolian erosion and deposition.

Except for the north vent at Black Jack 2, the mine sites are located on low ground. Runoff as sheet flow and stream flow from high ground crosses all four mine sites, but watercourses are ephemeral, flowing only after large storms. Wind causes some erosion and deposition of sediment, but the dominant active processes affecting landforms are fluvial, either as sheet flow down slopes or stream flow, which is the more dynamic process in erosion.

The four mine Sites have similar geomorphic features, including: ephemeral, single thread watercourses, low- to moderate- channel sinuosity, slope grades on the mine sites of less than 7%, and sedimentary terrain with bedrock that dips ENE at 4 degrees or less.

1.3 Mine History

Historical information regarding operations at each of the four mines, primarily obtained from a 1970 report from the US Atomic Energy Commission (USAEC) concerning uranium mining methods and production in the Grants Mineral Belt (Holmquist, 1970), is summarized as follows:

- Black Jack No. 1: This former underground uranium mine consisted of a 825-foot, three-compartment shaft with multiple drifts. The mine was operated from 1959 through 1967, though uranium deliveries from stockpiles continued until 1971. In total, the mine produced approximately 1.44 million tons of ore yielding approximately 6,447,000 pounds of uranium concentrate. Mining operations ceased on June 30, 1967. In July 1967, the vent holes and mine shaft were sealed with half-inch steel plates, which were welded in place. Available records (Holmquist, 1970) indicate that the underground workings are situated above the local groundwater table (i.e. the mine was dry). One groundwater well in the area has been identified, and records obtained from the Navajo Nation Water Code Administration (NNWCA) indicate a well depth of 1,000 feet. The historic origin and purpose of this well is unknown.

- Black Jack No. 2: This former underground uranium mine consisted of 330-foot vertical shaft with drifts developed in the range of 280-330 feet. The mine was operated from 1960 through 1964, and ore deliveries from stockpiles at the mine apparently continued until 1970. In total, the mine produced 247,613 tons of ore yielding 1,129,004 pounds of uranium concentrate. In August 1964, Homestake-Sapin Partners requested permission from the United States Department of the Interior to extract the shaft pillars, backfill the shaft and seal the mine. Permission was granted in August 1964, the shaft pillars were extracted, the shaft was backfilled, and the mine's vent holes and shaft were sealed with half-inch steel plates. Subsequently, the mine shaft was covered with a concrete slab. There are indications in historic documentation that portions of this mine required some dewatering (Holmquist, 1970). Historic well records from the NNWCA indicate one well completed at a depth of 350 feet, but HMC has not been able to verify the existence of this well.

- Mac No. 1: The underground mine workings at Mac No. 1 consisted of a 515-foot vertical shaft with two drift levels. The mine was operated from 1968 through April 1971, though uranium deliveries from ore stockpiles at the mine are believed to have continued until 1979 or 1980. In total, the mine produced approximately 400,000 pounds of uranium concentrate. Mine closure in 1971 including backfilling of the shaft and covering with a concrete slab. The reported depth to static water (450 feet) is based on data obtained from the NNWCA for a well located north of the hoist building. The lowest level, situated in the Brushy Basin shale formation, was apparently abandoned before significant mining took place due to "boggy conditions" and a related inability to construct the necessary mine infrastructure.

- Mac No. 2: The underground mine workings at Mac No. 2 consisted of a 288-foot vertical shaft with multiple drifts. The mine was operated from 1968 through 1969 (Holmquist, 1970). In total, the mine produced 31,194 tons of ore yielding 109,009 pounds of uranium concentrate. The mine was closed in late 1969, and the shaft was backfilled followed by installation of a concrete slab. No information regarding wells in the vicinity of this mine was obtained from a records search

conducted by the NNWCA. The USAEC report (Holmquist, 1970) indicates that the "...ore is in the Poison Canyon sandstone and for the most part the formation was dry..."

1.4 Regulatory Requirements

An Administrative Settlement Agreement and Order on Consent (AOC) between HMC and the EPA for Interim Removal Action at the Black Jack and Mac mine Sites became effective on August 27, 2014 (EPA, 2014). Appendix A of the AOC details a scope of work (SOW) to investigate the nature and extent of actual or threatened releases of mine-related material at the Sites. The SOW includes three basic elements:

- SOW Section 4.1 – Phase 1: Gamma survey, geomorphologic survey and background study
- SOW Section 4.2 – Phase 2: Mitigation of physical mine hazards; posting of caution signage
- SOW Section 4.3 – Phase 3: Removal Site Evaluation (RSE)

Phase 1 field work was completed in early May 2017[1], and the Phase 1 Summary Report (ERG and AKA, 2017) required by Section 6.9 of the SOW was accepted by EPA on September 12, 2017. The Phase 2 Report for Site Hazards Assessment (iina ba, 2018) was accepted by EPA and NNEPA on July 2, 2018. This RSE Report summarizes Phase 1 and Phase 2 results, then provides a detailed presentation of the Phase 3 work along with overall RSE conclusions.

For the purposes of this RSE Report, mine-related material means local geologic materials (soil and rock) and remnant mine structures and related debris (e.g. concrete, metal, wood, etc.) having levels of uranium decay series radionuclides that may be elevated relative to that occurring naturally in local background soils/rocks residing at or near the ground surface[2], and potentially, elevated levels of stable elements (e.g. metals) associated with uranium ore and/or former mining operations. It does not include naturally occurring background concentrations found in local native soils or underlying bedrock formations.

1.5 RSE Report Organization

This RSE Report is organized in general accordance with the three AOC/SOW Phases listed above. The results and conclusions of Phase 1 (Section 2) and Phase 2 (Section 3) SOW elements are summarized with references to previously approved Work Plans and Reports containing detailed information. For Phase 3, new data and information are presented in Section 4 to complete the RSE element of the AOC/SOW (EPA, 2014). This RSE Report will be used in the next step in the process specified Section 7.5 of the AOC/SOW,

[1] Initial gamma radiation surveys and background soil sampling were conducted between April 20-25, 2015. Due to subsequent discussions between EPA, Navajo Nations EPA (NNEPA), and the Bureau of Indian Affairs (BIA) regarding proper procedure for notification/approval of access to Sites located on lands allotted by the BIA to individual members of the Navajo Nation ("Allottees"), or on lands subject to grazing permits, Phase I work was suspended pending resolution of this matter. The Respondent (HMC) was given permission to resume Phase I field work at the Sites in December 2016, and respective field work was completed in early May 2017.

[2] "Background" levels of gamma radiation, radionuclides and stable elements in local geologic materials have been defined based on Phase 1 SOW characterization surveys conducted at locally representative areas of native soil/rock types situated in upwind and hydrologically upgradient locations expected to be free of impacts by historic mining activities (ERG, 2017a).

which is to develop an Engineering Evaluation and Cost Analysis (EE/CA) in accordance with applicable EPA guidance on non-time-critical removal actions (EPA, 1993).

2. PHASE 1 PROJECT SUMMARY

The Phase 1 Summary Report (ERG and AKA, 2017) was accepted by EPA on September 12, 2017. The objective of this Report was to characterize – both radiologically and geomorphologically – the areas surrounding the Black Jack and Mac mine Sites. In support of this objective, Phase 1 work included four study areas, the results of which are summarized below.

2.1 Phase 1 Transect Gamma Scan

The majority of gamma radiation survey work was performed April 20-25, 2015, with follow-up scanning performed on December 6-7, 2016 and May 3, 2017. All work was performed with Ludlum Model 44-10 sodium iodide scintillation detectors paired to Ludlum Model 2221 ratemeter/scalers and an appropriate global positioning (GPS) receiver and handheld data logger. Two background areas (BA1 and BA2, see Figure 1) and four mine areas were scanned. The gamma data was used to map the spatial extent of the impacted area for each mine location, defined as the 95% upper tolerance limit (UTL) on background gamma radiation readings, which were equivalent to 15 and 13.7 µR/hr for BA1 and BA2, respectively. Resulting estimates of the total impacted area for each Site are provided in Table 1. Details of these results are provided in the Phase 1 Summary Report (ERG, 2017a).

Table 1: Phase 1 estimates of areal extent of mine impacts at the Sites.

Mine Site	Estimated Areal Extent of Impacted Soils*
Black Jack No. 1	159 acres
Black Jack No. 2	65 acres
Mac No. 1	22 acres
Mac No. 2	42 acres

*In excess of the upper 95% UTL on background gamma readings.

2.2 Phase 1 Background Study

Soil sampling at two background areas was performed from April 20-21, 2015. Soils were analyzed for both radioactive and stable constituents of potential concern (COPCs), including: uranium (U-nat), radium-226 (Ra-226), molybdenum, vanadium, and arsenic. Actinium-228 (Ac-228) and potassium-40 (K-40) were added to the list of analytes for potential diagnostic purposes related to the gamma/Ra-226 correlation.[3] All soil COPC concentrations, including surface and subsurface soils, were consistent with published ranges for naturally occurring background.

During the development of this Report, it was discovered that summary statistics for average concentrations of radionuclides and metals in soil as presented in Table 1 of the Phase 1 Summary Report (ERG, 2017a) were incorrectly entered in the table. In addition, analytical results for two subsurface

[3] Actinium-228 was analyzed as a surrogate radionuclide to represent natural thorium (Th-232) concentrations based on an assumption of radiological equilibrium.

samples in Background Area 2, as presented in Attachment A1 to the Phase 1 Summary Report (ERG, 2017a), were incorrectly entered in the original data table.

Because two additional discrete samples of surface soil were collected in each Background Area in association with Phase 3 field correlation work (n = 4 samples total), respective analytical results have been added to the Phase 1 Background Area data sets. The Background Area data sets have been corrected/updated accordingly and summary statistics were recalculated as provided in Appendix A (Attachment A1) to this RSE Report. These updated Background Area data tables supersede the original background data sets presented in the Phase 1 Report.

2.3 Phase 1 Characterization of Indoor Radon in Buildings

Ambient indoor radon was measured in the west and east buildings at the Mac No. 1 mine from December 5-7, 2016. The measured concentrations were consistent with typical outdoor background levels, possibly because the buildings were well-ventilated due to structural deterioration (visible holes or openings in walls, windows, and/or doors). Specifically, average results for the west and east buildings at Mac No. 1 Mine were 1.1 pCi/L and 0.8 pCi/L respectively. Complete results are presented in the Phase 1 Summary Report (ERG, 2017a).

2.4 Phase 1 Geomorphic Study

The geomorphology of both the watersheds and the landforms adjacent to and within the four mine Sites were characterized at intermittent intervals between April 2014 and May 2017. The four mine Sites have similar geomorphic features, including: ephemeral, single thread watercourses, low- to moderate-channel sinuosity, slope grades on the mine sites of less than 7%, and sedimentary terrain with bedrock that dips ENE at 4 degrees or less. The results of the geomorphic study support grazing as the apparent historical land use.

Specifications in the AOC/SOW for Phase 1 (EPA, 2014) included interim plugging of open shafts or vents, but this work was deferred to Phase 2 (fencing to prevent access to physical hazards was temporarily improved pending Phase 2 interim hazards mitigation work).

Additional detail concerning the methods and results of the geomorphic studies are provided within the Phase 1 Geomorphic Study Report (AKA, 2017).

3. PHASE 2 PROJECT SUMMARY

Phase 2 work included mitigation (elimination or removal) of physical hazards at the former mine in addition to passive outdoor radon monitoring near mine features.

3.1.1 Mitigation of Physical Hazards

Mitigation work occurred during November and December 2017. Identified physical hazards at the mine Sites included:

- Former mine shafts
- Former mine vents

- Former utility raises
- Concrete slabs
- Former utility infrastructure
- Former mine buildings
- Miscellaneous open holes

Physical hazards were mitigated in successive actions. The approach to mitigation varied depending upon the hazard being mitigated. Mitigation actions included:

- Cutting and/or removal of sharp metal objects
- Plugging and/or capping open holes with native soils or flowable fill mixture
- Installation of chain-link fence
- Installation of hazard warning signage

Additional detailed information concerning mitigation work is available in the Phase 2 Physical Hazards Mitigation Report (iina ba, 2018).

3.1.2 Special Outdoor Radon Monitoring near Vents/Shafts

Monitoring of ambient airborne radon gas (Rn-222) concentrations was conducted August 29, 2017 through October 2, 2017 in response to a special request from NNEPA. While not required under the AOC, EPA supported the conduct of this outdoor radon monitoring next to remnant mine features, some of which apparently once served as operational vertical conduits to the underground mine workings at the mine Sites (e.g. mine shafts, ventilation shafts and utility raises). Many of these former operational conduits appear to have previously been backfilled or otherwise closed as part of historic mine reclamation efforts. This monitoring was conducted in accordance with Standard Operating Procedure (SOP) P2-1 "Phase 2 Radon Monitoring" as provided in an Attachment to the Phase 2 Hazards Assessment Work Plan (iina ba, 2017). SOP P2-1 describes the radon monitoring locations, equipment, procedures, and quality assurance/quality control (QA/QC) protocols used for deploying and collecting radon detectors. The purpose was to obtain measures of the time-integrated average concentration of radon gas in outdoor air near the openings of any historic conduits to the underground mine workings, and to evaluate potentially elevated levels relative to ambient outdoor radon concentrations at appropriate background locations.

Outdoor radon monitoring results were presented in a Phase 2 outdoor radon monitoring Data Transmittal (ERG, 2017b) and follow-up addendum (ERG, 2017c). A compilation of results is presented in Table 2. Generally, monitoring data reflect slightly elevated concentrations of ambient radon associated with mine-impacted soils. Near the north and south vent shafts and utility raises at the Black Jack No. 1 mine, however, radon levels were significantly elevated as these features were not sealed to the outside atmosphere. Although releases from these vent shafts and utility raises do not pose a health concern as they are situated far from any dwellings (radon levels decrease rapidly with distance from the source due to atmospheric mixing/dispersion), HMC performed interim mitigation measures to prevent further releases as noted below.

The elevated radon associated with impacted soils will be remedied when these soils are removed to meet site cleanup levels. As part of the Phase 2 hazards mitigation, applicable vent shafts and utility raises at the Black Jack No. 1 Site were temporarily sealed, as approved by EPA on Nov. 8, 2017, with inflatable packer plugs or quick-set epoxy cement to prevent further radon releases (iina ba, 2018) until permanent mitigation measures can be determined through the EE/CA process and implemented once remedies have been selected.

Table 2: Outdoor radon monitoring results near mine shafts, vent holes and utility raises.

Mine Site	Easting*	Northing*	Radon Monitoring Location ID	Phase 1 Summary Report Mine Feature Description	Phase 1 Summary Report Mine Feature ID	Radon Result (pCi/L)
Black Jack 1	2623453	1654060	BJ1-MS	Buried Main Shaft	M1	0.89
Black Jack 1	2623484	1654222	BJ1-VR1	Vent/Utility Raise	VR1[a]	0.57
Black Jack 1	2623799	1654260	BJ1-VR2	Vent/Utility Raise	VR2[a]	1.3
Black Jack 1	2624652	1654142	BJ1-NVS	North Vent Shaft	NV	25.2
Black Jack 1	2624744	1654138	BJ1-NUR	Utility Raise (North)	UR	1.6
Black Jack 1	2624635	1653265	BJ1-URS	Utility Raise (South)	HL[c]	4.9
Black Jack 1	2624519	1652815	BJ1-SVS	South Vent Shaft	SV	150
Black Jack 1	2621953	1654141	BJ1-BKG	Background	N/A[b]	< 0.22
Black Jack 2	2597919	1649435	BJ2-MS	Mine Shaft	M1	2.1
Black Jack 2	2597703	1649704	BJ2-V1	South Vent Shaft	V1	1.3
Black Jack 2	2597441	1650853	BJ2-V2	North Vent Shaft	V2	0.59
Black Jack 2	2597800	1649498	BJ2-U1[d]	Utility Raise	U2	2.9
Black Jack 2	2597733	1649508	BJ2-U2[d]	Utility Raise	U1	1.6
Black Jack 2	2597442	1650678	BJ2-U3	Utility Raise	U3	0.24
Black Jack 2	2597411	1650835	BJ2-U4	Utility Raise	U4	< 0.22
Black Jack 2	2598129	1648676	BJ2-BKG	Background	N/A[b]	0.27
Mac 1	2594448	1653248	MAC1-MS	Main Mine Shaft	MS	1.1
Mac 1	2594372	1653338	MAC1-V2	Vent Raise	VR2	1.2
Mac 1	2594535	1653425	MAC1-WW	Water Well	WW	0.62
Mac 1	2593486	1653887	MAC1-BKG	Background	N/A[b]	1.0
Mac 2	2600226	1647216	MAC2-VS	Vent Shaft	V1	0.38
Mac 2	2600070	1647599	MAC2-MS	Main Shaft	M1	1.1
Mac 2	2599576	1646530	MAC2-BKG	Background	N/A[b]	0.54

*State Plane Coordinate System: NAD 83 (ft), NM West (FIPS 3003)

[a]Identified in the P1 Summary Report and/or SOP P2-1 of P2 Work Plan.

[b]Not applicable (location not identified in P1 Summary Report or P2 HA Report).

[c]A steel utility raise pipe was not identified for radon monitoring near the south vent shaft, but one was identified at the location of "Open Hole" as indicated in the P1 Summary Report, P2 HA Work Plan and P2 HA Report.

[d]Radon monitoring station IDs for U1 and U2 inadvertently transposed relative to locations shown in the P1 Summary Report and subsequent documents.

4. PHASE 3 RSE REPORT

4.1 Overview

Environmental Restoration Group Inc. (ERG), with input from HMC and Alan Kuhn Associates, LLC (AKA), has prepared this Phase 3 RSE Report in accordance with the specifications of Section 5.1 of the AOC/SOW (EPA, 2014) and the Phase 3 Work Plan (ERG, 2017d).

4.2 Objectives

The objectives of Phase 3 characterization studies were identified in the Phase 3 Work Plan (ERG, 2017d) based on the specifications provided in Section 5.1 of the AOC/SOW. These objectives are summarized in Table 3.

Table 3: Phase 3 SOW objectives.

SOW Section No.	SOW Objective
4.1.4	Gamma/Ra-226 Correlation
4.3.1	Characterize Lateral/Vertical Extent of Impacts
4.3.2	Screen for Additional Analytes
4.3.3	Groundwater Sampling
4.3.4	Geotechnical Sampling
4.3.5	Radiological Surveys of Buildings
4.3.6	Open Hole Closure
4.3.7	Testing of Solid Waste
6.13	Final Report with Removal Site Evaluation

As indicated in the Phase 3 Work Plan, interim closure of open holes (SOW objective 4.3.6) was addressed in Phase 2 of the AOC/SOW (iina ba, 2018). With respect to SOW objectives 4.3.5 and 4.3.7, HMC has opted in favor of demolition of all structures and inclusion of all solid wastes along with contaminated soil in a common final disposal solution, to be determined in accordance with the next phase of the AOC/SOW through the EE/CA process. This deviation from the Phase 3 Work Plan has no implications for the other AOC/SOW objectives given in Table 3, which are the subject of the remainder of this RSE Report. Deviations from the Phase 3 Work Plan are summarized and evaluated in Section 4.3.9.

4.3 Methods

4.3.1 Project Team

The project team included HMC technical and managerial staff, community liaison services (Rusted Peak, LLC), environmental health physics support (ERG), geotechnical engineering experts (AKA), and hazard mitigation specialists (iina ba), all of which contributed to the development of the data, evaluations and conclusions presented in this Report. The Project Coordinator (PC) for the Sites is Clark Burton of HMC. The Remedial Project Manager is Jacob Phipps of EPA (Region 9).

4.3.2 Site Access

In accordance with Section 27 of the AOC, HMC made all reasonable efforts to properly notify local members of the Navajo Nation community allotted lands by the BIA ("Allottees") of field activities to be conducted under the AOC/SOW, and to work with applicable agencies and individual Allottees to obtain appropriate permissions for access to the Sites. Approved authorization letters were sent to known Allottees within AOC/SOW project areas, and to the best of HMC's knowledge, all notification requirements for Site access were met prior to initiating Phase 3 field work activities.

In accordance with Sections 3.9 and 3.10 of the AOC/SOW, cultural resource surveys for applicable areas near the Black Jack and Mac Mines were performed and approved by the Navajo Nation Historic Preservation Department (NNHPD) and EPA/NNEPA. In response to a "Data Request" for information on biological resources specific to the Sites ("Data Request") submitted by ERG on behalf of HMC, the Navajo Natural Heritage Program ('NNHP") identified no Known Species of Concern at the Sites, but 11 Potential Species were determined to require a biological evaluation. Biological assessment surveys were conducted at the mine Sites June 29-30, 2017 by a qualified contractor (Dodge Environmental, 2017a and 2017b), and approval of the resulting biological clearance Reports was obtained from the Navajo Nation Department of Fish & Wildlife (NNDFW) on September 18, 2017 (NNDFW, 2017a and 2017b).

In accordance with AOC/SOW requirements, HMC made the appropriate notifications to EPA, NNEPA and the Navajo Nation Department of Justice (NNDOJ) before performing field work under a Site Access Agreement with the NNEPA and NNDOJ (NNEPA and NNDOJ, 2014).

4.3.3 Gamma/Ra-226 Correlation

As indicated in the SOW (EPA, 2014), a statistical correlation between ambient gamma radiation (gamma) and Ra-226 concentrations in surface soils (0-15 cm) was developed in accordance with the methods described in the Phase 3 Work Plan (ERG, 2017d). This portion of the Phase 3 field work took place on October 10-12, 2017. Established field sampling and measurement techniques for gamma/Ra-226 correlations (e.g. Johnson et al., 2006; Whicker et al., 2006 and 2008) were used to generate data for least squares regression analysis, the results of which were used to statistically predict Ra-226 concentrations in surface soils based on Phase 1 gamma survey data (ERG, 2017a). Results are provided in Section 4.4.1 of this Report.

To evaluate prediction error in the correlation, the Phase 3 Work Plan called for 4 randomly located, discrete samples of surface soil to be collected at each Site (ERG, 2017d). While not specifically collected for this purpose, many discrete soil samples were collected for other purposes and those samples were suitable for this evaluation objective and were thus used instead. This includes discrete samples taken at the center of each correlation plot location (n = 20 samples) and at borehole transect sampling locations (n = 53 samples). This deviation from the Work Plan is expected to provide more robust estimates of prediction error across a wider range of conditions across all mine Sites. Results of this evaluation are discussed in Section 4.4.6.

4.3.4 Characterization of Lateral/Vertical Extent of Impacts

4.3.4.1 Lateral Extent

The general lateral (areal) extent of mine-related impacts (above background levels) at each Site was estimated based on Phase 1 gamma survey data (ERG, 2017a). Results are summarized in Section 2.1 of this Report. The original plan was to refine these estimates based on conversion of gamma survey data in to estimates of Ra-226 concentrations in surface soil (0-15 cm) using the results of the gamma/Ra-226 correlation along with the Investigation Level indicated in the SOW (1.24 pCi/g Ra-226 above background) (ERG, 2017d). However, in the region of the gamma/Ra-226 correlation relationship corresponding to the Investigation Level, the statistical relationship appears to have a high bias sufficient to result in significant overestimation of the lateral extent of impacts.

At the boundary of impacted areas, defined at the 95% upper tolerance level (UTL) on background gamma radiation readings as delineated in the Phase 1 report (ERG, 2017a), the correlation predicts that Ra-226 concentrations should generally exceed the Investigation Level for surface soil at each Site (Table 4), a conclusion not supported by gamma survey data alone, or by direct soil sampling results (see Section 4.4.6 for details). This technical problem is believed attributable to differences in methods of estimation and insufficient resolution in the correlation to accurately predict low-level Ra-226 impacts in soil relative to background levels. As a result, the original conservative estimates of the areal extent of impacts were used for estimation of the volume of contaminated soil at each mine Site [this deviation from the Work Plan was discussed with EPA on a bi-weekly conference call (April 18, 2018)]. Details of the methods used to estimate the original areal extent of impacts are given in detail in the Phase 1 Summary Report (ERG, 2017a).

Table 4: Investigation Level values and applicability by mine Site.

Background Area	Mean Ra-226 (pCi/g)[1]	Investigation Level (pCi/g)[2]	Site(s) of Investigation Level Applicability
BA1 Surface Samples	1.31	2.6	BJ-1
BA2 Surface Samples	1.01	2.3	BJ-2, Mac-1, Mac-2
BA1 Subsurface Samples	1.21	2.5	BJ-1
BA2 Subsurface Samples	0.89	2.1	BJ-2, Mac-1, Mac-2

[1]Based on 13 samples collected within each Background Area (BA) in Phases 1 and 3 of the AOC/SOW (see Appendix A, Attachment A1 for updated analytical results and summary statistics).

[2]Defined (in the AOC/SOW) as 1.24 pCi/g Ra-226 in surface soil plus the mean background concentration, herein rounded to the nearest tenth of a pCi/g to avoid unwarranted precision in reporting and use of analytical laboratory results.

4.3.4.2 Vertical Extent

The vertical extent of contamination above background levels was based on downhole measurements of subsurface gamma radiation and soil depth profile samples collected along borehole sampling transects. This data was obtained between October 3-13, 2017 in general accordance with Phase 3 Work Plan

specifications (ERG, 2017d), though there were deviations in how these data were evaluated to estimate the maximum depth of soil impacts and inform decisions on the depth at which subsurface soil samples should be collected for confirmatory analysis. This change in data evaluation and sampling strategy was approved by EPA and NNEPA during an October 11, 2017 Site visit to oversee soil boring, gamma logging and subsurface sampling activities. Methods and circumstances leading to these deviations from the Work Plan are described below.

Boreholes were developed at approximately 100-meter intervals along transects as shown in the Work Plan. Boreholes were advanced with a direct-push Geoprobe with a 3.25" diameter probe to allow downhole gamma measurements with a 2" x 2" sodium iodide (NaI) detector attached to a cable with depth increments indicated on the cable. Additional (unplanned) boreholes were collected at biased locations of interest, for example areas of potential "principle threat wastes" such as remnant waste rock piles, or where evidence of subsurface contamination near mine shafts was identified.

At each borehole, the gamma detector was lowered downhole and gamma measurements [in counts per minute (CPM)] were taken at 15 cm depth increments until readings stabilized at apparent background levels or until drilling advancement met refusal. The gamma data were documented in the field logbook for subsequent generation and evaluation of depth profiles. The approach proposed in the Phase 3 Work Plan to identify subsurface impacts based on exceedance of a fixed downhole gamma cutoff criterion (28,000 CPM at Black Jack No. 1 and 22,000 CPM for the other three mine Sites), was determined to be ineffective because of variable background readings encountered at depth for various boreholes, and because downhole "geometry effects" often significantly influenced the shape of depth profiles near the surface.

Instead of a fixed numeric criterion, the maximum depth of subsurface impacts to soil was evaluated on a case-by-case basis, considering relevant information from several qualitative and quantitative factors, including the shape of the gamma depth profile (e.g. the depth of an inflection point in the profile followed by stabilization of gamma readings at a relatively constant level with increasing depth) and later in the data analysis process, the results of confirmatory Ra-226 analysis for select subsurface soil samples (selected based on the shape of the downhole gamma logging profile).

Guidelines for profile evaluation and selection of sampling depths, as discussed with and verbally approved by EPA/NNEPA in the field and via email on October 25, 2017, included taking soil samples in 15-cm increments at a clear inflection point in the gamma depth profile, just below the inflection point, and at a depth of 1-foot (approximately 30 cm) below the gamma inflection point. For areas with evidence of principle threat wastes, additional subsurface soil samples were collected in systematic increments as described in the Phase 3 Work Plan (ERG, 2017d).

4.3.5 Screen for Additional Analytes

All surface/subsurface soil samples taken under the Phase 3 Work Plan were analyzed for uranium, Ra-226, arsenic, molybdenum, selenium and vanadium (per SOW paragraph 3.2).[4] This includes all

[4] As previously noted, Ac-228 and K-40 were not required by the AOC/SOW but were parameters included for potential diagnostic purposes with respect to gamma radiation readings in relation to soil Ra-226 concentrations.

correlation samples (Section 4.4.1) and borehole depth samples (Section 4.4.10). Analytical laboratory methods and quality control (QC) requirements are detailed in Section 3.2 of the Work Plan (ERG, 2017d).

4.3.6 Groundwater Sampling

One potential well associated with the Mac No. 1 mine was identified in Phase 1. Two additional potential wells were identified in Phase 2, and these wells were investigated by *iiná bá*, Inc. to determine if groundwater was present, the depth to groundwater, and to analyze samples of any groundwater encountered for the constituents listed in the AOC/SOW. After accessing the well casing at the Black Jack No. 1 location, an electronic water level indicator was lowered down the well casing until a hard, fixed object was encountered at a total depth of 580 feet. At the MAC No. 1 location, a total of 185 feet of water tape was lowered into the well casing until a hard, fixed object was encountered. In both cases, no indication of static groundwater was observed.

At the time of the well investigation, no records regarding these wells were available but the Navajo Nation Water Code Administration (WCA) was contacted to request a search for records in the Smith Lake Chapter area regarding groundwater wells and water level data. Based on information provided by the WCA, the following well statistics were on file for the subject Sites:

MAC No. 1 Well (windmill)

Total Well Depth = 1,376 feet; static water level at 450 feet.

Black Jack No. 1 Well (windmill)

Total Well Depth = 1,000 feet; no water level data available

Black Jack No. 2 Well (inside hoist house)

Total Well Depth = 350 feet; no water level data available

iiná bá attempted to obtain data from the third potential well as identified above from the WCA records (inside the hoist house at Black Jack No. 2). However, it was quickly determined that this feature did not extend vertically into the ground but instead turned 90 degrees to the south, extending horizontally at a shallow depth towards the outside of the hoist house.

Because groundwater was not identified in any of these potential wells, this AOC/SOW objective is not discussed further in this Report.

4.3.7 Geotechnical Sampling

Geotechnical sampling of soils at the Sites was conducted in accordance with Section 2.7 and Table 3 of the Phase 3 Work Plan (ERG, 2017d); however, only Geoprobe borehole cores were examined in the field, sampled and subsequently tested by a geotechnical laboratory. Results are discussed in Section 4.4.9. Backhoe test pits were not performed in Phase 3 as field assessment of soil cores and laboratory screening tests for soil classification (e.g. grain size, plasticity) of samples was sufficient to characterize and draw conclusions regarding the geotechnical suitability of soil resources at the mines. Geotechnical specifications for soils identified in Phase 3 to be suitable for remedial applications (repository cover or

backfill) will be determined as needed for future engineering design phases of the project depending on the outcome of the EE/CA (e.g. bulk sample collection and compaction tests per ASTM D 698).

4.3.8 Radiological Surveys of Buildings and Testing of Solid Waste

As previously indicated, these AOC elements were eliminated based on discussions with EPA/NNEPA and a decision by HMC to demolish remaining structures and likely place all solid wastes in the overall waste stream to be managed under a common final disposal solution (to be determined through the EE/CA process). However, depending on the selected action for the mines, segregation of debris for potential separate disposal in an appropriate offsite commercial facility remains a possibility provided radiological acceptance criteria for such disposal can be demonstrated by HMC. This deviation from the Phase 3 Work Plan has no implications for other AOC/SOW objectives (Table 3).

4.3.9 Deviations from Work Plan

Deviations from the Phase 3 Work Plan are summarized below, with comments on implications for meeting the data quality objectives (DQOs) outlined in the Work Plan:

1) Planned correlation locations at Black Jack No. 2 Mine Site, based on the cross-calibration locations used in Phase 1 to normalize detector readings (ERG, 2017a), were modified in the field during Phase 3 to find more uniform radiological conditions across areas > 100 m^2. Identification of any correlation plots that would meet the variance criteria specified in the Phase 3 Work Plan was not possible as spatial variability in most areas was higher than could be accommodated under the specified variance limitation criteria.

   Implications: The observed spatial variability in gamma readings across correlation plots may have increased the amount of prediction error in the correlation, possibly a contributing factor to limitations on use near the Ra-226 Investigation Level (see Table 4 and Figure 13).

2) Discrete samples of surface soils were taken at correlation plot and borehole transect sampling locations rather than at random locations within the survey area.

   Implications: More discrete samples were collected, likely across a wider range of values versus random locations. This deviation has no impact on data quality but should provide more data from which to evaluate prediction error in gamma-based estimates of Ra-226 in soil.

3) Phase 1 estimates of the lateral extent of impacts (ERG, 2017a) were not "refined" based on the correlation. This deviation was necessitated by a slight high bias at the low end of the correlation relationship and potential overestimation of impacts as defined at the Ra-226 Investigation Level.

   Implications: This deviation, as discussed with EPA on a bi-weekly conference call (April 18, 2018), avoids significant overestimation of areal extent of impacts, yet is conservative as the outer limits of the lateral extent of impacts are based on the upper range of background rather than on the Ra-226 investigation level (1.24 pCi/g plus background).

4) Elimination of radiological surveys and testing for structures and solid wastes (to be demolished and added to the contaminated soil waste stream).

Implications: This deviation has no impact on other project DQOs. HMC's decision not to salvage these structures/materials for potential future use, or depending on the selected action for the mines, to survey at a later time to determine suitability for offsite disposal in an appropriate commercial facility, eliminated the current need for radiological surveys as specified in the AOC/SOW (EPA, 2014).

5) Estimated maximum soil depth of mine impacts was based on downhole gamma depth profiles and analytical results for subsurface soil samples, versus use of a fixed gamma cutoff value for downhole readings based on reference readings from the background areas.

   Implications: This deviation has no effect on the quality or usability of the data but does affect the estimated depth of subsurface contamination as respective criteria were modified. The criteria for estimating maximum depth of impacts was based primarily on inflection points in downhole gamma radiation depth profiles and other radiological characteristics of these profiles (such as measurement geometry effects) as previously noted (Section 4.3.4.2). This modification is expected to improve the accuracy of estimated total depth of radiological contamination relative to the criteria specified for this parameter in the Phase 3 Work Plan (ERG, 2017d).

6) Backhoe test pits for geotechnical sampling was not performed in Phase 3 as previously noted.

   Implications: This does not represent a data gap at this stage of the AOC/SOW. Geoprobe sampling and field observations were sufficient for the geotechnical team to identify and evaluate remedial engineering options within the EE/CA, the next stage of the AOC/SOW process.

7) Borehole transect location M2-21 at the Mac No. 2 Site was inadvertently not staked out in the field and a borehole was not advanced at this planned location.

   Implications: This location was a planned biased location near a small rock pile just west of the main mine rock dump (see empty symbol for this station in Figure 17). While this location may have a maximum depth of soil impacts somewhat deeper than the majority of borehole locations at the Mac No. 2 mine Site, bedrock is relatively shallow in this and most areas of the Site and any affect of this missing data point on the calculated average depth of impacts is expected to be insignificant relative to the uncertainty in estimates of impacted soil volumes. These estimates and the underlying data collected are suitable for use in the EE/CA process for conceptual evaluation of remedial options. Likewise, this missing sampling location will not significantly affect average or median concentration values that may be used for human health and ecological risk assessments under the EE/CA.

4.4 Phase 3 Results

4.4.1 Correlation

Per the Phase 3 Work Plan, gamma/Ra-226 correlation plots were scanned/sampled at 10 locations at the Black Jack 1 Site (Figure 2) and 10 locations at the Black Jack 2 Site (Figure 3). This portion of the Phase 3 field work took place October 10-12, 2017. Locations were selected to span a representative range of gamma radiation readings (in CPM) as observed from Phase 1 gamma survey data (ERG, 2017a). As previously indicated, field adjustments were made to planned locations for some correlation plots to find areas with more uniform gamma radiation levels, though this proved difficult at these Sites in general and the target criteria to limit variability as specified in the Work Plan (ERG, 2017d) could not be achieved. This circumstance is not uncommon and does not warrant rejection of the correlation as a general characterization tool, though the uncertainty in predicted Ra-226 values based on the correlation was likely negatively impacted by this circumstance.

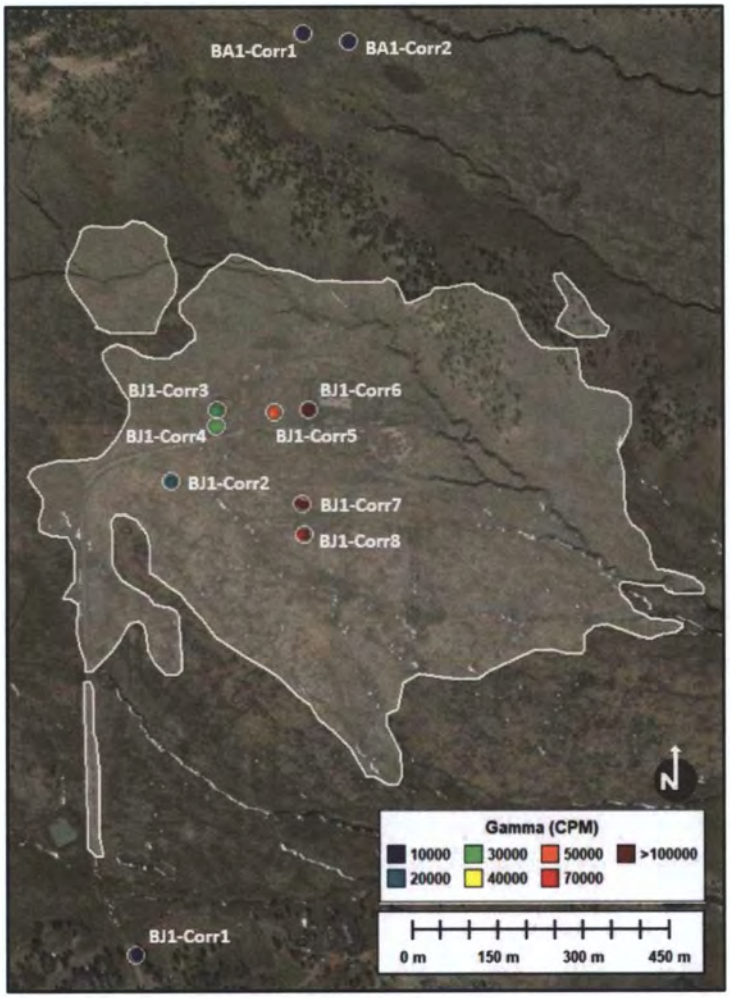


Figure 2: Correlation plot locations and gamma scan results within and near impacted (white shaded) areas at Black Jack No.

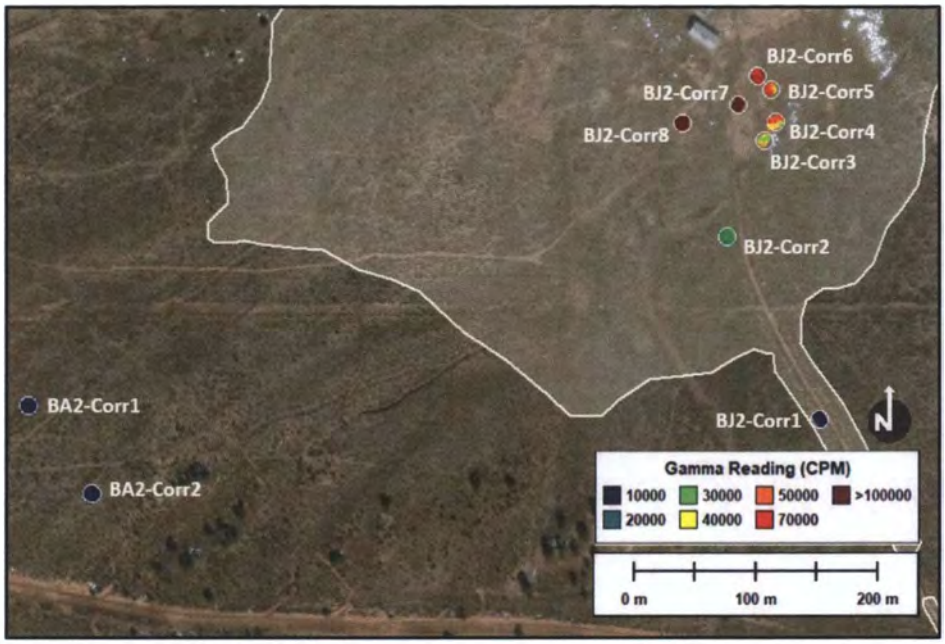


Figure 3: Correlation plot locations and gamma scan results within and near impacted (white shaded) areas at Black Jack No. 2.

At each correlation plot, the average gamma count rate reading was determined by scanning an approximate 100 m^2 area, and soil composite sampling was performed across the same area to estimate the corresponding average concentration of Ra-226 in surface soil (0-15 cm). A least-squares linear regression model was fitted to the paired gamma/Ra-226 results, along with a best-fitting non-linear power function (Figure 4). The coefficient of determination (R^2) is very similar for either regression model ($R^2 \approx 0.93$). The linear model appears to better represent higher paired gamma/Ra-226 values, while the nonlinear model appears more representative of values at the low end of the range of the relationship (in the range of Ra-226 Investigation Levels for these Sites as given in Table 4).

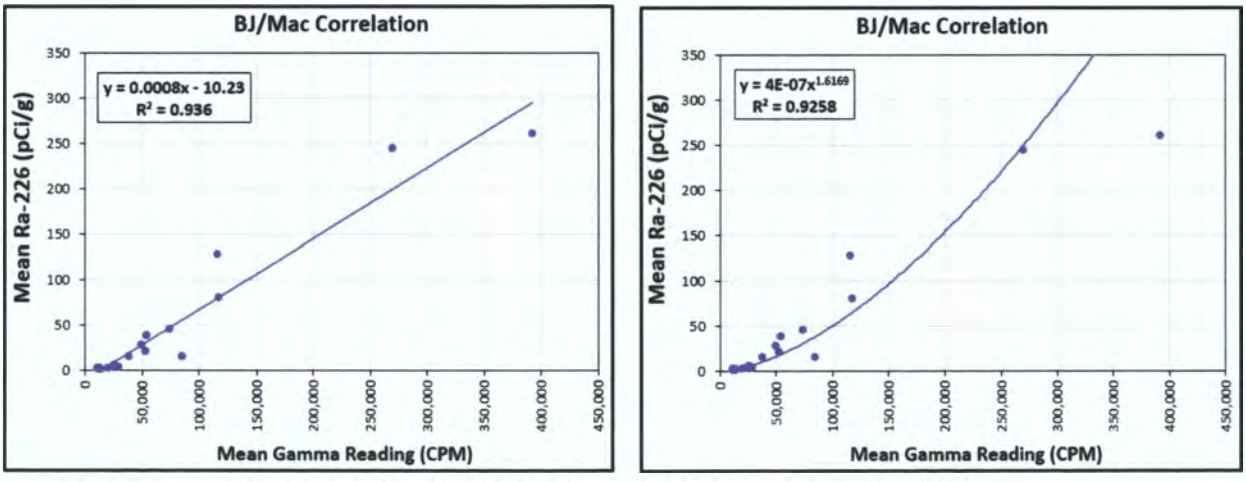


Figure 4: Regression results for a linear model (left) and best-fit nonlinear model (right).

The variance in data scatter about these regression models increases with increasing gamma radiation, and in both cases, several data points reflect relatively large residuals which appear non-representative of the overall relationship (Figure 4). Such residuals may be outliers associated with gamma shine from adjacent areas or confounding effects from small hotspots as indicated in the Phase 3 Work Plan (ERG, 2017d). The bivariate data were evaluated for statistical outliers (Figure 5) using scatter plot matrices (data density ellipses), Mahalanobis Distances, and Jackknife Distances as calculated with the JMP statistical package (SAS, 2016).

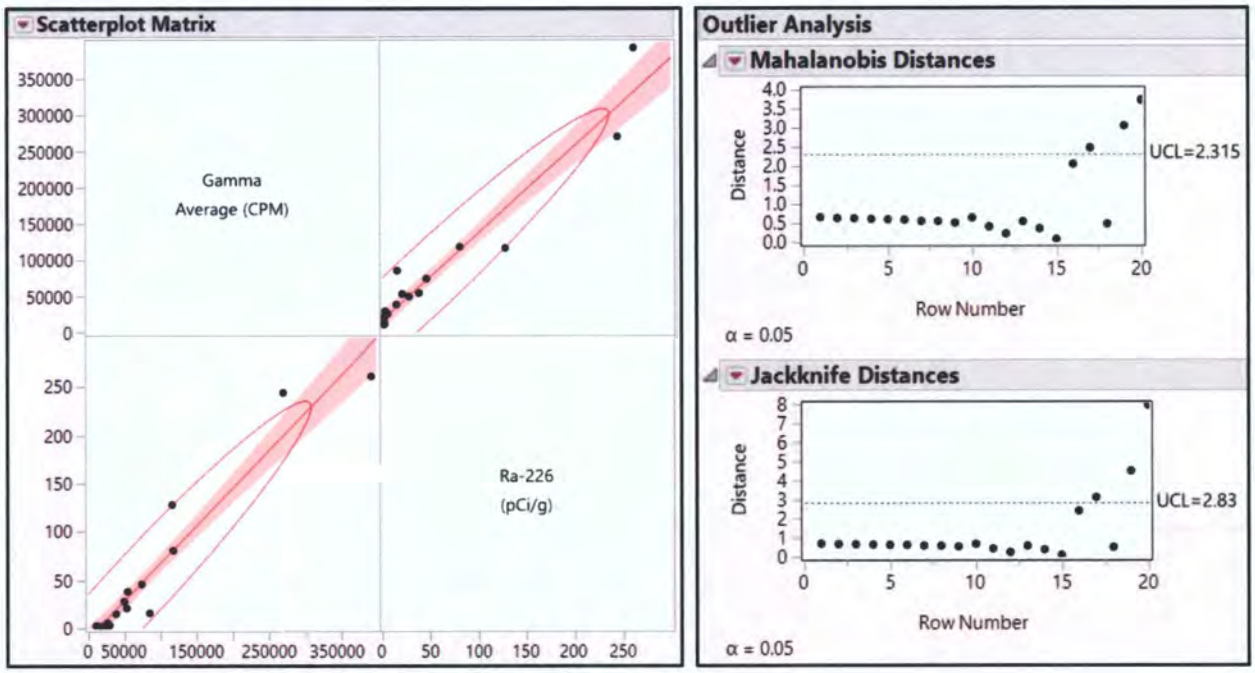


Figure 5: Outlier analysis for bivariate correlation data.

Based on the data in Figure 5, it appears that three data points are statistical outliers, and a fourth value is also distant from the general relationship. An outlier box-plot of the distribution of residuals (Figure 6) indicates that all four data points in question are statistical outliers. Because these outliers may influence the predictive model in a non-representative manner, they were excluded from the model in accordance with the specifications of the Phase 3 Work Plan (ERG, 2017d).

A non-linear power curve provides the best statistical fit to the final correlation data set (Figure 7). This regression is considered a reasonable approximation of the average relationship between gamma radiation and Ra-226 concentrations in surface soils across the four Sites. As previously mentioned and as detailed in Section 4.4.6, this relationship appears to have a high bias on average for predicting concentrations in the range of the Investigation Levels for Ra-226 (Table 4) based on gamma readings. For this reason, the original conservative estimates of areal extent (based on background gamma readings alone) were used for development of volume estimates to be used in the EE/CA process. Analytical results for average gamma readings and all soil analysis parameters for correlation plots are shown in Table 5.

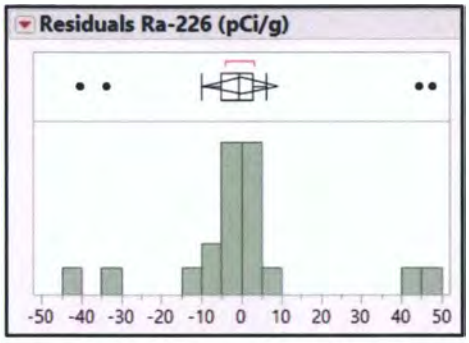


Figure 6: Histogram and outlier box-plot for residuals on the regression.

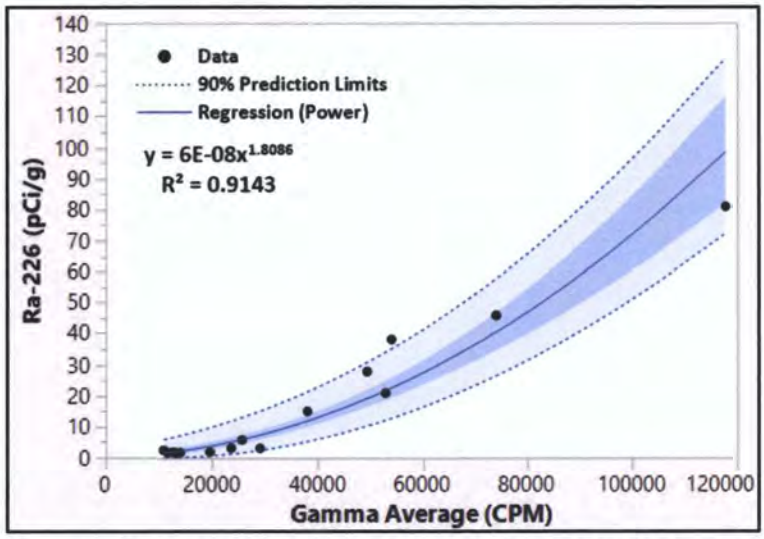


Figure 7: Final regression model for prediction of Ra-226 levels in surface soils (0-15 cm) based on gamma survey data.

Table 5: Average gamma radiation and soil analytes tested in composite samples from correlation plots (data outliers from yellow-highlighted plots were excluded from inclusion in final regression shown in Figure 7).

Field ID	Mean Gamma Reading (CPM)	Collection Date	Uranium (mg/kg)	Uranium (pCi/g)*	Ra-226 (pCi/g)	Ac-228 (pCi/g)	K-40 (pCi/g)	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Vanadium (mg/kg)
BA1-CORR1	13490	10/10/2017	1.55	1.0	1.4	1	29.3	6.3	0.5	0.5	24.7
BA1-CORR2	14160	10/10/2017	1.58	1.1	1.7	5.3	31.4	8	0.4	0.4	34.8
BA2-CORR1	11883	10/12/2017	0.81	0.5	1.7	0.4	25.1	2.8	0.3	0.2	13.7
BA2-CORR2	12903	10/12/2017	1.37	0.9	1.9	2.7	19.6	4.2	0.4	0.2	21.8
BJ1-CORR1	11020	10/10/2017	1.32	0.9	2.5	0.5	17.9	4.8	0.5	0.4	17.3
BJ1-CORR2	19729	10/10/2017	1.57	1.1	1.9	3.9	24.7	9	1.4	0.6	28.1
BJ1-CORR3	23757	10/10/2017	2.81	1.9	3.2	6.4	30.1	9.5	1.2	0.6	36.6
BJ1-CORR4	29160	10/10/2017	5.58	3.8	3.1	2.4	28.7	8.6	1.3	1	33.7
BJ1-CORR5	53074	10/10/2017	16.7	11.3	20.9	6.8	30	6.2	1.2	13.9	49.3
BJ1-CORR6	117798	10/10/2017	66.9	45.3	80.6	6.7	42.4	5.6	4.7	48.2	58.8
BJ1-CORR7	392409	10/10/2017	533	360.8	261	20.8	75.1	12	21.2	79	82.1
BJ1-CORR8	85211	10/10/2017	36.5	24.7	15.7	5.8	28	8.3	1.9	5	33.6
BJ2-CORR1	11744	10/12/2017	3.97	2.7	1.9	2.7	16.5	3.5	0.3	0.6	15.9
BJ2-CORR2	25802	10/12/2017	7.04	4.8	5.8	4.2	23.3	5.1	0.5	1.9	29
BJ2-CORR3	38231	10/12/2017	23.7	16.0	15	6.1	26.7	5.4	1	4.5	50.1
BJ2-CORR4	49572	10/12/2017	44.4	30.1	27.8	0.8	30.1	5.6	2	17.6	114
BJ2-CORR5	54219	10/12/2017	36.6	24.8	38.1	2.2	26.4	6.6	1.3	11.7	79.8
BJ2-CORR6	74084	10/12/2017	112	75.8	45.8	11.7	37.8	7	2.9	28.9	199
BJ2-CORR7	116356	10/12/2017	137	92.7	128	18	40.1	8.4	5.9	50.9	343
BJ2-CORR8	269897	10/12/2017	515	348.7	244	4.9	68.2	13.3	10.3	93	397
Mean			77.5	52.4	45.1	5.7	32.6	7.0	3.0	18.0	83.1
Std. Dev.			157.4	106.6	77.9	5.5	14.9	2.7	4.9	28.0	107.5
Median			11.9	8.0	10.4	4.6	29.0	6.5	1.3	3.2	35.7
Minimum			0.8	0.5	1.4	0.4	16.5	2.8	0.3	0.2	13.7
Maximum			533.0	360.8	261.0	20.8	75.1	13.3	21.2	93.0	397.0
n			20	20	20	20	20	20	20	20	20

*Calculated value based on conversion factor of 0.677 pCi/g per mg/kg.

4.4.2 Estimated Ra-226 Levels in Surface Soil at Black Jack No. 1 Mine

As specified in the Work Plan (ERG, 2017d), the correlation relationship was used to predict Ra-226 concentrations in surface soils (0-15 cm) based on gamma radiation readings across the Black Jack No. 1 Mine and adjacent Background Area (BA1) as shown in Figure 8. These data are based on measured count rates (CPM) and conversion to soil Ra-226 concentration (pCi/g) using the regression equation provided in Figure 7. Gamma-based predictions of Ra-226 were mapped with an interpolated color format for values falling between the discrete legend values as indicated in the legend. Summary statistics for the Black Jack No. 1 Mine are also shown in Figure 8.

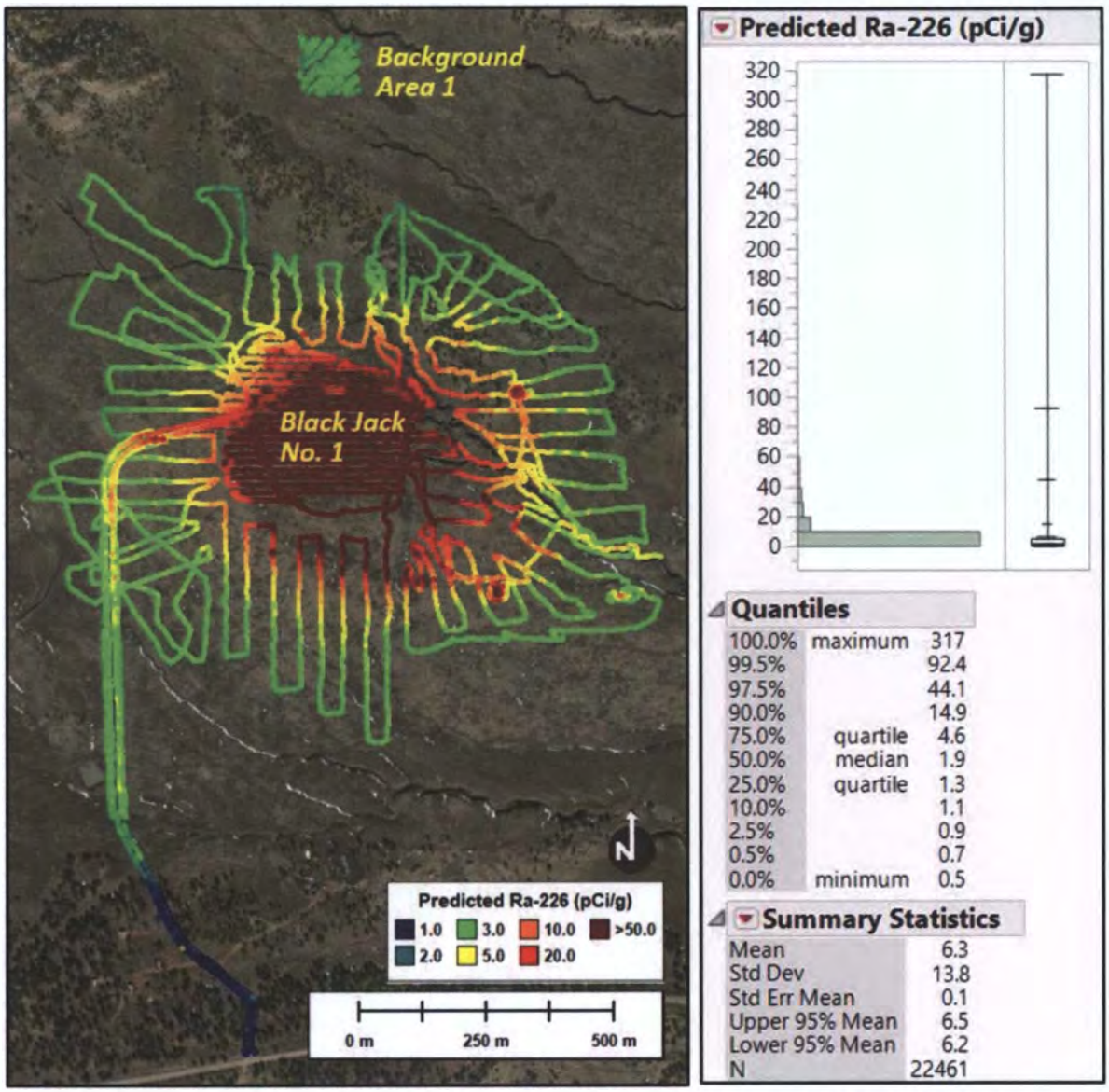


Figure 8: Gamma-based predictions of Ra-226 concentrations in surface soil (0-15 cm) at Black Jack No. 1 and Background Area 1.

4.4.3 Estimated Ra-226 Levels in Surface Soil at Black Jack No. 2 Mine

As specified in the Work Plan (ERG, 2017d), the correlation relationship was used to predict Ra-226 concentrations in surface soils (0-15 cm) based on gamma radiation readings across the Black Jack No. 2 Mine and adjacent Background Area (BA2) as shown in Figure 9. These data are based on measured count rates (CPM) and conversion to soil Ra-226 concentration (pCi/g) using the regression equation provided in Figure 7. Gamma-based predictions of Ra-226 were mapped with an interpolated color format for values falling between the discrete legend values as indicated in the legend. Summary statistics for the Black Jack No. 2 Mine are also shown in Figure 9.

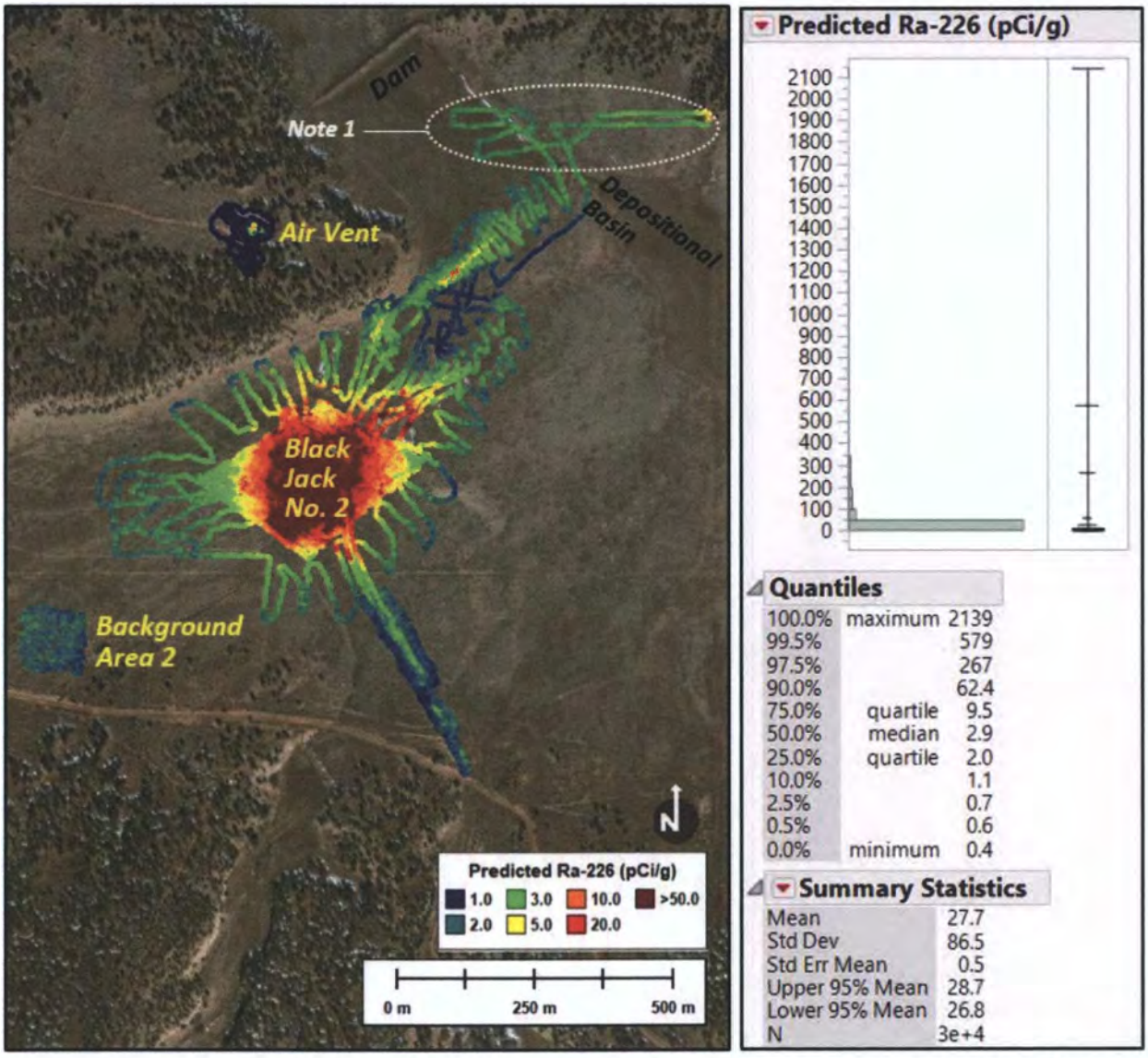
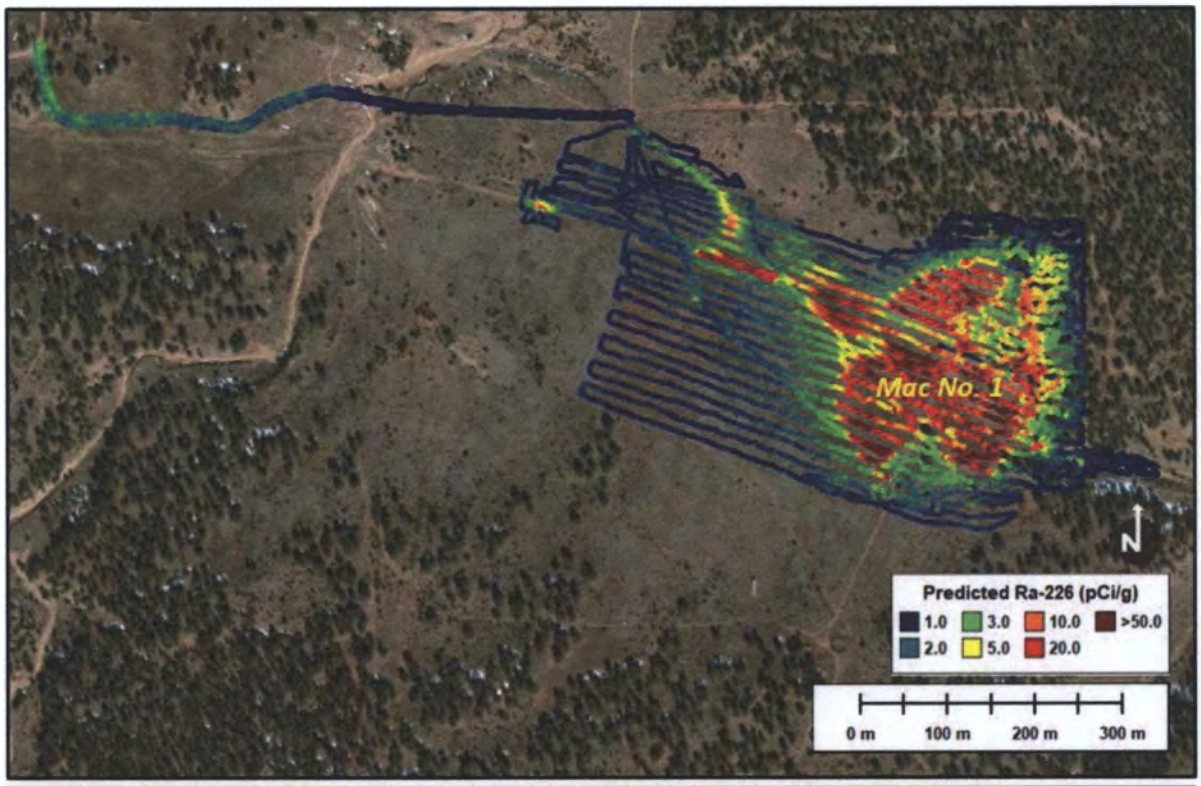


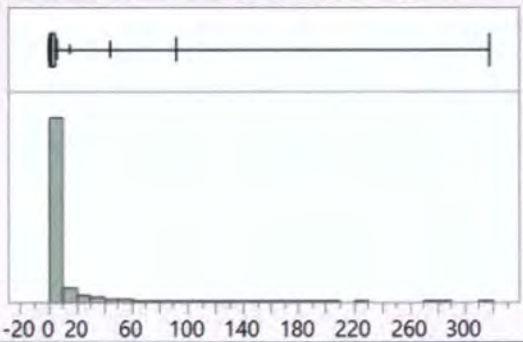
Figure 9: Gamma-based predictions of Ra-226 concentrations in surface soil (0-15 cm) at Black Jack No. 2 and Background Area 2. (Note 1: as concluded in the Phase 1 Report, this area is subject to elevated background levels of naturally occurring radionuclides in soil, sediments and/or underlying geology).

4.4.4 Estimated Ra-226 Levels in Surface Soil at Mac No. 1 Mine

As specified in the Work Plan (ERG, 2017d), the correlation relationship was used to predict Ra-226 concentrations in surface soils (0-15 cm) based on gamma radiation readings across the Mac No. 1 Mine as shown in Figure 10. These data are based on measured count rates (CPM) and conversion to soil Ra-226 concentration (pCi/g) using the regression equation provided in Figure 7. Gamma-based predictions of Ra-226 were mapped with an interpolated color format for values falling between the discrete legend values as indicated in the legend. Summary statistics for the Mac No. 1 Mine are also shown in Figure 10.



Predicted Ra-226 (pCi/g)



Quantiles

100.0%	maximum	316.9
99.5%		92.4
97.5%		44.1
90.0%		14.9
75.0%	quartile	4.6
50.0%	median	1.9
25.0%	quartile	1.3
10.0%		1.1
2.5%		0.9
0.5%		0.7
0.0%	minimum	0.5

Summary Statistics

Mean	6.3
Std Dev	13.8
Std Err Mean	0.1
Upper 95% Mean	6.5
Lower 95% Mean	6.2
N	22461

Figure 10: Gamma-based predictions of Ra-226 concentrations in surface soil (0-15 cm) at Mac No. 1.

4.4.5 Estimated Ra-226 Levels in Surface Soil at Mac No. 2 Mine

As specified in the Work Plan (ERG, 2017d), the correlation relationship was used to predict Ra-226 concentrations in surface soils (0-15 cm) based on gamma radiation readings across the Mac No. 2 Mine as shown in Figure 11. These data are based on measured count rates (CPM) and conversion to soil Ra-226 concentration (pCi/g) using the regression equation provided in Figure 7. Gamma-based predictions of Ra-226 were mapped with an interpolated color format for values falling between the discrete legend values as indicated in the legend. Summary statistics for the Mac No. 2 Mine are also shown in Figure 11.

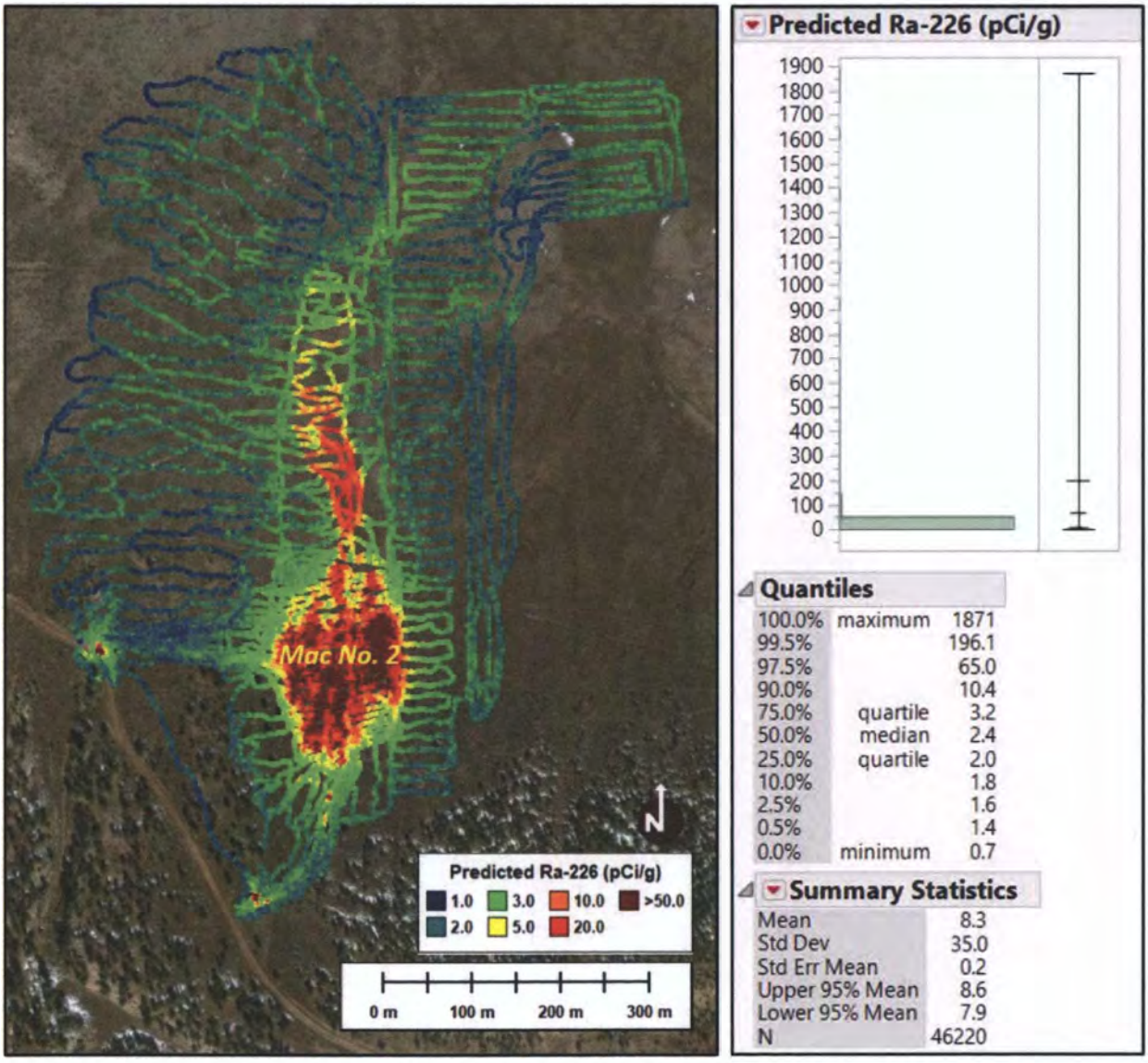
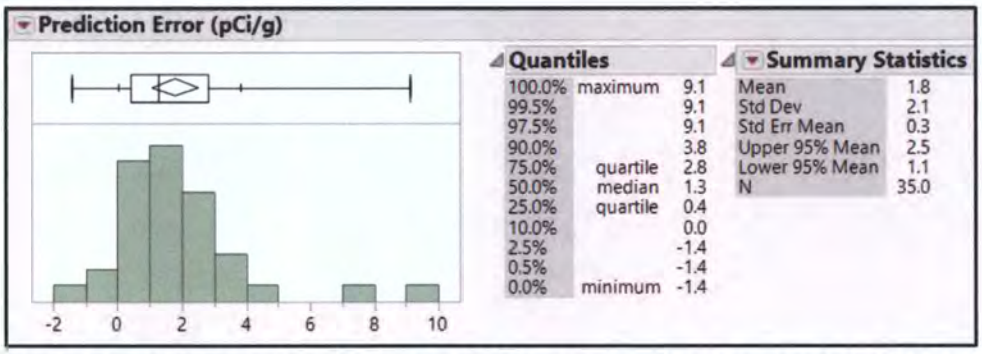


Figure 11: Gamma-based predictions of Ra-226 concentrations in surface soil (0-15 cm) at Mac No. 2.

4.4.6 Prediction Error Assessment

Per the Phase 3 Work Plan (ERG, 2017d), the uncertainty in estimates of Ra-226 in surface soil was evaluated. A total of 73 discrete samples of surface soil (0-15 cm) were collected for other purposes at the Sites, of which 64 locations had some amount of gamma survey data available within a 100 m^2 area surrounding the sample location. Twenty of these discrete samples were taken at the center of correlation plots, while the remainder (44 samples) were taken as part of borehole transect surveys (downhole gamma logging and depth profile soil sampling). The gamma survey data were converted to predicted Ra-226 values, and for each discrete soil sampling location as noted above, the predicted Ra-226 values (based on gamma survey data) within 100 m^2 were averaged for comparison with measured concentrations in soil samples. The measured Ra-226 result for each soil sample was subtracted from the corresponding average gamma-based prediction within a 100 m^2 area to provide an indication of prediction error expected with use of the gamma/Ra-226 correlation relationship.

Evaluation of prediction error as described above was limited to data from locations with relatively low Ra-226 concentrations (Figure 12) in the critical range of interest near the Investigation Level (see Table 4). In this case, only sampling locations with measured Ra-226 concentrations below 4 pCi/g were considered.[5] For these samples the average prediction error is somewhat right skewed and biased high with a mean of + 1.8 pCi/g and a median of + 1.3 pCi/g. The implications of this high bias in prediction error is spatially apparent as shown in Figure 13, which indicates that use of gamma-based predictions of Ra-226 to estimate areas exceeding the Investigation Level would lead to significant overestimation of the lateral extent of impacts to surface soil from past mining operations in most areas, a conclusion not supported by gamma data alone, or by direct soil sampling results.



Quantiles

100.0%	maximum	9.1
99.5%		9.1
97.5%		9.1
90.0%		3.8
75.0%	quartile	2.8
50.0%	median	1.3
25.0%	quartile	0.4
10.0%		0.0
2.5%		-1.4
0.5%		-1.4
0.0%	minimum	-1.4

Summary Statistics

Mean	1.8
Std Dev	2.1
Std Err Mean	0.3
Upper 95% Mean	2.5
Lower 95% Mean	1.1
N	35.0

Figure 12: Prediction error for estimated Ra-226 concentrations in surface soils (0-15 cm) near the Investigation level based on gamma survey data.

[5] Note that a single location in this category, out of 36 locations, was omitted from the analysis due to a grossly elevated average gamma-based prediction that was clearly a statistical outlier and not representative of the degree of prediction error generally present at the low end of the apparent range of soil Ra-226 values.

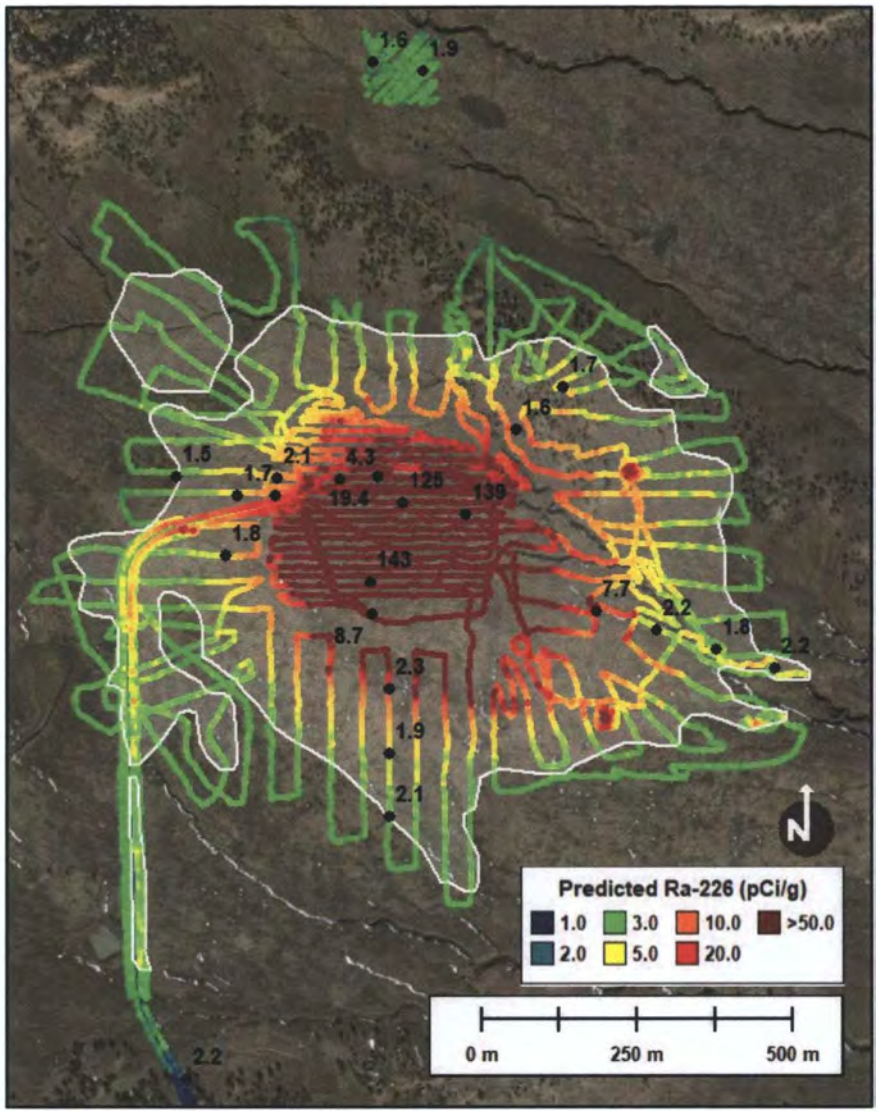


Figure 13: Gamma-survey-based predictions of Ra-226 concentrations in surface soils (0-15 cm) with overlay of annotated Ra-226 values based on direct soil sampling results along with the originally estimated lateral extent of impacts as presented in the Phase 1 Report (white-shaded area in the figure). Note that the Investigation Level for this Site is 2.6 pCi/g (see Table 4).

4.4.7 Subsurface Borehole Investigation

The objective of the subsurface borehole investigation was to estimate the average vertical extent (depth) of impacts to subsurface soils across each Site. The field work for this investigation, including downhole gamma radiation logging and confirmatory soil sampling, was performed October 3-13, 2017. This information, combined with the estimates of lateral (areal) extent of impacts from the Phase 1 Report (ERG, 2017a), was used to generate estimates of the total volume of impacted soil for future use in an EE/CA as specified in the AOC/SOW (EPA, 2014).

The following subsections of this report summarize subsurface borehole survey results for each mine Site. The data for gamma radiation depth profiles and associated confirmatory soil sampling are provided in Appendix A (Attachment A2). Section 4.4.8 provides overall estimates of contaminated soil volumes, and Section 5 provides summary conclusions for the overall RSE project under the AOC/SOW (EPA, 2014).

Downhole gamma logging profiles and subsurface soil Ra-226 values were reviewed with EPA/NNEPA during a conference call on March 2, 2018. Concurrence was reached on 13 archived samples of subsurface soil to send to the lab for supplemental confirmatory analysis, and after receipt and validation of the archived sample results, the respectively updated profile data, depth estimates, estimation rationale, and volume estimates were provided to EPA/NNEPA by email on May 7, 2018.

4.4.7.1 Vertical Extent of Impacts at Black Jack No. 1

Based on the radiological depth profile data provided in Appendix A (Attachment A2), the maximum depth of impacts to soil at each borehole sampling location at the Black Jack No. 1 Site was estimated and mapped (Figure 14). Sampling location coordinates, depth estimates and notes on the basis for estimation are provided in Table 6. Vertical impacts to soil in outlying portions of this Site are generally limited to the top 6 inches (≈ 15 cm) of the soil profile, while the deepest impacts occur in small, localized areas of principle threat wastes such as former ore stockpiles and soils in close proximity to remnant mine structures such as former shafts and vents.

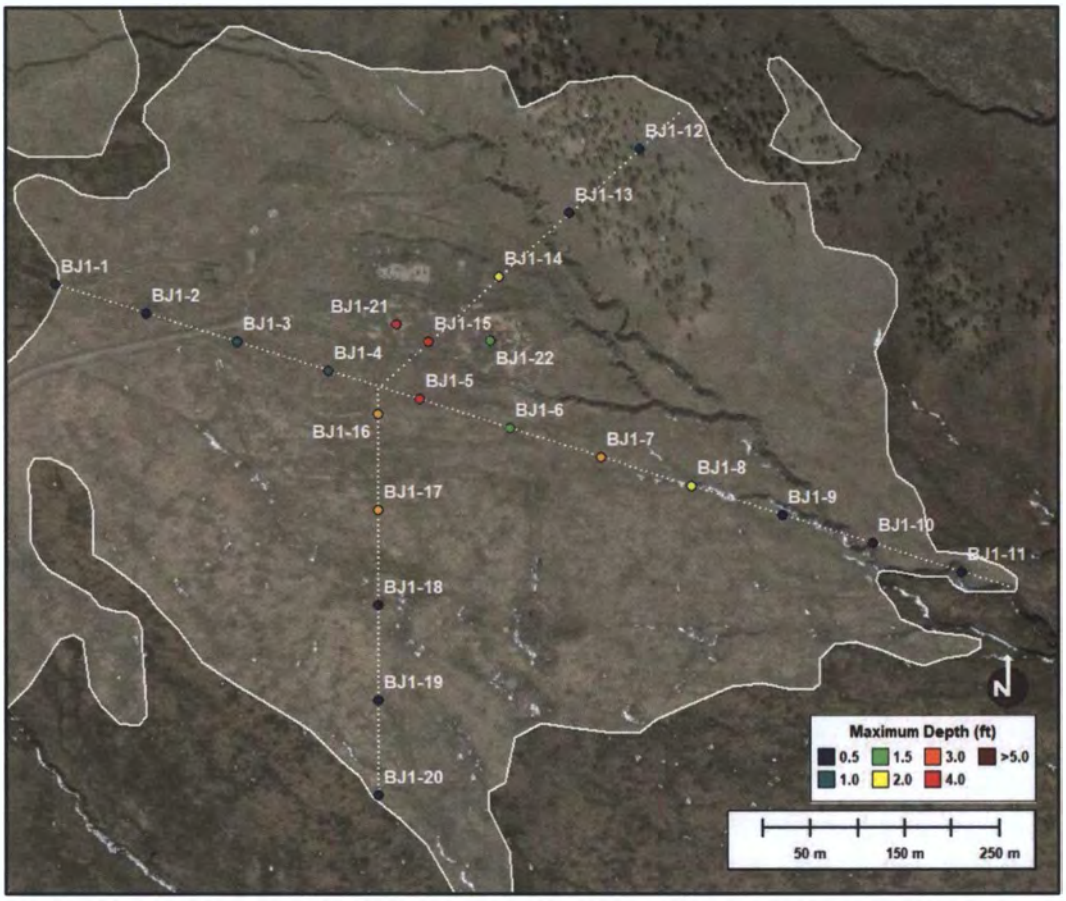


Figure 14: Borehole sampling locations and estimated maximum depth of impacts to soil at Black Jack No. 1 (see Table 6 for tabular reference data).

Table 6: Borehole ID numbers, coordinates, depth estimates and notes on estimation basis for Black Jack No. 1.

Borehole Location	Easting*	Northing*	Estimated Max Depth (feet)	Depth Estimate Basis
BJ1-1	2622299.9	1654114.0	0.0	Gamma profile looks natural (not impacted)
BJ1-2	2622612.6	1654015.0	0.0	Gamma profile looks natural (not impacted)
BJ1-3	2622925.4	1653915.9	1.5	Based on gamma inflection point + soil data
BJ1-4	2623238.2	1653816.9	1.5	Based on gamma inflection point near 30K cpm
BJ1-5	2623550.9	1653717.9	4.0	Based on gamma readings < 30K cpm
BJ1-6	2623863.7	1653618.9	1.5	Based on gamma readings < 30K cpm + soil data
BJ1-7	2624176.5	1653519.9	2.5	Based on gamma readings near 30K cpm + soil data
BJ1-8	2624489.2	1653420.9	2.0	Based on gamma readings < 30K cpm
BJ1-9	2624802.0	1653321.9	0.0	Gamma profile looks natural (not impacted)
BJ1-10	2625114.8	1653222.9	0.0	Gamma profile looks natural (not impacted)
BJ1-11	2625427.5	1653123.9	0.0	Gamma profile looks natural (not impacted)
BJ1-12	2624311.6	1654580.8	0.0	Gamma profile looks natural (not impacted)
BJ1-13	2624069.0	1654360.0	0.0	Gamma profile looks natural (not impacted)
BJ1-14	2623826.3	1654139.2	2.0	Based on gamma < 30K cpm + soil data
BJ1-15	2623583.7	1653918.4	3.5	Based on gamma near 30K cpm + soil data
BJ1-16	2623409.5	1653667.4	2.5	Based on gamma < 30K cpm + soil data
BJ1-17	2623409.5	1653339.3	2.5	Based on gamma < 30K cpm + soil data
BJ1-18	2623409.5	1653011.3	0.5	Based on gamma profile shape + soil data
BJ1-19	2623409.5	1652683.2	0.0	Gamma profile looks natural (no impacts)
BJ1-20	2623409.5	1652355.1	0.0	Gamma profile looks natural (no impacts)
BJ1-21	2623472.8	1653976.4	3.5	Based on apparent inflection point + soil data
BJ1-22	2623798.1	1653922.2	1.5	Based on inflection point + soil data

*State Plane Coordinate System: NAD 83 (ft), NM West (FIPS 3003).

Average Depth (ft) = 1.3

4.4.7.2 Vertical Extent of Impacts at Black Jack No. 2

Based on the radiological depth profile data provided in Appendix A (Attachment A2), the maximum depth of impacts to soil at each borehole sampling location at the Black Jack No. 2 Site was estimated and mapped (Figure 15). Sampling location coordinates, depth estimates and notes on the basis for estimation are provided in Table 7. Vertical impacts to soil in outlying portions of this Site are generally limited to the top 6 inches (≈ 15 cm) of the soil profile, while the deepest impacts occur in small, localized areas of principle threat wastes such as former ore stockpiles and soils in close proximity to remnant mine structures such as former shafts and vents.

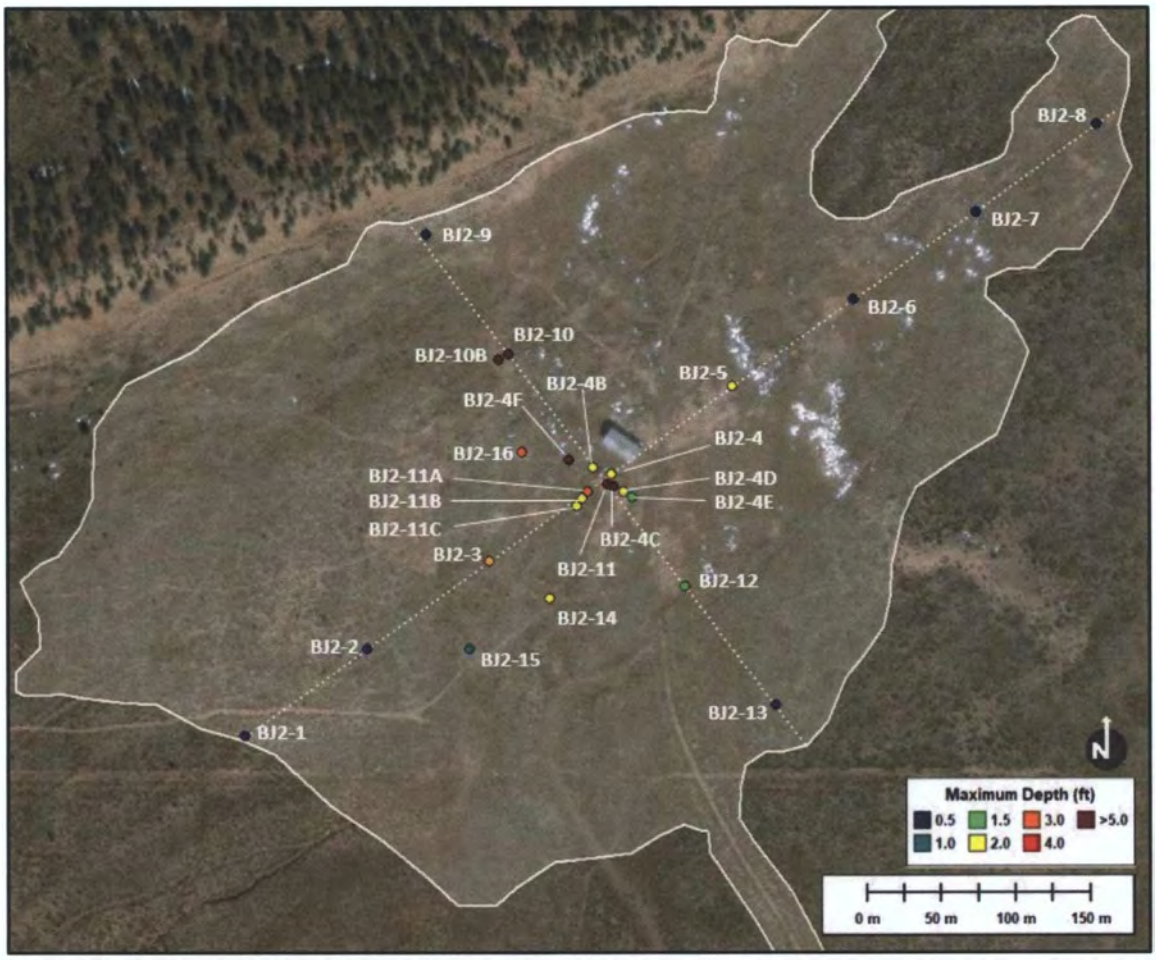


Figure 15: Borehole sampling locations and estimated maximum depth of impacts to soil at Black Jack No. 2 (see Table 7 for tabular reference data).

Table 7: Borehole ID numbers, coordinates, depth estimates and notes on estimation basis for Black Jack No. 2.

Borehole Location	Easting*	Northing*	Estimated Max Depth (feet)	Depth Estimate Basis
BJ2-1	2597127.5	1648875.9	0.0	Gamma profile looks natural
BJ2-2	2597394.6	1649066.3	0.0	Gamma profile looks natural
BJ2-3	2597661.7	1649256.7	2.5	Based on gamma profile + soil data
BJ2-4	2597928.8	1649447.2	2.0	Based on gamma profile inflection point + soil data
BJ2-4B	2597889.8	1649461.6	2.0	Based on gamma profile inflection point + soil data
BJ2-4C	2597935.8	1649420.1	7.0	Based on gamma profile inflection point (apparent)
BJ2-4D	2597956.6	1649409.4	2.0	Based on gamma profile inflection point (apparent)
BJ2-4E	2597974.6	1649396.3	1.5	Based on gamma profile inflection point
BJ2-4F	2597837.4	1649479.2	6.0	Based on gamma inflection point ≈ 30K cpm
BJ2-5	2598196.0	1649637.6	2.0	Based on gamma inflection point + soil data
BJ2-6	2598463.1	1649828.1	0.0	Gamma profile looks natural (no apparent impacts)
BJ2-7	2598730.2	1650018.5	0.0	Gamma profile looks natural (no apparent impacts)

Borehole Location	Easting*	Northing*	Estimated Max Depth (feet)	Depth Estimate Basis
BJ2-8	2598997.3	1650209.0	0.0	Gamma profile looks natural (no apparent impacts)
BJ2-9	2597524.2	1649968.7	0.0	Gamma profile looks natural (no apparent impacts)
BJ2-10	2597705.0	1649708.8	6.5	Based on gamma inflection point (< 30K cpm) + soil data
BJ2-10B	2597683.9	1649696.2	9.0	Assume bedrock at 9 ft (everything above impacted)
BJ2-11	2597920.3	1649425.7	8.0	Based on gamma inflection point near 30K cpm, + soil data
BJ2-11A	2597876.8	1649409.0	3.0	Based on gamma inflection point near 30K cpm, + soil data
BJ2-11B	2597865.1	1649393.3	2.0	Based on gamma inflection point
BJ2-11C	2597852.5	1649378.5	2.0	Based on gamma inflection point
BJ2-12	2598091.1	1649203.5	1.5	Based on gamma inflection point + soil data
BJ2-13	2598290.3	1648942.9	0.0	Gamma profile looks natural (not impacted)
BJ2-14	2597792.6	1649177.2	2.0	Gamma inflection point not clear (based on soil data)
BJ2-15	2597618.1	1649066.7	1.0	Based on gamma inflection point
BJ2-16	2597733.3	1649495.0	3.0	Based on gamma inflection point near 30K cpm

*State Plane Coordinate System: NAD 83 (ft), NM West (FIPS 3003).

Average Depth (ft) = **2.5**

4.4.7.3 Vertical Extent of Impacts at Mac No. 1

Based on the radiological depth profile data provided in Appendix A (Attachment A2), the maximum depth of impacts to soil at each borehole sampling location at the Mac No. 1 Site was estimated and mapped (Figure 16). Sampling location coordinates, depth estimates and notes on the basis for estimation are provided in Table 8. Vertical impacts to soil at this Site are generally relatively shallow (within the top 2 feet), with the deepest impacts occurring primarily in localized areas of principle threat wastes such as former ore or mine waste stockpiles. Bedrock is relatively shallow across most areas of this Site.

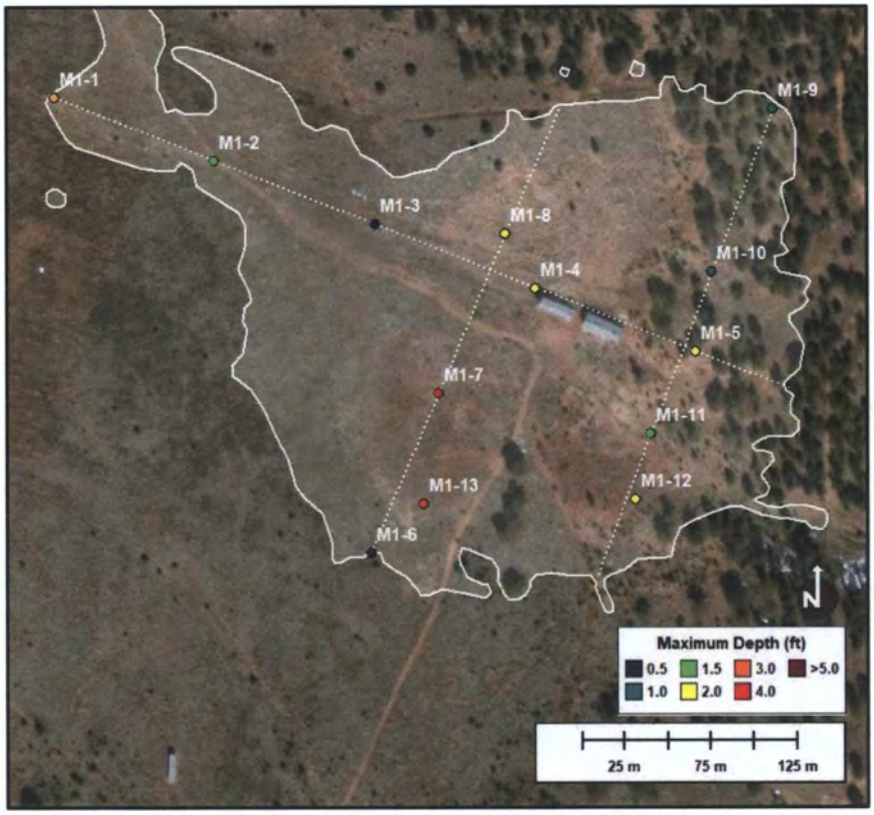


Figure 16: Borehole sampling locations and estimated maximum depth of impacts to soil at Mac No. 1 (see Table 8 for tabular reference data).

Table 8: Borehole ID numbers, coordinates, depth estimates and notes on estimation basis for Mac No. 1.

Borehole Location	Easting*	Northing*	Estimated Max Depth (feet)	Depth Estimate Basis
M1-1	2593426.9	1653762.8	2.5	Based on inflection point
M1-2	2593732.0	1653642.3	1.5	Based on inflection point
M1-3	2594037.1	1653521.8	0.5	Based on soil data more than gamma
M1-4	2594342.2	1653401.2	2.0	subsurface looks natural, but assume dig to bedrock
M1-5	2594647.4	1653280.7	2.0	Subsurface looks natural, but assume dig to bedrock
M1-6	2594028.9	1652901.1	0.0	Gamma profile looks natural
M1-7	2594157.8	1653202.7	4.0	Assumes bedrock at 4 ft.
M1-8	2594286.8	1653504.4	2.0	Based on inflection point + soil data
M1-9	2594796.1	1653739.2	1.0	Based on inflection point + soil data
M1-10	2594679.6	1653432.5	1.0	Assumes bedrock at 1 foot
M1-11	2594563.1	1653125.8	1.5	Assumes bedrock at 1.5 ft
M1-12	2594534.3	1653001.4	2.0	Assumes bedrock at 2 ft
M1-13	2594128.1	1652992.5	3.5	Assumes bedrock at 3.5 ft

*State Plane Coordinate System: NAD 83 (ft), NM West (FIPS 3003).

Average Depth (ft) = **1.8**

4.4.7.4 Vertical Extent of Impacts at Mac No. 2

Based on the radiological depth profile data provided in Appendix A (Attachment A2), the maximum depth of impacts to soil at each borehole sampling location at the Mac No. 2 Site was estimated and mapped (Figure 17). Sampling location coordinates, depth estimates and notes on the basis for estimation are provided in Table 9. Vertical impacts to soil are generally limited to the top 6 inches (≈ 15 cm) of the soil profile, with the deepest impacts occurring primarily in small, localized areas of principle threat wastes such as former ore stockpiles or remnant waste rock piles, or within small drainage channels where sediments have accumulated downgradient from mine waste deposits.

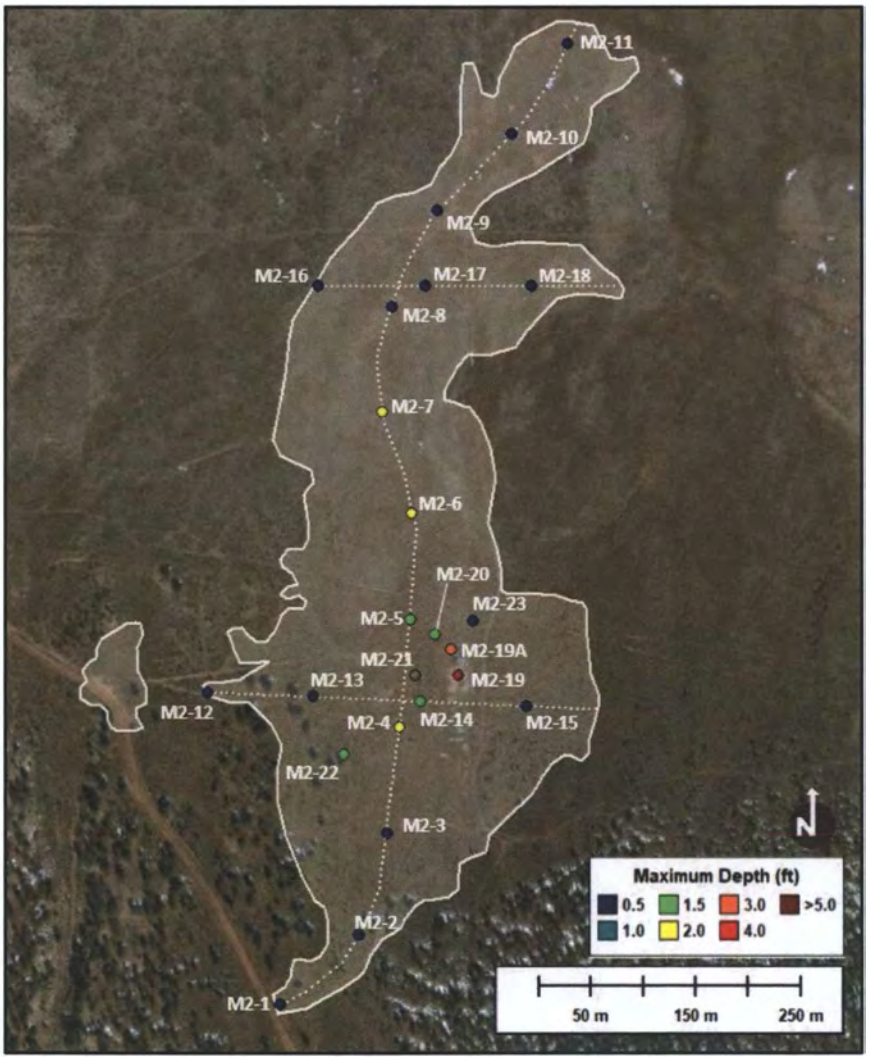


Figure 17: Borehole sampling locations and estimated maximum depth of impacts to soil at Mac No. 2 (see Table 9 for tabular reference data).

Table 9: Borehole ID numbers, coordinates, depth estimates and notes on estimation basis for Mac No. 2.

Borehole Location	Easting*	Northing*	Estimated Max Depth (feet)	Depth Estimate Basis
M2-1	2599606.3	1646417.6	0.5	Based on soil data, gamma looks natural
M2-2	2599848.5	1646629.7	0.0	Gamma profile looks natural
M2-3	2599933.9	1646942.2	0.0	Gamma profile looks natural
M2-4	2599974.5	1647267.8	2.0	Assumes refusal @ 2 ft
M2-5	2600006.8	1647594.2	1.5	No clear inflection point (based on soil data)
M2-6	2600012.9	1647920.4	2.0	Based on inflection point
M2-7	2599920.9	1648233.6	2.0	Based on profile & soil data
M2-8	2599949.6	1648553.4	0.5	G-profile looks natural, yet high soil result @ surface
M2-9	2600089.7	1648848.7	0.0	G-profile looks natural
M2-10	2600317.5	1649084.7	0.0	G-profile looks natural
M2-11	2600494.0	1649359.1	0.0	G-profile looks natural
M2-12	2599382.1	1647373.8	0.0	G-profile looks natural
M2-13	2599709.8	1647359.3	0.0	G-profile looks natural
M2-14	2600037.6	1647344.8	1.5	Assumes bedrock @ 1.5 ft
M2-15	2600365.3	1647330.4	0.0	G-profile looks natural
M2-16	2599724.4	1648619.1	0.0	G-profile looks natural
M2-17	2600052.4	1648619.1	0.0	G-profile looks natural
M2-18	2600380.5	1648619.1	0.0	G-profile looks natural, including increase near 4'
M2-19	2600154.5	1647424.5	4.5	Assumes bedrock @ 4.5 ft
M2-19A	2600132.7	1647503.3	3.0	Assumes bedrock @ 3 ft
M2-20	2600082.9	1647550.8	1.5	Based on G-profile + sample data
M2-21	2600023.1	1647424.7	-	Location inadvertently not drilled/sampled
M2-22	2599801.4	1647181.4	1.5	Gamma profile looks natural
M2-23	2600199.3	1647592.2	0.5	Based on soil data more than gamma

*State Plane Coordinate System: NAD 83 (ft), NM West (FIPS 3003).

Average Depth (ft) = **1.0**

4.4.8 Estimated Volumes of Impacted Soil

The estimated volume of radiologically impacted soil for each mine Site is shown in Table 10. These estimates are conservative as the estimated maximum depths of impacts are based on average values, even though the data distributions are right-skewed and slightly lower median values could be more representative and result in somewhat smaller volume estimates. As previously noted, additional conservatism is built into volume estimates since delineation of the areal extent of impacts to surface soil was not based on predicted Ra-226 concentrations (using the correlation) relative to the Investigation Level as originally proposed, but was instead based on raw gamma readings in excess of 95% UTLs on background gamma readings. The volume estimates given in Table 10 will be used for development of an EE/CA as specified in the AOC/SOW (EPA, 2014).

Table 10: Estimated volume of contaminated soil.

Mine Site	Areal Extent (acres)[a]	Areal Extent (ft^2)	Average Depth (ft)[b]	Volume (ft^3)	Volume (yd^3)[c]
Black Jack 1	159	6,926,040	1.3	9,003,852	**333,476**
Black Jack 2	65	2,831,400	2.5	7,078,500	**262,167**
Mac 1	22	958,320	1.8	1,724,976	**63,888**
Mac 2	42	1,829,520	0.9	1,646,568	**60,984**
				Total =	**720,515**

[a]From Phase 1 Report (ERG, 2017a)

[b]From Phase 3 Borehole Investigations (Section 4.4.7) per Work Plan (ERG, 2017d)

[c]Calculated per Phase 3 Work Plan (ERG, 2017d)

4.4.9 Geotechnical Testing Results

Geotechnical examination and testing of Geoprobe soil cores was performed as described in Section 4.3.7). The general geologic settings of the Black Jack and Mac mine Sites are in the lower part of the Mancos Formation and the upper part of the Dakota Formation, which intertongue along the ESE-WNW trending Smith Lake Syncline and the Mariano Lake Anticline. Black Jack 1 is located over the thickest amount of Mancos Shale, and the other three mine sites are in the zone where the lower Mancos and upper Dakota intertongue to create interbedded, relatively thin layers of shale and sandstone/siltstone at ground surface and the shallow subsurface. At Black Jack 2, these interbeds have been eroded to at least 10 feet depth and replaced by alluvial soils derived from the mesas to the south.

As a result of these geologic conditions:

- Black Jack 1 has shallow windblown and colluvial/alluvial deposits overlying apparently continuous Mancos shale across the entire mine Site.
- Black Jack 2 has colluvial/alluvial soil to at least 10 feet depth over the erosion surface of Mancos/ Dakota bedrock.
- Mac 1 sits on the axis of the Smith Lake Syncline where shallow sandstone controls the ground surface and is exposed in windows in the thin soil cover.
- Mac 2 is on the south limb of the Smith Lake Syncline where the ground surface exposes a succession of thin sandstone layers alternating with thin shale down the north-facing slope.

Geoprobe samples were collected below the depth of contamination at Black Jack 1 and Black Jack 2. Because of the shallow sandstone, no geotechnical samples were collected at Mac 1 and Mac 2.

Soil samples collected within the Black Jack 1 disturbed area and below the depth of contamination (3 to 5 feet) were consistently low to moderate plasticity clay (USCS classification CL) with some sandy clay. This type of soil has naturally low permeability and compacts well to form good covers.

The soils below the depth of contamination at Black Jack 2 (2 to 9 feet) are predominantly silty sand (USCS classification SP-SM) with some SP and SC (clayey sand). This soil is naturally moderately permeable, would compact to about the same permeability, and would be more erodible than a more clayey soil.

Although no soil samples from Mac 1 or Mac 2 were tested for geotechnical properties, visual examination indicates that Mac 1 soils are colluvial (derived from upgradient rock sources) and reflect the properties of the source rocks – predominantly fine sand with some clay. Mac 2 soils have relatively more sand and less clay than Mac 1 soils. The shale interbeds at both Sites are potential sources of clay, but test pit exploration is needed to characterize the locations, extents, and properties of these potential sources.

Based on this Phase 3 geotechnical characterization and the previous geomorphological characterization, the following conclusions are supported:

1. Locations of mine-related material disposal facilities – Black Jack 1, Mac 1, and Mac 2 are suitable locations for a permanent mine-related material disposal facility. Black Jack 2 is not suitable because of its position in a floodplain and relatively large up-gradient watershed.

2. Suitable subgrade soil – Black Jack 2 has relatively permeable subgrade soils, making it unsuitable for either at-grade or below-grade mine-related material disposal. Mac 1 and Mac 2 have rock at or near ground surface, making both suitable for at-grade disposal but unsuitable for below-grade disposal of mine-related material. Black Jack 1 has low-permeability soils at surface or shallow depths, providing suitable subgrade for either at-grade or below grade disposal of mine-related material.

3. Suitable cover soil – Black Jack 2 lacks suitable clean cover soil within the disturbed area. Mac 1 and Mac 2 are likely to have suitable soil sources in the shale interbeds but exploiting these sources would probably require excavation of sandstone between the shale layers. Black Jack 1 has ample quantities of readily-excavated Mancos shale with good cover-soil properties across the entire mine site. The clay-rich Mancos soil has good radon-attenuation properties and would be suitable for waste cover and void backfill but will require erosion protection where exposed to runoff.

4. Erosion control material – Both Black Jack 1 and Black Jack 2 lack durable rock sources within the disturbed area, but sandstone outcrops exist immediately adjacent to these two mine Sites. At both Mac 1 and Mac 2, sandstone outcrops provide easy access to rock that can be exploited for rock mulch within the soil cover or for riprap on the rock cover. Rock durability testing will be needed to qualify these or other rock sources for riprap application. As part of long-term erosional stability of the mine-related material containment structure, a vegetative cover will be used, but until the vegetation is established, short-term erosion protection of the soil cover will be needed. In place of, or in addition to, riprap or rock mulch, natural materials (straw, wood chips, etc.) or synthetics (e.g., plastic netting) may be used.

The volumes of cover soil and rock required for the removal action depend on the selected action. Assuming that the selected removal action is excavation and removal of all contaminated material from three mine Sites and disposal and stabilization at a fourth mine site, and a 2.0-foot-thick soil cover is placed over the combined waste pile, approximately 135,000 cubic yards of soil and up to 14,000 cubic yards of crushed rock are estimated to be needed. If the mine-related materials from the four mine Sites are moved to two or more of the four Sites, these volumes will probably increase.

4.4.10 Radiological and Chemical Soil Properties

Tabulated results of all radiological and chemical borehole soil sampling data is provided in Appendix A (Attachment A3). Investigation Levels and summary statistics for radionuclides and metals specified in the AOC/SOW (Table 11) and correlation matrices (Figure 18) reflect positive, and statistically significant, covariate relationships between these soil parameters. While most of these relationships appear strongly influenced by a few high outliers, increasing covariate trends are generally qualitatively apparent.

To evaluate whether the analytes specified in the AOC/SOW as shown above are elevated relative to background at each mine Site, all soil sampling results for each mine Site and applicable Background Area were pooled and tested for differences in average values based on parametric T-tests, and for differences in median values based on non-parametric Wilcoxon Rank Sum (WRS) tests (Table 12). The data distributions appear right-skewed for concentrations of most analytes at the mine Sites noted in Table 12, suggesting that the non-parametric test results are more appropriate. These statistical tests indicate that with the potential exceptions of arsenic at Mac 1 and selenium at Mac 2, all analytes evaluated are statistically elevated relative to background levels at each of the four mine Sites.

Table 11: Summary statistics for Phase 3 borehole samples at each mine Site.

Investigation Level*

Pathway	Uranium (mg/kg)	Uranium (pCi/g)**	Ra-226 (pCi/g)	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Vanadium (mg/kg)
Carcinogenic	-	-	1.24 + Bkg.	0.7	-	-	-
Non-Carcinogenic	16.0	10.8	-	35.0	390	390	390

*Based on AOC for Ra-226, or for other constituents, EPA Regional Screening Levels for residential soil

Black Jack No. 1

Statistic	Uranium (mg/kg)	Uranium (pCi/g)**	Ra-226 (pCi/g)	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Vanadium (mg/kg)
Mean	44.3	30.0	12.7	7.8	6.1	10.7	33.5
Std. Dev.	111.9	75.8	29.1	2.0	18.4	29.2	14.0
Median	7.1	4.8	2.2	8.1	1.4	1.0	31.4
Minimum	1.0	0.7	1.4	1.5	0.5	0.3	12.3
Maximum	650	440	139	14	105	148	89
n	57	57	57	57	57	57	57

Black Jack No. 2

Statistic	Uranium (mg/kg)	Uranium (pCi/g)**	Ra-226 (pCi/g)	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Vanadium (mg/kg)
Mean	72.7	49.2	20.8	4.7	3.1	7.9	69.7
Std. Dev.	162.1	109.7	53.9	2.3	6.4	19.6	146.4
Median	8.2	5.5	2.0	4.1	1.1	0.6	22.5
Minimum	0.5	0.3	1.1	2.1	0.2	0.1	7.0
Maximum	1110	751	376	15	39	124	978
n	74	74	74	74	74	74	74

Mac No. 1

Statistic	Uranium (mg/kg)	Uranium (pCi/g)**	Ra-226 (pCi/g)	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Vanadium (mg/kg)
Mean	166.9	113.0	59.4	4.6	3.2	5.2	158.3
Std. Dev.	359.1	243.1	148.1	3.7	5.5	8.8	363.4
Median	41.4	28.0	6.8	3.1	1.2	2.0	41.8
Minimum	1.0	0.7	1.2	1.6	0.3	0.1	6.1
Maximum	1590	1076	638	17	29	45	1560
n	37	37	36	37	37	37	37

Mac No. 2

Statistic	Uranium (mg/kg)	Uranium (pCi/g)**	Ra-226 (pCi/g)	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Vanadium (mg/kg)
Mean	27.9	18.9	17.8	6.4	1.2	2.1	56.4
Std. Dev.	56.4	38.2	62.3	2.1	1.3	5.0	74.6
Median	3.1	2.1	2.1	6.6	0.7	0.3	27.5
Minimum	0.6	0.4	1.0	2.0	0.2	0.1	9.5
Maximum	378	256	462	14.0	6.0	33	425
n	62	62	62	62	62	62	62

**Calculated value based on conversion factor of 0.677 pCi/g per mg/kg.

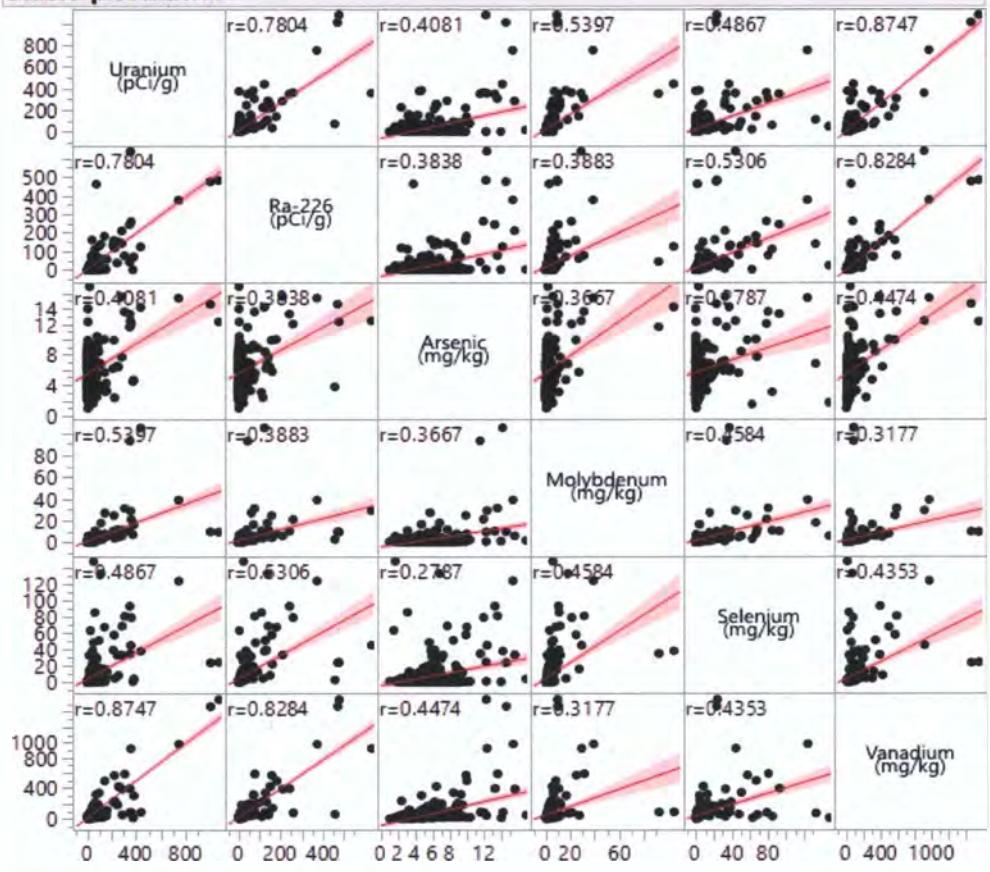
Multivariate

Correlations

	Uranium (pCi/g)	Ra-226 (pCi/g)	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Vanadium (mg/kg)
Uranium (pCi/g)	1.0000	0.7804	0.4081	0.5397	0.4867	0.8747
Ra-226 (pCi/g)	0.7804	1.0000	0.3838	0.3883	0.5306	0.8284
Arsenic (mg/kg)	0.4081	0.3838	1.0000	0.3667	0.2787	0.4474
Molybdenum (mg/kg)	0.5397	0.3883	0.3667	1.0000	0.4584	0.3177
Selenium (mg/kg)	0.4867	0.5306	0.2787	0.4584	1.0000	0.4353
Vanadium (mg/kg)	0.8747	0.8284	0.4474	0.3177	0.4353	1.0000

There are 1 missing values. The correlations are estimated by REML method.

Scatterplot Matrix



Nonparametric: Spearman's ρ

Variable	by Variable	Spearman ρ	Prob>|ρ|
Ra-226 (pCi/g)	Uranium (pCi/g)	0.8349	<.0001*
Arsenic (mg/kg)	Uranium (pCi/g)	0.2612	<.0001*
Arsenic (mg/kg)	Ra-226 (pCi/g)	0.3262	<.0001*
Molybdenum (mg/kg)	Uranium (pCi/g)	0.8628	<.0001*
Molybdenum (mg/kg)	Ra-226 (pCi/g)	0.7839	<.0001*
Molybdenum (mg/kg)	Arsenic (mg/kg)	0.4163	<.0001*
Selenium (mg/kg)	Uranium (pCi/g)	0.7596	<.0001*
Selenium (mg/kg)	Ra-226 (pCi/g)	0.7671	<.0001*
Selenium (mg/kg)	Arsenic (mg/kg)	0.3292	<.0001*
Selenium (mg/kg)	Molybdenum (mg/kg)	0.7148	<.0001*
Vanadium (mg/kg)	Uranium (pCi/g)	0.7023	<.0001*
Vanadium (mg/kg)	Ra-226 (pCi/g)	0.7892	<.0001*
Vanadium (mg/kg)	Arsenic (mg/kg)	0.5918	<.0001*
Vanadium (mg/kg)	Molybdenum (mg/kg)	0.7094	<.0001*
Vanadium (mg/kg)	Selenium (mg/kg)	0.6974	<.0001*

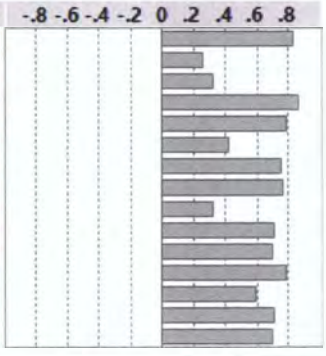


Figure 18: Bivariate correlation relationships between soil analytes specified in the AOC/SOW (EPA, 2014).

Areas Compared		P-value from Parametric T-test For Differences Between Areas*					
Mine Site	Bkg Area	Uranium	Ra-226	Arsenic	Molybdenum	Selenium	Vanadium
BJ1	BA1	0.2800	0.4861	0.0166	0.0107	0.0148	0.7656
BJ2	BA2	0.0613	0.2086	<0.0001	0.1998	0.0563	0.1312
Mac1	BA2	0.0001	0.0013	0.0353	0.2243	0.2758	0.0005
Mac2	BA2	0.4913	0.2973	<0.0001	0.6839	0.6681	0.2637
Areas Compared		**P-value from Non-Parametric WRS Test For Differences Between Areas***					
Mine Site	**Bkg Area**	**Uranium**	**Ra-226**	**Arsenic**	**Molybdenum**	**Selenium**	**Vanadium**
BJ1	BA1	<0.0001	<0.0001	<0.0001	<0.0001	0.0214	<0.0001
BJ2	BA2	<0.0001	<0.0001	0.0008	<0.0001	0.0156	<0.0001
Mac1	BA2	<0.0001	<0.0001	0.8349	<0.0001	<0.0001	<0.0001
Mac2	BA2	<0.0001	<0.0001	<0.0001	<0.0001	0.9886	<0.0001

*P-values < 0.05 (highlighted) show statistical differences inferred with 95% probability.

Table 12: Statistical testing results for differences in analyte levels relative to Background Area locations.

5. SUMMARY AND CONCLUSIONS

General

This Phase 3 RSE Report, in conjunction with the Phase 1 Summary Report (ERG and AKA, 2017) and Phase 2 Report for Physical Hazards Mitigation (iina ba, 2018), provides supporting documentation of completion of the following AOC/SOW objectives (EPA, 2014) regarding characterization of the nature and extent of actual or threatened releases of mine-related material at the Black Jack and Mac mine Sites. The AOC/SOW included three basic elements:

- SOW Section 4.1 – Phase 1: Gamma survey, geomorphologic survey and background study
- SOW Section 4.2 – Phase 2: Mitigation of physical mine hazards; posting of caution signage
- SOW Section 4.3 – Phase 3: Removal Site Evaluation (RSE)

The data for each phase of the project, collected in accordance with work plans approved by EPA/NNEPA, are complete and are of sufficient quantity and quality to meet the objectives outlined in the AOC/SOW. Interim mitigation of physical mine hazards has been completed, along with posting of caution signage. The characterization data and information presented in this and earlier project reports and data transmittals (for Phases 1-3) will be used to develop an EE/CA to support selection of an appropriate remedy for lands impacted by these former uranium mines.

Phase 1 (Gamma survey, geomorphologic survey and background study)

- Comprehensive gamma radiation surveys provided data used to delineate the areal extent of impacts to surface soil (0-15 cm) at each mine Site as follows:
  - Black Jack No. 1 = 159 acres
  - Black Jack No. 2 = 65 acres
  - Mac No. 1 = 22 acres
  - Mac No. 2 = 42 acres

These estimates, totaling 288 acres, are conservatively based on areas where terrestrial gamma radiation exceeds the 95% UTL on local background readings.

- Concentrations of radionuclides and metals in surface and subsurface soils in locally representative background areas are generally consistent with published ranges for naturally occurring background. Analytes tested included U-nat, Ra-226, arsenic, molybdenum, selenium and vanadium. Elevated gamma radiation levels northeast of the Black Jack No. 2 Site are indicative of naturally occurring, low-level uranium mineralization in underlying geologic formations.
- Ambient indoor radon in the west and east buildings at the Mac No. 1 mine were 1.1 pCi/L and 0.8 pCi/L respectively. These levels are consistent with typical outdoor background levels.
- All four mine Sites have similar geomorphic features, including: ephemeral, single thread watercourses, low- to moderate- channel sinuosity, slope grades of less than 7%, and sedimentary terrain with bedrock that dips ENE at 4 degrees or less. The results of the geomorphic study support livestock grazing as the apparent historical land use.

Phase 2 (Mitigation of physical mine hazards; posting of caution signage)

- Physical hazards identified in Phase 2 included former mine shafts, vents, utility raises, concrete slabs, exposed rebar, etc. Interim mitigation measures included cutting/removal of sharp metal objects, plugging/capping open holes with native soil or flowable fill, installation of chain link fencing and posting of hazard caution signage.
- While not required under the AOC, special monitoring of ambient outdoor radon gas (Rn-222) levels was conducted near remnant mine features that once served as vertical conduits to the underground mine workings. Respective monitoring data showed slightly elevated concentrations of ambient radon associated with mine-impacted soils, and significantly elevated levels near the north and south vent shafts and utility raises at Black Jack No. 1. Previously unsealed vent shafts and utility raises were temporarily sealed with inflatable packer plugs or quick-set epoxy cement to prevent further radon releases until permanent mitigation measures can be determined through the EE/CA process and implemented as part of the selected remedy.

Phase 3 (Removal Site Evaluation)

- A non-linear regression model (a power function) provides the best statistical fit to the gamma/Ra-226 correlation data. While the correlation provides reasonable estimates of Ra-226 concentrations in surface soils, there is a demonstrated high bias in prediction error in the regression model for concentrations near the Ra-226 Investigation Level (1.24 pCi/g above background). This bias is sufficient to significantly overpredict the areal extent of soil impacts when defined at the Ra-226 Investigation Level. As a result, estimates of the areal (lateral) extent of impacts from the Phase 1 Summary Report (ERG, 2017a), defined at the 95% UTL on background gamma readings, were carried forward for use in calculating estimates of the volume of impacted soil at each mine Site.

- Based on borehole gamma radiation logging and subsurface sampling, the majority of vertical impacts to soil across all of these mine Sites are relatively shallow in outlying areas (e.g. within the top 15 cm of the soil profile), whereas the deepest impacts tend to occur in isolated locations associated with principle threat wastes (e.g. near former ore stockpiles, shafts and vents). Estimates of the depth of impacts were conservatively based on average values for use in calculating the volume of impacted soil at each mine Site.
- The total estimated volume of impacted soil among all four mine Sites is 710,943 yd^3, about 45% of which resides at Black Jack No. 1 and 37% resides at Black Jack No. 2. The remainder (about 18%) is split nearly evenly between the Mac No. 1 and Mac No. 2 mine Sites.
- Based on Phase 3 geotechnical examination and testing of subsurface soil along with the Phase 1 geomorphic investigation results, Black Jack 1, Mac 1, and Mac 2 are suitable locations for a permanent mine-related material disposal facility. Black Jack 2 is not suitable because of its position in a floodplain and relatively large up-gradient watershed. Black Jack 1 has low-permeability soils at surface or shallow depths, providing suitable subgrade for either at-grade or below grade disposal of mine-related material, and also has ample quantities of readily-excavated Mancos shale with good cover-soil properties across the entire mine site. The clay-rich Mancos soil has good radon attenuation properties and would be suitable for waste cover and void backfill but will require erosion protection where exposed to runoff. Both Black Jack 1 and Black Jack 2 lack durable rock sources within the disturbed area, but sandstone outcrops exist immediately adjacent to these two mine Sites.
- In general, the data and statistical testing supports a conclusion that all analytes specified in the AOC/SOW have elevated (above background) concentrations to some extent in soil at each of the mine Sites. A positive and statistically significant correlation exists between each soil testing parameter, though the significance of these relationships is typically driven by a few influential data points at the high end of the range of measured data.

6. QUALITY ASSURANCE

This Section describes the requirements and procedures used to ensure acceptable data quality for use in addressing Phase 3 AOC/SOW objectives. The quality assurance (QA) specifications of the Phase 3 Work Plan (ERG, 2017d) are consistent with EPA guidance on quality assurance (QA) (EPA, 1998 and 2001). This Section provides a summary of results of data QA and quality control (QC) protocols and evaluations, including validation of analytical laboratory data.

6.1 Data Quality Objectives

Data quality objectives (DQO's) are statements that define the type, quality and quantity of data needed to address the stated study objectives. DQOs were developed in the Phase 3 Work Plan (ERG, 2017d) based on EPA guidance document QA/G-4 (EPA, 2006). Table 13 shows select DQO statements and objectives as outlined in the Work Plan, followed by comments regarding the quality and adequacy of data relative to project objectives and QC specifications.

Table 13: Retrospective DQO assessment.

Step 1: Problem Statement	Step 2: Identify Study Objective	Objectives Achieved?	Step 6: Specify Performance or Acceptance Criteria	Useable Data Quality?
Existing estimates of lateral extent of mine impacts need to be refined for Phase 3 volume estimation.	Characterize lateral extent of soil Ra-226 levels relative to Ra-226 Investigation Level specified in SOW.	Partially – A statistical Gamma/Ra-226 correlation was developed based on gamma measurements, but the correlation has slight high bias at the low end of the scale sufficient to overestimate extent of impacts based on the Ra-226 Investigation Level.	Least squares regression slope coefficient should be statistically significant at the 90% confidence level.	Yes – regression slope is significant at the 90% confidence level (P-value < 0.1). However, prediction error at low end of the scale has a high bias sufficient to significantly overestimate the extent of impacts based on the Ra-226 Investigation Level.
Vertical extent of mine impacts unknown and needs to be estimated for volume calculations.	Characterize vertical extent of soil Ra-226 levels.	Yes – Downhole gamma logging and soil depth sampling completed along borehole transects across areas of known surface impacts.	At least 95% of soil samples collected below gamma-based prediction of max vertical extent should confirm that Ra-226 concentrations are ≤ the Investigation Level.	Yes – less than 5% of confirmatory samples taken below the estimated maximum depth of impacts exceeded the Investigation Level.
Ra-226 is associated with mine impacts, but other mine-related constituents have not been characterized.	Analyze soil samples for additional constituents that may be associated with mine impacts.	Yes - Soil samples taken and analyzed for U-nat, Ra-226, arsenic, molybdenum, selenium and vanadium. Additional radionuclides, not required by the AOC/SOW, included Th-232 and K-40.	Analytical data quality specifications indicated in the Phase 3 Work Plan (ERG, 2017d) observed for data validation purposes.	Yes – while a number of analytical results were qualified during data validation as estimates ("J") or undetected ("U"), none of the data were determined to be unusable for the objectives specified in the Phase 3 Work Plan.
Potential wells at Mac-1 and Black Jack 1 identified. Need to evaluate any mine impacts to groundwater.	Determine if groundwater well is present and sample/analyze for SOW parameters.	Yes – wells investigated, and no indications of groundwater identified.	N/A – data quality specifications not relevant as no samples were taken.	N/A
Suitable fill/cover soils and erosion control materials may be needed to stabilize mine related material and fill/cover physical void space hazards.	Identify and characterize suitable borrow materials to address mine-related materials and physical hazards	Yes – Suitability of materials residing below impacted soils within impacted areas successfully evaluated for fill/cover and erosion control purposes. However, additional sampling and geotechnical soil testing will be required for engineering design work once a remedial remedy is selected.	Applicable data quality specifications indicated in the references cited in Section 2.7 of the Phase 3 Work Plan will be observed for data validation purposes.	Yes – the geotechnical soil analysis data were generated in accordance with applicable specifications provided in the Work Plan.

Table 13: Retrospective DQO assessment.

Step 1: Problem Statement	Step 2: Identify Study Objective	Objectives Achieved?	Step 6: Specify Performance or Acceptance Criteria	Useable Data Quality?
Indoor concentrations of airborne radon-222 and its short-lived decay products could be present. Surfaces of mine buildings could be contaminated.	If needed, conduct additional monitoring for airborne radon. Develop preliminary data regarding the presence or absence of surface contamination.	N/A – radon monitoring completed in Phase 1. Mac 1 buildings showed radon levels < 4 pCi/L (ERG, 2017a), so no further radon measurements were necessary. N/A - surface contamination surveys eliminated from SOW by HMC decision to demolish structures and dispose of debris with impacted soil waste stream.	N/A	N/A
Mine-related solid waste materials, miscellaneous debris and old equipment may be contaminated.	Document, characterize and categorize mine related solid waste and equipment as "impacted" or "non-impacted".	N/A – Objectives rendered N/A by HMC's decision to demolish all structures and place debris in contaminated soil waste stream for final disposition.	N/A	N/A

6.2 Analytical Method Quality Objectives

Table 14 provides the laboratory data quality objectives and analytical methods for soil parameters associated with soil sampling objectives specified for the RSE under the AOC/SOW (note that Ac-228 and K-40 are not required by the AOC but were added as potential diagnostic tools related to the gamma/Ra-226 correlation). A data validation report is provided in Appendix A (Attachment A4). Analytical laboratory data reports are provided in Appendix B (Attachment B1).

Table 14: Soil sample analytical methods and QC requirements.

Parameter	Method	Detection or Reporting Limit	Minimum Sample Size	Preservation Method	Comments
Digestion	EPA Method 3050B	N/A	1-2 g	None	Strong acid digestion prep for ICP-MS analysis.
Arsenic	EPA Method 6020A	0.2 mg/kg	500 g	None	Sample size governed by radium-226 analysis
Molybdenum	EPA Method 6020A	0.1 mg/kg	500 g	None	"
Natural Uranium	EPA Method 6020A	0.01 mg/kg	500g	None	"
Radium-226	EPA 901.1M	0.2 pCi/g	500 g	None	"
Actinium-228*	EPA 901.1M	0.2 pCi/g	500 g	None	"
Potassium-40	EPA 901.1M	0.2 pCi/g	500 g	None	"
Selenium	EPA Method 6020A	0.1 mg/kg	500g	None	"
Vanadium	EPA Method 6020A	0.1 mg/kg	500 g	None	"

* The measured Ac-228 concentration will be considered equivalent that of its precursor Thorium-232 based on an assumption of secular equilibrium between the long-lived Th-232 parent (≈ 10^{10} yr half-life) and its Ac-228 progeny (≈ 6 hr half-life).

6.3 Field Procedures

Standard operating procedures (SOPs) provided in the Phase 3 Work Plan (ERG, 2017d) were followed, including the SOP titles below (Table 15) as provided in Appendix A of the Work Plan.

Table 15: Standard Operating Procedure (SOP) numbers and titles for the Phase 3 SOW.

SOP ITC.101	Calibration of a Radiological Survey Meter
SOP ITC.102.R1	Calibration of a Radiological Survey Detector
SOP ITC.201	Operational Checkout of Single-Channel Detector with Meter
SOP ITC.202	Operational Checkout of Dual-Channel Alpha/Beta Detector with Meter
SOP PWT.105	Performing a GPS-Based Gamma Radiation Survey
SOP PWT.106	Making Exposure Rate Measurements Using a High-Pressure Ionization Chamber (HPIC)
SOP PWT.108	Soil Sampling for Analytical Purposes
SOP PWT.109	Developing a Correlation
SOP 2.15	Sample Control and Documentation
SOP 4.10	Technical Quality Control
SOP 4.12	Soil Data Validation

6.4 Personnel Qualifications

All project personnel met the minimum requirements for their assignments through formal education, experience, and project-specific training as appropriate. This included training in the specific data collection, surveying, sampling, sample handling, and site safety procedures required for their respective assignments on this project. A certified health physicist (CHP) directed the field sampling and survey efforts, evaluated environmental characterization data, and developed this RSE Report in collaboration with geotechnical engineers and mine reclamation specialists.

6.5 Quality Assurance for Field Survey Data

6.5.1 Field Documentation

Multiple forms of field data sheets were maintained to document information relevant to data QA/QC:

1. Field logbook (Appendix A, Attachment A5)
2. Soil sampling sheets (Appendix A, Attachment A6)
3. Instrument function check forms (Appendix A, Attachment A7)
4. Instrument calibration certificates (Appendix A, Attachment A8)

6.5.2 Sample Handling, Chain of Custody, and Sample Shipment

A chain-of-custody (CoC) form accompanied all samples sent to the analytical laboratory. Completed CoC forms are provided with the analytical data results from the laboratory (lab data packages are provided on CD as Attachment B1 to Appendix B). Several discrepancies in sample IDs were noted by the lab during sample login, primarily mislabeled split or field duplicate sample designators. Corrections were made as noted in the case narrative for each data report.

6.5.3 Quality Control

Equipment and instruments used for radiological field surveys were inspected before use to ensure proper function. Radiation detection instruments were calibrated within a year prior to use and were subject to daily function checks and documentation on function check forms. All field instruments met applicable performance and data quality criteria specified in the Phase 3 Work Plan (ERG, 2017d). Quality control documentation for field measurements and sampling is provided in Appendix A as noted above.

6.6 Quality Assurance for Analytical Laboratory Data

Laboratory QC samples were analyzed in accordance with standard analytical method protocols, including field splits/duplicates, lab duplicates, matrix spikes, laboratory control standards and method blanks. All analytical laboratory data reports included Level IV backup information for use in the data validation process. Quality control data for each laboratory data package and were reviewed and evaluated for accuracy, precision and completeness based on data validation criteria specified in the Phase 3 Work Plan (ERG, 2017d). Data validation results are briefly summarized in Section 6.8 with reference to a complete data validation report provided in Appendix A (Attachment A4).

6.7 Data Management and Records Keeping

Data generated for the Black Jack and Mac mine Sites under Phase 3 of the AOC/SOW (EPA, 2014) is managed in accordance with the Data Management Plan provided in the Phase 3 Work Plan (ERG, 2017d). HMC has compiled in the Appendices to this RSE Report all field data sheets as noted above, along with analytical data packages and reports as needed to document and support the findings of the Phase 3 investigation. Analytical laboratory data have been imported into the project database (a MS Access database), and if possible, an attempt will be made to also import these data into the SCRIBE database format as previously requested by EPA.

6.8 Data Quality and Usability

The requirements and methods specified in the Phase 3 Work Plan (ERG, 2017d) for data review, validation, and verification were followed as described in this Section. The data QA/QC process for this project facilitated generation of consistent and defensible analytical data to address project DQOs.

6.8.1 Data Validation

All analytical laboratory data generated were reviewed and validated prior to import into the project database. A qualified and independent staff member from ERG (someone not involved with previous or subsequent work at the Black Jack and Mac mine sites) performed the validation of laboratory data in accordance with Phase 3 Work Plan specifications. The following elements of each laboratory data report were reviewed as part of the data validation/verification process:

- Method
- Holding times
- Instrument calibration
- Method blanks
- Matrix Spikes
- Laboratory control standards (LCS)
- Field splits/duplicates and laboratory duplicates
- Detection or reporting Limits
- Data completeness

The data validation report provided in Appendix A (Attachment A4) reveals a small percentage of results falling outside various QC specifications of the Work Plan (ERG, 2017d). Such results have been appropriately qualified, and their use is not considered limited in a context of the stated DQOs as the potential degree of associated data uncertainty would not significantly affect any of the estimates or conclusions developed in this RSE Report.

6.8.2 Data Verification

Data verification included a review of procedures used for field data collection, sample labeling, chain-of-custody and data assessment protocols to verify that procedural specifications of the Work Plan were followed. Deviations from specifications of the Work Plan were identified and their potential impact

relative to the DQOs was assessed [see Section 4.3.9 and Appendix A (Attachment A4)]. None of these deviations have significant implications for the estimates and conclusions drawn in this RSE Report.

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APPENDIX A

Attachment A1 (Updated Background Data)

Table A1-1: Updated analytical results and summary statistics for Background Area 1 soil samples (supersedes Table 1 from ERG, 2017a).

Background Area 1 - Surface Soil (0-15 cm)

Sample ID	Collection Date	Uranium (mg/kg)	Uranium (pCi/g)*	Ra-226 (pCi/g)	Ac-228 (pCi/g)	K-40 (pCi/g)	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Vanadium (mg/kg)
BA1-01-S-0015	4/20/2015	1.2	0.8	1.5	2.6	23.5	5.2	0.4	0.6	17.9
BA1-02-S-0015	4/20/2015	1.3	0.9	1.1	0.6	13.9	5.9	0.4	0.6	18.7
BA1-03-S-0015	4/20/2015	1.2	0.8	0.9	2	22.8	6.2	0.4	0.6	20.6
BA1-04-S-0015	4/20/2015	1.4	0.9	1.4	2.6	23.6	7.7	0.5	0.7	26.4
BA1-05-S-0015	4/20/2015	1.5	1.0	1.2	1.3	22.3	7.1	0.4	0.7	23
BA1-06-S-0015	4/20/2015	1.5	1.0	1.4	3	23.5	7	0.4	0.7	22.6
BA1-07-S-0015	4/20/2015	1.8	1.2	1.4	0.9	22.2	6.6	0.4	0.6	22
BA1-08-S-0015	4/20/2015	1.5	1.0	1.2	2.9	24.9	6.5	0.5	0.7	21.8
BA1-09-S-0015	4/20/2015	1.5	1.0	1.3	2.1	17.4	1	0.5	0.7	3.8
BA1-10-S-0015	4/20/2015	1.3	0.9	1	1.5	20.5	6.3	0.4	0.7	20.1
BA1-11-S-0015	4/20/2015	1.3	0.9	1.1	2.1	15.5	6.4	0.4	0.6	21.1
BA1-CORR1-DIS	10/10/2017	1.3	0.9	1.6	4.7	25.8	6.9	0.4	0.3	27.6
BA1-CORR2-DIS	10/10/2017	1.5	1.0	1.9	2.1	27	8.1	0.4	0.4	35.2

*Calculated value based on conversion factor of 0.677 pCi/g per mg/kg.

Mean	1.4	1.0	1.3	2.2	21.8	6.2	0.4	0.6	21.6
Std. Dev.	0.2	0.1	0.3	1.1	3.9	1.7	0.0	0.1	7.0
Median	1.4	0.9	1.3	2.1	22.8	6.5	0.4	0.6	21.8
Minimum	1.2	0.8	0.9	0.6	13.9	1.0	0.4	0.3	3.8
Maximum	1.8	1.2	1.9	4.7	27.0	8.1	0.5	0.7	35.2
n	13	13	13	13	13	13	13	13	13

Background Area 1 - Subsurface Soil (15-60 cm)

Sample ID	Collection Date	Uranium (mg/kg)	Uranium (pCi/g)*	Ra-226 (pCi/g)	Ac-228 (pCi/g)	K-40 (pCi/g)	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Vanadium (mg/kg)
BA1-01-S-1560	4/20/2015	1.3	0.9	1.1	1.6	16	6.4	0.4	0.7	19.5
BA1-02-S-1560	4/20/2015	1.3	0.9	1.8	2.9	18.9	6.5	0.4	0.7	23.1
BA1-03-S-1560	4/20/2015	1.3	0.9	1	2.5	19.6	6.1	0.4	0.7	18.4
BA1-04-S-1560	4/20/2015	1.5	1.0	1.1	1.8	21.4	6.6	0.4	0.8	22.7
BA1-05-S-1560	4/20/2015	1.5	1.0	1.1	2.8	23.7	6.9	0.4	0.8	24.2
BA1-06-S-1560	4/20/2015	1.7	1.2	1.1	1.9	22	7.1	0.5	0.7	23.6
BA1-07-S-1560	4/20/2015	1.7	1.2	1.4	1.5	19.3	6.9	0.4	0.8	22.6
BA1-08-S-1560	4/20/2015	1.2	0.8	0.8	1.9	20.9	6	0.4	0.6	18.6
BA1-09-S-1560	4/20/2015	1.5	1.0	1.5	1.6	20.7	7	0.4	0.7	21.9
BA1-10-S-1560	4/20/2015	1.3	0.9	1.2	2.8	16.7	6.5	0.5	0.8	22.8

*Calculated value based on conversion factor of 0.677 pCi/g per mg/kg.

Mean	1.4	1.0	1.2	2.1	19.9	6.6	0.4	0.7	21.7
Std. Dev.	0.2	0.1	0.3	0.6	2.3	0.4	0.0	0.1	2.1
Median	1.4	0.9	1.1	1.9	20.2	6.6	0.4	0.7	22.7
Minimum	1.2	0.8	0.8	1.5	16.0	6.0	0.4	0.6	18.4
Maximum	1.7	1.2	1.8	2.9	23.7	7.1	0.5	0.8	24.2
n	10	10	10	10	10	10	10	10	10

Table A1-2: Updated analytical results and summary statistics for Background Area 2 soil samples (supersedes Table 1 from ERG, 2017a).

Background Area 2 - Surface Soil (0-15 cm)

Sample ID	Collection Date	Uranium (mg/kg)	Uranium (pCi/g)*	Ra-226 (pCi/g)	Ac-228 (pCi/g)	K-40 (pCi/g)	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Vanadium (mg/kg)
BA2-01-S-0015	4/21/2015	0.9	0.6	1	1.6	12.8	3.3	0.3	0.4	13.4
BA2-02-S-0015	4/21/2015	1.1	0.7	0.9	2.2	16.7	3.4	0.4	0.4	14.9
BA2-03-S-0015	4/21/2015	1	0.7	1	1.8	14.2	3.1	0.3	0.4	14.3
BA2-04-S-0015	4/21/2015	0.9	0.6	0.7	1.3	18.6	2.7	0.3	0.3	14.3
BA2-05-S-0015	4/21/2015	1.1	0.7	0.8	1.3	10.7	3.3	0.3	0.3	14.6
BA2-06-S-0015	4/21/2015	0.9	0.6	1.2	1.5	17.5	3.1	0.3	0.4	15.3
BA2-07-S-0015	4/21/2015	1.1	0.7	0.8	1.4	17.2	3.3	0.4	0.4	15.3
BA2-08-S-0015	4/21/2015	1	0.7	1.2	1.3	15	3.3	0.4	0.3	15.4
BA2-09-S-0015	4/21/2015	1.1	0.7	1.1	1.4	15.9	4	0.3	0.3	16.8
BA2-10-S-0015	4/21/2015	0.5	0.3	0.8	0	12.2	2.3	0.2	0.3	9.7
BA2-11-S-0015	4/21/2015	0.6	0.4	0.8	0.9	14.4	2.2	0.2	0.3	10.1
BA2-CORR1-DIS	10/12/2017	0.8	0.5	1.2	1	21.6	2.7	0.3	0.1	13.3
BA2-CORR2-DIS	10/12/2017	1.2	0.8	1.6	3.2	25.7	4	0.4	0.2	20.2

*Calculated value based on conversion factor of 0.677 pCi/g per mg/kg.

Mean	0.9	0.6	1.0	1.5	16.3	3.1	0.3	0.3	14.4
Std. Dev.	0.2	0.1	0.2	0.7	4.0	0.5	0.1	0.1	2.7
Median	1.0	0.7	1.0	1.4	15.9	3.3	0.3	0.3	14.6
Minimum	0.5	0.3	0.7	0.0	10.7	2.2	0.2	0.1	9.7
Maximum	1.2	0.8	1.6	3.2	25.7	4.0	0.4	0.4	20.2
n	13	13	13	13	13	13	13	13	13

Background Area 2 - Subsurface Soil (15-60 cm)

Sample ID	Collection Date	Uranium (mg/kg)	Uranium (pCi/g)*	Ra-226 (pCi/g)	Ac-228 (pCi/g)	K-40 (pCi/g)	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Vanadium (mg/kg)
BA2-01-S-1560	4/21/2015	0.9	0.6	0.7	1	17.1	3.3	0.3	0.3	12.9
BA2-02-S-1560	4/21/2015	1.1	0.7	1.2	2.2	16.5	3.9	0.4	0.4	16.4
BA2-03-S-1560	4/21/2015	1.1	0.7	0.9	0	17.3	3.7	0.3	0.4	16.3
BA2-04-S-1560	4/21/2015	0.8	0.5	0.7	0	15.3	2.9	0.2	0.3	14.5
BA2-05-S-1560	4/21/2015	0.9	0.6	0.8	1.5	13.1	3.2	0.3	0.4	14.4
BA2-06-S-1560	4/21/2015	0.9	0.6	1.1	2.5	19.6	3.8	0.7	0.4	17.7
BA2-07-S-1560	4/21/2015	1.2	0.8	0.9	1.7	16.8	4.8	0.4	0.4	17.3
BA2-08-S-1560	4/21/2015	1.1	0.7	1	2.4	17.4	4.4	0.4	0.8	17.9
BA2-09-S-1560	4/21/2015	0.9	0.6	1	1.4	15.3	3.6	0.3	0.4	14.4
BA2-10-S-1560	4/21/2015	0.5	0.3	0.6	1.2	14.4	2.2	0.2	0.3	10.7

*Calculated value based on conversion factor of 0.677 pCi/g per mg/kg.

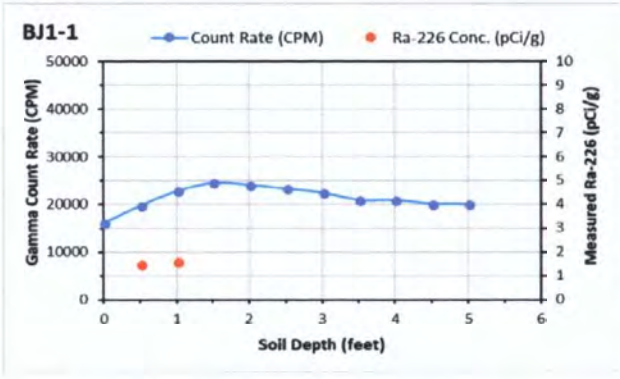
Mean	0.9	0.6	0.9	1.4	16.3	3.6	0.4	0.4	15.3
Std. Dev.	0.2	0.1	0.2	0.9	1.8	0.7	0.1	0.1	2.3
Median	0.9	0.6	0.9	1.5	16.7	3.7	0.3	0.4	15.4
Minimum	0.5	0.3	0.6	0.0	13.1	2.2	0.2	0.3	10.7
Maximum	1.2	0.8	1.2	2.5	19.6	4.8	0.7	0.8	17.9
n	10	10	10	10	10	10	10	10	10

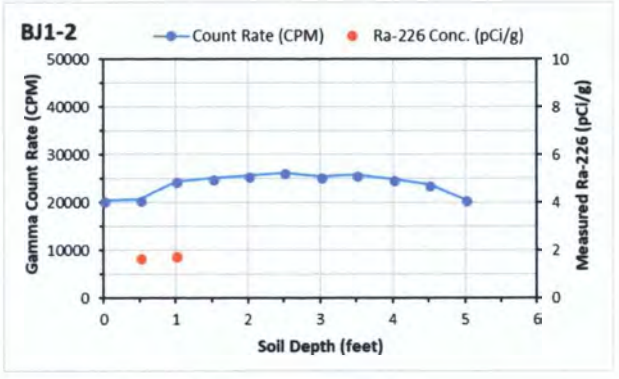
Table A1-3: Corrected analytical lab results (yellow highlighted cells) for soil samples collected in Background Area 2 (supersedes corresponding table in Attachment A1 from ERG, 2017a).

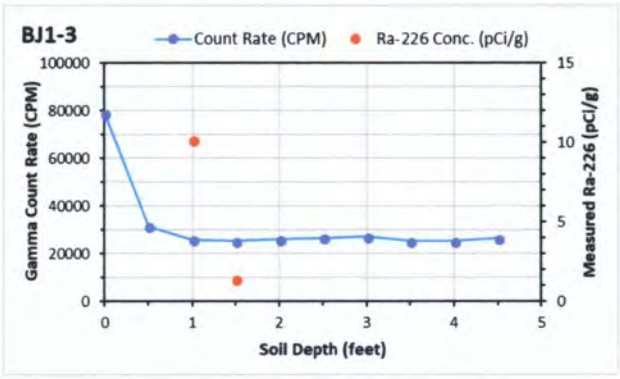
Sample ID	Location	Depth (cm)	Ra-226 (pCi/g)			Ac-228 (pCi/g)			K-40 (pCi/g)			Uranium (mg/kg)		Molybdenum (mg/kg)		Vanadium (mg/kg)		Selenium (mg/kg)		Arsenic (mg/kg)		Moisture (%)	
			Final Result	MDC	Precision (±)	Final Result	MDC	Precision (±)	Final Result	MDC	Precision (±)	Final Result	PQL	Final Result	PQL	Final Result	PQL	Final Result	PQL	Final Result	PQL	Final Result	PQL
BA2-01-S-0015-04212015	BA2-01	0-15	1	0.4	0.3	1.6	1.1	0.7	12.8	3.3	3.5	0.9	0.05	0.3	0.10	13.4	1	0.4	0.1	3.3	1	4.2	0.1
BA2-01-S-1560-04212015	BA2-01	15-60	0.7	0.6	0.4	1	1.6	0.4	17.1	1.7	3.3	0.9	0.06	0.3	0.10	12.9	1	0.3	0.1	3.3	1	6.1	0.1
BA2-02-S-0015-04212015	BA2-02	0-15	0.9	0.6	0.4	2.2	1.1	0.6	16.7	2.1	3.3	1.1	0.06	0.4	0.10	14.9	1	0.4	0.1	3.4	1	5.5	0.1
BA2-02-S-1560-04212015*	BA2-02	15-60	0.07 (~~1.2~~)	0.8 (~~0.3~~)	0.5 (~~0.2~~)	1.2 (~~2.2~~)	1.1 (~~0.3~~)	0.4 (~~0.3~~)	14.6 (~~16.5~~)	4.4 (~~1.1~~)	4.4 (~~2.3~~)	1.1	0.06	0.4	0.10	16.4	1	0.4	0.1	3.9	1	8.2	0.1
BA2-03-S-0015-04212015	BA2-03	0-15	1	0.5	0.4	1.8	0.5	0.4	14.2	1.7	3	1	0.05	0.3	0.10	14.3	1	0.4	0.1	3.1	1	3.8	0.1
BA2-03-S-1560-04212015	BA2-03	15-60	0.9	0.6	0.4	0	1.7	0.3	17.3	2.8	3.8	1.1	0.06	0.3	0.10	16.3	1	0.4	0.1	3.7	1	7.6	0.1
BA2-04-S-0015-04212015	BA2-04	0-15	0.7	0.5	0.4	1.3	1	0.4	18.6	1.7	3.4	0.9	0.06	0.3	0.10	14.3	1	0.3	0.1	2.7	1	5.8	0.1
BA2-04-S-1560-04212015	BA2-04	15-60	0.7	0.6	0.4	0	0.5	0.3	15.3	1.8	3.2	0.8	0.06	0.2	0.10	14.5	1	0.3	0.1	2.9	1	8.2	0.1
BA2-05-S-0015-04212015	BA2-05	0-15	0.8	0.6	0.4	1.3	1.1	0.6	10.7	3.8	3.9	1.1	0.06	0.3	0.10	14.6	1	0.3	0.1	3.3	1	4.9	0.1
BA2-05-S-1560-04212015	BA2-05	15-60	0.8	0.6	0.4	1.5	1.4	0.5	13.1	4.2	4.2	0.9	0.06	0.3	0.10	14.4	1	0.4	0.1	3.2	1	6.7	0.1
BA2-06-S-0015-04212015	BA2-06	0-15	1.2	0.6	0.4	1.5	1.2	0.5	17.5	1.7	3.3	0.9	0.05	0.3	0.10	15.3	1	0.4	0.1	3.1	1	4.1	0.1
BA2-06-S-1560-04212015	BA2-06	15-60	1.1	0.5	0.5	2.5	0.8	0.7	19.6	1.7	3.5	0.9	0.06	0.7	0.10	17.7	1	0.4	0.1	3.8	1	6.6	0.1
BA2-07-S-0015-04212015	BA2-07	0-15	0.8	0.6	0.4	1.4	1.3	0.6	17.2	1.6	3.2	1.1	0.05	0.4	0.10	15.3	1	0.4	0.1	3.3	1	4.1	0.1
BA2-07-S-1560-04212015	BA2-07	15-60	0.9	0.6	0.4	1.7	0.5	0.4	16.8	1.7	3.2	1.2	0.06	0.4	0.10	17.3	1	0.4	0.1	4.8	1	6.6	0.1
BA2-08-S-0015-04212015	BA2-08	0-15	1.2	0.5	0.4	1.3	1.5	0.5	15	3.5	4	1	0.06	0.4	0.10	15.4	1	0.3	0.1	3.3	1	5	0.1
BA2-08-S-1560-04212015	BA2-08	15-60	1	0.5	0.4	2.4	0.5	0.8	17.4	1.7	3.3	1.1	0.06	0.4	0.10	17.9	1	0.8	0.1	4.4	1	7.2	0.1
BA2-09-S-0015-04212015	BA2-09	0-15	1.1	0.4	0.3	1.4	0.5	0.4	15.9	1.7	3.2	1.1	0.06	0.3	0.10	16.8	1	0.3	0.1	4	1	4.6	0.1
BA2-09-S-1560-04212015	BA2-09	15-60	1	0.5	0.4	1.4	0.5	0.4	15.3	1.6	3	0.9	0.06	0.3	0.10	14.4	1	0.4	0.1	3.6	1	6.9	0.1
BA2-10-S-0015-04212015	BA2-10	0-15	0.8	0.5	0.4	0	0.5	583	12.2	4.2	4.3	0.5	0.05	0.2	0.10	9.7	1	0.3	0.1	2.3	1	3.1	0.1
BA2-10-S-1560-04212015*	BA2-10	15-60	0.4 (~~0.6~~)	0.6 (~~0.3~~)	0.3 (~~0.2~~)	0.5 (~~1.2~~)	1.2 (~~0.5~~)	0.3	17.6 (~~14.4~~)	1.7 (~~1.1~~)	3.4 (~~2.2~~)	0.5	0.06	0.2	0.10	10.7	1	0.3	0.1	2.2	1	5.3	0.1
BA2-11-S-0015-04212015	BA2-11	0-15	0.8	0.4	0.3	0.9	1	0.3	14.4	1.6	2.9	0.6	0.05	0.2	0.10	10.1	1	0.3	0.1	2.2	1	3	0.1

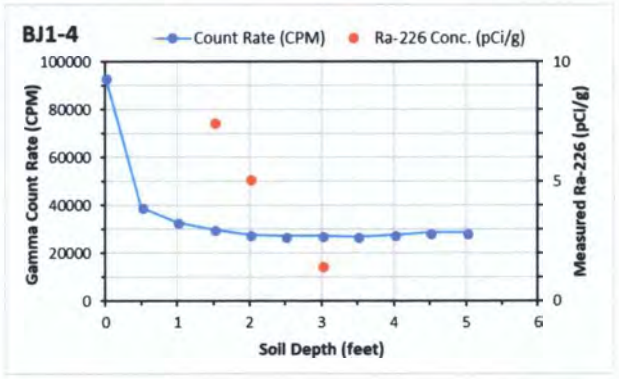
*Original data entry errors (in parentheses) corrected to match official lab results

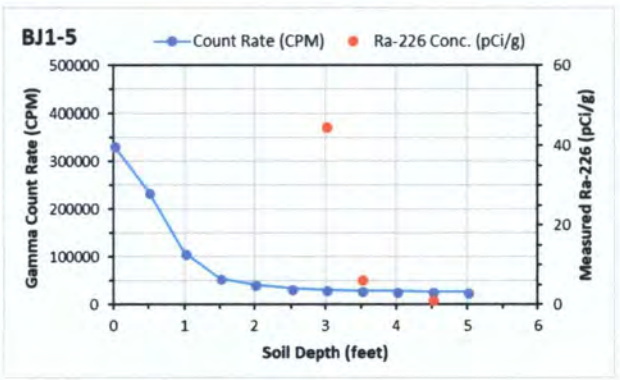
Attachment A2 (Radiological Depth Profile Data)

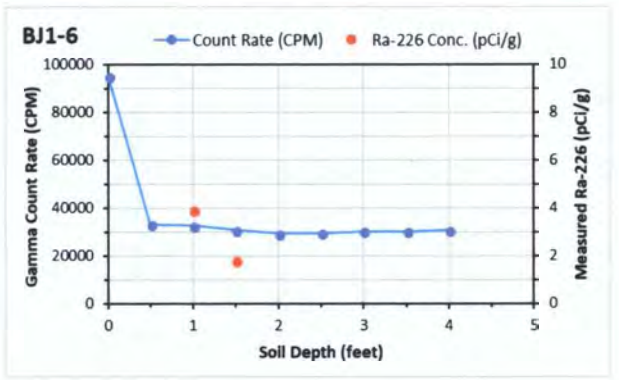

BJ1-1
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

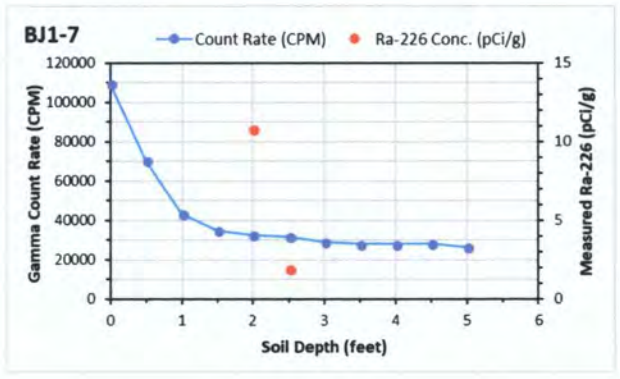

BJ1-2
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

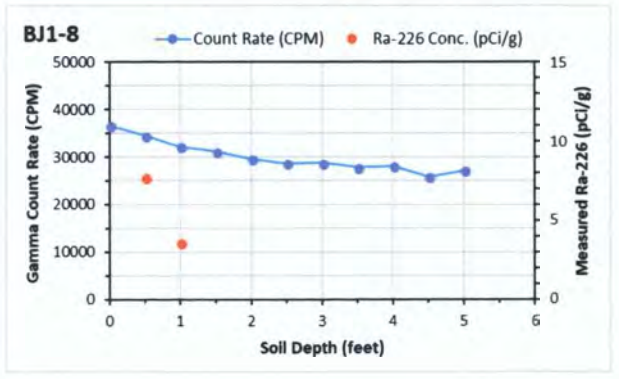

BJ1-3
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

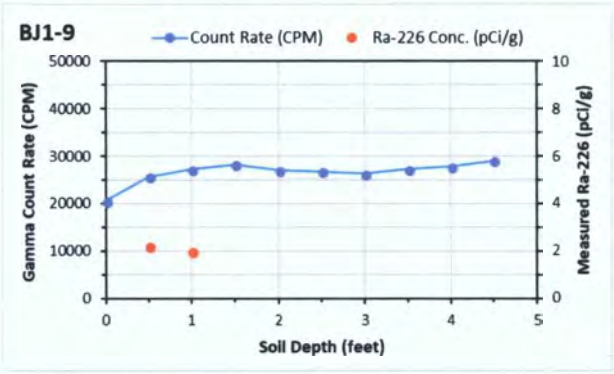

BJ1-4
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

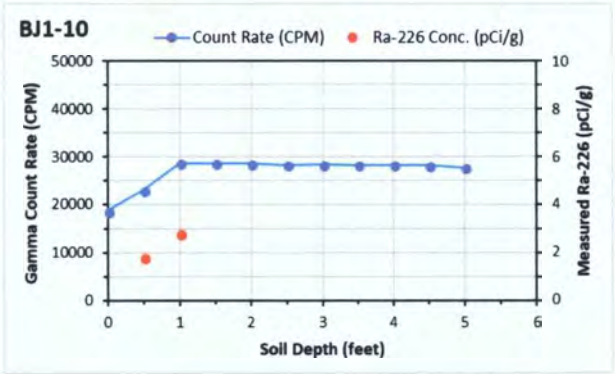

BJ1-5
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

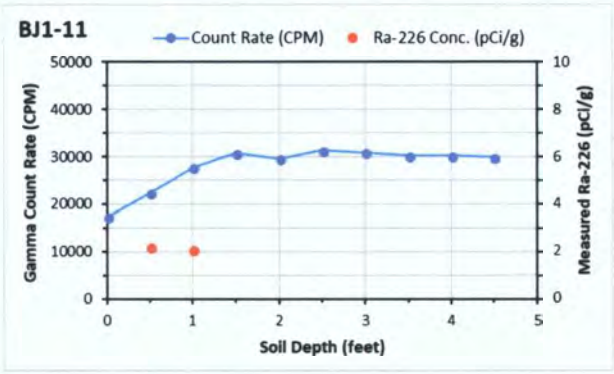

BJ1-6
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

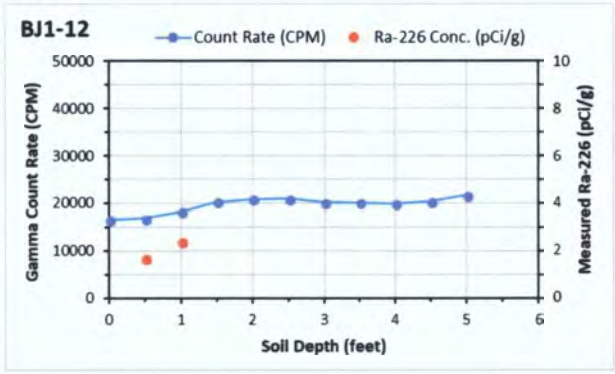

BJ1-7
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

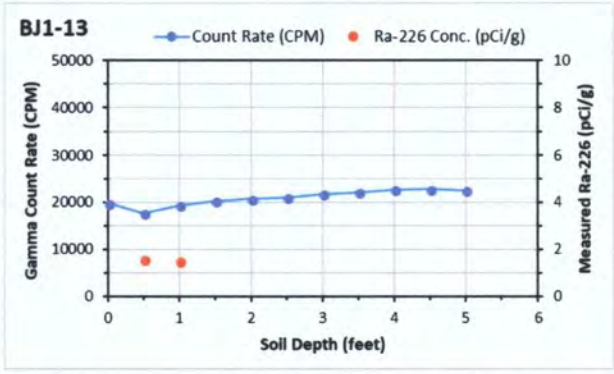

BJ1-8
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

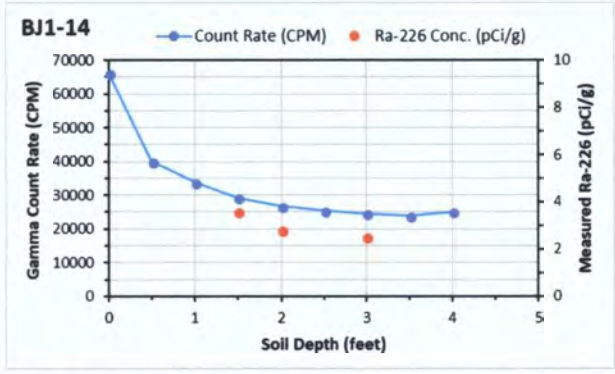

BJ1-9
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

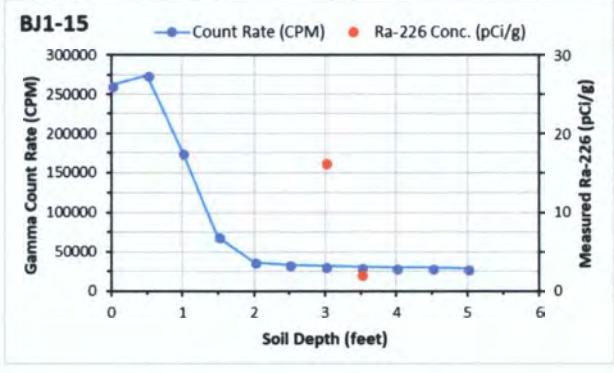

BJ1-10
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

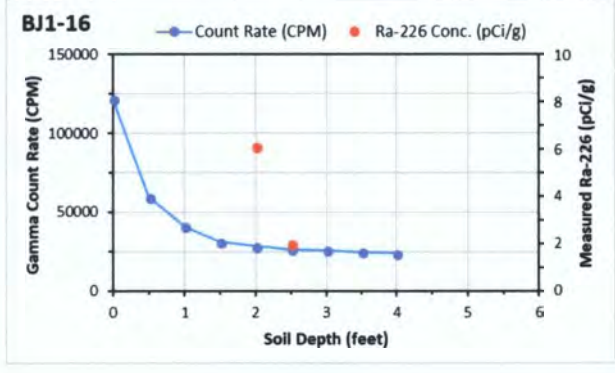

BJ1-11
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

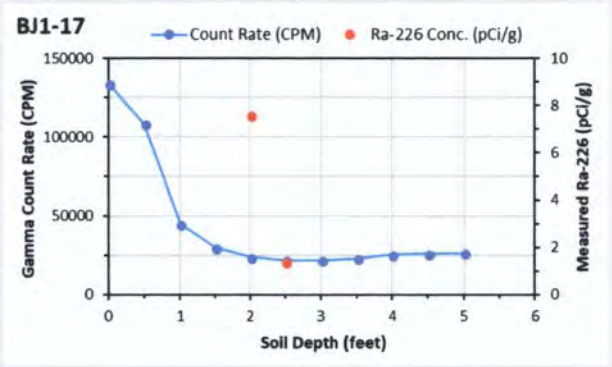

BJ1-12
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

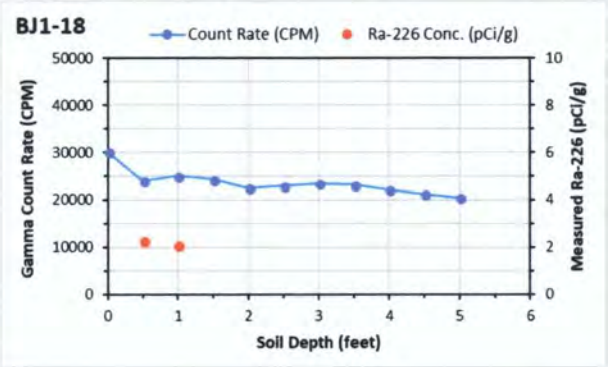

BJ1-13
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

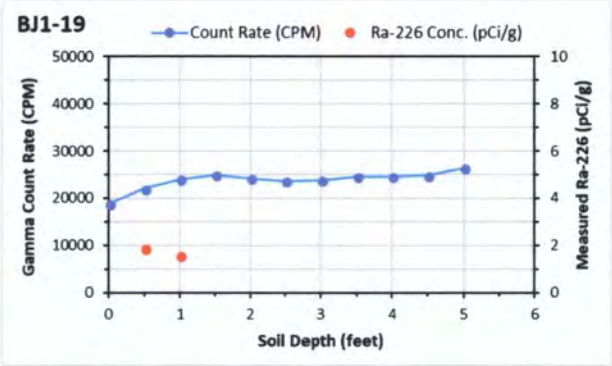

BJ1-14
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

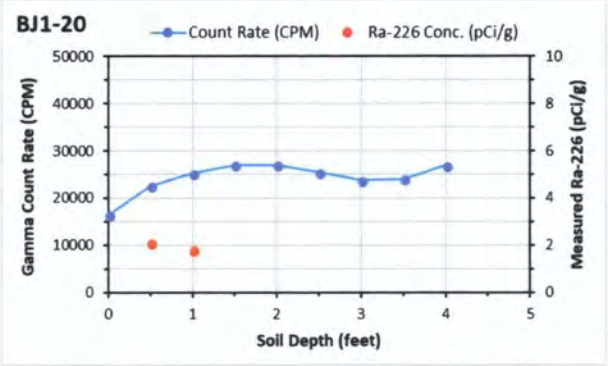

BJ1-15
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

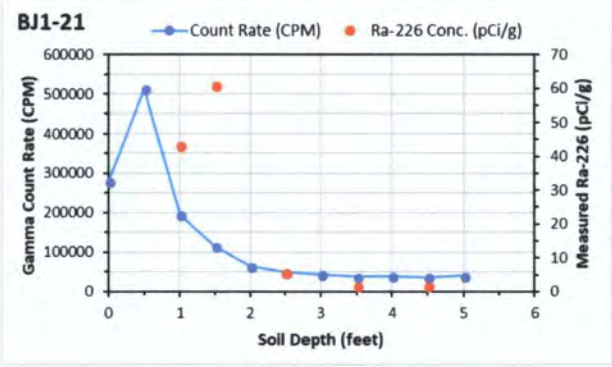

BJ1-16
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

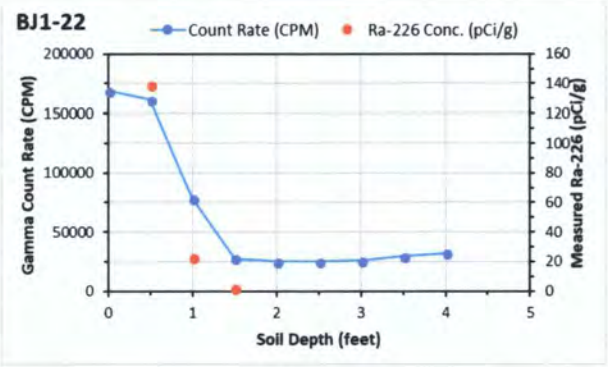

BJ1-17
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

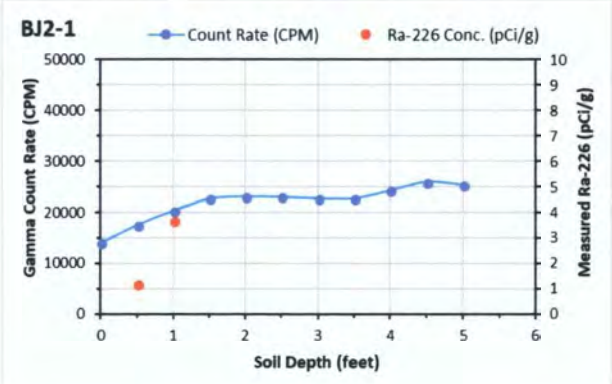

BJ1-18
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

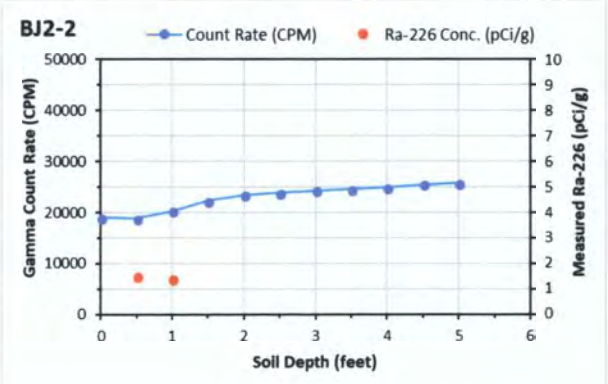

BJ1-19
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

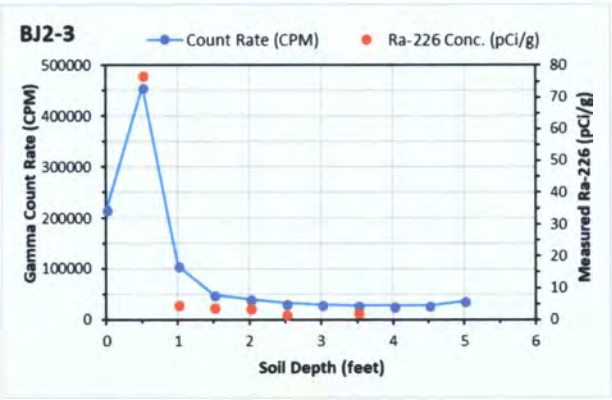

BJ1-20
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

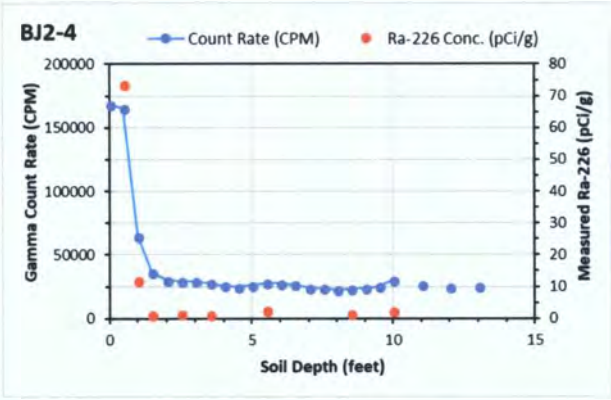

BJ1-21
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

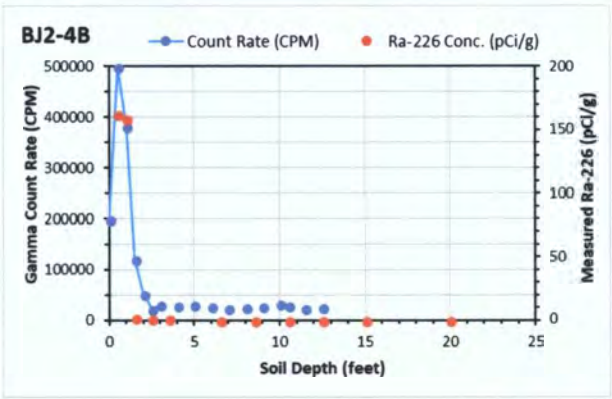

BJ1-22
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

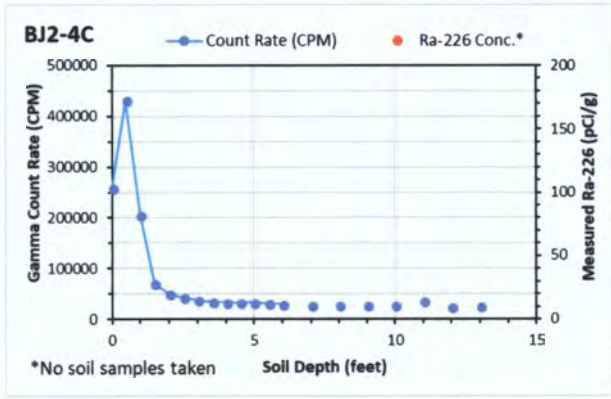

BJ2-1
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

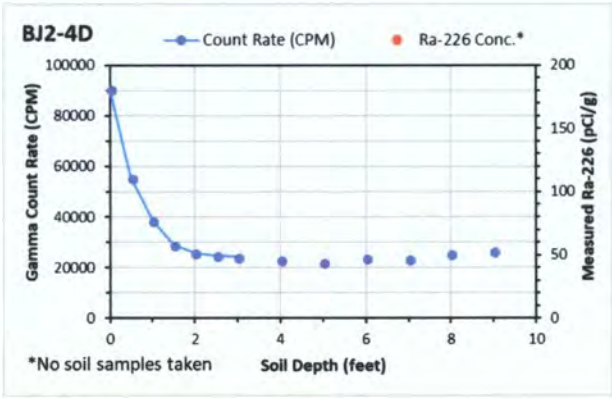

BJ2-2
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

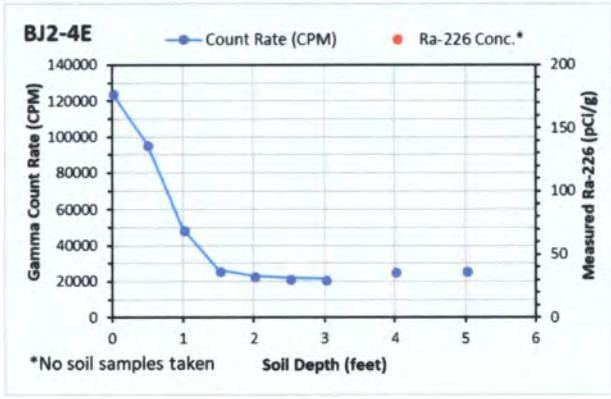

BJ2-3
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

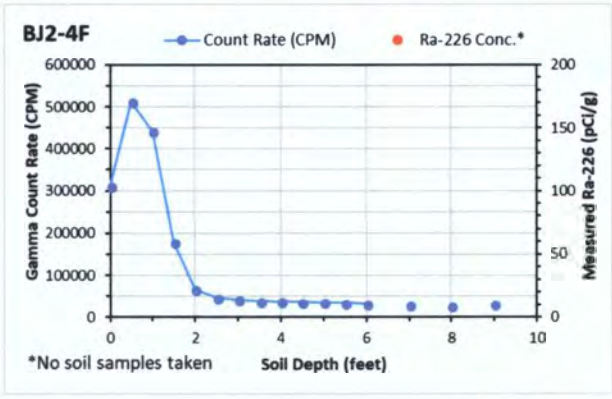

BJ2-4
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

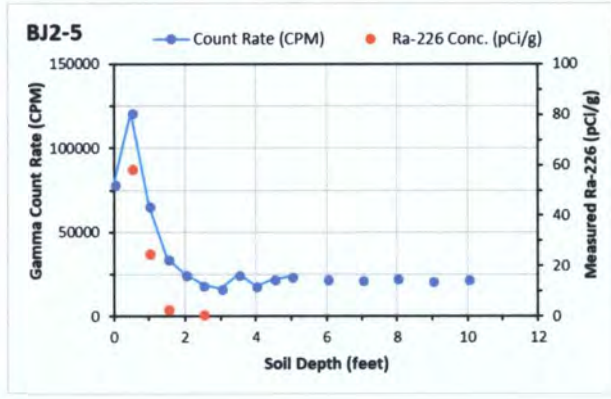

BJ2-4B
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

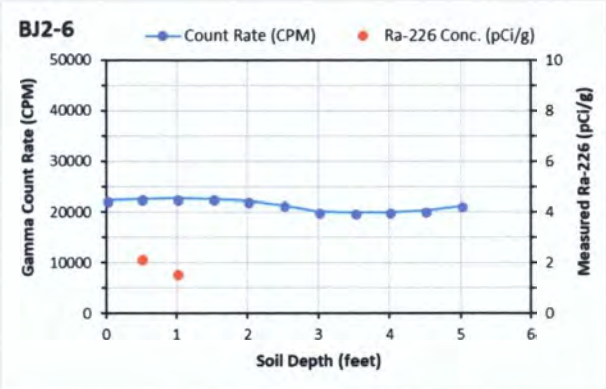

BJ2-4C
Count Rate (CPM)
Ra-226 Conc.*
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
*No soil samples taken
Soil Depth (feet)

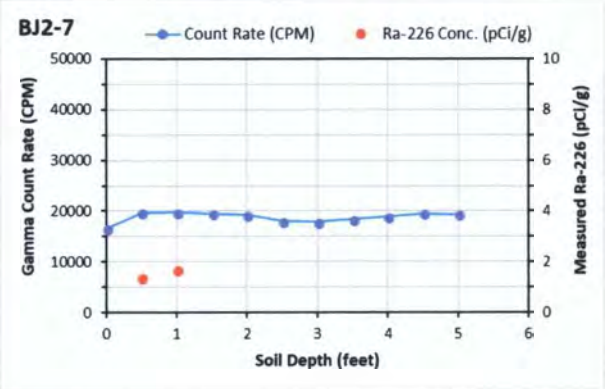

BJ2-4D
Count Rate (CPM)
Ra-226 Conc.*
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
*No soil samples taken
Soil Depth (feet)

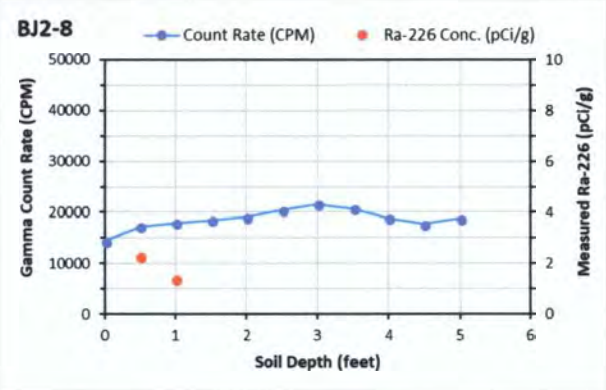

BJ2-4E
Count Rate (CPM)
Ra-226 Conc.*
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
*No soil samples taken
Soil Depth (feet)

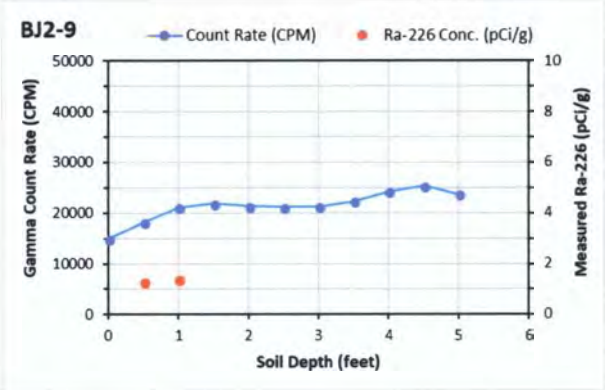

BJ2-4F
Count Rate (CPM)
Ra-226 Conc.*
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
*No soil samples taken
Soil Depth (feet)

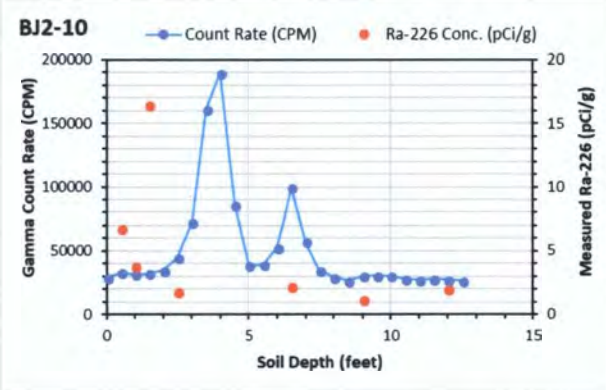

BJ2-5
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

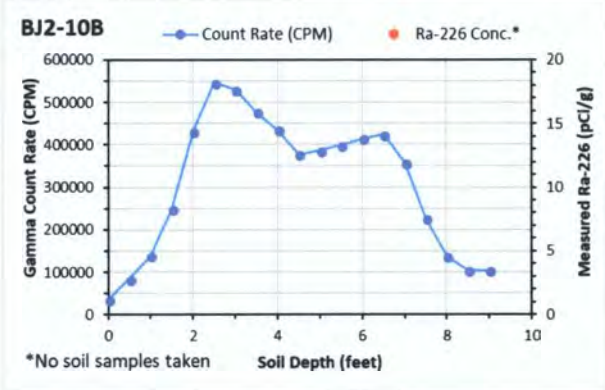

BJ2-6
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

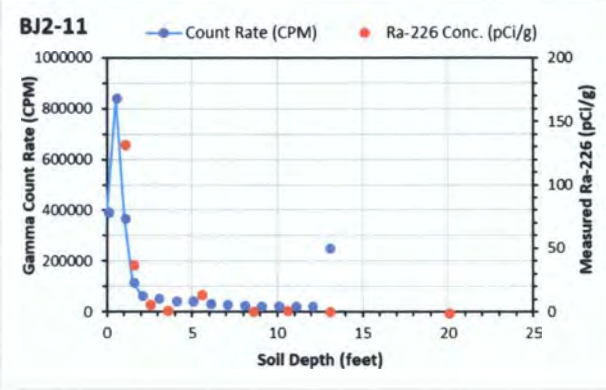

BJ2-7
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

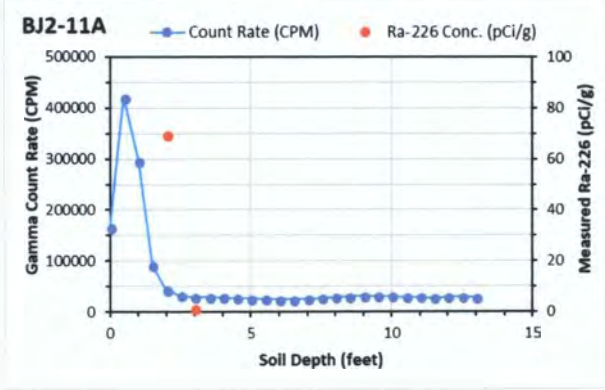

BJ2-8
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

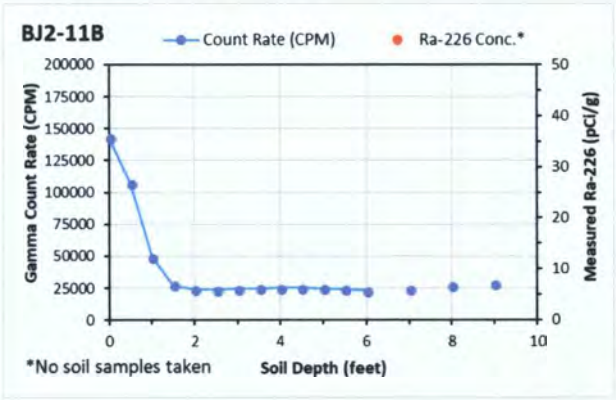

BJ2-9
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

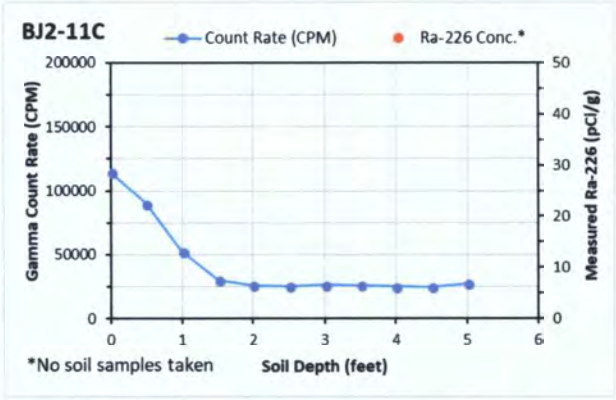

BJ2-10
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

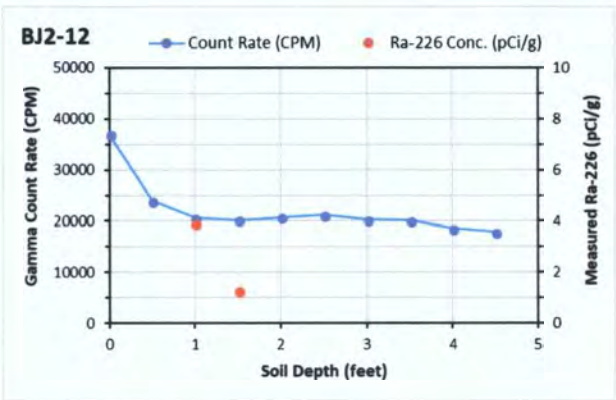

BJ2-10B
Count Rate (CPM)
Ra-226 Conc.*
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
*No soil samples taken
Soil Depth (feet)

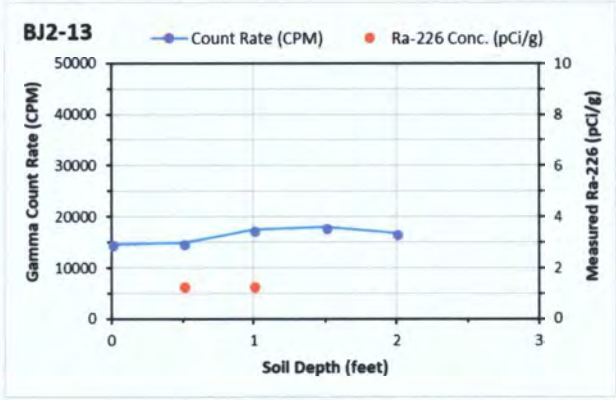

BJ2-11
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

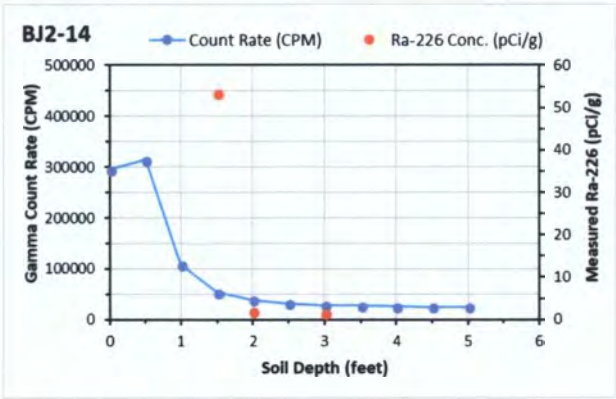

BJ2-11A
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

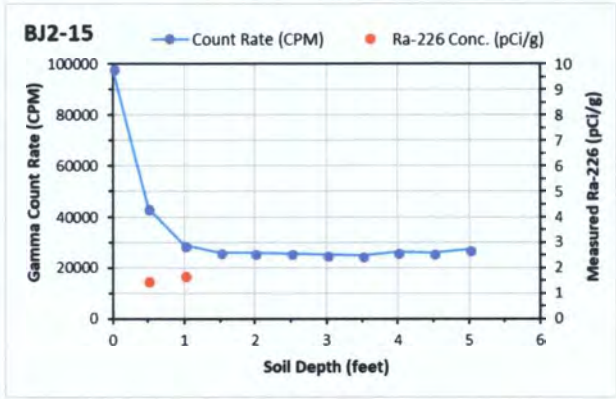

BJ2-11B
Count Rate (CPM)
Ra-226 Conc.*
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
*No soil samples taken
Soil Depth (feet)

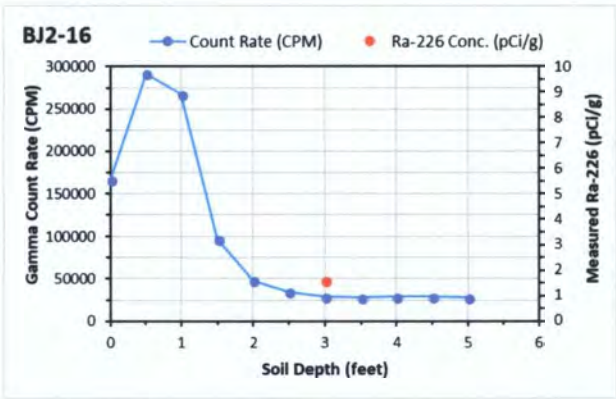

BJ2-11C
Count Rate (CPM)
Ra-226 Conc.*
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
*No soil samples taken
Soil Depth (feet)

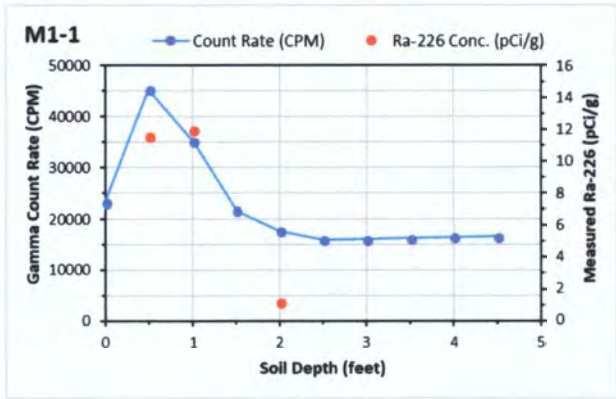

BJ2-12
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

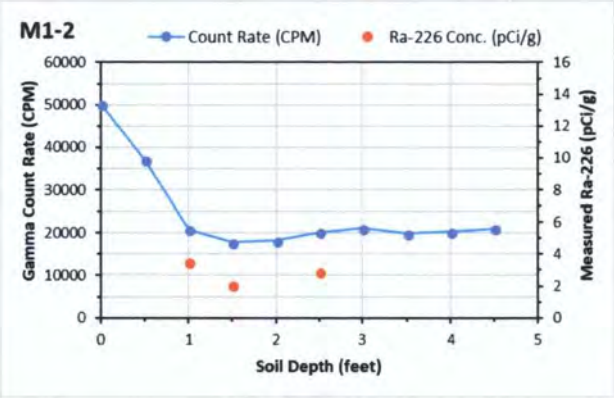

BJ2-13
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

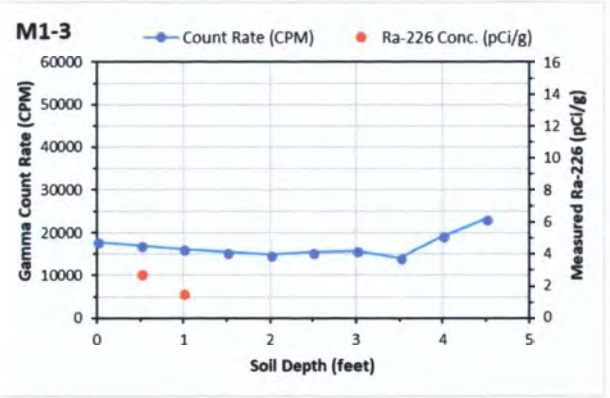

BJ2-14
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

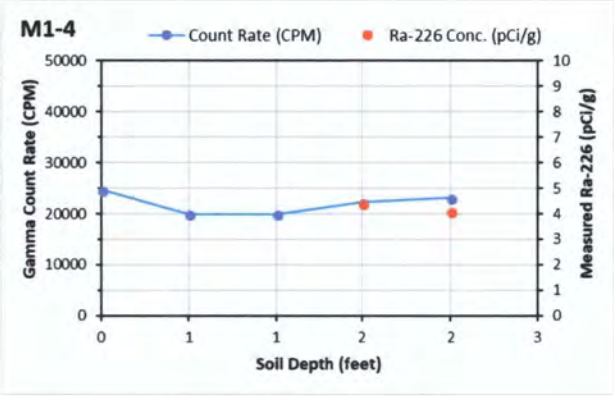

BJ2-15
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

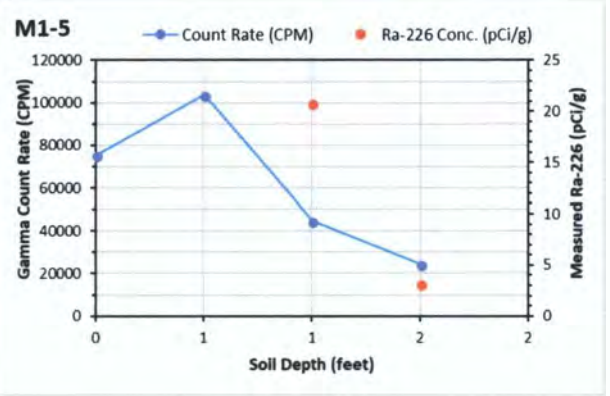

BJ2-16
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

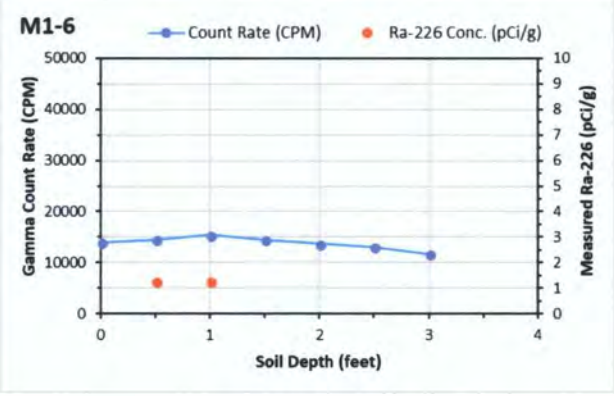

M1-1
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

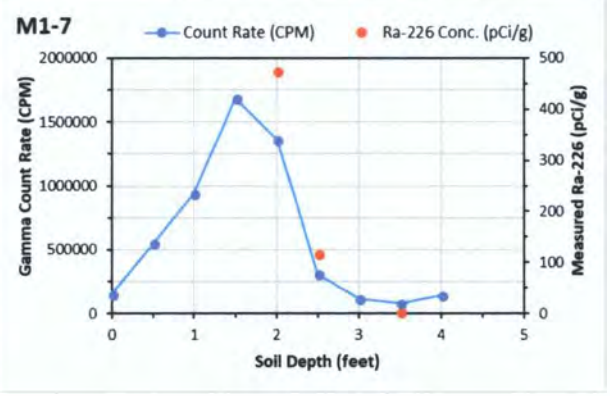

M1-2
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

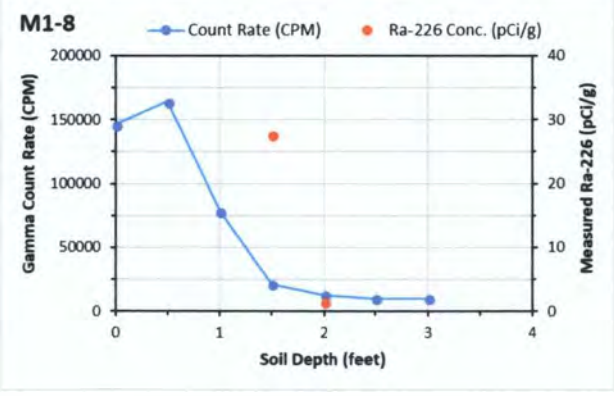

M1-3
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

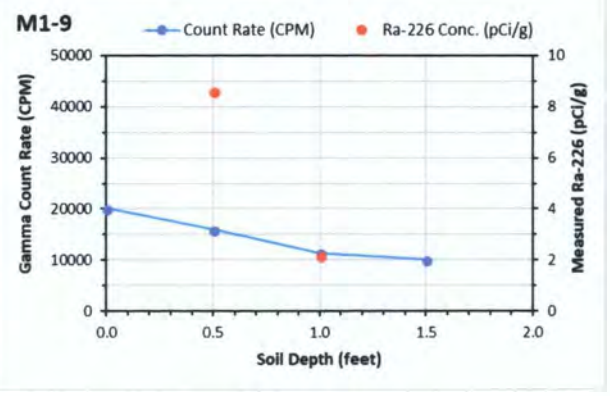

M1-4
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

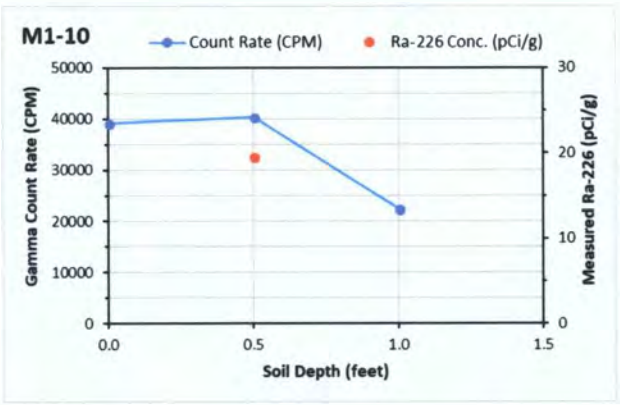

M1-5
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

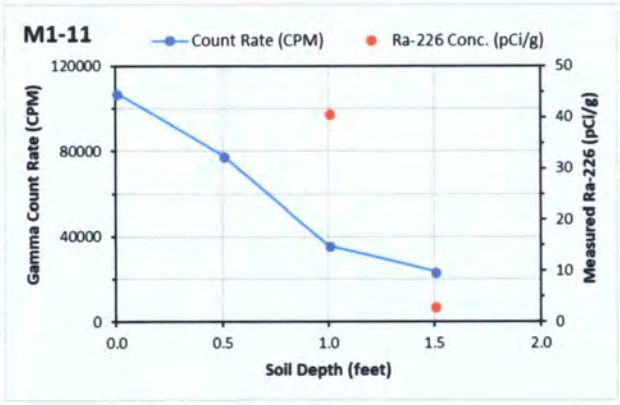

M1-6
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

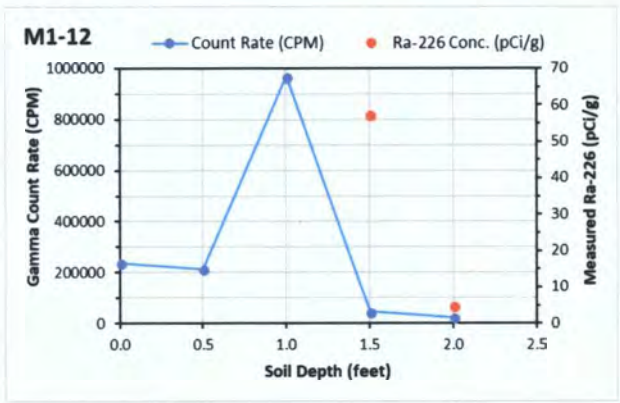

M1-7
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

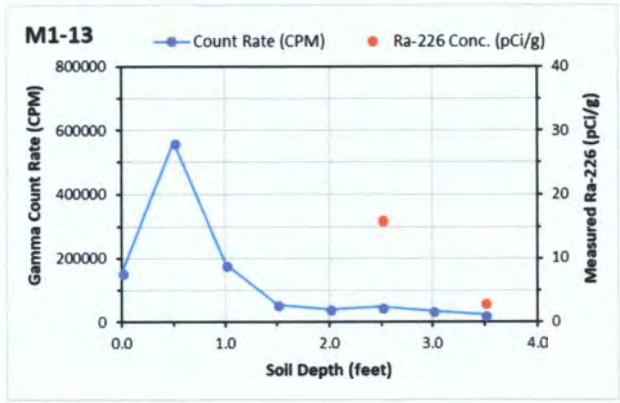

M1-8
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

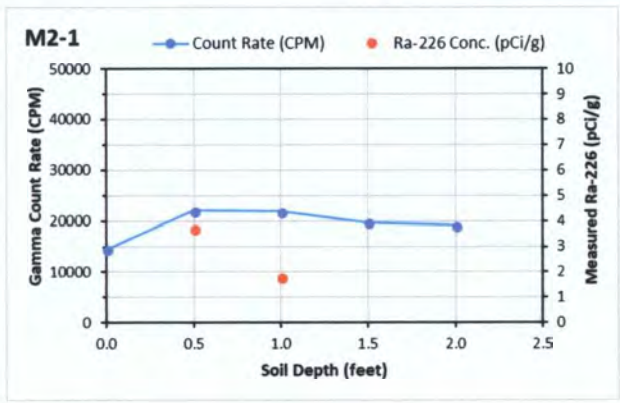

M1-9
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

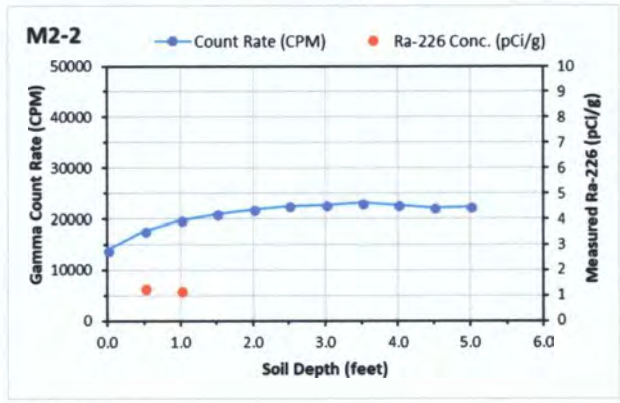

M1-10
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

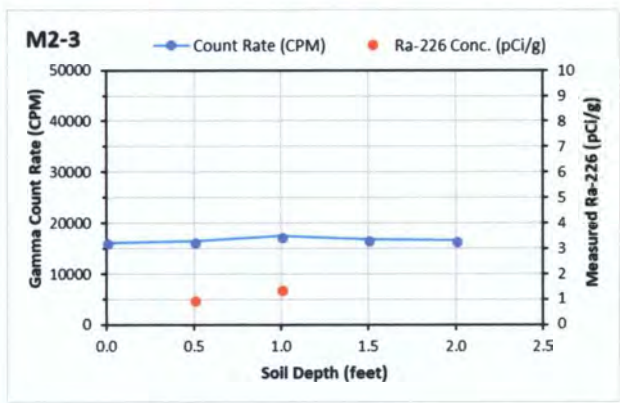

M1-11
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

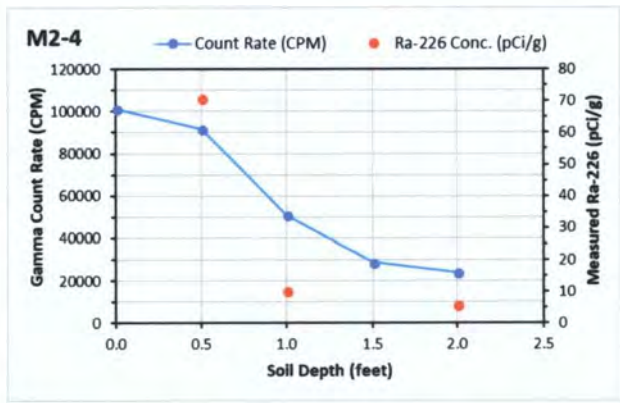

M1-12
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

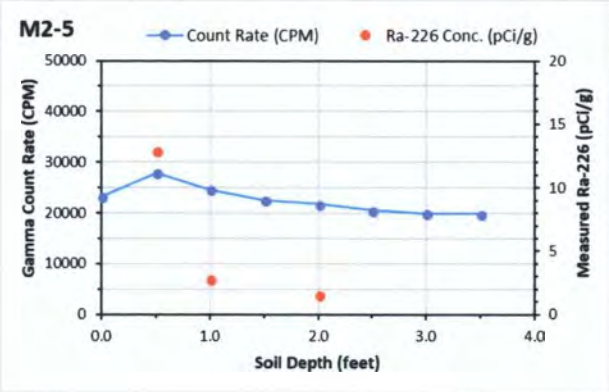

M1-13
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

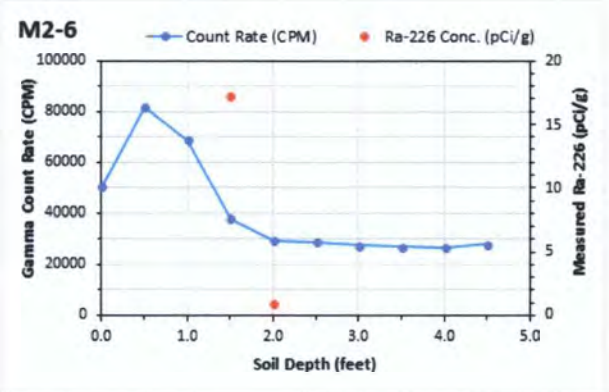

M2-1
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

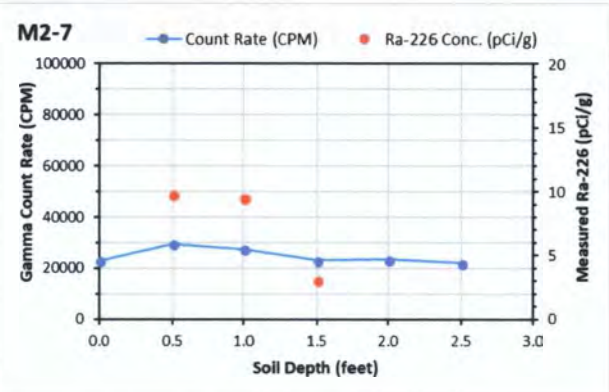

M2-2
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

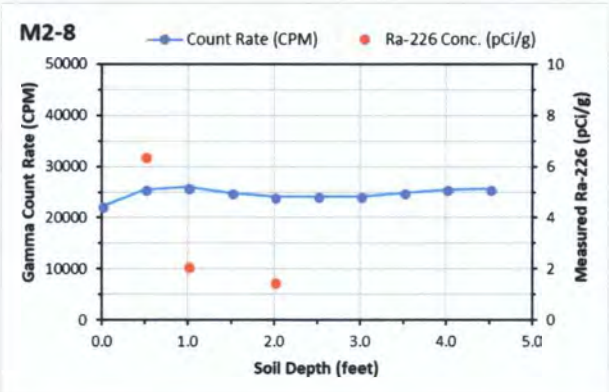

M2-3
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

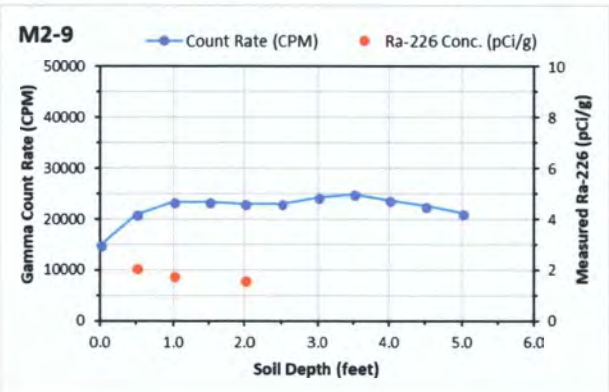

M2-4
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

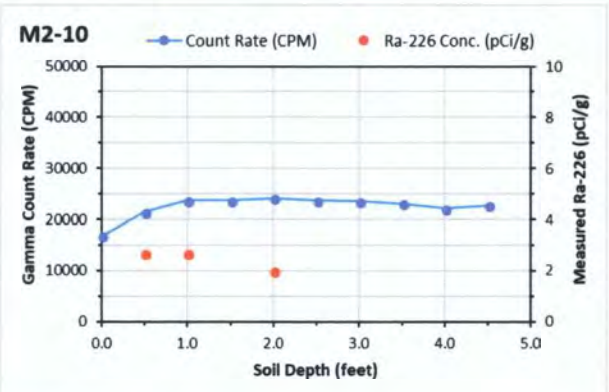

M2-5
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

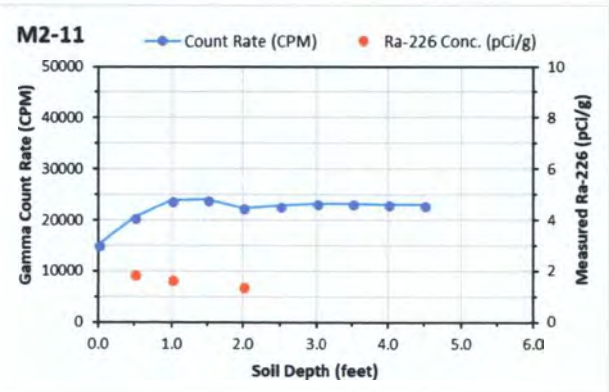

M2-6
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

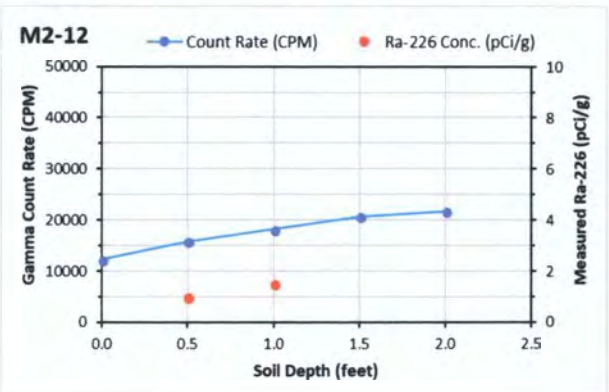

M2-7
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

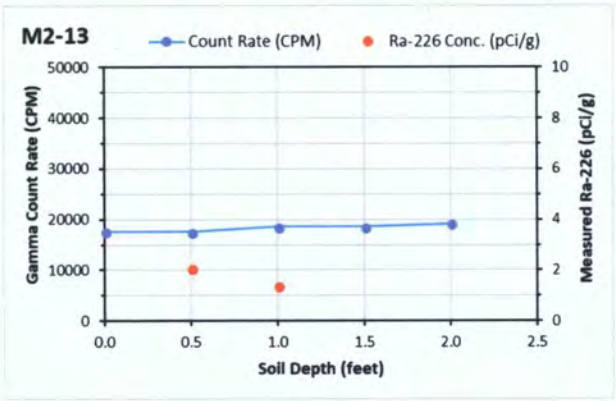

M2-8
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

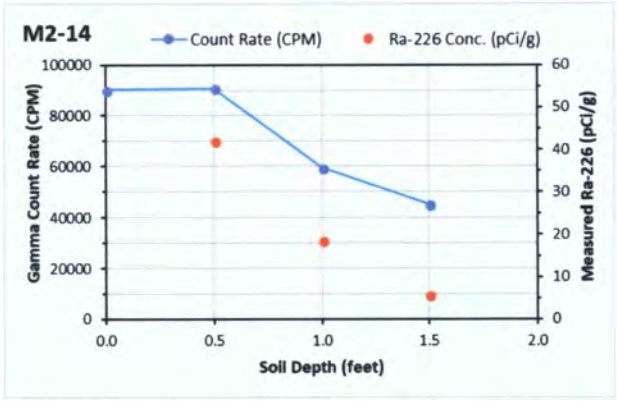

M2-9
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

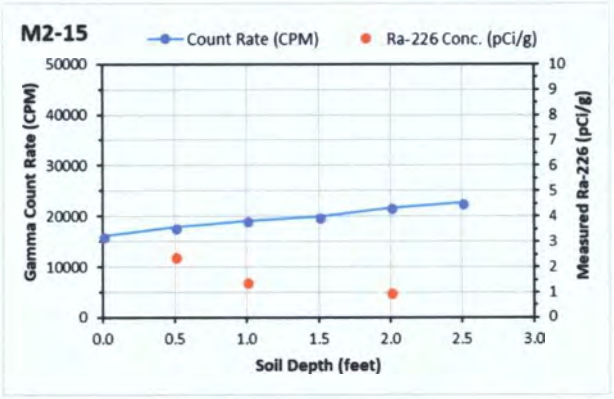

M2-10
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

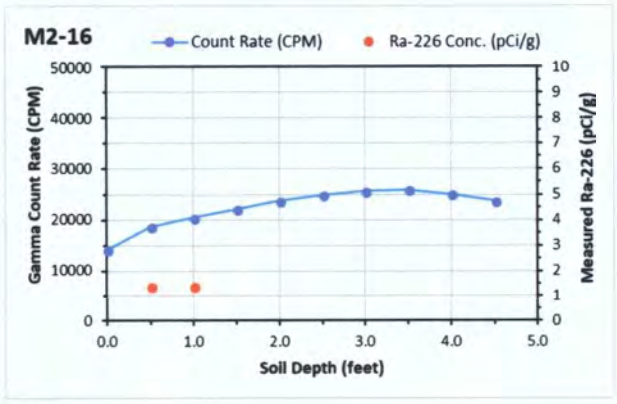

M2-11
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

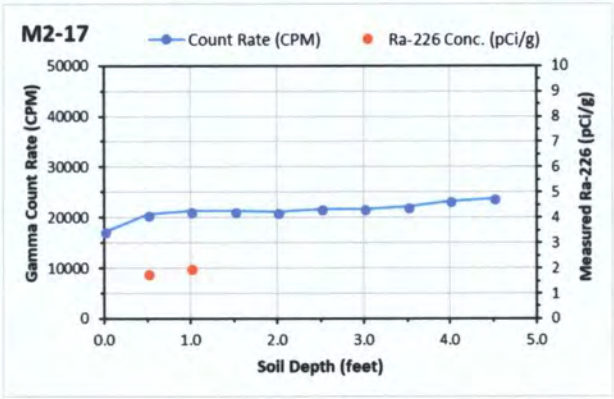

M2-12
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

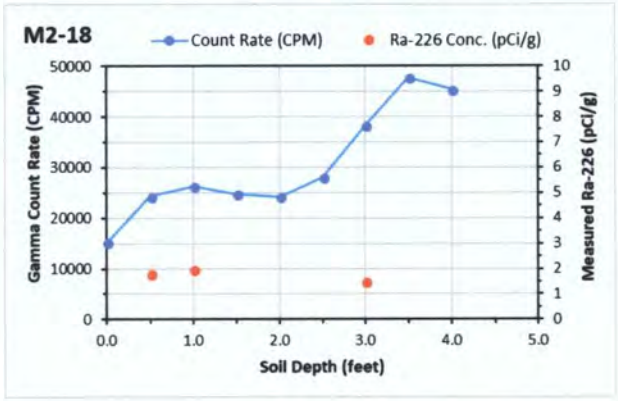

M2-13
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

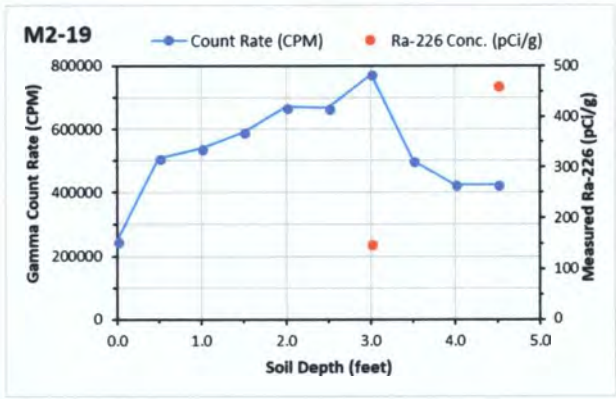

M2-14
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

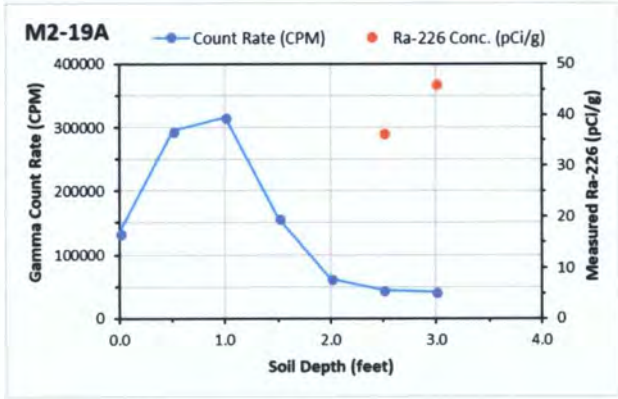

M2-15
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

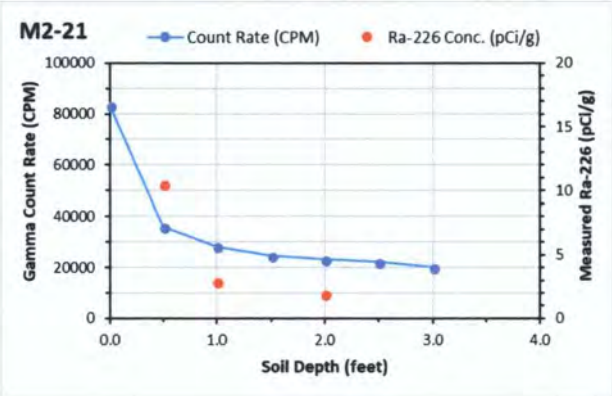

M2-16
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

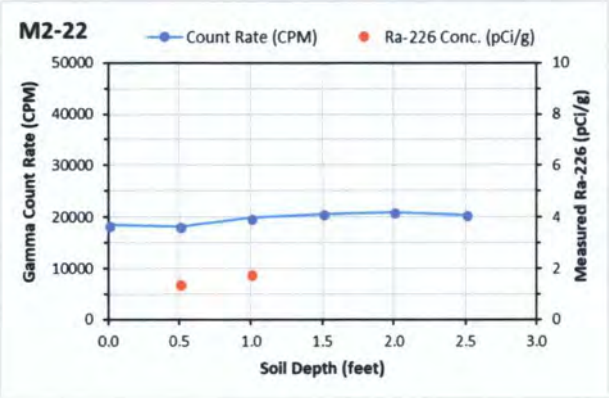

M2-17
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

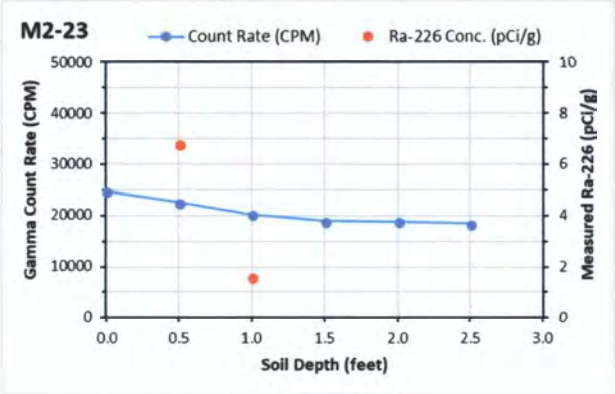

M2-18
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)


M2-19
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)


M2-19A
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)


M2-21
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)


M2-22
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)


M2-23
Count Rate (CPM)
Ra-226 Conc. (pCi/g)
Gamma Count Rate (CPM)
Measured Ra-226 (pCi/g)
Soil Depth (feet)

Attachment A3 (Analytical Results for Borehole Samples)

ble A3-1: Analytical results for Black Jack No. 1 borehole soil samples.

Sample ID	Collection Date	Uranium (mg/kg)	*Uranium (pCi/g)	Ra-226 (pCi/g)	Ac-228 (pCi/g)	K-40 (pCi/g)	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Vanadium (mg/kg)
BJ1-1-0006-S-01	10/13/2017	1.2	0.8	1.5	0.7	27.0	6.9	0.8	0.4	26.3
BJ1-1-0006-S-02D	10/13/2017	1.5	1.0	1.6	5.0	28.4	8.2	0.9	0.5	31.4
BJ1-1-0612-S-01	10/13/2017	1.0	0.7	1.6	2.6	25.6	7.2	0.9	0.4	23.8
BJ1-2-0006-S-01	10/13/2017	2.4	1.7	1.7	4.0	30.2	7.1	0.9	0.4	25.5
BJ1-2-0612-S-01	10/13/2017	1.6	1.1	1.8	2.1	25.5	7.8	1.0	0.4	28.4
BJ1-3-0012-S-01	10/13/2017	16.3	11.0	10.2	3.4	28.6	8.0	1.4	4.4	40.2
BJ1-3-1218-S-01	10/13/2017	17.9	12.1	1.4	2.6	24.8	7.2	1.4	0.6	21.7
BJ1-4-0018-S-01	10/13/2017	28.2	19.1	7.5	0.3	33.1	8.5	1.6	1.0	34.2
BJ1-4-0018-S-02S	10/13/2017	25.8	17.5	5.1	2.2	32.9	8.2	1.5	1.2	34.4
BJ1-4-1824-S-01	10/13/2017	7.1	4.8	2.6	0.5	29.4	8.4	1.2	1.2	29.5
BJ1-4-3036-S-01	10/13/2017	1.2	0.8	1.5	4.1	29.5	7.5	1.1	0.9	23.5
BJ1-5-0036-S-01	10/13/2017	127.0	86.0	45.0	11.1	36.9	8.8	7.9	14.7	40.6
BJ1-5-3642-S-01	10/13/2017	30.6	20.7	6.4	6.6	29.7	8.2	2.7	5.5	37.5
BJ1-5-4854-S-01	10/13/2017	1.2	0.8	1.4	0.9	29.9	6.0	0.9	0.9	14.8
BJ1-6-0012-S-01	10/13/2017	42.1	28.5	3.9	0.6	22.9	6.2	2.3	3.5	30.1
BJ1-6-1218-S-01	10/13/2017	33.5	22.7	1.8	2.3	25.6	8.1	1.5	1.9	33.9
[illegible]-7-0024-S-01	10/13/2017	48.2	32.6	10.8	5.7	30.2	8.7	3.3	3.1	30.5
[illegible]-7-0024-S-02S	10/13/2017	51.0	34.5	9.9	6.2	29.6	8.6	3.5	3.4	34.2
BJ1-7-2430-S-02S	10/13/2017	16.0	10.8	1.9	1.6	27.7	8.4	1.8	0.8	36.0
BJ1-8-0006-S-01	10/9/2017	13.6	9.2	7.7	0.8	30.0	8.9	1.6	2.0	37.9
BJ1-8-0612-S-01	10/9/2017	7.6	5.2	3.6	6.4	29.1	8.8	1.4	2.0	39.2
BJ1-9-0006-S-01	10/9/2017	2.7	1.8	2.2	0.5	26.4	8.3	1.1	0.6	39.5
BJ1-9-0612-S-01	10/9/2017	2.6	1.8	2.0	3.8	25.5	8.3	1.2	0.7	38.1
BJ1-10-0006-S-01	10/9/2017	1.6	1.1	1.8	4.7	28.6	8.8	1.5	0.5	39.9
BJ1-10-0612-S-01	10/9/2017	1.5	1.0	2.8	5.5	28.1	8.5	0.5	0.5	35.0
BJ1-11-0006-S-01	10/9/2017	1.9	1.3	2.2	0.6	30.6	12.3	0.7	0.6	44.9
BJ1-11-0612-S-01	10/9/2017	1.5	1.0	2.1	5.9	28.0	8.2	0.6	0.5	34.2
BJ1-12-0006-S-01	10/9/2017	9.6	6.5	1.7	0.2	21.6	7.1	1.4	0.5	27.6
BJ1-12-0006-S-02D	10/13/2017	5.4	3.7	1.8	2.5	21.6	5.9	1.3	0.5	26.6
BJ1-12-0612-S-01	10/9/2017	7.1	4.8	2.4	5.8	22.0	6.6	0.8	0.6	26.9
BJ1-13-0006-S-01	10/13/2017	3.7	2.5	1.6	2.5	24.3	7.9	1.1	0.6	31.0
BJ1-13-0612-S-01	10/13/2017	1.3	0.9	1.5	0.2	23.6	7.1	0.8	0.3	25.5
BJ1-14-0018-S-01	10/13/2017	32.2	21.8	3.6	6.3	27.6	8.7	1.9	1.9	36.0
BJ1-14-1824-S-01	10/13/2017	27.3	18.5	2.8	2.3	27.2	8.4	1.4	1.4	34.8
BJ1-14-3036-S-01	10/13/2017	6.1	4.1	2.5	1.4	28.9	7.8	1.7	1.4	21.2
BJ1-15-0036-S-01	10/13/2017	85.4	57.8	16.3	8.9	35.5	5.4	8.9	15.1	36.3
BJ1-15-3642-S-01	10/13/2017	4.0	2.7	2.2	0.8	24.6	9.0	1.1	2.6	29.9
[illegible]-16-0024-S-01	10/13/2017	41.7	28.2	6.1	2.9	28.8	8.1	3.8	1.7	32.9

Table A3-1: Analytical results for Black Jack No. 1 borehole soil samples.

Sample ID	Collection Date	Uranium (mg/kg)	*Uranium (pCi/g)	Ra-226 (pCi/g)	Ac-228 (pCi/g)	K-40 (pCi/g)	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Vanadium (mg/kg)
BJ1-16-2430-S-01	10/13/2017	3.6	2.5	2.6	2.5	28.3	7.5	1.1	0.8	29.0
BJ1-17-0024-S-01	10/13/2017	29.7	20.1	7.6	2.5	22.7	7.5	2.8	1.9	23.3
BJ1-17-2430-S-01	10/13/2017	5.2	3.5	1.4	2.7	22.8	7.1	1.0	0.6	19.0
BJ1-18-0006-S-01	10/13/2017	8.5	5.8	2.3	0.3	29.5	7.1	0.9	1.8	25.0
BJ1-18-0612-S-01	10/13/2017	2.3	1.6	2.1	1.5	31.5	7.7	0.9	0.6	23.6
BJ1-19-0006-S-01	10/13/2017	1.6	1.1	1.9	0.6	28.3	9.1	1.4	0.6	30.9
BJ1-19-0612-S-01	10/13/2017	1.5	1.0	1.6	1.3	27.9	8.7	1.3	0.6	32.8
BJ1-20-0006-S-01	10/13/2017	1.3	0.9	2.1	4.3	29.4	7.6	1.2	0.4	35.5
BJ1-20-0612-S-01	10/13/2017	1.4	0.9	1.8	0.7	26.1	8.3	1.2	0.4	33.1
BJ1-21-0006-S-01	10/13/2017	650.0	440.1	125.0	11.5	47.9	14.2	105.0	37.8	89.3
BJ1-21-0612-S-01	10/13/2017	516.0	349.3	43.2	9.7	36.2	11.6	92.8	34.6	88.4
BJ1-21-1218-S-01	10/13/2017	210.0	142.2	60.9	5.1	29.8	5.7	27.3	15.7	45.4
BJ1-21-2430-S-01	10/13/2017	28.0	19.0	5.7	1.2	29.7	8.6	1.8	3.8	30.8
BJ1-21-3642-S-01	10/13/2017	2.8	1.9	1.9	7.4	29.6	8.5	1.2	1.2	30.1
BJ1-21-4854-S-01	10/13/2017	2.0	1.4	1.9	0.7	29.2	7.8	1.0	0.6	27.5
BJ1-22-0006-S-01	10/13/2017	162.0	109.7	139.0	15.4	62.3	6.8	18.0	133.0	73.0
BJ1-22-0006-S-02D	10/13/2017	86.9	58.8	111.0	3.1	44.0	3.1	10.8	85.3	32.2
BJ1-22-0612-S-01	10/13/2017	69.8	47.3	22.8	10.6	40.7	1.7	5.7	148.0	13.1
BJ1-22-1218-S-01	10/13/2017	30.0	20.3	2.2	2.7	36.2	1.5	3.0	63.1	12.3

*Calculated value based on conversion factor of 0.677 pCi/g per mg/kg.

**Values highlighted in yellow exceed the Investigation level for the indicated analyte.

Table A3-2: Analytical results for Black Jack No. 2 borehole soil samples.

Sample ID	Collection Date	Uranium (mg/kg)	Uranium (pCi/g)*	Ra-226 (pCi/g)	Ac-228 (pCi/g)	K-40 (pCi/g)	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Vanadium (mg/kg)
BJ2-1-0006-S-01	10/4/2017	0.7	0.5	1.2	1.5	21.0	2.8	0.3	0.1	14.3
BJ2-1-0612-S-01	10/4/2017	0.9	0.6	3.7	0.9	21.3	3.2	0.6	0.2	18.7
BJ2-2-0006-S-01	10/4/2017	1.2	0.8	1.5	2.9	21.9	3.0	0.3	0.3	17.6
BJ2-2-0612-S-01	10/4/2017	1.1	0.7	1.4	1.9	21.5	4.0	0.5	0.2	20.7
BJ2-3-0006-S-01	10/4/2017	452.0	306.0	77.2	11.8	40.0	13.6	31.5	80.8	590.0
BJ2-3-0612-S-01	10/4/2017	116.0	78.5	5.0	2.5	20.5	3.4	3.3	1.1	20.6
BJ2-3-1218-S-01	10/4/2017	176.0	119.2	4.1	2.1	22.7	3.5	2.6	0.2	21.6
BJ2-3-1824-S-01	10/4/2017	169.0	114.4	3.8	1.2	23.3	3.9	3.9	0.4	24.3
BJ2-3-2430-S-01	10/4/2017	102.0	69.1	1.8	2.7	24.1	4.5	3.7	0.2	25.7
BJ2-3-3642-S-01	10/4/2017	1.0	0.7	1.3	1.2	20.5	3.2	1.8	0.3	15.3
BJ2-4-0006-S-01	10/3/2017	42.3	28.6	73.7	5.1	44.6	4.9	1.9	16.9	115.0
BJ2-4-0612-S-01	10/3/2017	7.9	5.3	12.0	4.6	29.1	3.9	1.1	0.5	13.3
BJ2-4-114120-S-01	10/3/2017	2.2	1.5	2.4	1.9	22.6	3.7	0.5	0.7	22.7
BJ2-4-1218-S-01	10/3/2017	16.5	11.2	1.4	0.9	25.0	5.6	1.5	0.2	15.0
BJ2-4-2430-S-01	10/3/2017	34.3	23.2	1.5	0.7	21.4	3.7	1.8	0.2	18.6
BJ2-4-3642-S-01	10/3/2017	8.5	5.8	1.2	0.3	17.5	2.8	0.5	0.2	14.5
[redacted]2-4-6066-S-01	10/3/2017	14.6	9.9	2.7	0.3	21.6	4.6	2.2	1.5	27.3
BJ2-4-96102-S-01	10/3/2017	1.5	1.0	1.6	2.6	21.9	4.4	0.6	0.2	20.1
BJ2-4B-0006-S-01	10/3/2017	52.4	35.5	162.0	29.8	59.3	5.8	4.5	21.7	144.0
BJ2-4B-0612-S-01	10/3/2017	325.0	220.0	159.0	12.1	73.8	9.9	24.8	57.6	570.0
BJ2-4B-120126-S-01	10/3/2017	1.7	1.1	1.9	0.5	22.5	5.8	6.1	0.8	35.5
BJ2-4B-1218-S-01	10/3/2017	554.0	375.1	1.7	6.3	22.9	4.5	7.2	0.6	16.5
BJ2-4B-144150-S-01	10/3/2017	0.7	0.5	1.4	0.9	20.8	2.8	0.2	0.1	14.9
BJ2-4B-174180-S-01	10/3/2017	0.5	0.3	1.1	0.3	15.4	2.2	0.3	0.1	11.1
BJ2-4B-234240-S-01	10/3/2017	1.4	0.9	2.3	3.1	23.0	4.3	1.2	0.2	27.6
BJ2-4B-2430-S-01	10/3/2017	27.7	18.8	1.4	2.3	20.9	3.2	1.2	0.6	17.8
BJ2-4B-3642-S-01	10/3/2017	0.7	0.5	1.2	3.5	15.2	2.4	0.3	1.1	11.4
BJ2-4B-7278-S-01	10/3/2017	0.9	0.6	2.1	2.6	24.2	4.1	0.4	0.5	23.8
BJ2-4B-96102-S-01	10/3/2017	0.8	0.5	1.5	0.9	19.0	3.3	0.4	0.3	17.0
BJ2-5-0006-S-01	10/4/2017	88.0	59.6	59.0	6.0	36.1	5.9	3.1	31.3	188.0
BJ2-5-0612-S-01	10/4/2017	108.0	73.1	25.4	6.7	36.0	8.9	2.4	16.2	124.0
BJ2-5-1218-S-01	10/3/2017	31.0	21.0	3.0	2.1	24.2	4.5	1.4	0.6	22.1
BJ2-5-2430-S-01	10/12/2017	2.4	1.6	1.2	2.0	17.6	2.8	0.5	0.2	15.4
BJ2-6-0006-S-01	10/4/2017	4.5	3.0	2.2	4.8	22.7	7.7	0.8	1.0	38.6
BJ2-6-0006-S-02D	10/4/2017	5.8	3.9	2.3	1.6	25.0	7.5	0.8	0.8	36.1
BJ2-6-0612-S-01	10/4/2017	1.3	0.9	1.6	0.3	22.1	5.1	0.7	0.5	28.6
BJ2-7-0006-S-01	10/4/2017	1.1	0.7	1.4	3.1	20.4	3.7	0.4	0.2	20.6
[redacted]2-7-0612-S-01	10/4/2017	27.9	18.9	1.7	0.8	0.1	5.8	1.0	4.3	48.5

Table A3-2: Analytical results for Black Jack No. 2 borehole soil samples.

Sample ID	Collection Date	Uranium (mg/kg)	Uranium (pCi/g)*	Ra-226 (pCi/g)	Ac-228 (pCi/g)	K-40 (pCi/g)	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Vanadium (mg/kg)
BJ2-8-0006-S-01	10/4/2017	5.0	3.4	2.3	3.8	22.7	7.0	0.7	1.0	34.1
BJ2-8-0612-S-01	10/4/2017	1.3	0.9	1.4	1.7	18.6	4.0	0.4	0.3	24.6
BJ2-9-0006-S-01	10/4/2017	2.1	1.4	1.3	0.6	20.3	3.9	0.5	0.9	15.7
BJ2-9-0612-S-01	10/4/2017	0.8	0.5	1.4	0.5	24.5	6.9	0.6	0.3	24.6
BJ2-10-0006-S-01	10/4/2017	13.2	8.9	6.8	1.9	24.2	4.4	0.9	5.0	36.8
BJ2-10-0612-S-01	10/4/2017	4.1	2.8	3.8	3.3	20.8	4.1	0.5	0.8	24.7
BJ2-10-102108-S-01	10/4/2017	5.2	3.5	1.2	0.9	16.0	3.1	1.4	1.2	10.2
BJ2-10-1218-01	10/12/2017	97.4	65.9	16.5	2.0	22.6	3.2	1.1	1.6	25.5
BJ2-10-138144-S-01	10/4/2017	2.0	1.4	2.0	5.6	31.5	5.8	0.6	0.2	34.8
BJ2-10-2430-S-01	10/4/2017	8.5	5.8	1.8	2.7	23.0	4.2	1.2	0.8	22.2
BJ2-10-4248-S-01	10/4/2017	55.8	37.8	33.0	10.2	42.3	5.8	4.1	38.4	146.0
BJ2-10-7278-S-01	10/4/2017	5.3	3.6	2.2	1.0	21.4	2.1	0.6	1.5	7.0
BJ2-11-0006-S-01	10/3/2017	1110.0	751.5	376.0	28.1	111.0	15.4	39.1	124.0	978.0
BJ2-11-0612-S-01	10/4/2017	313.0	211.9	133.0	20.4	79.3	6.2	10.5	39.3	224.0
BJ2-11-120126-S-01	10/3/2017	1.7	1.2	1.9	4.7	29.1	7.3	0.6	0.3	41.3
BJ2-11-1218-S-01	10/3/2017	363.0	245.8	38.4	10.2	36.7	6.5	11.8	32.9	186.0
BJ2-11-150156-S-01	10/3/2017	0.6	0.4	1.4	0.9	21.6	2.9	0.2	0.1	12.2
BJ2-11-234240-S-01	10/3/2017	0.8	0.6	1.4	1.7	20.6	2.8	0.2	0.1	16.5
BJ2-11-2430-S-01	10/3/2017	66.3	44.9	7.1	0.5	19.1	4.1	5.1	10.2	62.5
BJ2-11-3642-S-01	10/12/2017	3.3	2.2	2.0	1.8	18.3	3.9	0.5	2.7	20.8
BJ2-11-6066-S-01	10/3/2017	63.9	43.3	14.5	3.1	21.8	4.7	3.1	9.7	58.8
BJ2-11-96102-S-01	10/3/2017	1.0	0.7	1.2	1.4	17.0	3.9	0.5	0.3	14.1
BJ2-11A-0024-S-01	10/4/2017	106.0	71.8	69.4	13.8	48.3	5.3	2.4	19.0	125.0
BJ2-11A-0024-S-02S	10/4/2017	114.0	77.2	57.4	11.9	34.2	5.6	2.4	16.5	125.0
BJ2-11A-3036-S-01	10/4/2017	27.9	18.9	1.3	3.2	18.4	2.9	1.4	0.3	13.9
BJ2-12-0012-S-01	10/3/2017	11.3	7.7	3.9	6.5	21.8	5.3	1.3	1.7	34.3
BJ2-12-1218-S-01	10/3/2017	0.8	0.6	1.3	3.7	18.8	3.4	0.5	0.3	19.0
BJ2-13-0006-S-01	10/3/2017	2.5	1.7	1.3	0.2	18.3	2.6	0.5	0.4	15.7
BJ2-13-0612-S-01	10/3/2017	0.8	0.5	1.3	1.3	18.4	3.4	0.7	0.3	17.5
BJ2-14-0018-S-01	10/4/2017	153.0	103.6	53.5	10.0	39.5	6.8	4.2	16.7	134.0
BJ2-14-0018-S-02D	10/4/2017	144.0	97.5	63.0	8.6	36.0	6.8	4.2	14.8	127.0
BJ2-14-1824-S-01	10/4/2017	127.0	86.0	2.1	1.7	19.8	3.8	2.9	0.2	22.9
BJ2-14-3036-S-01	10/12/2017	38.8	26.3	1.5	2.2	18.6	3.1	1.6	0.2	15.4
BJ2-15-0006-S-02S	10/4/2017	2.3	1.6	1.5	2.4	23.7	4.2	0.5	0.5	21.2
BJ2-15-0612-S-01	10/4/2017	57.1	38.7	1.7	1.0	18.7	2.7	0.7	0.6	17.2
BJ2-16-3036-S-01	10/12/2017	83.4	56.5	1.6	2.4	20.9	3.7	3.3	0.5	20.1

*Calculated value based on conversion factor of 0.677 pCi/g per mg/kg.

**Values highlighted in yellow exceed the Investigation level for the indicated analyte.

Table A3-3: Analytical results for Mac No. 1 borehole soil samples.

Sample ID	Collection Date	Uranium (mg/kg)	Uranium (pCi/g)*	Ra-226 (pCi/g)	Ac-228 (pCi/g)	K-40 (pCi/g)	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Vanadium (mg/kg)
M1-1-0006-S-01	10/13/2017	18.6	12.6	11.6	4	19.5	3	0.8	4.7	54
M1-1-0612-S-01	10/13/2017	20.8	14.1	12	8	22.9	3.3	1.2	1.5	42
M1-1-1824-S-01	10/13/2017	7.09	4.8	1.2	1.2	21.2	3.5	0.8	0.2	24.9
M1-2-0012-S-01	10/13/2017	21.3	14.4	3.5	4.2	16.3	5.4	1.7	4	50.1
M1-2-1218-S-01	10/13/2017	24	16.2	2.1	2	17	16.9	1.8	3.5	51.3
M1-2-2430-S-01	10/13/2017	4.96	3.4	2.9	3.2	17.5	8	0.7	2.3	29.4
M1-3-0006-S-01	10/13/2017	5.4	3.7	2.8	2.3	26.8	2.5	0.3	0.4	6.1
M1-3-0612-S-01	10/13/2017	3.05	2.1	1.6	0.3	15.7	2.3	0.5	0.4	9.2
M1-4-0018-S-01	10/13/2017	13.3	9.0	4.4	0.8	13.1	2.4	1.2	1	19.5
M1-4-0018-S-02S	10/13/2017	12.1	8.2	4.2	0.8	10.5	2.4	1.2	1.6	18.9
M1-4-1824-S-01	10/13/2017	12.6	8.5	4.1	0.4	12.3	2.5	0.6	1.2	19.4
M1-5-0012-S-01	10/13/2017	77	52.1	20.8	3.2	15.9	2.8	0.9	4.8	49.8
M1-5-1218-S-01	10/13/2017	23.8	16.1	3.2	0.3	13	1.9	0.8	2	19.1
M1-6-0006-S-01	10/13/2017	1.33	0.9	1.3	1.5	18.8	2.8	0.6	0.2	21.7
M1-6-0612-S-01	10/13/2017	1.02	0.7	1.3	3.4	19.9	3.1	0.4	0.1	23.8
M1-7-0024-S-01	10/13/2017	1490	1008.7	475	11.3	74.6	14.6	9.8	23.5	1470
M1-7-0024-S-02S	10/13/2017	1590	1076.4	482	41.9	68.2	12.3	9.5	24.1	1560
M1-7-2430-S-01	10/13/2017	332	224.8	118	19.2	47.9	2.4	3.9	4.5	235
M1-7-3642-S-01	10/13/2017	228	154.4	3.3	2.7	12.7	4.3	5.9	5.8	41.8
M1-8-0018-S-01	10/13/2017	117	79.2	27.7	1.7	20.5	3.3	2.7	5	116
M1-8-1824-S-01	10/13/2017	9.75	6.6	1.6	0.6	10	1.6	0.6	0.7	14.8
M1-9-0006-S-01	10/13/2017	61.7	41.8	8.6	0.8	12.7	2.4	0.9	1.7	35.7
M1-9-0006-S-02D	10/13/2017	43.1	29.2	10.8	2.1	16.2	2	0.8	1.2	33
M1-9-0612-S-01	10/13/2017	8.8	6.0	2.2	0.9	13.9	2.3	0.5	0.4	17.3
M1-10-0006-S-01	10/13/2017	71.7	48.5	19.6	4.6	15.6	2.3	0.8	2.8	46.5
M1-10-0006-S-02D	10/13/2017	88.4	59.8	23.3	0.9	17.1	2.7	0.8	3.4	60
M1-10-0612-S-01	10/13/2017	14	9.5	14.6	0.7	13.2	5.7	0.8	1.9	18.8
M1-11-0012-S-01	10/13/2017	45.5	30.8	40.8	7.1	27.1	4.1	2.1	9.1	72.9
M1-11-0012-S-02S	10/13/2017	44.7	30.3	44.6	5.5	35.9	4.6	2.3	12.1	108
M1-11-1218-S-01	10/13/2017	41.4	28.0	3.2	0.9	11.8	3.1	1.3	0.7	15.9
M1-12-0018-S-01	10/13/2017	235	159.1	57.5	8.7	45.9	3.3	5.4	12.6	114
M1-12-1824-S-01	10/13/2017	111	75.1	4.9	1	10	2.5	3	2.2	20.1
M1-13-0006-S-01	10/13/2017	525	355.4	638	26.5	65.8	12.4	29.2	44.9	921
M1-13-0612-S-01	10/13/2017	564	381.8	71	12.8	43.2	4.7	16.5	4.1	306
M1-13-1824-S-01	10/13/2017	215	145.6	8.6	1.6	22.5	3.2	5.6	0.7	97.7
M1-13-2430-S-01	10/13/2017	88	59.6	16.1	1.4	18.3	8	3.2	1.5	99.5
M1-13-3642-S-01	10/13/2017	4.73	3.2	3.1	0.4	11.2	4.9	0.6	0.8	14.3

Table A3-3: Analytical results for Mac No. 1 borehole soil samples.

Sample ID	Collection Date	Uranium (mg/kg)	Uranium (pCi/g)*	Ra-226 (pCi/g)	Ac-228 (pCi/g)	K-40 (pCi/g)	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Vanadium (mg/kg)

*Calculated value based on conversion factor of 0.677 pCi/g per mg/kg.

**Values highlighted in yellow exceed the Investigation level for the indicated analyte.

Table A3-4: Analytical results for Mac No. 2 borehole soil samples.

Sample ID	Collection Date	Uranium (mg/kg)	Uranium (pCi/g)*	Ra-226 (pCi/g)	Ac-228 (pCi/g)	K-40 (pCi/g)	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Vanadium (mg/kg)
M2-1-0006-S-01	10/12/2017	3.1	2.1	3.7	1.4	23.3	4.8	0.9	0.6	25.3
M2-1-0612-S-01	10/12/2017	3.2	2.1	1.8	3.2	25.3	6.2	0.8	0.3	27.0
M2-2-0006-S-01	10/12/2017	1.0	0.7	1.3	0.3	24.0	7.7	0.5	0.2	27.7
M2-2-0612-S-01	10/12/2017	1.3	0.9	1.2	1.2	22.7	8.0	0.5	0.2	21.4
M2-3-0006-S-01	10/12/2017	1.6	1.1	1.0	2.1	23.6	8.0	0.5	0.2	19.4
M2-3-0612-S-01	10/12/2017	1.1	0.7	1.4	0.2	22.0	7.3	0.4	0.2	23.9
M2-4-0006-S-01	10/11/2017	99.7	67.5	71.0	14.6	41.1	9.3	6.0	12.8	320.0
M2-4-0006-S-02D	10/11/2017	77.4	52.4	90.6	6.3	56.7	8.9	3.7	12.8	207.0
M2-4-0612-S-01	10/11/2017	126.0	85.3	10.3	7.8	29.1	9.5	4.7	11.5	184.0
M2-4-1824-S-01	10/11/2017	15.4	10.4	5.9	5.1	25.1	7.2	0.9	32.8	31.5
M2-5-0006-S-01	10/11/2017	42.4	28.7	12.9	7.1	27.3	6.5	1.2	2.9	81.2
M2-5-0612-S-01	10/11/2017	14.3	9.7	2.8	0.4	29.5	7.0	0.8	0.8	40.0
M2-5-1824-S-01	10/12/2017	1.1	0.8	1.6	1.1	26.0	6.0	0.4	0.2	24.6
M2-6-0018-S-01	10/11/2017	37.1	25.1	17.3	4.6	30.7	6.5	2.1	1.7	68.9
M2-6-0018-S-02S	10/11/2017	38.3	25.9	14.2	0.5	28.9	7.3	1.3	1.9	66.7
M2-6-1824-S-01	10/11/2017	5.2	3.5	1.0	2.3	24.7	7.0	0.5	0.2	35.4
M2-7-0006-S-01	10/11/2017	26.7	18.1	9.8	6.2	30.1	7.6	0.9	1.1	55.5
M2-7-0612-S-01	10/11/2017	33.1	22.4	9.5	7.4	29.4	6.8	1.1	1.2	55.4
M2-7-1218-S-01	10/11/2017	11.0	7.4	3.1	2.0	24.4	6.7	0.9	0.4	36.5
M2-8-0006-S-01	10/11/2017	31.0	21.0	6.4	3.2	26.6	7.7	1.2	1.6	62.2
M2-8-0612-S-01	10/11/2017	3.7	2.5	2.1	5.6	27.0	7.0	0.6	0.3	37.6
M2-8-1824-S-01	10/11/2017	1.3	0.9	1.5	2.5	29.4	5.8	0.5	0.3	16.4
M2-9-0006-S-01	10/11/2017	2.3	1.5	2.1	1.2	25.3	6.0	0.5	0.2	28.2
M2-9-0612-S-01	10/11/2017	2.4	1.6	1.8	3.5	25.6	7.9	0.9	0.4	29.6
M2-9-1824-S-01	10/11/2017	0.8	0.5	1.6	0.9	26.9	5.0	0.4	0.3	13.4
M2-10-0006-S-01	10/11/2017	3.1	2.1	2.7	6.8	26.3	5.5	0.6	0.3	27.8
M2-10-0612-S-01	10/11/2017	4.1	2.8	2.7	2.5	29.3	7.0	0.6	0.2	30.0
M2-10-1824-S-01	10/11/2017	2.3	1.6	2.0	0.7	29.8	5.0	0.5	0.3	16.9
M2-11-0006-S-01	10/11/2017	2.7	1.8	1.9	2.2	24.1	6.1	0.6	0.2	27.2
M2-11-0612-S-01	10/11/2017	1.2	0.8	1.7	2.5	26.8	7.5	0.5	0.2	29.0

Table A3-4: Analytical results for Mac No. 2 borehole soil samples.

Sample ID	Collection Date	Uranium (mg/kg)	Uranium (pCi/g)*	Ra-226 (pCi/g)	Ac-228 (pCi/g)	K-40 (pCi/g)	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Vanadium (mg/kg)
M2-11-1824-S-01	10/11/2017	0.6	0.4	1.4	0.6	25.5	4.7	0.3	0.2	11.9
M2-12-0006-S-01	10/12/2017	1.4	1.0	1.0	3.4	25.4	2.0	0.2	0.1	11.8
M2-12-0612-S-01	10/12/2017	0.6	0.4	1.5	2.2	26.8	2.0	0.4	0.1	9.5
M2-13-0006-S-01	10/12/2017	4.2	2.9	2.1	3.0	27.7	3.8	0.5	0.3	23.8
M2-13-0612-S-01	10/12/2017	0.9	0.6	1.4	2.7	22.2	3.8	0.3	0.1	18.7
M2-14-0006-S-01	10/11/2017	65.8	44.5	42.1	10.4	31.0	7.0	4.5	8.7	187.0
M2-14-0612-S-01	10/11/2017	57.2	38.7	18.7	5.6	31.1	6.6	3.4	3.5	140.0
M2-14-1218-S-01	10/11/2017	88.2	59.7	5.7	2.3	26.1	8.5	3.1	3.6	92.5
M2-15-0006-S-01	10/11/2017	3.1	2.1	2.4	2.7	23.8	3.5	0.7	0.5	18.1
M2-15-0612-S-01	10/11/2017	1.9	1.3	1.4	2.2	22.0	3.5	0.5	0.2	21.2
M2-15-1824-S-01	10/11/2017	0.9	0.6	1.0	1.6	27.3	4.1	0.5	0.2	14.7
M2-16-0006-S-01	10/11/2017	0.7	0.5	1.4	2.1	23.0	4.7	0.4	0.1	15.2
M2-16-0612-S-01	10/11/2017	0.7	0.5	1.4	0.1	23.7	4.3	0.3	0.1	16.8
M2-17-0006-S-01	10/11/2017	2.5	1.7	1.8	3.2	28.6	5.2	0.4	0.2	21.1
M2-17-0006-S-02S	10/11/2017	1.5	1.0	2.2	3.0	31.5	5.0	0.4	0.2	22.5
M2-17-0612-S-01	10/11/2017	2.6	1.7	2.0	1.9	26.6	5.8	0.7	0.3	22.8
M2-18-0006-S-01	10/11/2017	1.2	0.8	1.8	3.5	30.1	7.0	0.7	0.1	18.4
2-18-0006-S-02D	10/11/2017	1.2	0.8	1.4	0.6	24.3	5.3	0.6	0.1	18.2
M2-18-0612-S-01	10/11/2017	1.8	1.2	2.0	6.1	29.2	9.9	0.7	0.1	19.4
M2-18-3036-S-01	10/12/2017	1.0	0.7	1.5	4.8	21.7	14.0	1.1	0.1	14.9
M2-19-0036-S-01	10/11/2017	378.0	255.9	151.0	11.9	83.1	6.4	5.1	8.1	425.0
M2-19-4854-S-01	10/11/2017	108.0	73.1	462.0	25.9	89.7	3.8	2.8	2.3	61.5
M2-19A-0030-S-02S	10/11/2017	97.1	65.7	36.4	2.6	33.9	5.0	1.5	2.7	131.0
M2-19A-0036-S-01	10/11/2017	112.0	75.8	2.5	0.6	28.4	10.4	2.3	0.5	22.6
M2-19A-3036-S-01	10/11/2017	74.1	50.2	46.1	11.5	32.9	5.4	2.5	5.0	168.0
M2-21-0006-S-01	10/11/2017	61.2	41.4	10.5	0.3	27.7	7.3	1.9	2.1	88.9
M2-21-0612-S-01	10/11/2017	31.6	21.4	2.9	3.3	30.1	9.3	1.3	0.5	40.3
M2-21-1824-S-01	10/11/2017	12.5	8.5	1.9	3.0	23.7	6.9	1.1	1.5	53.6
M2-22-0006-S-01	10/12/2017	1.1	0.7	1.4	0.6	23.8	4.6	0.6	0.1	17.9
M2-22-0612-S-01	10/12/2017	1.3	0.8	1.8	0.8	22.2	3.8	0.4	0.1	18.4
M2-23-0006-S-01	10/12/2017	14.3	9.7	6.8	4.3	25.8	7.7	1.0	0.9	57.2
M2-23-0612-S-01	10/12/2017	5.9	4.0	1.6	0.2	25.8	7.0	0.5	0.2	26.0

*Calculated value based on conversion factor of 0.677 pCi/g per mg/kg.

**Values highlighted in yellow exceed the Investigation level for the indicated analyte.

Attachment A4 (Data Validation Report)

NOTE: The following table represents the data validation report for Phase 3 soil sampling results. It provides validation categories, requirements, evaluation and conclusions regarding data quality for intended use under the project DQOs.

Validation Category	Specified Requirements	Validation Requirement Met?	Qualifiers	Samples Affected	Comments
I. Relevant Field Data Review					
Sample Documentation, Handling, and Custody Requirements.	Field Logbook is present and complete according to the Work Plan. Information required: survey/sample date, survey/sample team, weather conditions, daily activities, deviation of SOPs.	Yes	None	All samples	
	Field data sheets are present and complete according to the Work Plan, including instrument function check sheets, instrument calibration certificates and soil sampling sheets.	Yes	None	All samples	All field QC documentation provided in Appendix A, though soil sampling sheets were generated retrospectively based on field logbook data entries. The time of day that soil samples were collected was not recorded, but this specification is not applicable as hold time specifications for radionuclides (none) and metals (6 months) in all soil samples were met to the nearest day.
	The relevant chain of custodies are present and complete according to the Work Plan.	Yes	None	All samples	All COC forms contained complete information and were properly signed by applicable custody personnel. Copies of the original COC forms were kept on file. However, not all COC entries matched the labels written on the samples received by the lab. This issue, primarily limited to data transcription errors in designation of field splits versus duplicates under the specified sample ID nomenclature, was resolved through contact with the Lab, and the case narrative for each lab report specifies the corrected sample ID numbers where applicable.
	Samples were labeled and packaged according to the Work Plan.	Yes	None	All samples	Modifications were made to the sample ID nomenclature: In naming field duplicate samples a "D" was added to the end of the sample name and an "S" was added to samples that were field splits.

Validation Category	Specified Requirements	Validation Requirement Met?	Qualifiers	Samples Affected	Comments
II. Analytical Lab Data Review					
Holding Times	Was the time between sampling and analysis less than six months for all samples?	Yes	None	All samples	Due to the time required for data reviews by EPA/NNEPA and related decisions regarding potential analysis of archived samples, one of the archived subsurface soil samples was not analyzed for metals until exactly 6 months after collection (narrowly meeting the applicable hold time specification).
Detection Limits	Did lab results for Arsenic meet the detection limit specifications of the Work Plan?	Yes	None	All samples	
	Did lab results for Actinium-228 meet the detection limit specifications of the Work Plan?	No	U, J	Report C17110208: BJ2-4-6066-S-01, BJ2-6-0612-S-01, BJ2-13-0006-S-01 Report C17110183: M1-4-1824-S-01, M1-5-1218-S-01 Report C17110195: BJ1-4-0018-S-01, BJ1-12-0006-S-01, BJ1-13-0612-S-01	Specified detection limits for these samples were not achieved by the lab, yet results for this analyte were flagged as below detection at a (higher) detection limit as reported by the lab. The appropriate qualifiers of undetected (U) and estimated value (J) are applicable to these samples. These qualifiers are not considered significant relative to the DQOs specified in the Phase 3 Work Plan.
	Did lab results for Molybdenum meet the detection limit specifications of the Work Plan?	Yes	None	All samples	
	Did lab results for Potassium-40 meet the detection limit specifications of the Work Plan?	No	U, J	Report C17110208: BJ2-7-0612-S-01	Specified detection limits for this sample was not achieved by the lab, and results for this analyte were flagged as below detection at a (higher) detection limit as reported by the lab. The appropriate qualifiers of undetected (U) and estimated value (J) are applicable to this sample. These qualifiers are not considered significant relative to the DQOs specified in the Phase 3 Work Plan.

Validation Category	Specified Requirements	Validation Requirement Met?	Qualifiers	Samples Affected	Comments
	Did lab results for Radium-226 meet the detection limit specifications of the Work Plan?	Yes	None	All samples	
	Did lab results for Selenium meet the detection limit specifications of the Work Plan?	No	N/A	Report C17110204: M2-12-0006-S-01, M2-12-0612-S-01 Report C17110208: BJ2-4B-144150-S-01, BJ2-11-150156-S-01	Specified detection limits for these samples were not achieved by the lab, and results for this analyte were not reported. Results for these samples were labeled as "ND" for not detected at the (higher) detection limit. For data analysis, the reported detection limit is assumed to be a suitably conservative estimated value.
	Did lab results for Uranium meet the detection limit specifications of the Work Plan?	Yes	None	All samples	
	Did lab results for Vanadium meet the detection limit specifications of the Work Plan?	Yes	None	All samples	
Calibration and Internal Standards	Energy Labs followed calibration standards and procedures according to the Work Plan.	Yes	None	All samples	
Laboratory Blanks	Analytes should not be detected above detection limits in calibration blank samples and the number of blanks reported in a data package should be 10% of the total number of samples reported.	Yes	None	All samples	

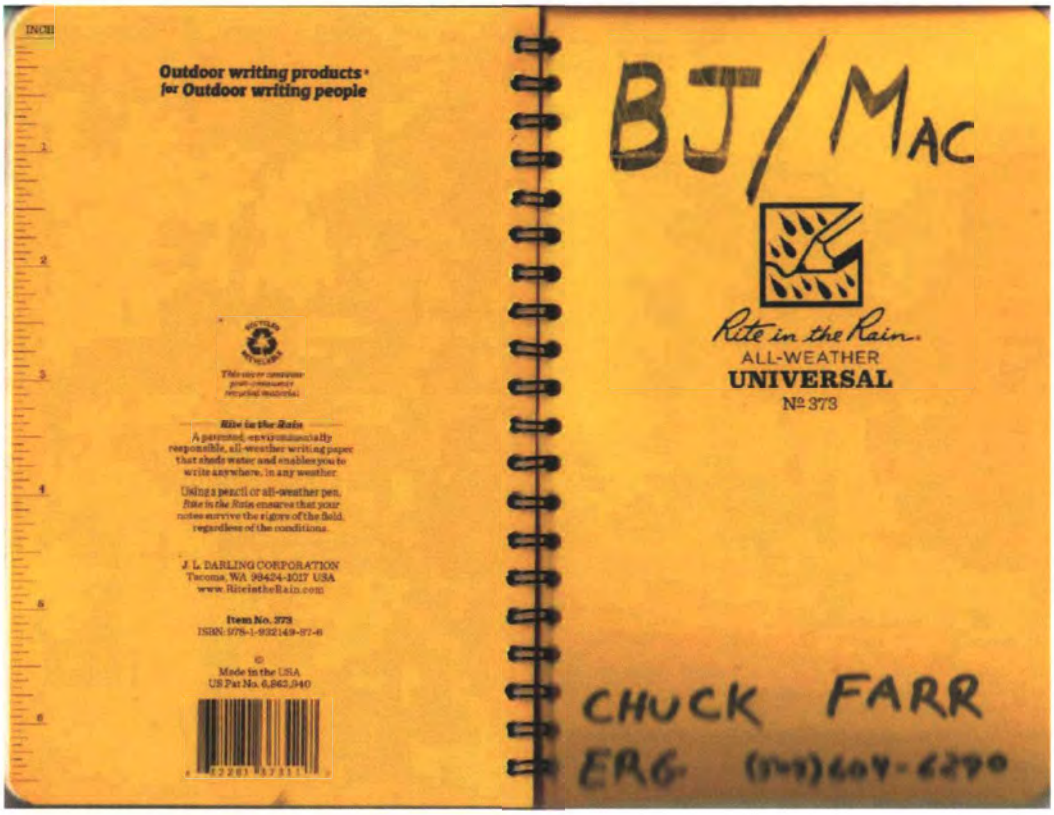
Validation Category	Specified Requirements	Validation Requirement Met?	Qualifiers	Samples Affected	Comments
	Preparation blanks should not exhibit contaminant concentrations > MDL and the number of preparation blanks should be at least 5% of the total number of samples reported.	No	B	Report C17110183: MB-39563, MB-50694 Report C17110195: MB-39563, MB-50706 Report C17110208: MB-50743 Report C17110204: MB-39598, MB-50722	According to Energy Labs, preparation blanks are method blanks. Method blank MB-39563 had a detectable amount of Uranium (0.04 mg/kg). None of the field samples in lab report C17110183 had a uranium concentration that was less than 10 times this amount, so a B qualifier (for "blank detection") does not apply to any samples in this data package. Method blank MB-39598 had a detectable amount of Molybdenum (0.05 mg/kg). The following field samples for lab report C17110204 had concentrations less than 10 times this amount, and are thus qualified as "B" for blank detection of molybdenum: M2-3-0612-S-01, M2-12-0006-S-01, M2-12-0612-S-01, M2-13-0612-S-01, M2-16-0006-S-01, M2-16-0612-S-01, M2-17-0006-S-01, M2-17-0006-S-02S, M2-22-0612-S-01 The other method blanks had detection of various radionuclides by gamma spectroscopy, including MB-50694 (K-40), MB-50706 (Ac-228 , Ra-226), MB-50743 (Ac-228, K-40, Ra-226), and MB-50722 (Ac-228, K-40, Ra-226). These detected parameters are all naturally occurring in geologic materials and may have been present in the blank sample matrix or sample container. For this reason, a blank detection qualifier is not appropriate in a context of data use under project DQOs.
Laboratory Control Standard Analysis	The LCS frequency must be at least 5% of the total reported samples. The LCS must fall within manufacturer's certified acceptance limits.	Yes	None	All samples	
Laboratory Duplicate Sample Analyses	Was a laboratory duplicate performed at a frequency of 5 percent of all investigative samples?	Yes	None	All samples	

Validation Category	Specified Requirements	Validation Requirement Met?	Qualifiers	Samples Affected	Comments
	With respect to radionuclides, do laboratory duplicates have a RER value of 2.0 or less?	No	J	Report C17110208: C17110208-080 C17110208-080Dup	With respect to Ac-228 this sample pair has a RER value of 2.9.
	With respect to metals and uranium do the laboratory duplicate pairs share a RPD value of 40% or less? Or alternatively, does the absolute difference of the pairs fall below 1 x RL?	N/A	None	All samples	Note: According to Energy Labs matrix spikes and a matrix spike dups serve as a metal duplicate sample (see Matrix Spike requirement below).
Field Duplicate Analysis	Field splits/replicates will be collected at a frequency of 5 percent of all soil samples collected (1 field split per 20 investigative samples).	Yes	None	All samples	Field splits/replicates were collected at a frequency of approximately 7% of all borehole samples.
	With respect to the metals and uranium the acceptance criteria for field splits/replicates will be a relative percent difference (RPD) that does not exceed 40 percent.	No	J	Report C17110195: BJ1-22-0006-S-02D, BJ1-12-0006-S-2D Report C17110204: M2-4-0006-S-02D, M2-6-0018-S-02S, M2-17-0006-S-02S Report C17110183: M1-4-0018-S-02S Report C17110204: M2-4-0006-S-02D, M2-6-0018-S-02S, M2-17-0006-S-02S	These sample duplicates/splits exceed the specified RPD for at least one analyte. Results for applicable analytes in these samples are considered only estimates (qualifier J). This does not impact estimates of contaminated soil volume based on Phase 3 data (these estimates are based primarily on gamma radiation measurements).

Validation Category	Specified Requirements	Validation Requirement Met?	Qualifiers	Samples Affected	Comments
	In the case of radiometric data with associate error reported, a replicate error ratio (RER) of 2 must not be exceeded.	No	J	Report C17110195: BJ1-22-0006-S-02D, BJ1-12-0006-S-2D, BJ1-4-0018-S-02S Report C17110208: BJ2-14-0018-S-02D, BJ2-6-0006-S-02D Report C17110183: M1-9-0006-S-02D, M1-10-0006-S-02D	These sample duplicates/splits exceed the acceptable RER for at least one radionuclide. Results for applicable analytes in these samples are considered only estimates (qualifier J). This does not impact estimates of contaminated soil volume based on Phase 3 data (those estimates are based primarily on gamma radiation measurements).
Matrix Spike	Do chemical recoveries of spike amounts fall within the control limit of 75-125% for metals and uranium?	No	J	Report C17110183: C17110183-024AMS, H17110372-001BMS, C17110183-035AMS Report C17110195: H17110341-004AMS Report C17110208: C17110208-080AMS, C17110208-060AMS	The following matrix spikes C17110183-024AMS, H17110372-001BMS, C17110183-035AMS, C17110208-080AMS, C17110208-060AMS have chemical recoveries greater than 125%, with respect to Vanadium. These spikes are all associated with batch report C17110183 and C17110208. All Vanadium sample results in these batches exceed the MDL and have been qualified as "J". Matrix spike C17110183-035AMS has a chemical recovery greater than 125%, with respect to Uranium. This matrix spike is associated with batch report C17110183. All Uranium sample results in this batch exceed the MDL and have been qualified as "J". The following matrix spikes H17110372-001BMS and H17110341-004AMS have chemical recoveries less than 75% or greater than 125%, with respect to Arsenic. These spikes are all associated with batch report C17110183 and C17110195. All Arsenic sample results in these batches exceed the MDL and have been qualified as "J".
Serial Dilution	Analysis of a 5-fold dilution must agree within 10 percent difference (5%) of the original results.	No	J	Report C17110204: H17110390-002ADIL Report C17110208: C17110208-080ADIL, C17110208-099ADIL, C17110208-002ADIL	A majority of the results showed that the analyte concentration was not sufficiently high enough to calculate a RPD for the serial dilution test. The samples listed to the left had results where the RPD exceeded specified limits.

Validation Category	Specified Requirements	Validation Requirement Met?	Qualifiers	Samples Affected	Comments
Assessment of Data Completeness	The percentage of valid data (%C) must meet the criteria established in the project plans (95%).	Yes	None	All samples	
Sample Result Verification	Are the reported results accurate and complete?	Yes	None	All samples	

Attachment A5 (Field Logbook Notes)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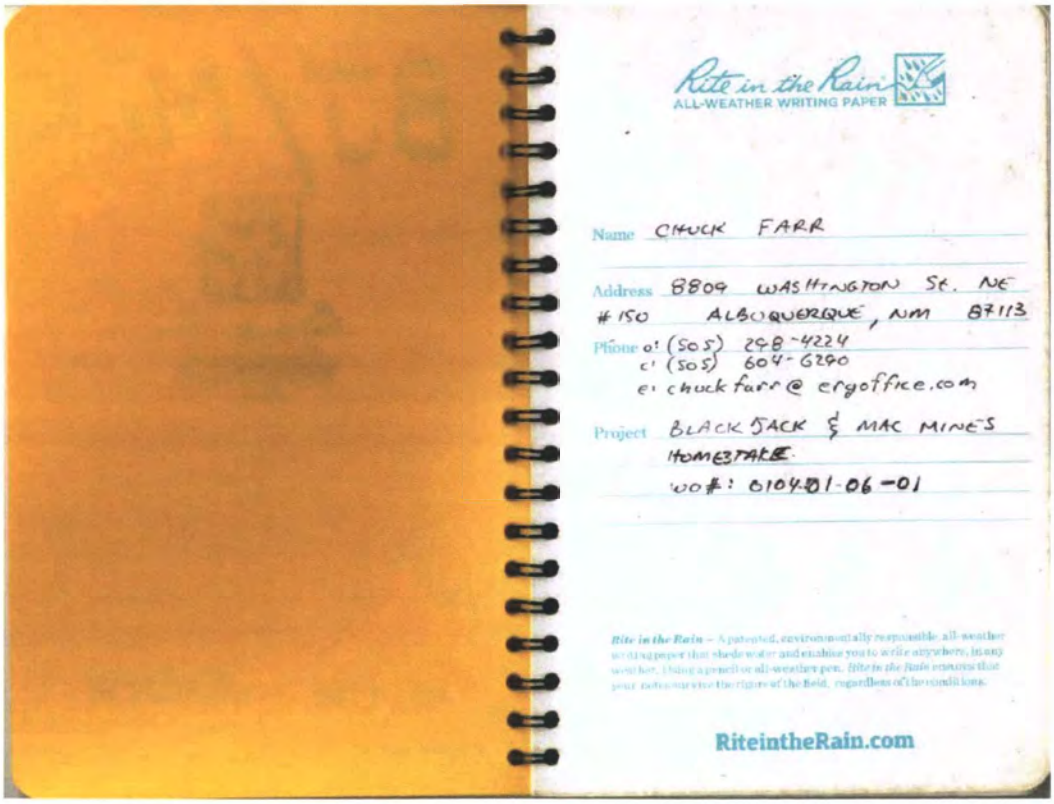
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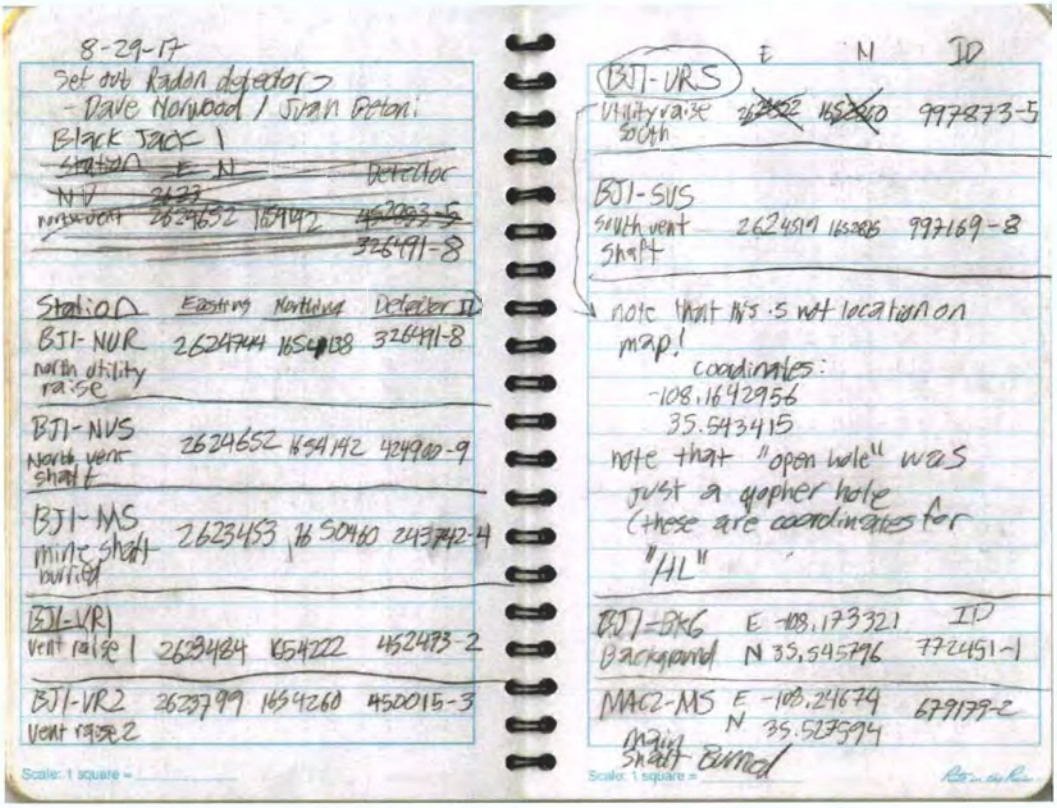


8-29-17
Set out Radon detectors
- Dave Norwood / Sean Beloni
Black Jack 1
~~Station E N Detector~~
NV 2433
~~Norwood 2624652 1654142 452093-5~~
326491-8

Station	Easting	Northing	Detector ID
BJ1-NUR north utility raise	2624744	1654138	326491-8
BJ1-NVS North vent shaft	2624652	1654142	424900-9
BJ1-MS mine shaft buried	2623453	1650460	243742-4
BJ1-VR1 Vent raise 1	2623484	1654222	452473-2
BJ1-VR2 Vent raise 2	2623799	1654260	450015-3

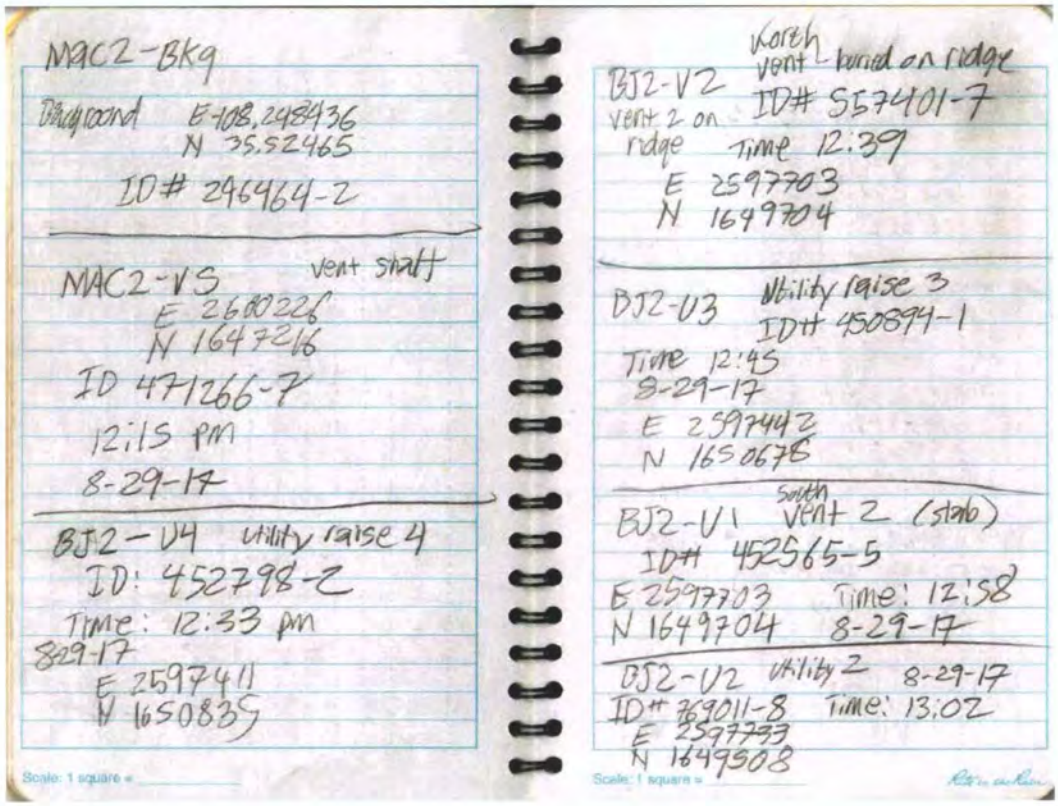
Scale: 1 square =

	E	N	ID
BJ1-URS Utility raise South	2624552	1652810	997873-5
BJ1-SVS South vent shaft	2624519	1653285	997169-8

note that MS-5 not location on map!
coordinates:
-108.1642956
35.543415
note that "open hole" was just a gopher hole (these are coordinates for "HL"

BJ1-BKG Background	E -108.173321 N 35.545796		ID 772451-1
MAC2-MS main shaft buried	E -108.24674 N 35.527594		679179-2

Scale: 1 square =



MAC2-BKg
Background E-108.248436
N 35.52465
ID# 246464-2

MAC2-VS vent shaft
E 2600226
N 1647216
ID 471266-7
12:15 pm
8-29-17

BJ2-V4 Utility raise 4
ID: 452798-2
Time: 12:33 pm
8-29-17
E 2597411
N 1650835

Scale: 1 square =

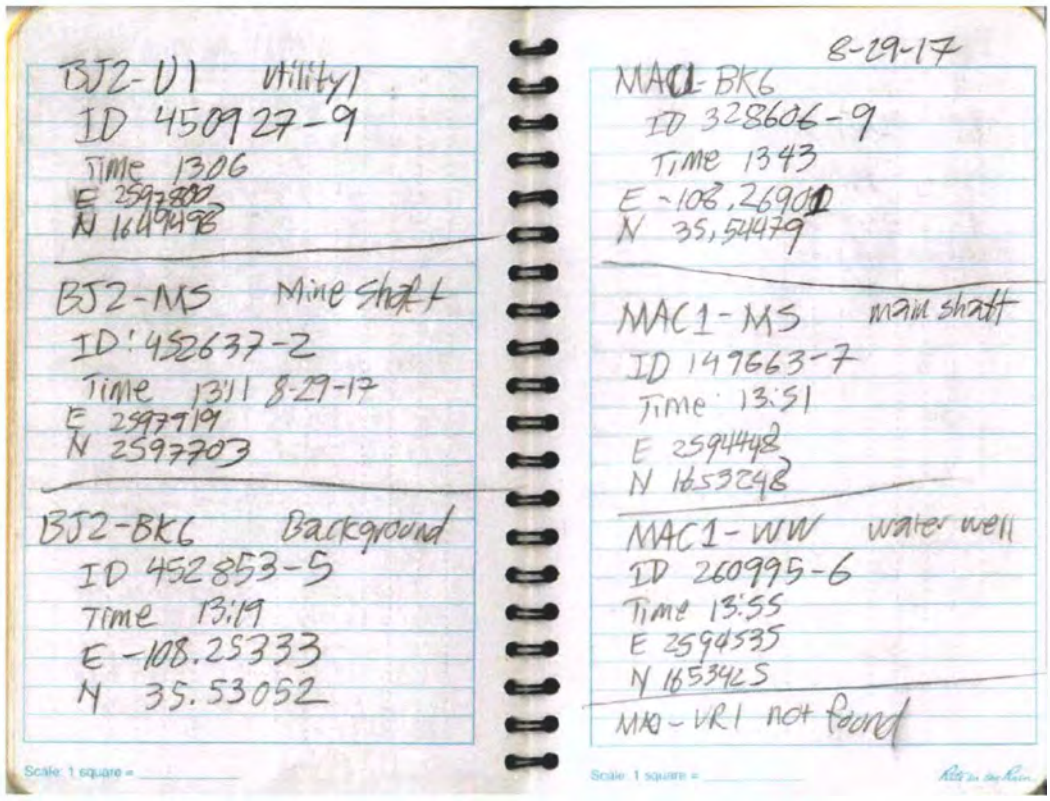
BJ2-V2 North vent buried on ridge
vent 2 on ridge ID# 557401-7
Time 12:39
E 2597703
N 1649704

BJ2-V3 Utility raise 3
ID# 450894-1
Time 12:45
8-29-17
E 2597442
N 1650678

BJ2-V1 South vent 2 (stake)
ID# 452565-5
E 2597703 Time: 12:58
N 1649704 8-29-17

BJ2-V2 utility 2 8-29-17
ID# 369011-8 Time: 13:02
E 2597793
N 1649508

Scale: 1 square =



BJ2-U1 Utility1
ID 450927-9
Time 1306
E 2597800
N 1649498

BJ2-MS Mine Shaft
ID 452637-2
Time 1311 8-29-17
E 2597719
N 2597703

BJ2-BK6 Background
ID 452853-5
Time 13:19
E -108.25333
N 35.53052

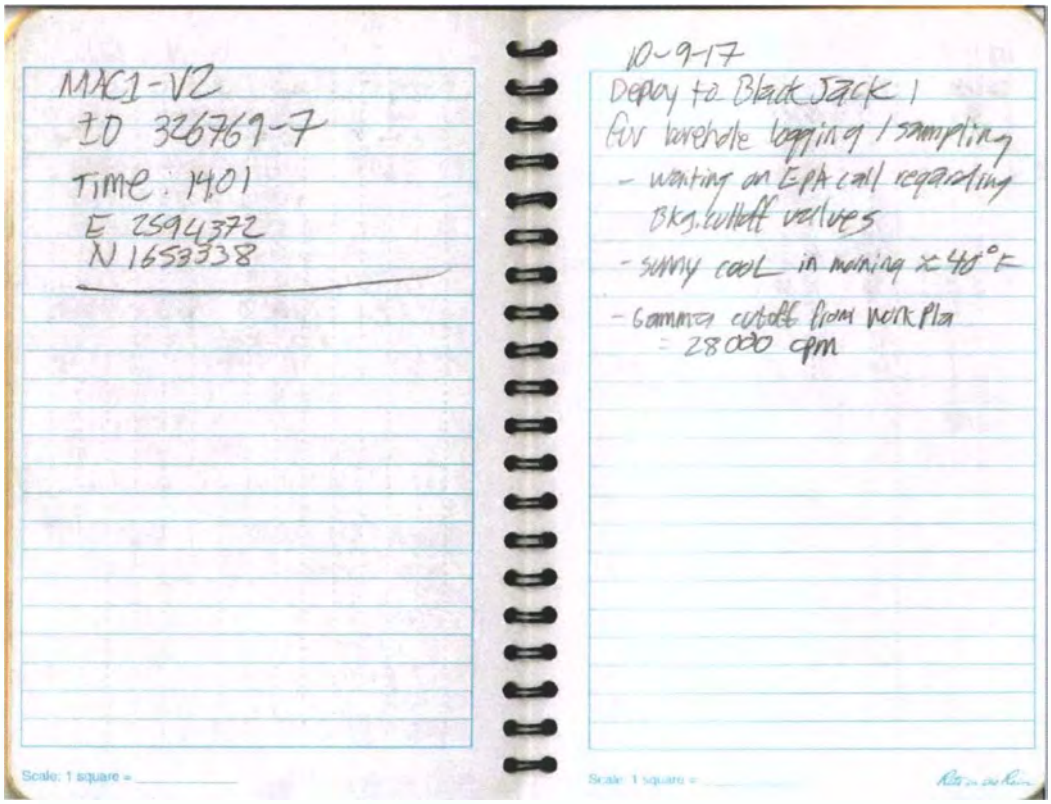
8-29-17

MAC1-BK6
ID 328606-9
Time 1343
E -108.26901
N 35.54479

MAC1-MS main shaft
ID 149663-7
Time 13:51
E 2594448
N 1653248

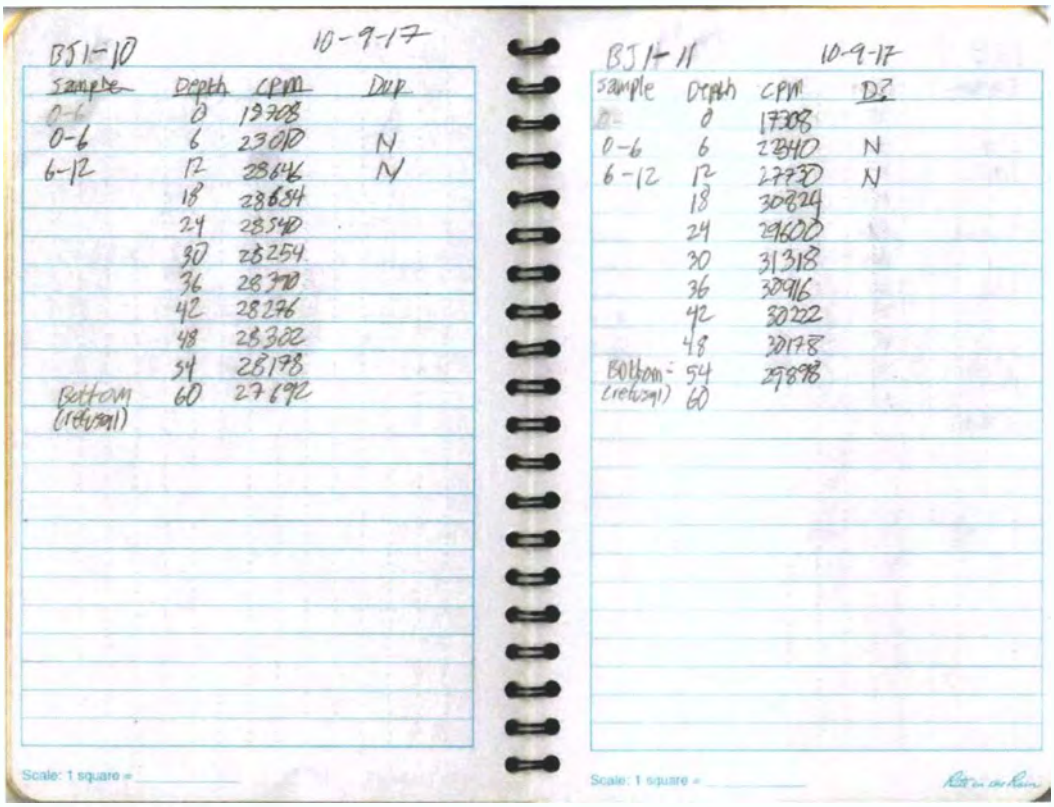
MAC1-WW water well
ID 260995-6
Time 13:55
E 2594535
N 1653425

MAC-VR1 not found



MAC1-V2
ID 326769-7
Time: 1401
E 2594372
N 1653338

10-9-17
Depay to Black Jack 1
for borehole logging / sampling
- waiting on EPA call regarding Bkg. cutoff values
- sunny cool in morning ~ 40°F
- Gamma cutoff from work Plan = 28000 cpm

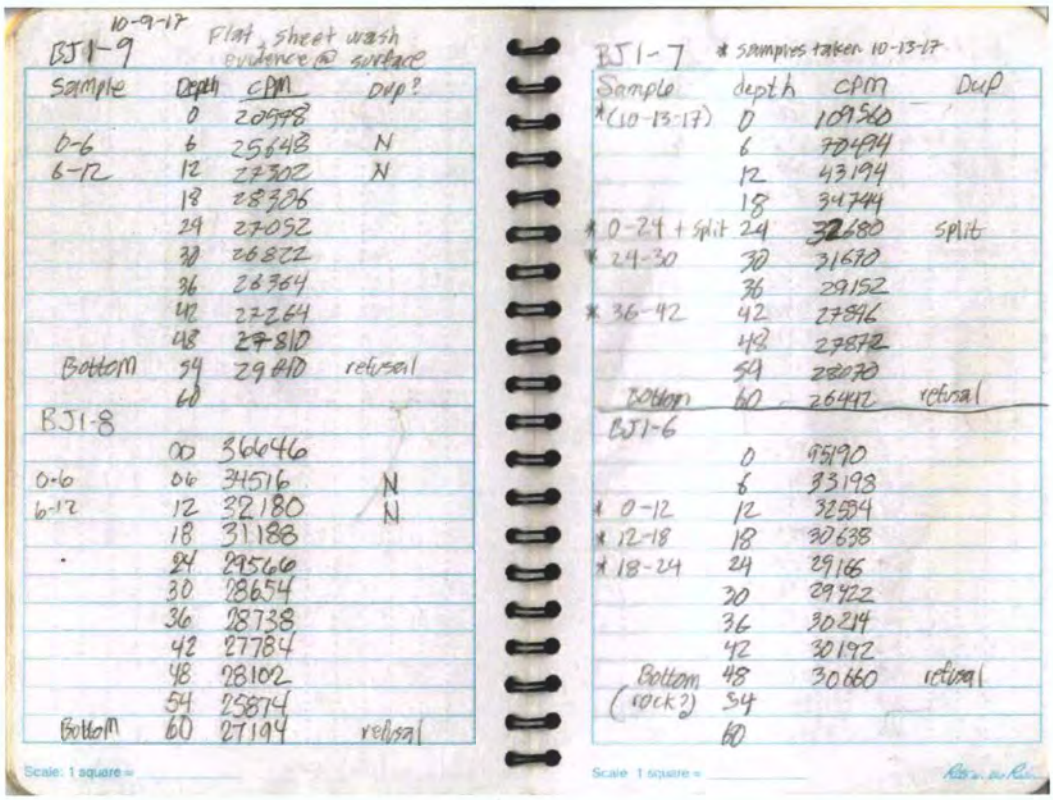


BJ1-10 10-9-17

Sample	Depth	CPM	Dup
0-6	0	19708	
0-6	6	23010	N
6-12	12	28646	N
	18	28654	
	24	28540	
	30	28254	
	36	28390	
	42	28296	
	48	28302	
	54	28198	
Bottom (refusal)	60	27692	

BJ1-11 10-9-17

Sample	Depth	CPM	Dup
0-	0	17308	
0-6	6	27840	N
6-12	12	27730	N
	18	30824	
	24	29600	
	30	31318	
	36	30916	
	42	30222	
	48	30178	
Bottom (refusal)	54	29898	
	60		



10-9-17 Flat, sheet wash evidence @ surface

BJ1-9

Sample	Depth	CPM	Dup?
	0	20578	
0-6	6	25648	N
6-12	12	27302	N
	18	28306	
	24	27052	
	30	26822	
	36	28364	
	42	27264	
	48	27810	
Bottom	54	29810	refusal
	60		

BJ1-8

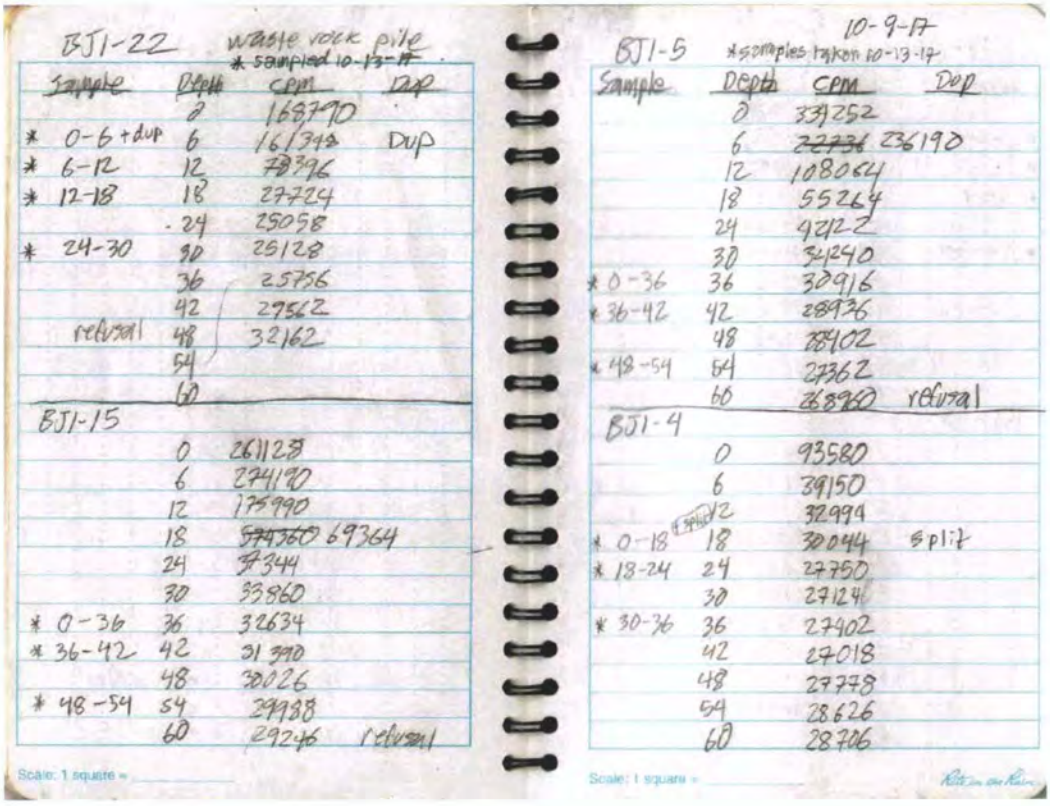
	00	36646	
0-6	06	34516	N
6-12	12	32180	N
	18	31188	
	24	29566	
	30	28654	
	36	28738	
	42	27784	
	48	28102	
	54	25874	
Bottom	60	27194	refusal

BJ1-7 * samples taken 10-13-17

Sample	depth	CPM	Dup
*(10-13-17)	0	109560	
	6	70494	
	12	43194	
	18	34744	
* 0-24 + split	24	32680	split
* 24-30	30	31690	
	36	29152	
* 36-42	42	27896	
	48	27872	
	54	28070	
Bottom	60	26442	refusal

BJ1-6

	0	95190	
	6	83198	
* 0-12	12	32594	
* 12-18	18	30638	
* 18-24	24	29186	
	30	29422	
	36	30214	
	42	30192	
Bottom (rock?)	48	30660	refusal
	54		
	60		



BJ1-22 waste rock pile
* sampled 10-13-17

Sample	Depth	cpm	Dup
	0	168790	
* 0-6 + dup	6	161342	Dup
* 6-12	12	78396	
* 12-18	18	27724	
	24	25058	
* 24-30	30	25128	
	36	25756	
	42	27562	
refusal	48	32162	
	54		
	60		

BJ1-15

	0	261128	
	6	274190	
	12	175990	
	18	~~574360~~ 69364	
	24	37344	
	30	33860	
* 0-36	36	32634	
* 36-42	42	31390	
	48	30026	
* 48-54	54	29938	
	60	29246	refusal

Scale: 1 square =

10-9-17

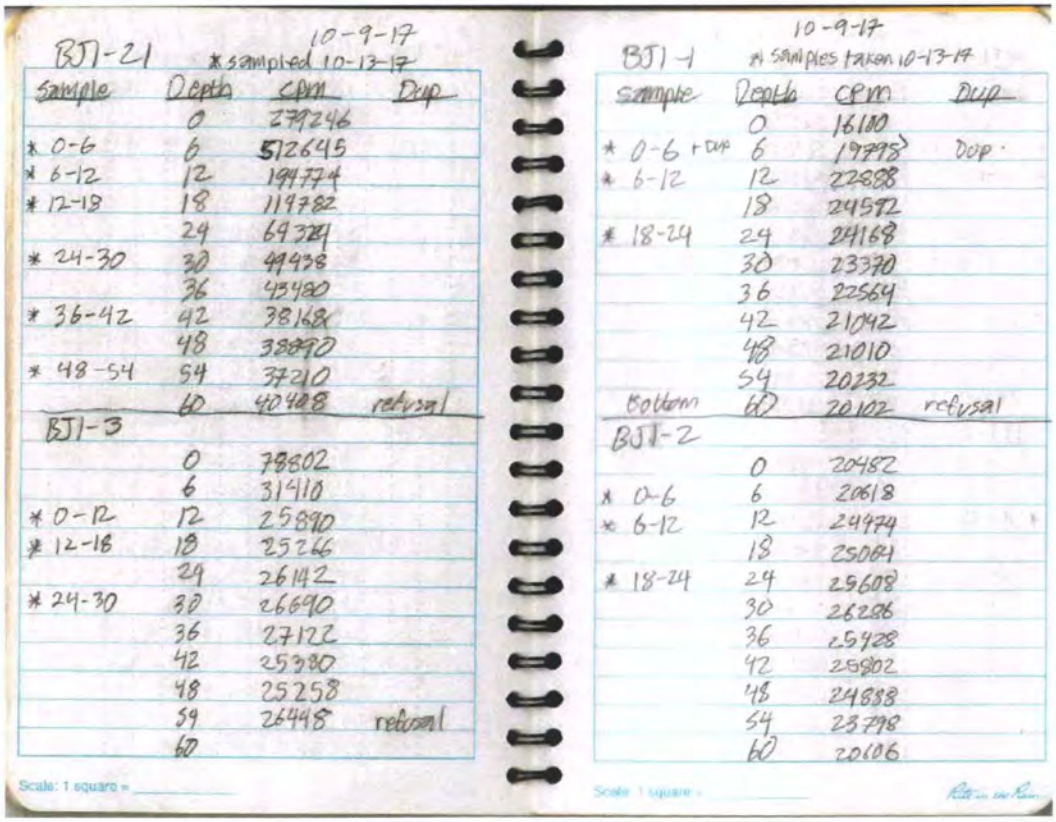
BJ1-5 * samples taken 10-13-17

Sample	Depth	cpm	Dup
	0	331252	
	6	~~22736~~ 236190	
	12	108064	
	18	55264	
	24	42122	
	30	34240	
* 0-36	36	30916	
* 36-42	42	28936	
	48	28402	
* 48-54	54	27362	
	60	26880	refusal

BJ1-4

	0	93580	
	6	39150	
	12	32994	
* 0-18 (* split)	18	30044	split
* 18-24	24	27750	
	30	27124	
* 30-36	36	27402	
	42	27018	
	48	27778	
	54	28626	
	60	28706	

Scale: 1 square =



10-9-17

BJ1-21 * sampled 10-13-17

Sample	Depth	cpm	Dup
	0	279246	
* 0-6	6	512645	
* 6-12	12	199774	
* 12-18	18	119782	
	24	69321	
* 24-30	30	49438	
	36	43480	
* 36-42	42	38168	
	48	38870	
* 48-54	54	37210	
	60	40428	refusal

BJ1-3

	0	78802	
	6	31410	
* 0-12	12	25890	
* 12-18	18	25246	
	24	26142	
* 24-30	30	26690	
	36	27122	
	42	25380	
	48	25258	
	54	26448	refusal
	60		

Scale: 1 square =

10-9-17

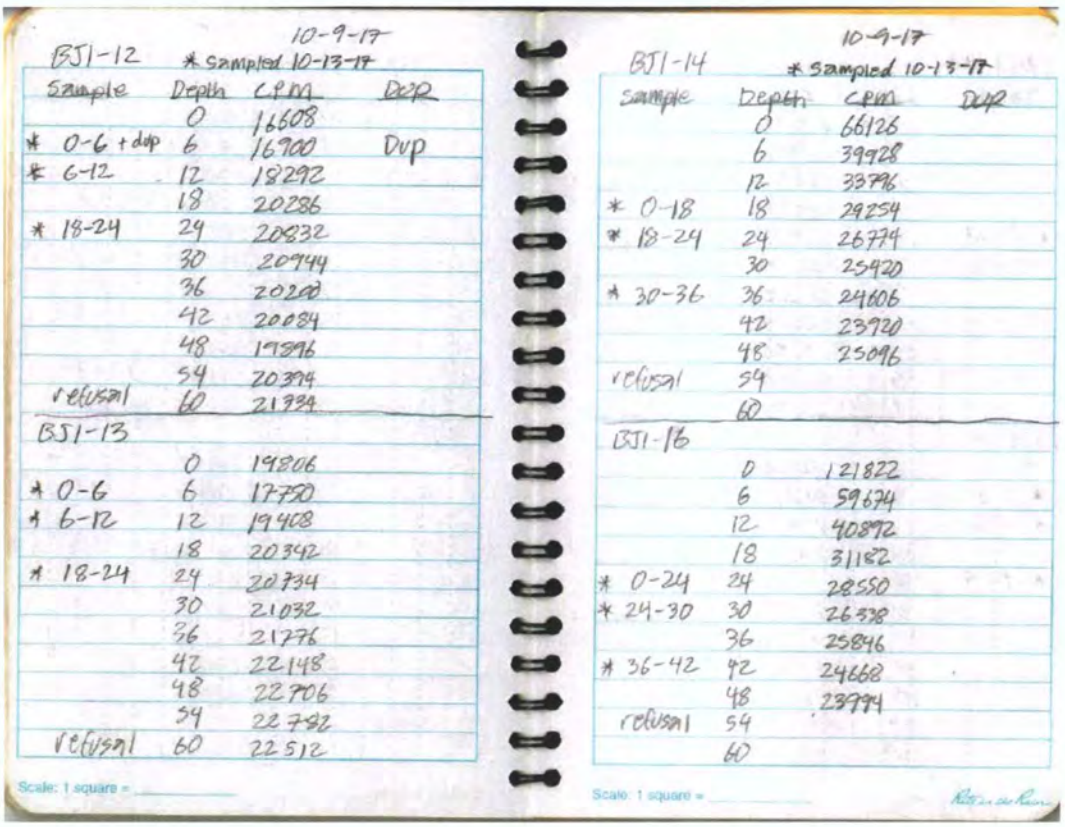
BJ1-1 * samples taken 10-13-17

Sample	Depth	cpm	Dup
	0	16180	
* 0-6 + dup	6	19795	Dup
* 6-12	12	22888	
	18	24592	
* 18-24	24	24168	
	30	23370	
	36	22564	
	42	21042	
	48	21010	
	54	20232	
Bottom	60	20102	refusal

BJ1-2

	0	20482	
* 0-6	6	20618	
* 6-12	12	24474	
	18	25084	
* 18-24	24	25608	
	30	26286	
	36	25428	
	42	25802	
	48	24838	
	54	23798	
	60	20606	

Scale: 1 square =



10-9-17

BJ1-12 * sampled 10-13-17

Sample	Depth	CPM	Dup
	0	16608	
* 0-6 + dup	6	16900	Dup
* 6-12	12	18292	
	18	20286	
* 18-24	24	20832	
	30	20744	
	36	20200	
	42	20084	
	48	19896	
	54	20394	
refusal	60	21934	

BJ1-13

	0	14806	
* 0-6	6	17750	
* 6-12	12	19408	
	18	20342	
* 18-24	24	20734	
	30	21032	
	36	21776	
	42	22148	
	48	22706	
	54	22782	
refusal	60	22512	

Scale: 1 square = _____

10-9-17

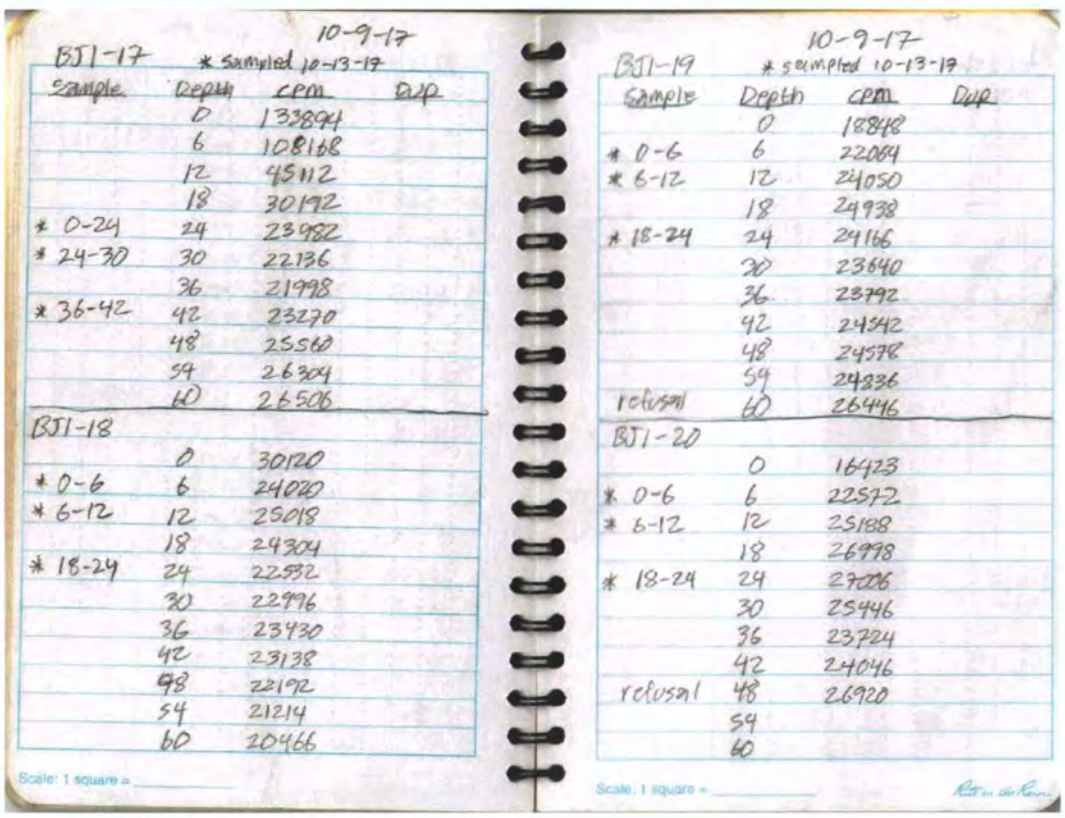
BJ1-14 * sampled 10-13-17

Sample	Depth	CPM	Dup
	0	66126	
	6	39928	
	12	33796	
* 0-18	18	29254	
* 18-24	24	26774	
	30	25920	
* 30-36	36	24606	
	42	23920	
	48	25096	
refusal	54		
	60		

BJ1-16

	0	121822	
	6	59674	
	12	40892	
	18	31182	
* 0-24	24	28550	
* 24-30	30	26538	
	36	25846	
* 36-42	42	24668	
	48	23994	
refusal	54		
	60		

Scale: 1 square = _____



10-9-17

BJ1-17 * sampled 10-13-17

Sample	Depth	CPM	Dup
	0	133894	
	6	108168	
	12	45112	
	18	30192	
* 0-24	24	23982	
* 24-30	30	22136	
	36	21998	
* 36-42	42	23270	
	48	25560	
	54	26304	
	60	26506	

BJ1-18

	0	30120	
* 0-6	6	24020	
* 6-12	12	25018	
	18	24304	
* 18-24	24	22532	
	30	22996	
	36	23430	
	42	23138	
	48	22192	
	54	21214	
	60	20466	

Scale: 1 square = _____

10-9-17

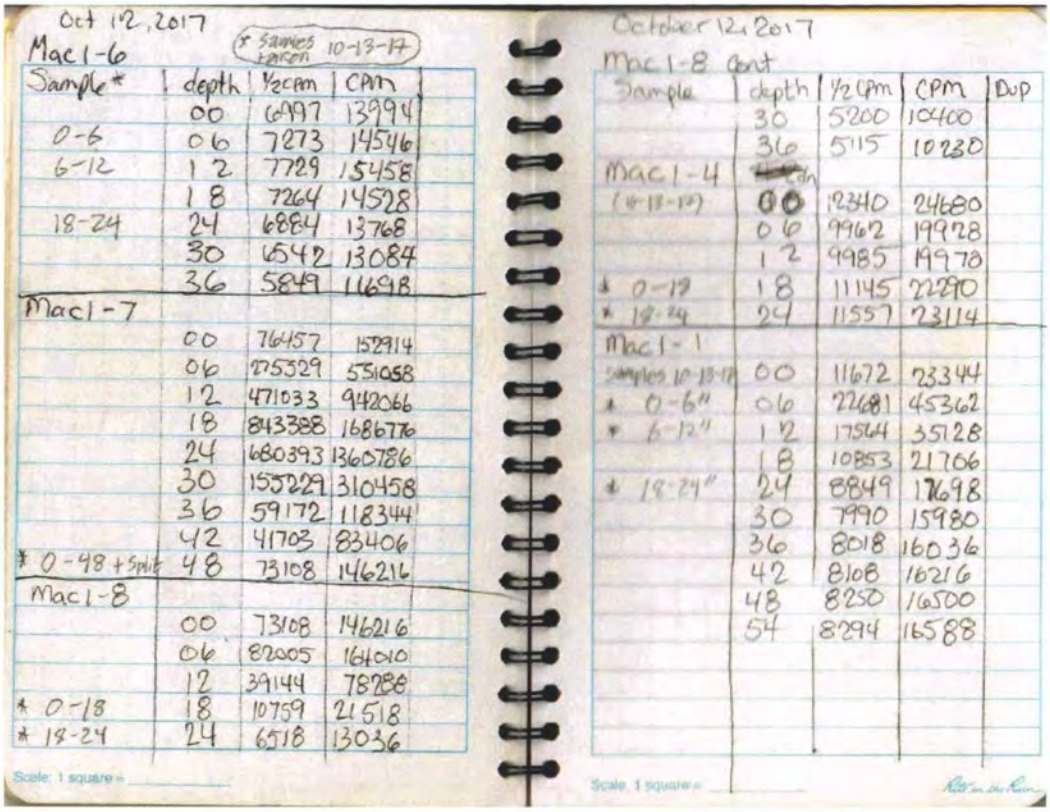
BJ1-19 * sampled 10-13-17

Sample	Depth	CPM	Dup
	0	18848	
* 0-6	6	22084	
* 6-12	12	24050	
	18	24938	
* 18-24	24	24166	
	30	23640	
	36	23792	
	42	24342	
	48	24578	
	54	24836	
refusal	60	26446	

BJ1-20

	0	16423	
* 0-6	6	22572	
* 6-12	12	25188	
	18	26998	
* 18-24	24	27006	
	30	25446	
	36	23724	
	42	24046	
refusal	48	26920	
	54		
	60		

Scale: 1 square = _____



Oct 12, 2017

Mac 1-6

(* Samples taken 10-13-17)

Sample*	depth	½cpm	cpm
	00	6997	13994
0-6	06	7273	14546
6-12	12	7729	15458
	18	7264	14528
18-24	24	6884	13768
	30	6542	13084
	36	5849	11698
Mac 1-7			
	00	76457	152914
	06	275529	551058
	12	471033	942066
	18	843388	1686776
	24	680393	1360786
	30	155229	310458
	36	59172	118344
	42	41703	83406
* 0-48 + Split	48	73108	146216
Mac 1-8			
	00	73108	146216
	06	82005	164010
	12	39144	78288
* 0-18	18	10759	21518
* 18-24	24	6518	13036

Scale: 1 square =

October 12, 2017

Mac 1-8 cont

Sample	depth	½ cpm	CPM	Dup
	30	5200	10400	
	36	5115	10230	
Mac 1-4				
(10-13-17)	00	12340	24680	
	06	9962	19928	
	12	9985	19970	
* 0-18	18	11145	22290	
* 18-24	24	11557	23114	
Mac 1-1				
Samples 10-13-17	00	11672	23344	
* 0-6"	06	22681	45362	
* 6-12"	12	17564	35128	
	18	10853	21706	
* 18-24"	24	8849	17698	
	30	7990	15980	
	36	8018	16036	
	42	8108	16216	
	48	8250	16500	
	54	8294	16588	

Scale: 1 square =

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BLACK Jack & MAC
Phase III 9/28/17

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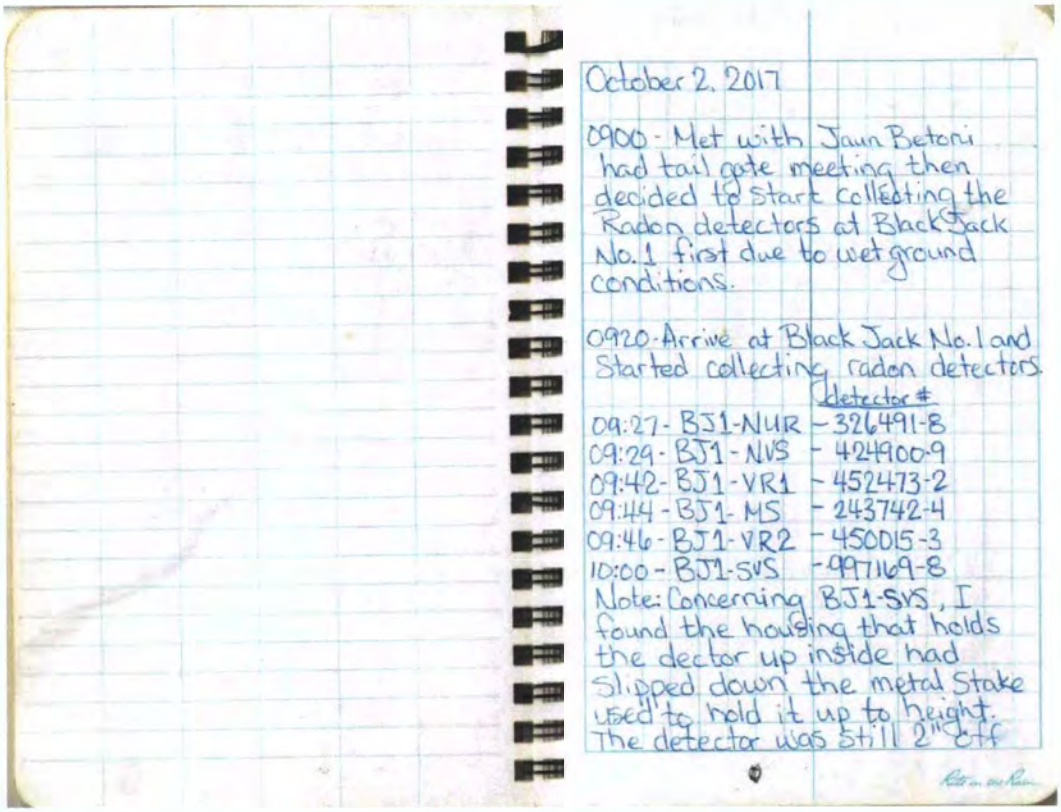


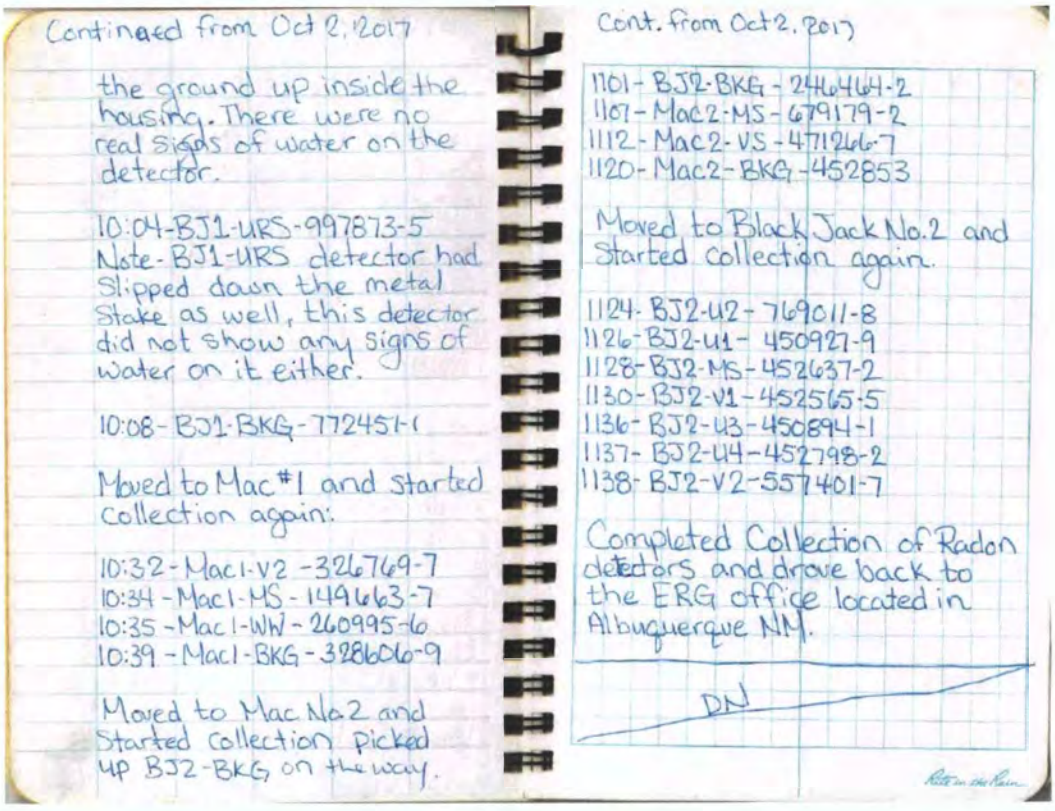
October 2, 2017

0900 - Met with Jaun Betoni had tail gate meeting then decided to start collecting the Radon detectors at Black Jack No. 1 first due to wet ground conditions.

0920 - Arrive at Black Jack No. 1 and Started collecting radon detectors.

	Detector #
09:27 - BJ1-NUR	- 326491-8
09:29 - BJ1-NVS	- 424900-9
09:42 - BJ1-VR1	- 452473-2
09:44 - BJ1-MS	- 243742-4
09:46 - BJ1-VR2	- 450015-3
10:00 - BJ1-SVS	- 997169-8

Note: Concerning BJ1-SVS, I found the housing that holds the dector up inside had slipped down the metal Stake used to hold it up to height. The detector was still 2" off



Continued from Oct 2, 2017

the ground up inside the housing. There were no real signs of water on the detector.

10:04 - BJ1-URS - 997873-5
Note - BJ1-URS detector had slipped down the metal Stake as well, this detector did not show any signs of water on it either.

10:08 - BJ1-BKG - 772451-1

Moved to Mac #1 and started collection again:

10:32 - Mac1-V2 - 326769-7
10:34 - Mac1-MS - 149663-7
10:35 - Mac1-WW - 260995-6
10:39 - Mac1-BKG - 328606-9

Moved to Mac No2 and Started collection picked up BJ2-BKG on the way.

Cont. from Oct 2, 2017

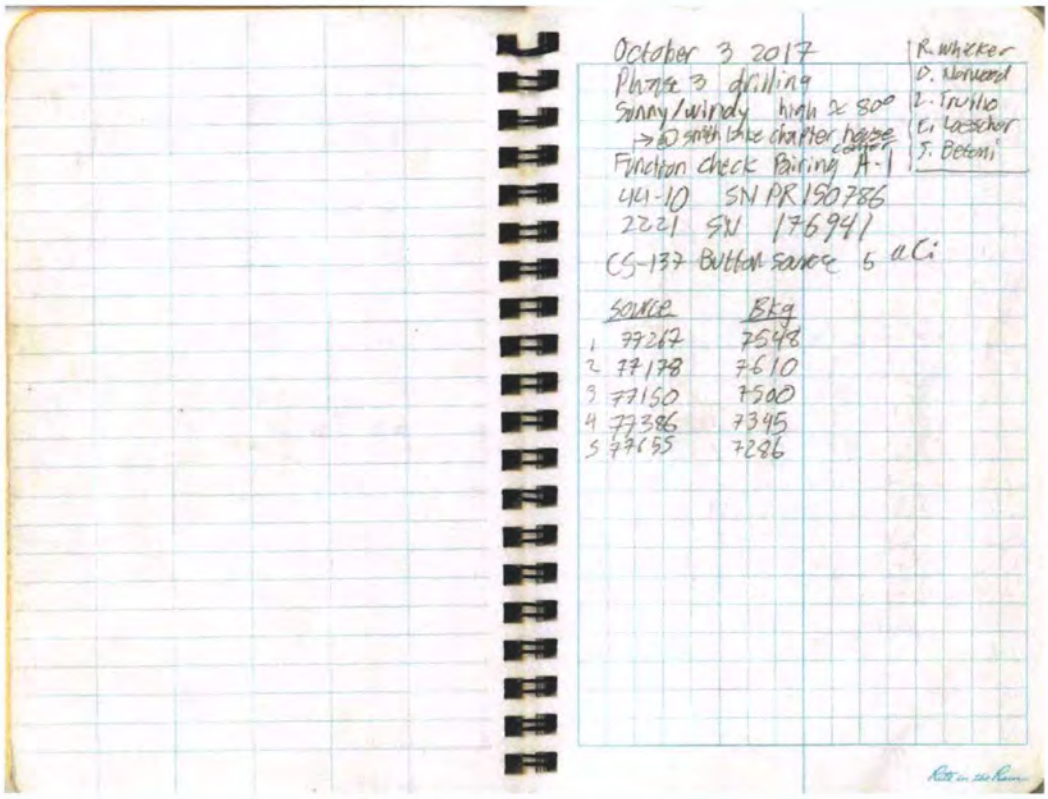
1101 - BJ2-BKG - 246464-2
1107 - Mac2-MS - 679179-2
1112 - Mac2-VS - 471266-7
1120 - Mac2-BKG - 452853

Moved to Black Jack No. 2 and started collection again.

1124 - BJ2-U2 - 769011-8
1126 - BJ2-U1 - 450927-9
1128 - BJ2-MS - 452637-2
1130 - BJ2-V1 - 452565-5
1136 - BJ2-U3 - 450894-1
1137 - BJ2-U4 - 452798-2
1138 - BJ2-V2 - 557401-7

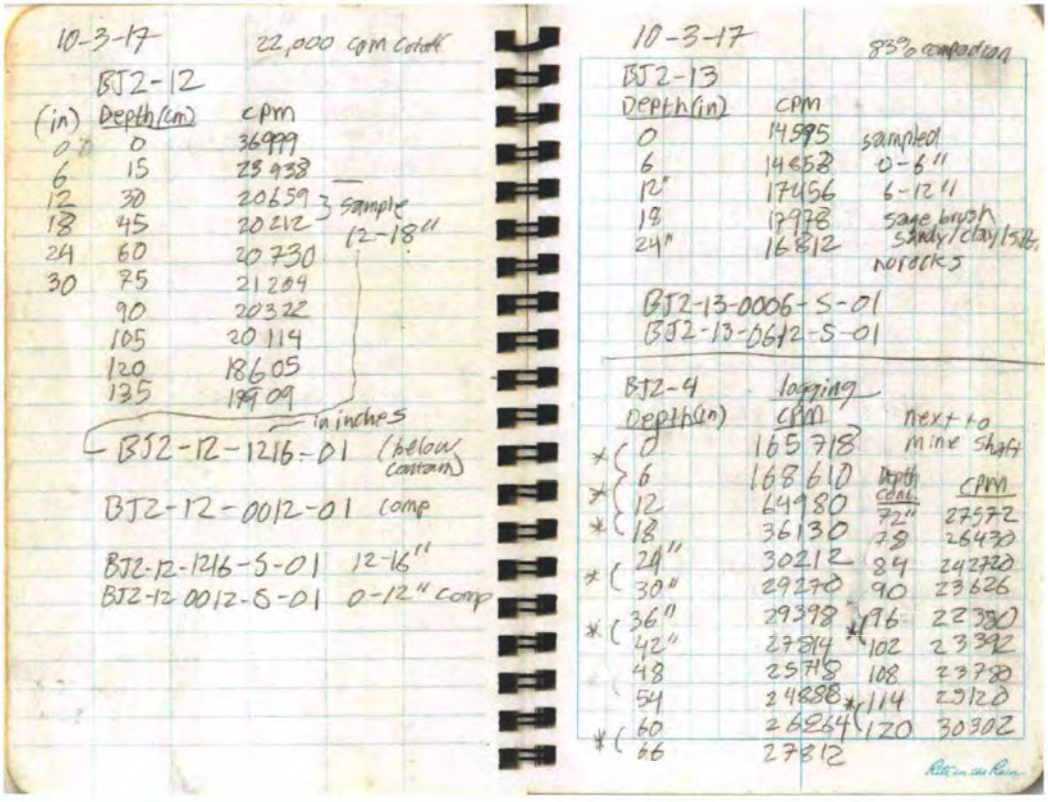
Completed Collection of Radon detectors and drove back to the ERG office located in Albuquerque NM.

DN



October 3 2017 | R. Whicker
Phase 3 drilling | D. Norwood
Sunny/windy high ~ 80° | L. Trujillo
→ 20 smith like chapter house | E. Loescher
Function check pairing A-1 | J. Bertoni
441-10 SN PR150786
2221 SN 176941
CS-137 Button source 5 uCi

	Source	Bkg
1	77267	7548
2	77178	7610
3	77150	7500
4	77386	7345
5	77155	7286



10-3-17 22,000 cpm cutoff

BJ2-12

(in)	Depth (cm)	cpm
0	0	36999
6	15	28938
12	30	20659
18	45	20212
24	60	20730
30	75	21204
	90	20322
	105	20114
	120	18605
	135	19909

3 sample 12-18" in inches

BJ2-12-1216-01 (below contam)

BJ2-12-0012-01 comp

BJ2-12-1216-5-01 12-16"
BJ2-12-0012-5-01 0-12" comp

10-3-17 83% completion

BJ2-13

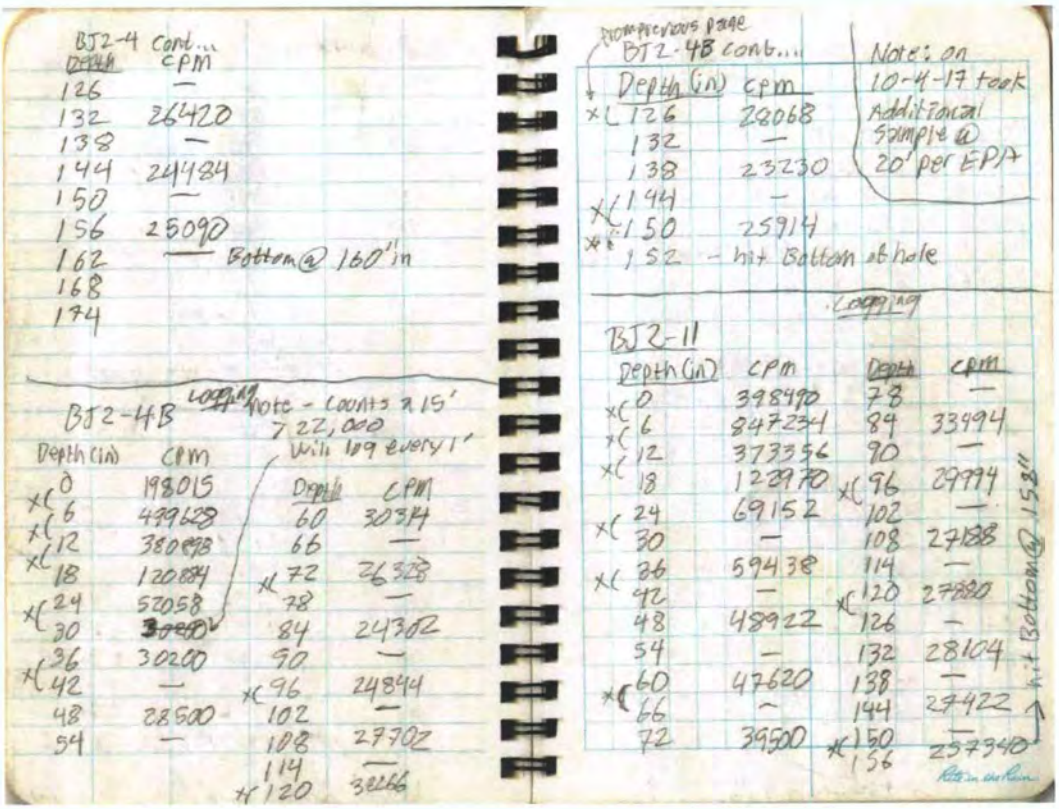
Depth (in)	cpm	
0	14595	sampled
6	14658	0-6"
12"	17456	6-12"
18	17978	sage brush sandy/clay/silt,
24"	16812	no rocks

BJ2-13-0006-5-01
BJ2-13-0612-5-01

BJ2-4 logging

Depth (in)	cpm	
* 0	165718	next to mine shaft
* 6	168610	
* 12	64980	
* 18	36130	
* 24"	30212	
* 30"	29270	
* 36"	29398	
42"	27814	
48	25718	
54	24888	
* 60	26264	
66	27812	

Depth coal	cpm
72"	27572
78	26430
84	24272
90	23626
96	22380
102	23392
108	23780
* 114	29120
120	30302



BJ2-4 cont...

Depth	cpm
126	—
132	26420
138	—
144	24484
150	—
156	25090
162	— Bottom @ 160' in
168	
174	

BJ2-4B Logging — Note - counts x 15' 7 22,000 With log every 1'

Depth (in)	cpm
0	198015
6	439628
12	380498
18	120884
24	52058
30	30200
36	
42	
48	28500
54	—
60	30314
66	—
72	26328
78	—
84	24302
90	—
96	24844
102	—
108	27702
114	—
120	38266

From previous page

BJ2-4B cont....

Depth (in)	cpm
126	28068
132	—
138	23230
144	—
150	25914
152	- hit Bottom of hole

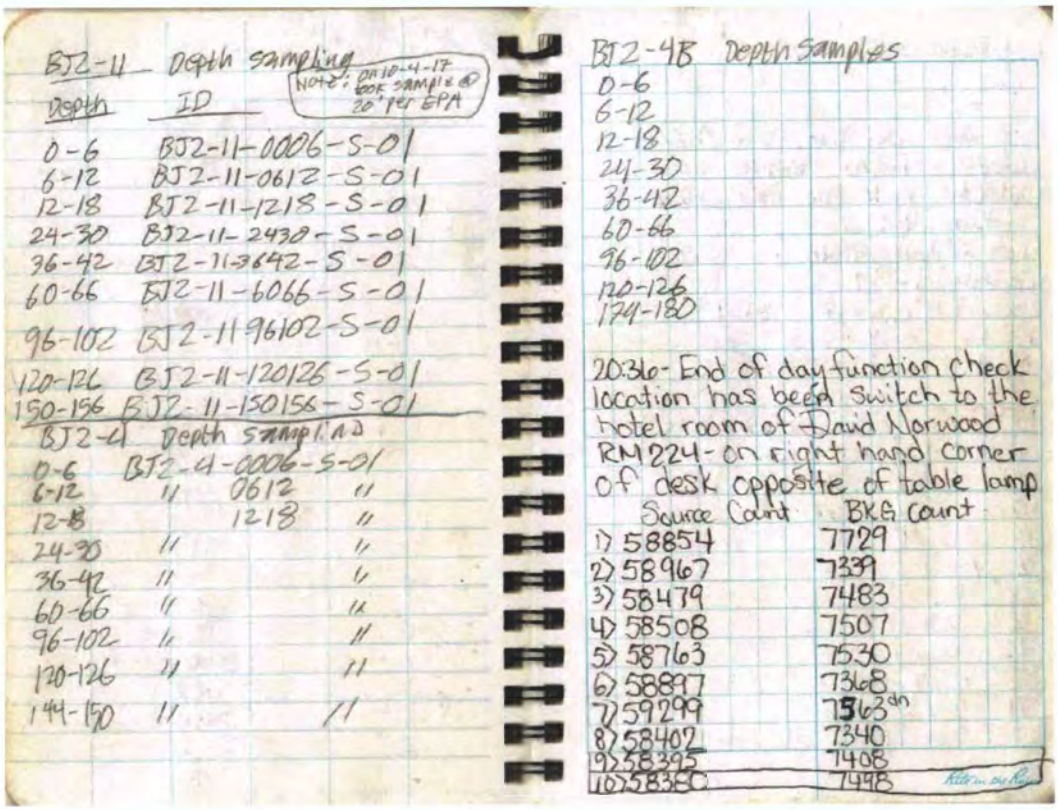
Note: on 10-4-17 took Additional sample @ 20' per EPA

Logging

BJ2-11

Depth (in)	cpm
0	398490
6	847234
12	373356
18	123970
24	69152
30	—
36	59438
42	—
48	48922
54	—
60	47620
66	—
72	39500
78	—
84	33494
90	—
96	29994
102	—
108	27188
114	—
120	27880
126	—
132	28104
138	—
144	27422
150	—
156	257340

Hit Bottom @ 158"



BJ2-11 Depth sampling

Note: On 10-4-17 took sample @ 20' per EPA

Depth	ID
0-6	BJ2-11-0006-S-01
6-12	BJ2-11-0612-S-01
12-18	BJ2-11-1218-S-01
24-30	BJ2-11-2430-S-01
36-42	BJ2-11-3642-S-01
60-66	BJ2-11-6066-S-01
96-102	BJ2-11-96102-S-01
120-126	BJ2-11-120126-S-01
150-156	BJ2-11-150156-S-01

BJ2-4 Depth sampling

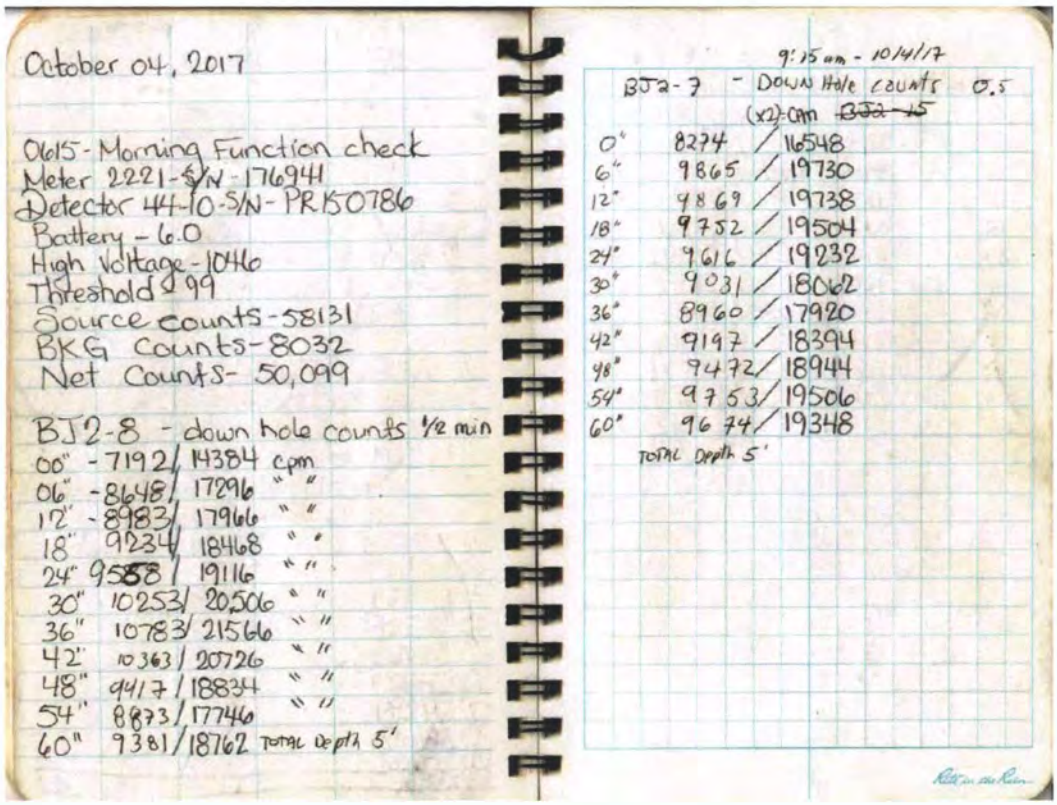
Depth	ID
0-6	BJ2-4-0006-S-01
6-12	" 0612 "
12-18	" 1218 "
24-30	" "
36-42	" "
60-66	" "
96-102	" "
120-126	" "
144-150	" "

BJ2-4B Depth Samples

0-6
6-12
12-18
24-30
36-42
60-66
96-102
120-126
174-180

20:36 - End of day function check location has been switch to the hotel room of David Norwood RM224 - on right hand corner of desk opposite of table lamp

	Source Count	BKG Count
1)	58854	7729
2)	58967	7339
3)	58479	7483
4)	58508	7507
5)	58763	7530
6)	58897	7368
7)	59299	7363 dn
8)	58402	7340
9)	58395	7408
10)	58350	7498



October 04, 2017

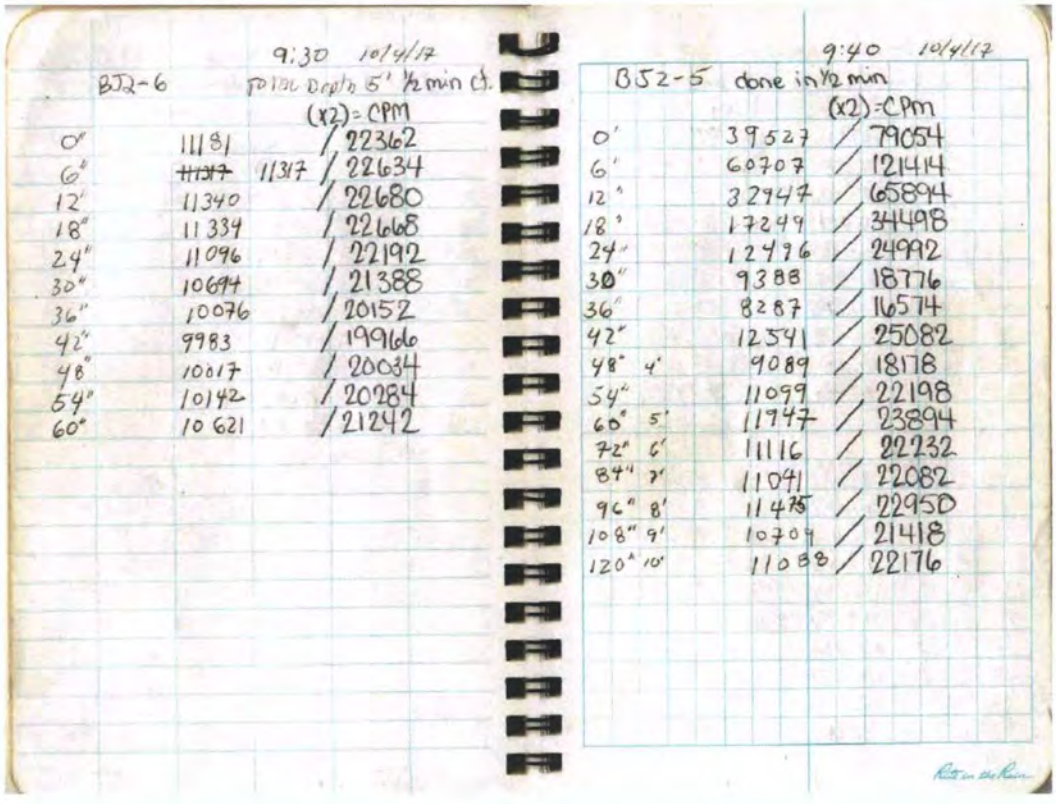
0615 - Morning Function check
Meter 2221 - S/N - 176941
Detector 44-10 - S/N - PR150786
Battery - 6.0
High Voltage - 1046
Threshold 99
Source counts - 58131
BKG counts - 8032
Net Counts - 50,099

BJ2-8 - down hole counts 1/2 min
00" - 7192 / 14384 cpm
06" - 8648 / 17296 " "
12" - 8983 / 17966 " "
18" 9234 / 18468 " "
24" 9588 / 19116 " "
30" 10253 / 20506 " "
36" 10783 / 21566 " "
42" 10363 / 20726 " "
48" 9417 / 18834 " "
54" 8873 / 17746 " "
60" 9381 / 18762 TOTAL Depth 5'

9:15 am - 10/4/17
BJ2-7 - Down Hole counts 0.5
(x2)=CPM ~~BJ2-25~~

0"	8274	/ 16548
6"	9865	/ 19730
12"	9869	/ 19738
18"	9752	/ 19504
24"	9616	/ 19232
30"	9031	/ 18062
36"	8960	/ 17920
42"	9197	/ 18394
48"	9472	/ 18944
54"	9753	/ 19506
60"	9674	/ 19348

TOTAL Depth 5'

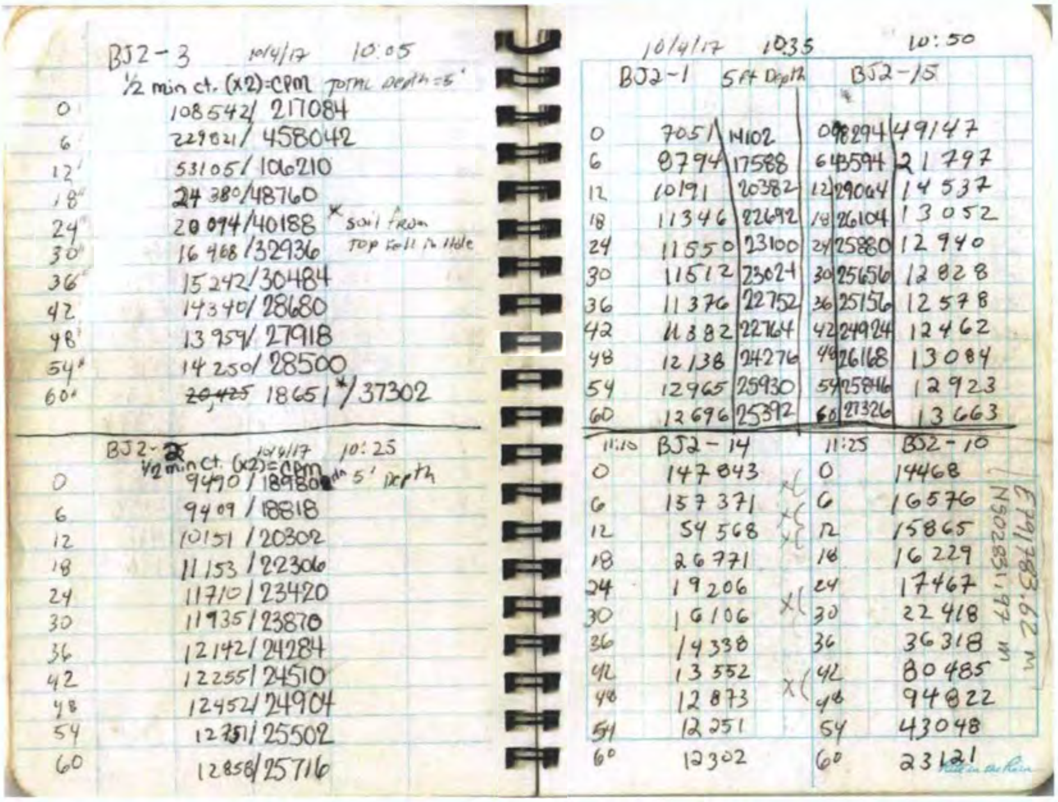


9:30 10/4/17
BJ2-6 TOTAL Depth 5' 1/2 min ct.
(x2)=CPM

0"	11181	/ 22362
6"	~~11317~~ 11317	/ 22634
12"	11340	/ 22680
18"	11334	/ 22668
24"	11096	/ 22192
30"	10694	/ 21388
36"	10076	/ 20152
42"	9983	/ 19966
48"	10017	/ 20034
54"	10142	/ 20284
60"	10621	/ 21242

9:40 10/4/17
BJ2-5 done in 1/2 min
(x2)=CPM

0'	39527	/ 79054
6'	60707	/ 121414
12"	32947	/ 65894
18"	17249	/ 34498
24"	12496	/ 24992
30"	9388	/ 18776
36"	8287	/ 16574
42"	12541	/ 25082
48" 4'	9089	/ 18178
54"	11099	/ 22198
60" 5'	11947	/ 23894
72" 6'	11116	/ 22232
84" 7'	11041	/ 22082
96" 8'	11475	/ 22950
108" 9'	10709	/ 21418
120" 10'	11088	/ 22176



BJ2-3 10/4/17 10:05
½ min ct. (x2)=CPM Total depth=5'

0	108542/ 217084
6	229021/ 458042
12	53105/ 106210
18	24380/48760
24	20094/40188 * soil from
30	16468/32936 top fell in hole
36	15242/30484
42	14340/ 28680
48	13959/ 27918
54	14250/ 28500
60	~~20,425~~ 18651*/37302

BJ2-~~25~~ 10/4/17 10:25
½ min ct. (x2)=CPM 5' depth

0	9490 / 18980
6	9409 / 18818
12	10151 / 20302
18	11153 / 22306
24	11710 / 23420
30	11935 / 23870
36	12142/ 24284
42	12255/ 24510
48	12452/ 24904
54	12751/ 25502
60	12858/ 25716

10/4/17 10:35 10:50

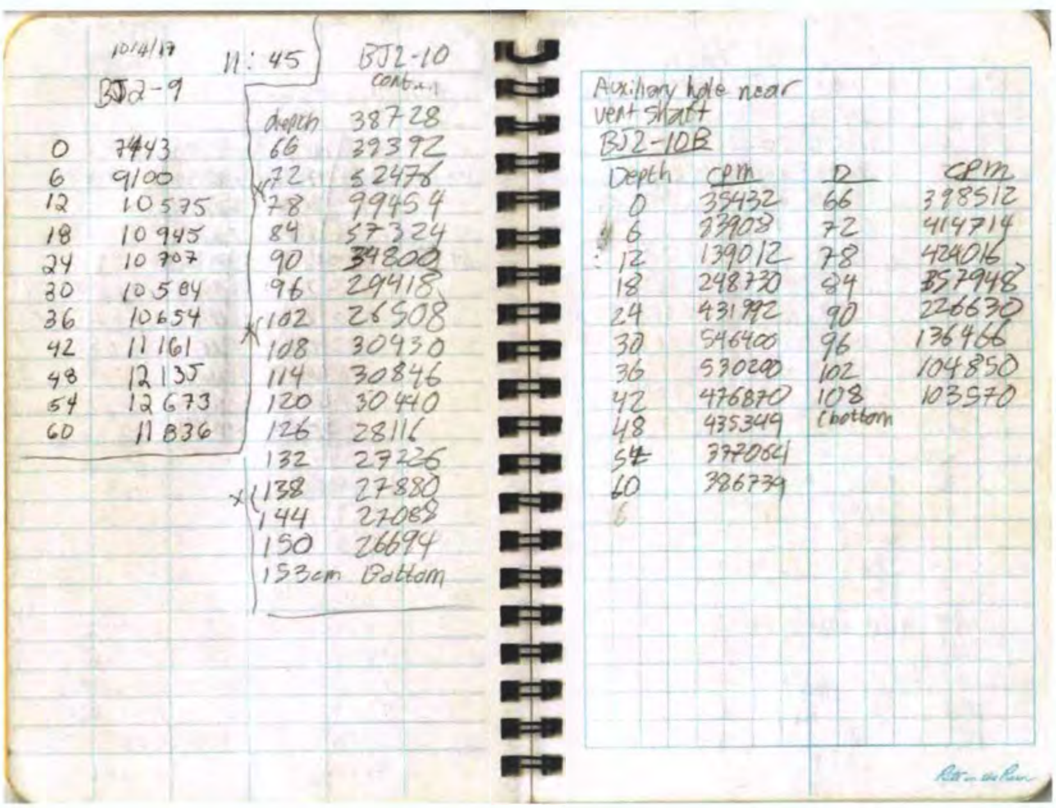
BJ2-1 5 ft Depth / BJ2-15

BJ2-1			BJ2-15		
0	7051	14102	0	98294	49147
6	8794	17588	6	43594	21797
12	10191	20382	12	29064	14537
18	11346	22692	18	26104	13052
24	11550	23100	24	25880	12940
30	11512	23024	30	25656	12828
36	11376	22752	36	25156	12578
42	11382	22764	42	24924	12462
48	12138	24276	48	26168	13084
54	12965	25930	54	25846	12923
60	12696	25392	60	27326	13663

11:10 BJ2-14		11:25 BJ2-10	
0	147843	0	14468
6	157371	6	16576
12	54568	12	15865
18	26771	18	16229
24	19206	24	17467
30	16106	30	22418
36	14338	36	36318
42	13552	42	80485
48	12873	48	94822
54	12251	54	43048
60	12302	60	23121

E797783.62 m
N5028851.97 m

Rite in the Rain



10/4/17 11:45

BJ2-9

0	7443
6	9100
12	10575
18	10945
24	10707
30	10584
36	10654
42	11161
48	12135
54	12673
60	11836

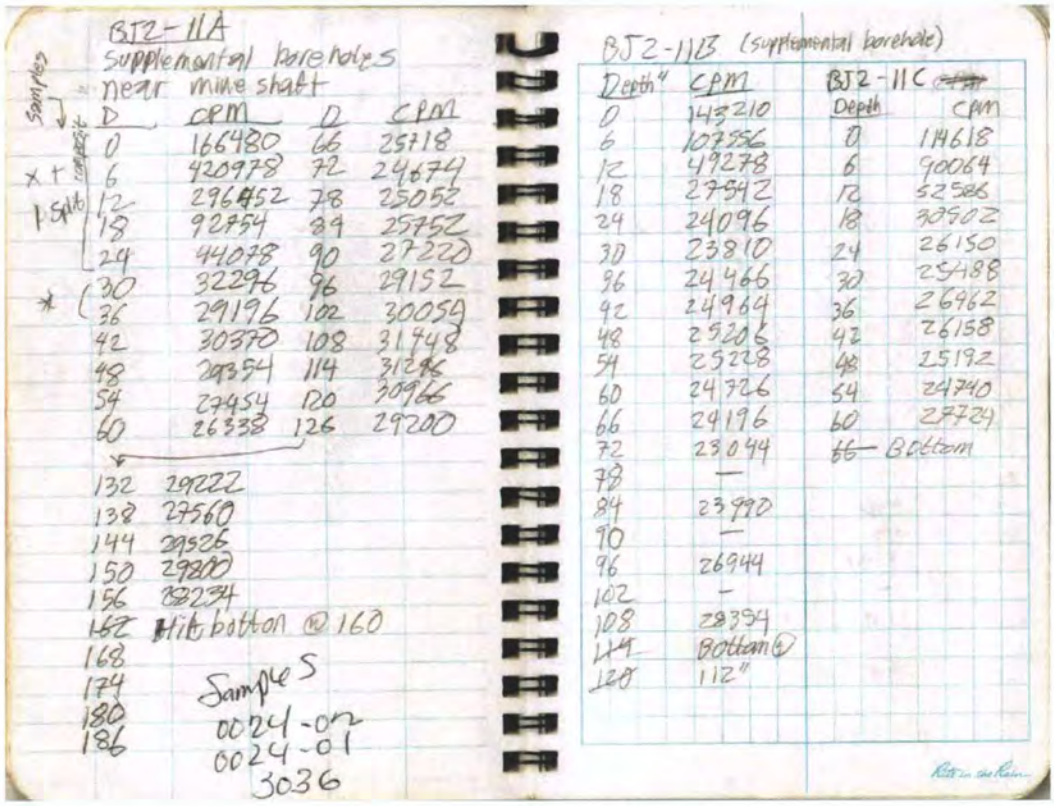
BJ2-10 contin.

depth	38728
66	39392
72	52478
78	99454
84	57324
90	34800
96	29418
102	26508
108	30930
114	30846
120	30440
126	28116
132	27226
138	27880
144	27088
150	26694
153cm	Bottom

Auxiliary hole near vent shaft
BJ2-10B

Depth	cpm	D	cpm
0	35432	66	398512
6	33908	72	414714
12	139012	78	424016
18	248730	84	357948
24	431992	90	226630
30	546400	96	136466
36	530290	102	104850
42	476870	108	103570
48	435349	(bottom	
54	377064		
60	386739		

Rite in the Rain



BJ2-11A
Supplemental boreholes near mine shaft

D	cpm	D	cpm
0	166480	66	25718
6	420978	72	24674
12	296452	78	25052
18	92754	84	25752
24	44078	90	27220
30	32296	96	29152
36	29196	102	30059
42	30370	108	31748
48	29354	114	31296
54	27454	120	30966
60	26338	126	29200
132	29222		
138	27560		
144	29526		
150	29800		
156	29234		
162	Hit bottom @ 160		
168			
174			
180			
186			

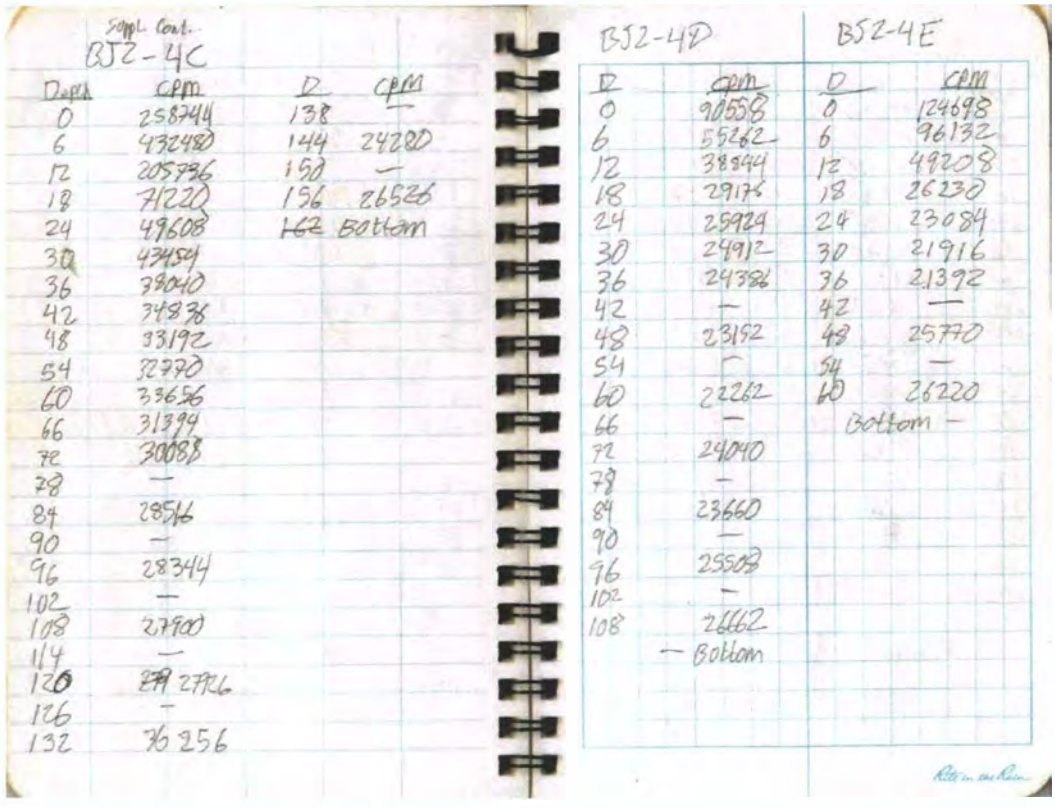
Samples
0024-02
0024-01
3036

BJ2-11B (supplemental borehole)

Depth	cpm
0	143210
6	107556
12	49278
18	27542
24	24096
30	23810
36	24466
42	24964
48	25206
54	25228
60	24726
66	24196
72	23044
78	—
84	23990
90	—
96	26944
102	—
108	28394
114	Bottom @
120	112"

BJ2-11C

Depth	cpm
0	114618
6	90064
12	52586
18	30502
24	26150
30	25488
36	26962
42	26158
48	25192
54	24740
60	27724
66	Bottom



Suppl. Cont.
BJ2-4C

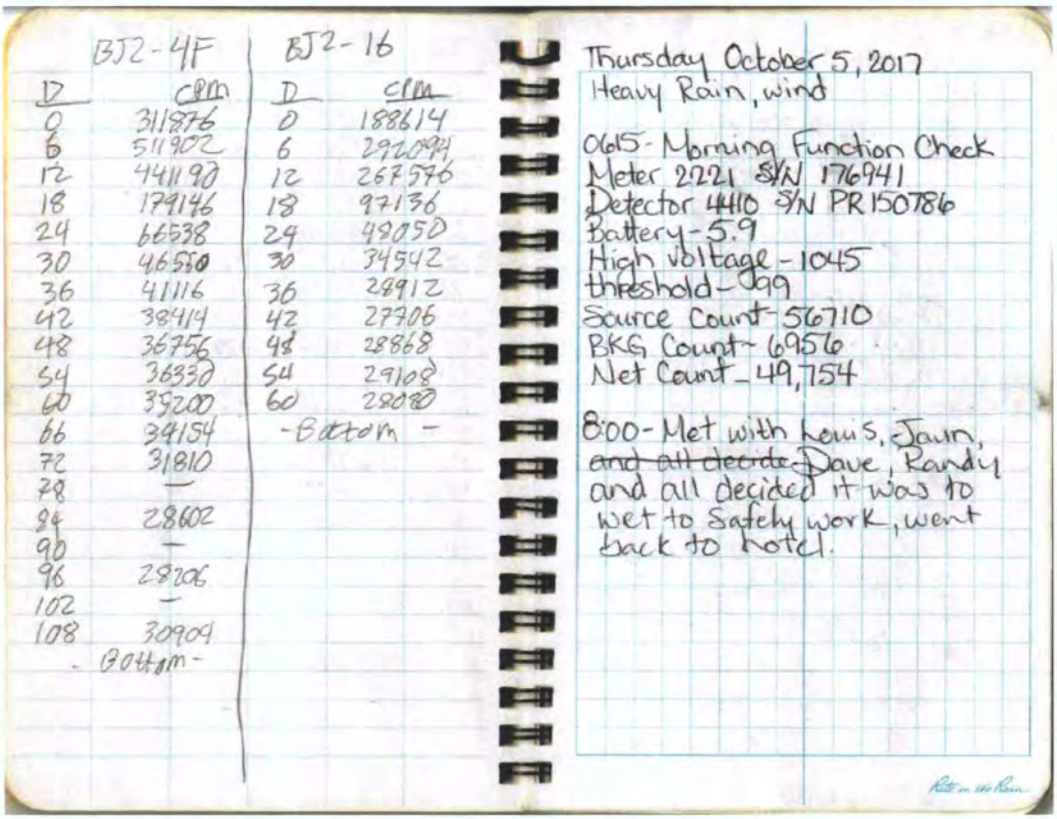
Depth	cpm	D	cpm
0	258744	138	—
6	432480	144	24280
12	205736	150	—
18	71220	156	26526
24	49608	162	Bottom
30	43454		
36	39040		
42	34838		
48	33192		
54	32770		
60	33656		
66	31394		
72	30088		
78	—		
84	28516		
90	—		
96	28344		
102	—		
108	27900		
114	—		
120	27726		
126	—		
132	26256		

BJ2-4D

D	cpm
0	90558
6	55262
12	38544
18	29176
24	25929
30	24912
36	24386
42	—
48	23192
54	—
60	22262
66	—
72	24040
78	—
84	23660
90	—
96	25508
102	—
108	26662
	— Bottom

BJ2-4E

D	cpm
0	124698
6	96132
12	49208
18	26230
24	23084
30	21916
36	21392
42	—
48	25770
54	—
60	26220
	Bottom —



BJ2-4F

D	cpm
0	311876
6	511902
12	441190
18	179146
24	66538
30	46550
36	41116
42	38414
48	36756
54	36330
60	35200
66	34154
72	31810
78	—
84	28602
90	—
96	28206
102	—
108	30904

- Bottom -

BJ2-16

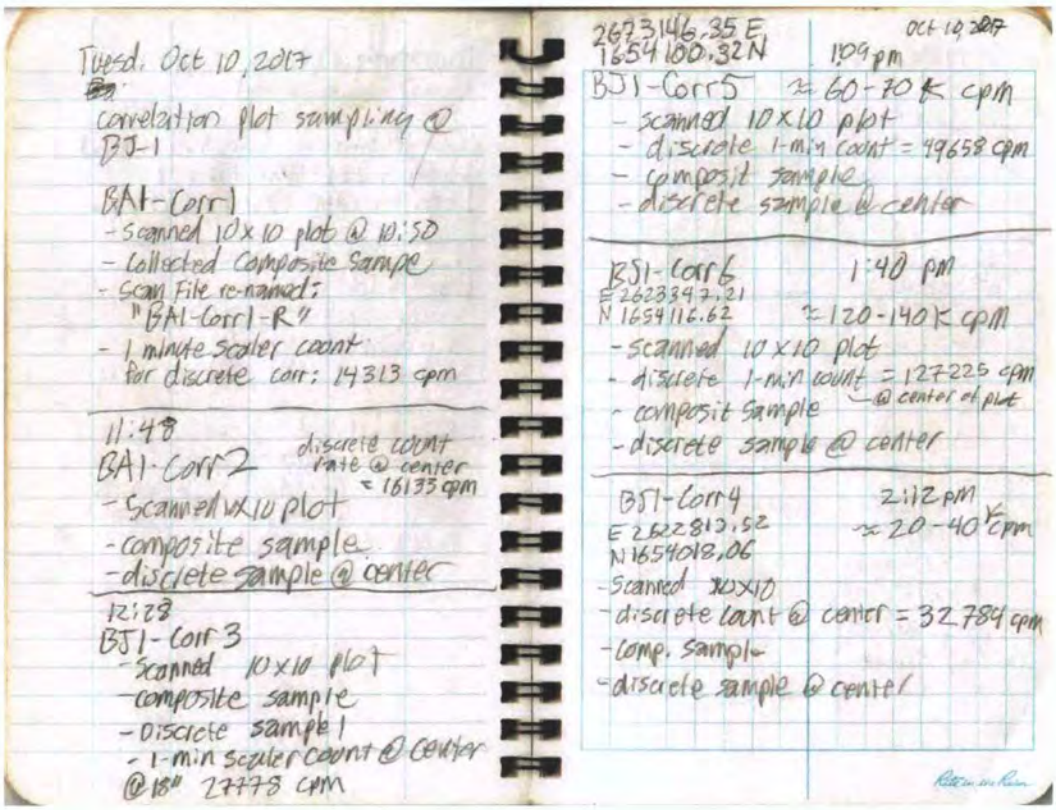
D	cpm
0	188614
6	292094
12	267576
18	97136
24	48050
30	34542
36	28912
42	27706
48	28868
54	29108
60	28080

- Bottom -

Thursday October 5, 2017
Heavy Rain, wind

0615 - Morning Function Check
Meter 2221 S/N 176941
Detector 4410 S/N PR150786
Battery - 5.9
High voltage - 1045
threshold - 99
Source Count - 56710
BKG Count - 6956
Net Count - 49,754

8:00 - Met with Lewis, Jaun, ~~and all decide~~ Dave, Randy and all decided it was to wet to safely work, went back to hotel.



Tuesd. Oct 10, 2017

correlation plot sampling @ BJ-1

BA1-Corr1
- Scanned 10x10 plot @ 10:50
- Collected Composite Sample
- Scan File re-named: "BA1-Corr1-R"
- 1 minute Scaler count for discrete corr: 14313 cpm

11:48
BA1-Corr2 discrete count rate @ center = 16133 cpm
- Scanned 10x10 plot
- composite sample
- discrete sample @ center

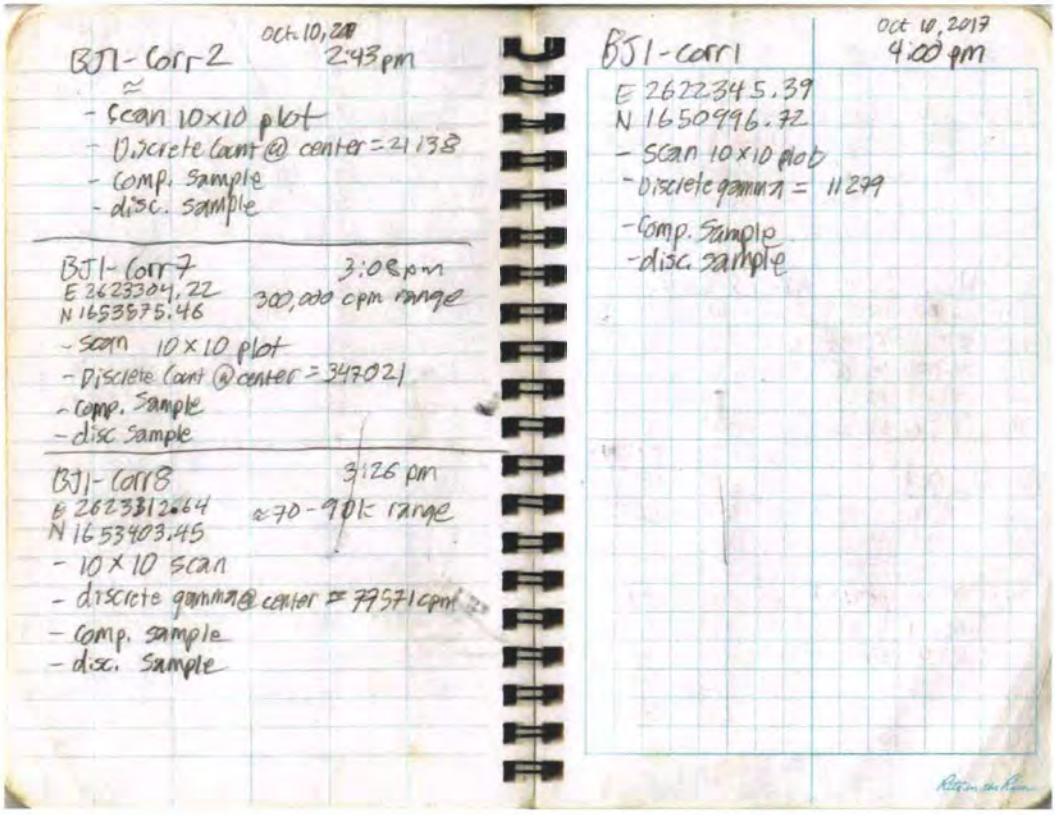
12:28
BJ1-corr3
- Scanned 10x10 plot
- composite sample
- Discrete sample
- 1-min scaler count @ center @18" 27778 cpm

2623146.35 E
1654100.32 N
Oct 10 2017
1:09 pm

BJ1-Corr5 ≈ 60-70 K cpm
- scanned 10x10 plot
- discrete 1-min count = 49658 cpm
- composit sample
- discrete sample @ center

BJ1-Corr6 1:40 pm
E 2623347.21
N 1654116.62 ≈ 120-140 K cpm
- scanned 10x10 plot
- discrete 1-min count = 127225 cpm @ center of plot
- composit sample
- discrete sample @ center

BJ1-Corr4 2:12 pm
E 2622813.52 ≈ 20-40 K cpm
N 1654018.06
- Scanned 10x10
- discrete count @ center = 32784 cpm
- comp. sample
- discrete sample @ center



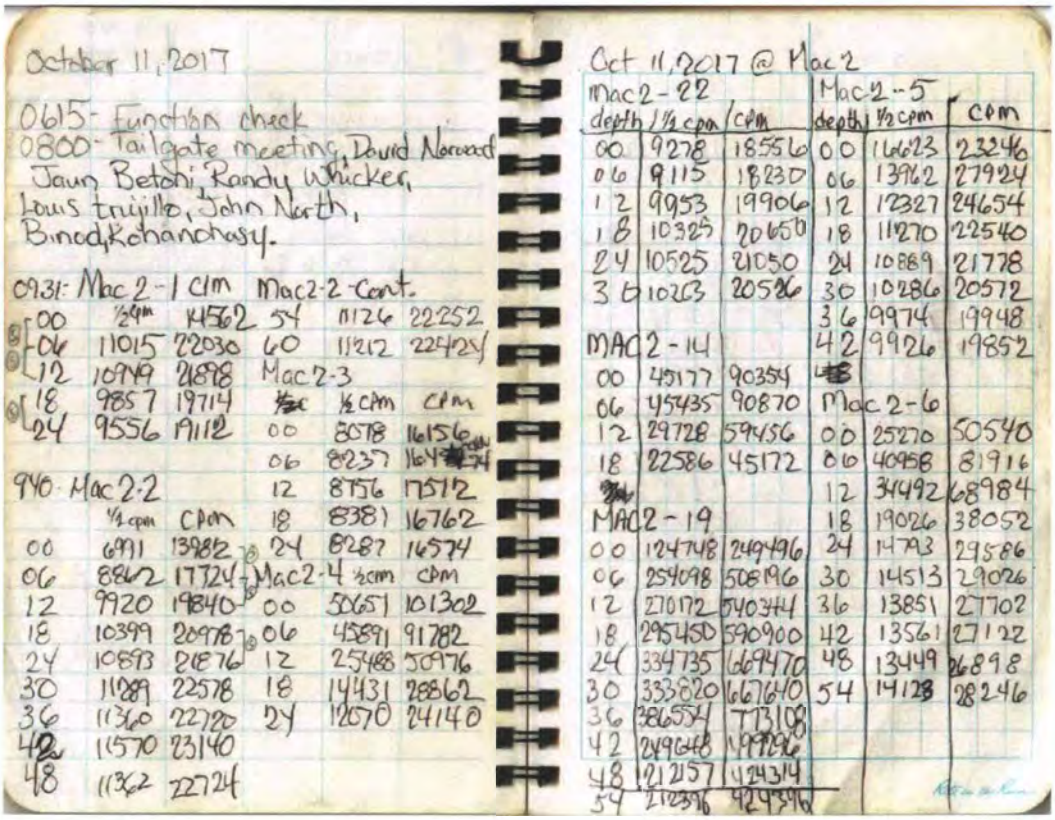
Oct. 10, 20[illegible]

BJ1-Corr 2 2:43 pm
≈
- Scan 10x10 plot
- Discrete Cont @ center = 21138
- Comp. Sample
- disc. sample

BJ1-Corr 7 3:08 pm
E 2623304.22
N 1653875.46 300,000 cpm range
- Scan 10 x 10 plot
- Discrete Cont @ center = 34702
- Comp. Sample
- disc Sample

BJ1-Corr 8 3:26 pm
E 2623312.64 ≈70-90K range
N 1653403.45
- 10 x 10 scan
- discrete gamma @ center = 77571 cpm
- comp. sample
- disc. sample

Oct 10, 2017
BJ1-corr 1 4:00 pm
E 2622345.39
N 1650996.72
- Scan 10x10 plot
- Discrete gamma = 11279
- Comp. Sample
- disc. sample



October 11, 2017

0615- Function check
0800- Tailgate meeting, David Norwood
Jaun Betoni, Randy Whicker,
Louis trujillo, John North,
Binod Kohanchasy.

09:31: Mac 2-1 cpm

	½ cpm	cpm
00	7281	14562
06	11015	22030
12	10949	21898
18	9857	19714
24	9556	19112

940 Mac 2-2

	½ cpm	cpm
00	6991	13982
06	8862	17724
12	9920	19840
18	10399	20798
24	10893	21876
30	11289	22578
36	11360	22720
42	11570	23140
48	11362	22724

Mac 2-2 Cont.

54	11126	22252
60	11212	22425

Mac 2-3

	½ cpm	cpm
00	8078	16156
06	8237	16474
12	8756	17512
18	8381	16762
24	8287	16574

Mac 2-4

	½ cpm	cpm
00	50651	101302
06	45891	91782
12	25488	50976
18	14431	28862
24	12070	24140

Oct 11, 2017 @ Mac 2

Mac 2-22

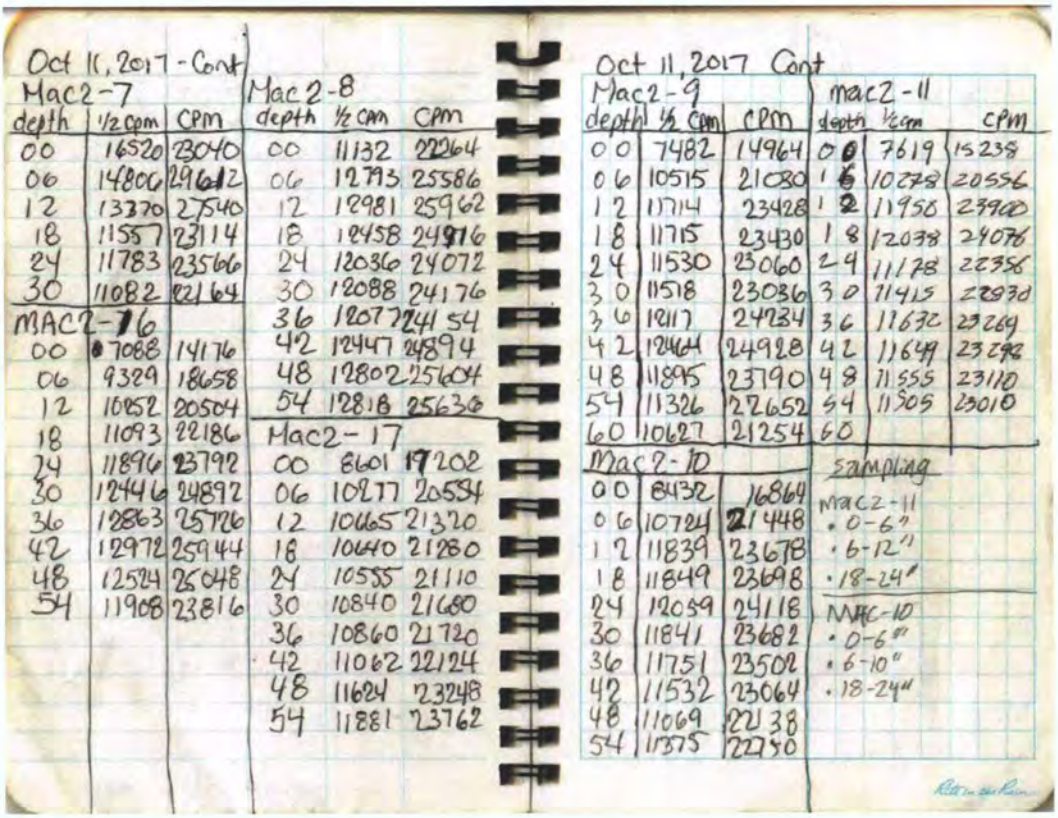
depth	½ cpm	cpm
00	9278	18556
06	9115	18230
12	9953	19906
18	10325	20650
24	10525	21050
30	10263	20526
MAC 2-14		
00	45177	90354
06	45435	90870
12	29728	59456
18	22586	45172
MAC 2-19		
00	124748	249496
06	254098	508196
12	270172	540344
18	295450	590900
24	334735	669470
30	333820	667640
36	286554	573108
42	249648	499296
48	212157	424314
54	212398	424796

Mac 2-5

depth	½ cpm	cpm
00	16623	23246
06	13962	27924
12	12327	24654
18	11270	22540
24	10889	21778
30	10286	20572
36	9974	19948
42	9926	19852

Mac 2-6

00	25270	50540
06	40958	81916
12	34492	68984
18	19026	38052
24	14793	29586
30	14513	29026
36	13851	27702
42	13561	27122
48	13449	26898
54	14128	28246



Oct 11, 2017 - Cont

Mac2-7

depth	½ cpm	cpm
00	16520	23040
06	14806	29612
12	13370	27540
18	11557	23114
24	11783	23566
30	11082	22164

MAC2-16

00	7088	14176
06	9329	18658
12	10252	20504
18	11093	22186
24	11896	23792
30	12446	24892
36	12863	25726
42	12972	25944
48	12524	25048
54	11908	23816

Mac2-8

depth	½ cpm	cpm
00	11132	22264
06	12793	25586
12	12981	25962
18	12458	24916
24	12036	24072
30	12088	24176
36	12077	24154
42	12447	24894
48	12802	25604
54	12818	25636

Mac2-17

00	8601	17202
06	10277	20554
12	10665	21320
18	10640	21280
24	10555	21110
30	10840	21680
36	10860	21720
42	11062	22124
48	11624	23248
54	11881	23762

Oct 11, 2017 Cont

Mac2-9

depth	½ cpm	cpm
00	7482	14964
06	10515	21080
12	11714	23428
18	11715	23430
24	11530	23060
30	11518	23036
36	12117	24234
42	12464	24928
48	11895	23790
54	11326	22652
60	10627	21254

Mac2-10

00	8432	16864
06	10724	21448
12	11839	23678
18	11849	23698
24	12059	24118
30	11841	23682
36	11751	23502
42	11532	23064
48	11069	22138
54	11575	23150

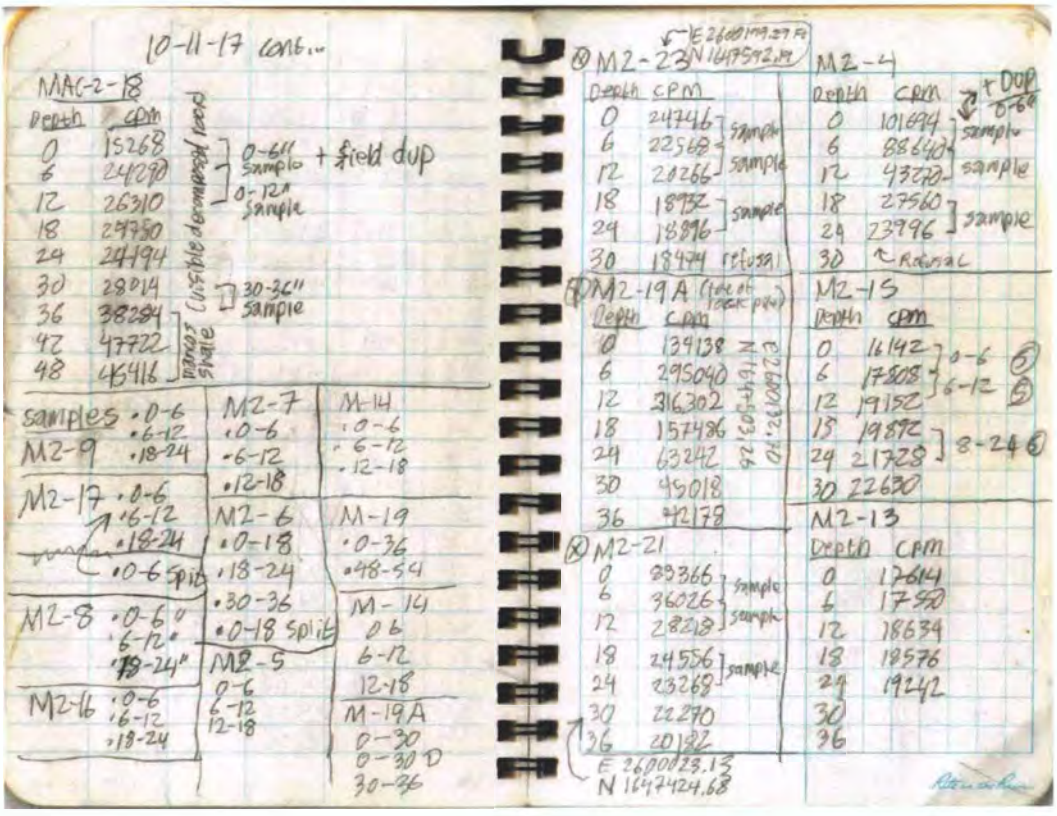
mac2-11

depth	½ cpm	cpm
00	7619	15238
06	10278	20556
12	11950	23900
18	12038	24076
24	11178	22356
30	11415	22830
36	11632	23264
42	11649	23298
48	11555	23110
54	11505	23010
60		

sampling

Mac2-11
- 0-6"
- 6-12"
- 18-24"

MAC-10
- 0-6"
- 6-10"
- 18-24"



10-11-17 cont...

MAC-2-18

Depth	cpm	
0	15268	0-6" sample + field dup
6	24290	
12	26310	0-12" sample
18	29780	
24	24194	
30	28014	30-36" sample
36	38284	
42	47722	
48	45416	

samples
- M2-9: 0-6, 6-12, 18-24
- M2-17: 0-6, 6-12, 18-24, 0-6 split
- M2-8: 0-6, 6-12, 18-24"
- M2-16: 0-6, 6-12, 18-24

M2-7: 0-6, 6-12, 12-18

M2-6: 0-18, 18-24, 30-36, 0-18 split

M2-5: 0-6, 6-12, 12-18

M-14: 0-6, 6-12, 12-18

M-19: 0-36, 48-54

M-14: 0-6, 6-12, 12-18

M-19A: 0-30, 0-30 D, 30-36

⊗ M2-23 E 2600179.27 ft N 1647592.39

Depth	cpm	
0	24746	sample
6	22568	sample
12	20266	
18	18932	sample
24	18896	
30	18474	refusal

⊗ M2-19A (face of rock pile)

Depth	cpm
0	139138
6	295040
12	316302
18	157486
24	63242
30	49018
36	42178

N 1647503.26 E 2600123.23

⊗ M2-21

0	29366	sample
6	36026	sample
12	28218	
18	24556	sample
24	23269	
30	22270	
36	20182	

E 2600023.13 N 1647424.68

M2-4

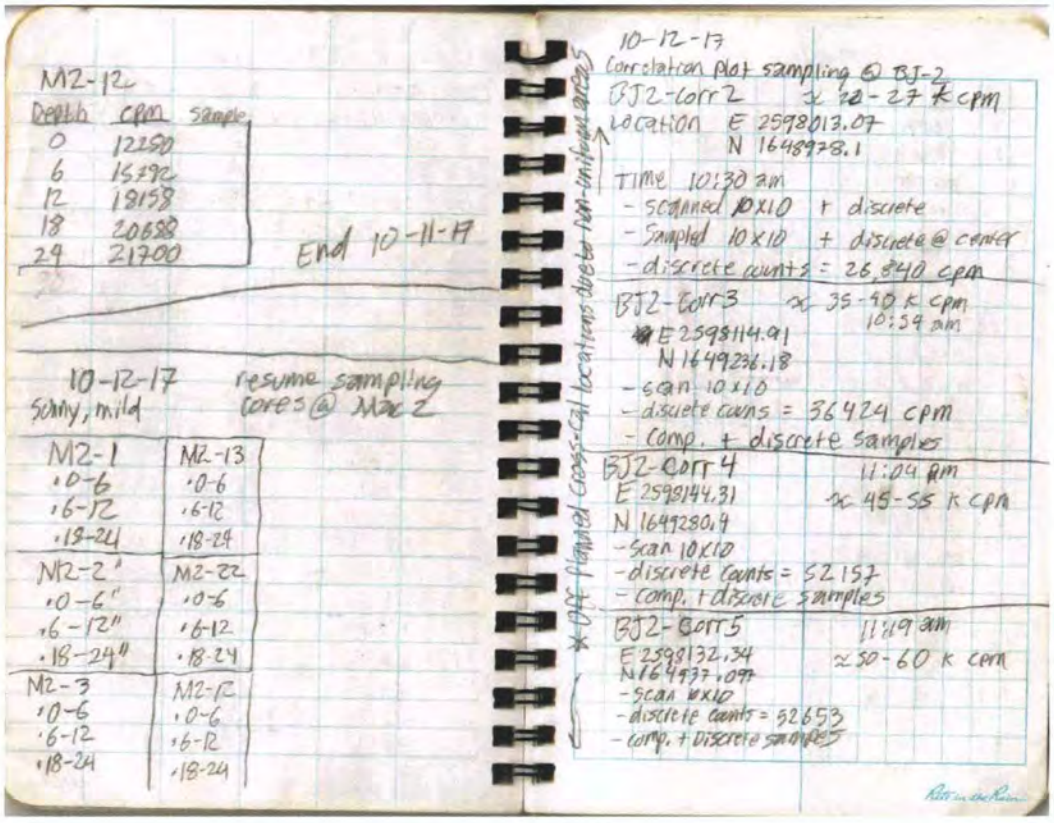
Depth	cpm	
0	101694	sample + Dup 0-6
6	88643	sample
12	43220	sample
18	27560	sample
24	23996	
30	↑ Refusal	

M2-15

Depth	cpm	
0	16142	0-6 ⑤
6	17808	
12	19152	6-12 ⑤
18	19892	
24	21728	18-24 ⑥
30	22630	

M2-13

Depth	cpm
0	17614
6	17550
12	18634
18	18576
24	19242
30	
36	



M2-12

Depth	cpm	sample
0	12250	
6	15792	
12	18158	
18	20688	
24	21700	

End 10-11-17

10-12-17
Sunny, mild

resume sampling cores @ Mac 2

M2-1	M2-13
·0-6	·0-6
·6-12	·6-12
·18-24	·18-24
M2-2	M2-22
·0-6"	·0-6
·6-12"	·6-12
·18-24"	·18-24
M2-3	M2-12
·0-6	·0-6
·6-12	·6-12
·18-24	·18-24

10-12-17
Correlation plot sampling @ BJ-2

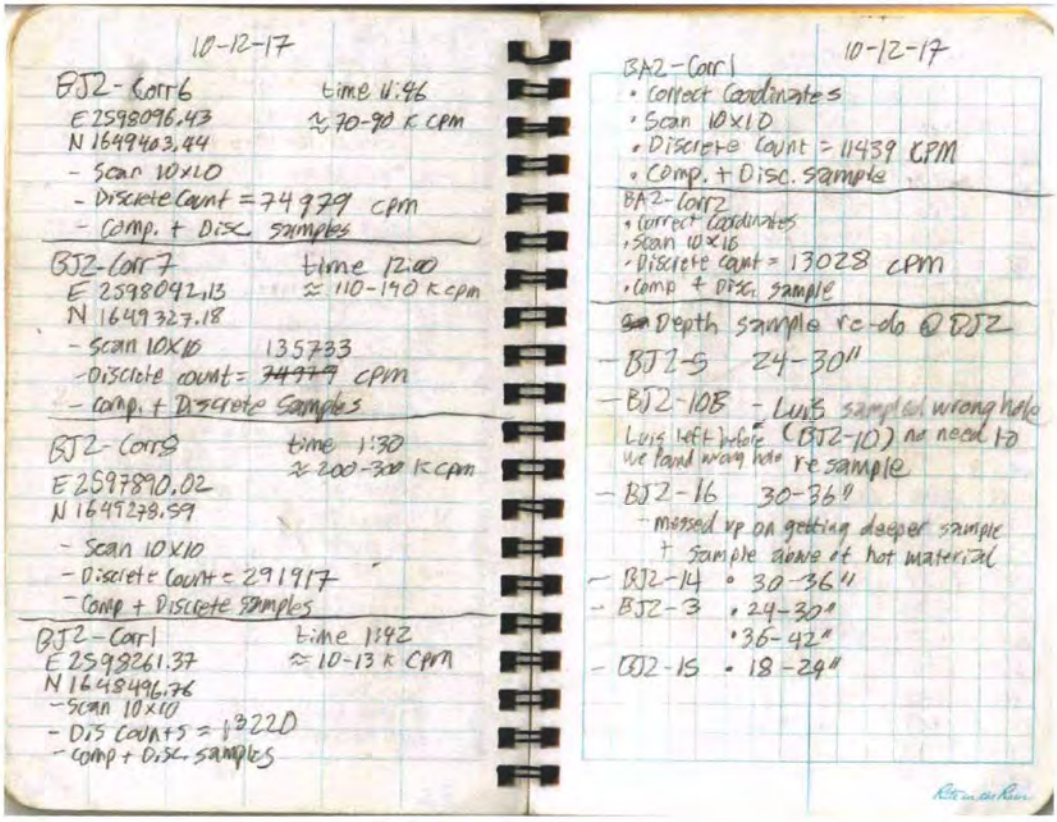
BJ2-corr2 ≈ 20-27 K cpm
Location E 2598013.07
N 1648978.1
Time 10:30 am
- scanned 10x10 + discrete
- Sampled 10x10 + discrete @ center
- discrete counts = 26,840 cpm

BJ2-corr3 ≈ 35-40 K cpm
10:54 am
E 2598114.91
N 1649236.18
- scan 10x10
- discrete cuns = 36424 cpm
- Comp. + discrete samples

BJ2-corr4 11:04 am
E 2598144.31 ≈ 45-55 K cpm
N 1649280.9
- Scan 10x10
- discrete counts = 52157
- comp. + discrete samples

BJ2-corr5 11:19 am
E 2598132.34 ≈ 50-60 K cpm
N 1649337.097
- Scan 10x10
- discrete counts = 52653
- comp. + discrete samples

* Off planned cross-cal locations due to non-uniform areas



10-12-17

BJ2-corr6 time 11:46
E 2598096.43 ≈ 70-90 K cpm
N 1649403.44
- Scan 10x10
- Discrete Count = 74979 cpm
- Comp. + Disc. samples

BJ2-corr7 time 12:00
E 2598092.13 ≈ 110-140 K cpm
N 1649327.18
- Scan 10x10 135733
- Discrete count = ~~74979~~ cpm
- Comp. + Discrete Samples

BJ2-corr8 time 1:30
E 2597890.02 ≈ 200-300 K cpm
N 1649279.59
- Scan 10x10
- Discrete Count = 291917
- Comp + Discrete Samples

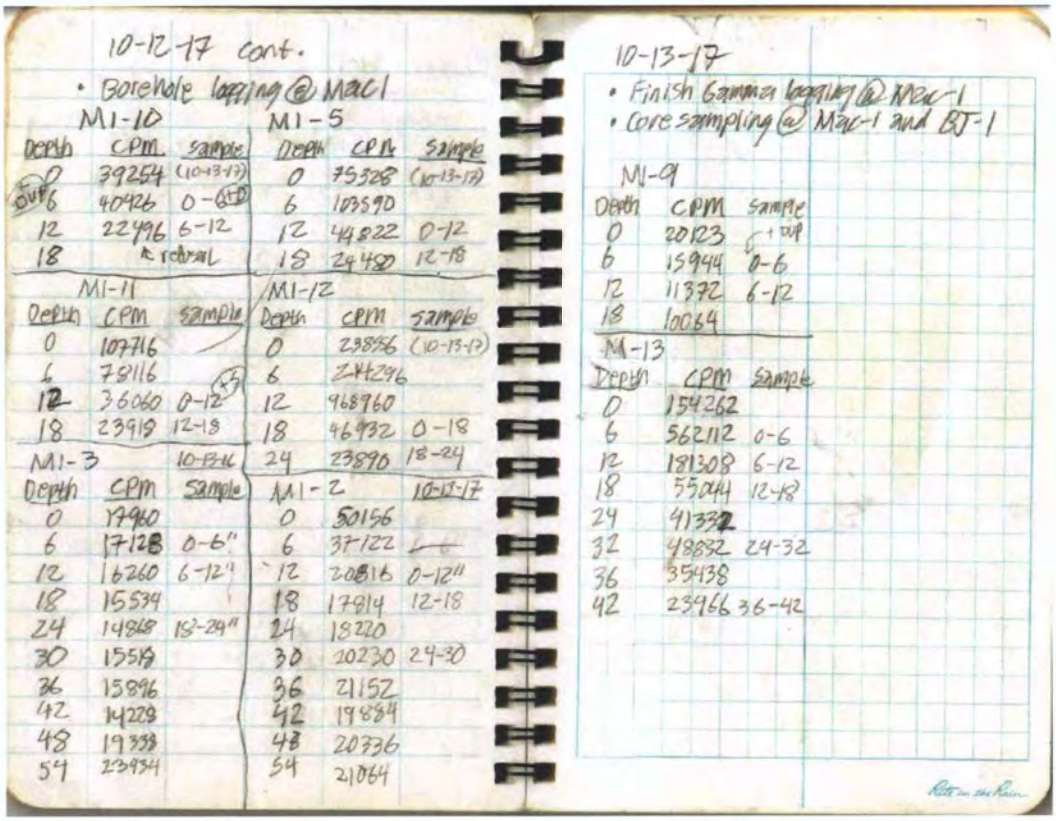
BJ2-corr1 time 1:42
E 2598261.37 ≈ 10-13 K cpm
N 1648496.76
- Scan 10x10
- Dis counts = 13220
- Comp + Disc. samples

10-12-17

BA2-Corr1
- Correct Coordinates
- Scan 10x10
- Discrete Count = 11439 CPM
- Comp. + Disc. Sample

BA2-Corr2
- Correct Coordinates
- Scan 10x10
- Discrete Count = 13028 cpm
- Comp + Disc. Sample

Depth sample re-do @ BJ2
- BJ2-5 24-30"
- BJ2-10B - Luis sampled wrong hole Luis left before (BJ2-10) no need to we found wrong hole re sample
- BJ2-16 30-36"
  - messed up on getting deeper sample + sample above of hot material
- BJ2-14 · 30-36"
- BJ2-3 · 24-30"
  · 36-42"
- BJ2-15 · 18-24"



10-12-17 cont.

- Borehole logging @ Mac1

MI-10

Depth	CPM	Sample
0	39254	(10-13-17)
6	40426	0-6"
12	22496	6-12
18	↳ retrieval	

MI-11

Depth	CPM	Sample
0	107716	
6	78116	
12	36060	0-12
18	23918	12-18

MI-3 10-13-17

Depth	CPM	Sample
0	17490	
6	17128	0-6"
12	16260	6-12"
18	15539	
24	14868	18-24"
30	15518	
36	15896	
42	14209	
48	19333	
54	23934	

MI-5

Depth	CPM	Sample
0	75328	(10-13-17)
6	103590	
12	44822	0-12
18	24480	12-18

MI-12

Depth	CPM	Sample
0	238856	(10-13-17)
6	244296	
12	968960	
18	46932	0-18
24	23890	18-24

MI-2 10-13-17

Depth	CPM	Sample
0	50156	
6	37122	
12	20816	0-12"
18	17814	12-18
24	18220	
30	20230	24-30
36	21152	
42	19884	
48	20336	
54	21064	

10-13-17

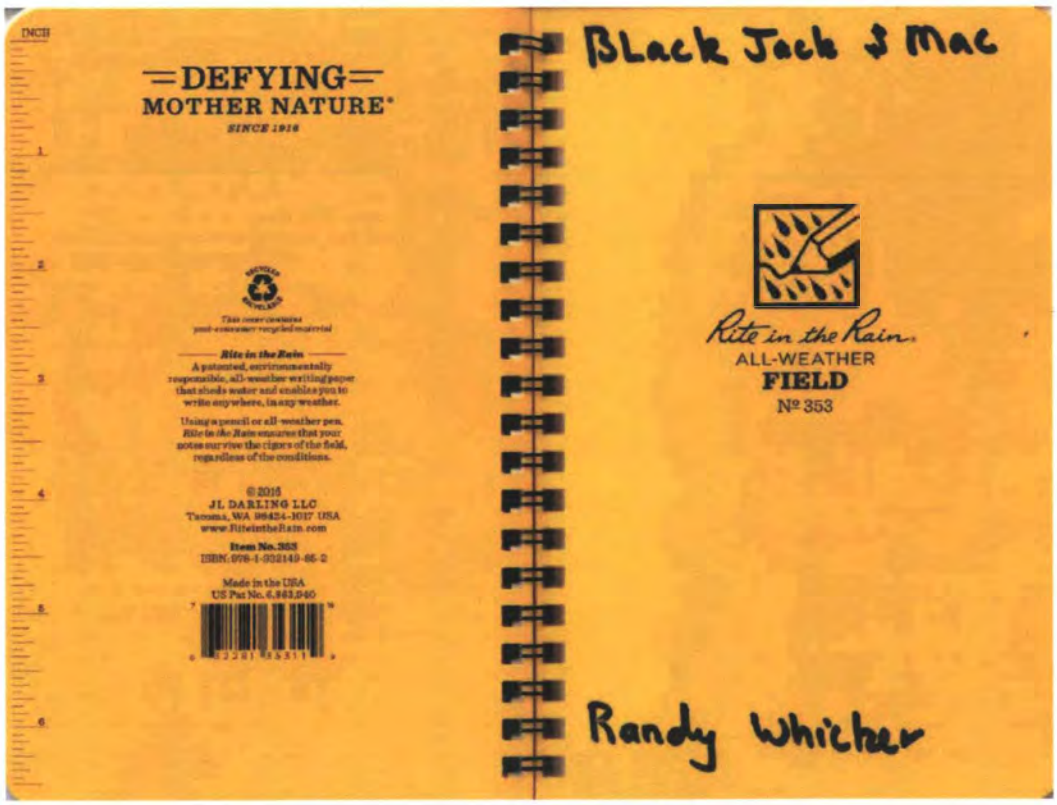
- Finish Gamma logging @ Mac-1
- Core sampling @ Mac-1 and BJ-1

MI-9

Depth	CPM	Sample
0	20123	6" + DUP
6	15944	0-6
12	11372	6-12
18	10064	

MI-13

Depth	CPM	Sample
0	154262	
6	562112	0-6
12	181308	6-12
18	55044	12-18
24	41332	
32	48832	24-32
36	35438	
42	23966	36-42



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Black Jack & Mac

Rite in the Rain
ALL-WEATHER
FIELD
№ 353

Randy Whicker

October 2, 2017

0900- Met with Jaun Betoni, had a tail gate meeting. We (David Norwood and Jaun Betoni) both agreed to start collecting the Radon Detectors at Black Jack No.1 first, due to wet ground condition.

0920- Arrived at Black Jack No.1 and immediately started collecting the radon detectors.

time	location	detector #
09:27	BJ1-NUR	326491-8
09:29	BJ1-NVS	424900-9
09:42	BJ1-VR1	452473-2
09:44	BJ1-MS	243742-4
09:46	BJ1-VR2	450015-3
10:00	BJ1-SVS	997169-8

Note: Concerning BJ1-SVS, I (David Norwood) found the housing that holds the detector

October 2, 2017 - Cont.

up ~~inside~~ above the collection area, to have slipped down the post landing on the ground. The radon detector was still suspended 2" up inside the housing and showed no signs that rain got on the detector.

10:04- BJ1-URS - 997873-5

Note:- BJ1-URS had the same thing happen as BJ1-SVS with the same outcome.

10:08 - BJ1-BKG - 772451-1

Moved to Mac #1 and started collection again.

10:32 - Mac1-V2 - 326769-7
10:34 - Mac1-MS - 149663-7
10:35 - Mac1-WW - 260995-6
10:39 - Mac1-BKG - 328606-9

October 2, 2017 - Cont.

Moved to Mac No.2 and started collection with BJ2-BKG on the way to the site.

1101 - BJ2-BKG - 246464-2
1107 - Mac2-MS - 679179-2
1112 - Mac2-VS - 471266-7
1120 - Mac2-BKG - 452853-5

Moved to Black Jack No.2 and started collection again.

1124 - BJ2-U2 - 769011-8
1126 - BJ2-U1 - 450927-9
1128 - BJ2-MS - 452637-2
1130 - BJ2-V1 - 452565-5
1136 - BJ2-U3 - 450894-1
1137 - BJ2-U4 - 452798-2
1138 - BJ2-V2 - 557401-7

Completed collection of Radon detectors and drove back to ERG office located in Alb. NM

October 03, 2017

Randy Whicker, David Norwood, Louis Trujillo, Ed Loeschor, Jaun Betori.

Sunny / Windy high temp 80°

Phase 3 drilling:

Morning function check: done in the parking lot of Smith Lake Chapter House

Pairing:
44-10 S/N-PR190786
2221 S/N-176941
Function check source:
Cs-137 Button Source 5uc:

Battery	H.V.	Thrshld	Time	
6.2	1050	99	09:22	Net Counts
Source:	77267	BKG:	7548	-69719
	77178		7610	-69568
	77150		7500	-69650
	77386		7345	-70041
	77655		7286	-70369

October 3, 2017 Cont.

0940- Held tailgate meeting
0950- Left Smith Lake Chapter House- went to Black Jack No. 2 to start soil sampling.

1020- Mobilized and started "down-hole data collection" and "Specified soil Sample collection".

Location:
BJ2-4

Sample depth:	Sample ID:	depth	CPM:	DUP or SPLIT
		0"	168610:	
0"-6":	BJ2-4-0006-S-1:	6":	165718:	N
6"-12":	BJ2-4-0612-S-1 :	12":	64980:	N
12"-18":	BJ2-4-1218-S-01:	18":	36130 :	N
		24":	30212 :	N/A
24"-30":	BJ2-4-2430-S-01:	30":	29270 :	N
		36":	29398 :	
36"-42":	BJ2-4-3642-S-01:	42":	27814 :	N
		48"	25718 :	
		54"	24888 :	

October 03, 2017 Cont.

Location: BJ2-4 Cont.

Sample depth	Sample ID	depth	CPM	DUP or Split
		60"	26264	
60"-66"	BJ2-4-6066-S-01	66"	27812	N
		72"	27572	
		78"	26430	
		84"	24272	
		90"	23626	
		96"	22380	
96"-102"	BJ2-4-9602-S-01	102"	23392	N
		108"	23780	
		114"	25120	
114"-120"	BJ2-4-114120-S-01	120"	30302	
Note: Skipping to 1' increments		126"	—	
		132"	26420	
		138"	—	
		144"	24484	
		150"		
		156"	25090	

Bottom @ 160"

October 03, 2017 Cont.

BJ2-4B

Sample depth	Sample ID	depth	CPM	Dup or Split
		00"	198015	
00"-06"	BJ2-4B-0006-S-01	6"	198015 499628	N
06"-12"	BJ2-4B-0612-S-01	12"	380898	N
12"-18"	BJ2-4B-1218-S-01	18"	120884	N
		24"	52058	
24"-30"	BJ2-4B-2430-S-01	30"	22000	
		36"	30200	
36"-42"	BJ2-4B-3642-S-01	42"	—	
		48"	28500	
		54"	—	
		60"	30314	
		66"	—	
		72"	26328	
72"-78"	BJ2-4B-7278-S-01	78"	—	
		84"	24302	
		90"	—	
		96"	24844	
96"-102"	BJ2-4B-9602-S-01	102"	—	
		108"	27702	
		114"	—	

October 03, 2017

BJ2-4B Cont.

Sample depth	Sample ID	depth	CPM	Dup or Split
		120"	32266	
120"-126"	BJ2-4B-120126-S-01	126"	28068	
		132"	—	
		138"	23230	
		144"	—	
144"-150"	BJ2-4B-144150-S-01	150"	25914	
234"-240"	BJ2-4B-234240-S-01	240"		

Bottom @ 240" Note: Sample @ 240" was taken on 10-4-17

BJ2-10B

Sample depth	Sample ID	depth	CPM	Dup or Split
		00"	35452	
		06"	83908	
		12"	139012	
		18"	248730	
		24"	431992	
		30"	546400	
		36"	530200	
		42"	476870	
		48	435349	
		54"	377064	

October 03, 2017 Cont.

BJ2-10B - Cont.

Sample depth	Sample ID	depth	CPM	Dup or Split
		60"	386739	
		66"	398712	
		72"	414714	
		78"	424016	
		84"	357948	
		90"	226630	
		96"	136466	
		102"	104850	
		108"	103570	

Bottom = 108"

BJ2-11

Sample depth	Sample ID	depth	CPM	Dup or Split
		06"	398490	
00"-06"	BJ2-11-0006-S-01	06"	847234	
06"-12"	BJ2-11-0612-S-01	12"	373356	
12"-18"	BJ2-11-1218-S-01	18"	122970	
		24"	69152	
24"-30"	BJ2-11-2430-S-01	30"	—	
		36"	59438	
36"-42"	BJ2-11-3642-S-01	42"	—	
		48"	48922	

October 03, 2017 Cont.

BJ2-11 Cont.

Sample depth	Sample ID	depth	CPM	Dup or Split
		54"	—	
		60"	47620	
60"-66"	BJ2-11-6066-S-01	66"	—	
		72"	39500	
		78"	—	
		84"	33494	
		90"	—	
		96"	29994	
96"-102"	BJ2-11-96102-S-01	102"	—	
		108"	27188	
		114"	—	
		120"	27880	
120"-126"	BJ2-11-120126-S-01	126"	—	
		132"	28104	
		138"	—	
		144"	27422	
		150"	—	
150"-156"	BJ2-11-150156-S-01	156"	257340	
234"-240"	BJ2-11-234240-S-01	240"	—	

Bottom = 240" Note: Sample @ 240" was taken on 10-4-17

October 03, 2017

BJ2-12

Sample depth	Sample ID	depth	CPM	Dup or Split
		00"	36999	
		06"	23938	
00"-12"	BJ2-12-0012-S-01	12"	20659	
12"-18"	BJ2-12-1218-S-01	18"	20212	
		24"	20730	
		30"	21204	
		36"	20322	
		42"	20114	
		48"	18605	
		54"	17909	

Bottom @ 58"

BJ2-13

Sample depth	Sample ID	depth	CPM	Dup or Spl
		00"	14595	
00"-06"	BJ2-13-0006-S-01	06"	14858	
06"-12"	BJ2-13-0612-S-01	12"	17456	
		18"	17978	
		24"	16812	

October 03, 2017 Cont.

BJ2-14

Sample depth	Sample ID	depth	CPM	Dup or Split
		00"	295686	
		06"	314742	
		12"	109136	
00-18"	BJ2-14-0018-S-01	18"	53542	
18-24"	BJ2-14-1824-S-01	24"	38412	
		30"	32212	
		36"	28676	
		42"	27140	
		48"	25746	
		54"	24502	
Bottom @ 60"		60"	24604	

BJ2-15

Sample depth	Sample ID	depth	CPM	Dup or Split
		00"	98294	
00"-06"	BJ2-15-0006-S-01	06"	43591	
06"-12"	BJ2-15-0612-S-01	12"	29064	
		18"	26104	
		24"	25880	
		30"	25656	
		36"	25156	
		42"	24924	
		48"	26168	
		54	25846	
Bottom @ 60"		60	27326	

October 03, 2017 - Cont.

BJ2-16

Sample depth	Sample ID	depth	CPM	Dup or Split
		00"	166614	
		06"	292094	
		12"	267576	
		18"	97136	
		24"	48050	
		30"	34542	
		36"	28912	
		42"	27706	
		48"	28868	
		54"	29108	
		60"	28080	

Bottom @ 60"

B

David Norwood

October 04, 2017

Function Check - 0615
Meter - 2221 - S/N - 176944
Detector 4440 - S/N - PR150786
Battery High Voltage Threshold
6.0 1046 99
Note: Function Check location has changed from Smith Lake Chapter house to the hotel room at the Holiday Inn Express Grants, New Mexico RM 224. Done on the right hand corner of the desk opposite of the table lamp and having the black-out curtains closed.

	Source count	BKG count	Net count
1)	58854	7729	51125
2)	58967	7339	51628
3)	58479	7483	50996
4)	58508	7507	51,001
5)	58763	7530	51233
6)	58897	7368	51529
7)	59299	7563	51736
8)	58402	7340	51062
9)	58395	7408	50987
10)	58380	7498	50882

October 04, 2017 Cont.

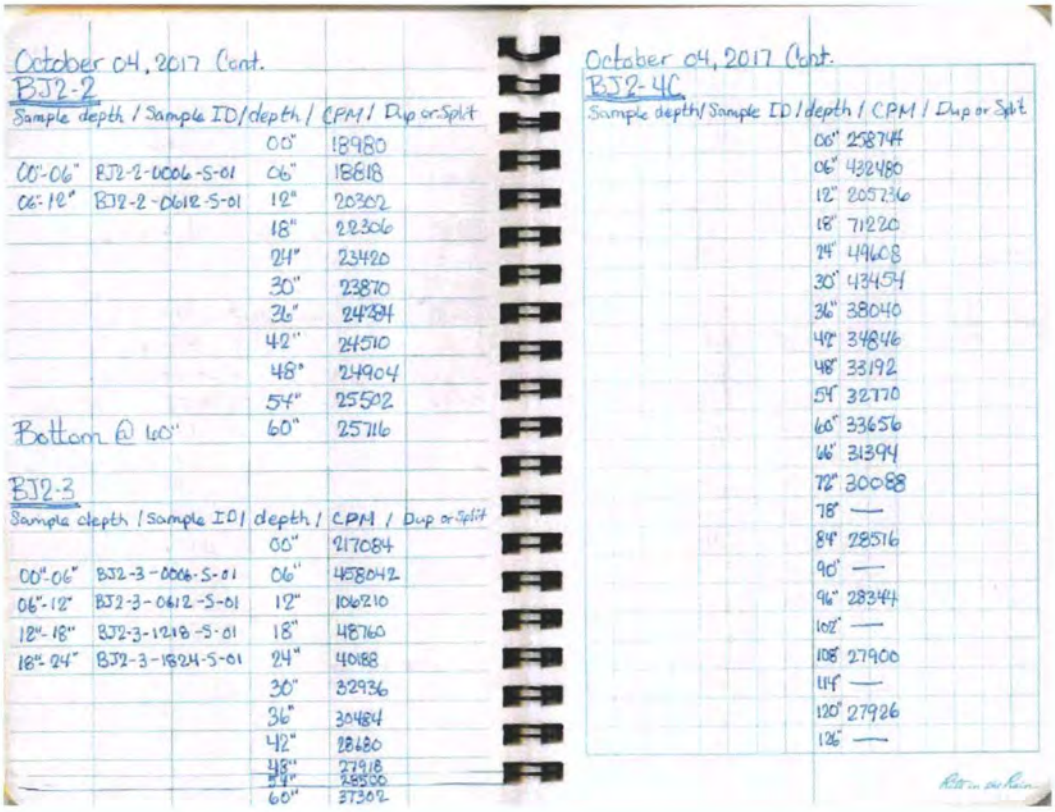
0800: Tailgate meeting - Randy Wicker, David Norwood, Jawn Betoni, Louis Trujillo, Ed Koestner.

0810: Drove to Black Jack No. 2

BJ2-1

Sample depth	Sample ID	depth	CPM	Dup or Split
		00"	~~17588~~ 14102	
00"-06"	BJ2-1-0086-S-01	06"	~~20382~~ 17588	
06"-12"	BJ2-1-0612-S-01	12"	20382	
		18"	22692	
		24"	23100	
		30	23024	
		36"	22752	
		42"	22764	
		48"	24276	
		54"	25930	
		60"	25392	

Bottom @ 60"



October 04, 2017 Cont.

BJ2-2

Sample depth	Sample ID	depth	CPM	Dup or Split
		00"	18980	
00"-06"	BJ2-2-0006-S-01	06"	18618	
06"-12"	BJ2-2-0612-S-01	12"	20302	
		18"	22306	
		24"	23420	
		30"	23870	
		36"	24384	
		42"	24510	
		48"	24904	
		54"	25502	
Bottom @ 60"		60"	25716	

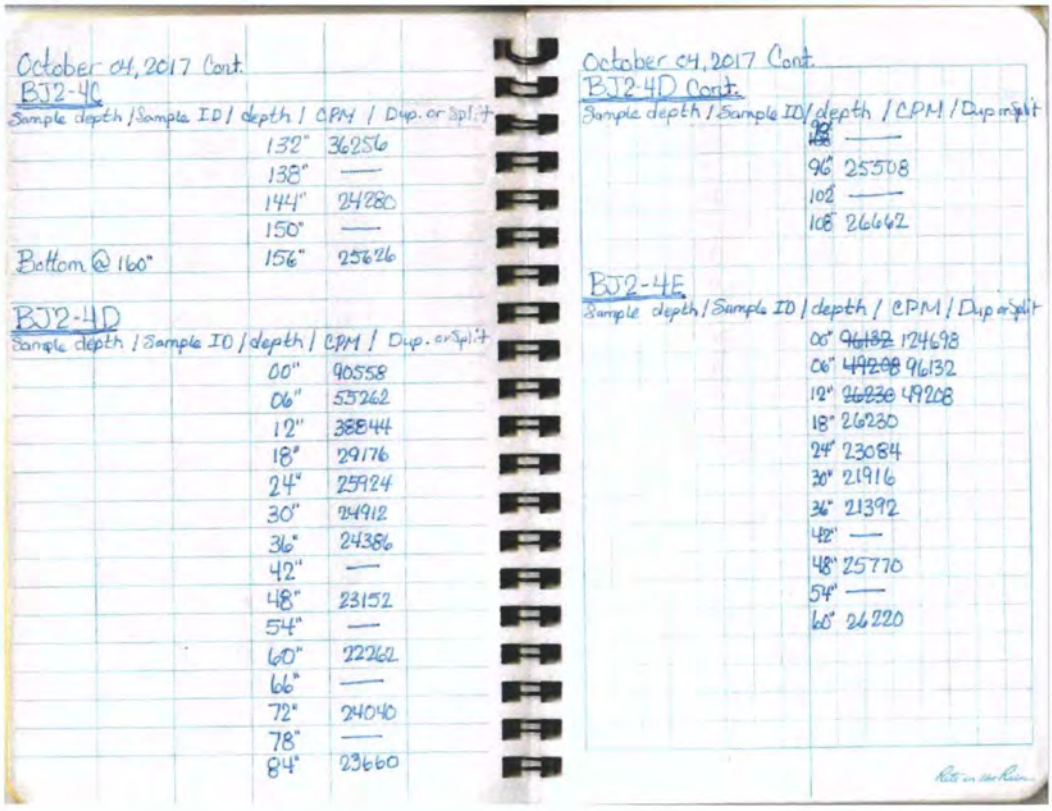
BJ2-3

Sample depth	Sample ID	depth	CPM	Dup or Split
		00"	217084	
00"-06"	BJ2-3-0006-S-01	06"	458042	
06"-12"	BJ2-3-0612-S-01	12"	106210	
12"-18"	BJ2-3-1218-S-01	18"	48760	
18"-24"	BJ2-3-1824-S-01	24"	40188	
		30"	32936	
		36"	30484	
		42"	28680	
		48"	27918	
		54"	28500	
		60"	37302	

October 04, 2017 Cont.

BJ2-4C

Sample depth	Sample ID	depth	CPM	Dup or Split
		00"	258744	
		06"	432480	
		12"	205736	
		18"	71220	
		24"	49608	
		30"	43454	
		36"	38040	
		42"	34846	
		48"	33192	
		54"	32770	
		60"	33656	
		66"	31394	
		72"	30088	
		78"	—	
		84"	28516	
		90"	—	
		96"	28344	
		102"	—	
		108"	27900	
		114"	—	
		120"	27926	
		126"	—	



October 04, 2017 Cont.

BJ2-4C

Sample depth	Sample ID	depth	CPM	Dup or Split
		132"	36256	
		138"	—	
		144"	24280	
		150"	—	
Bottom @ 160"		156"	25626	

BJ2-4D

Sample depth	Sample ID	depth	CPM	Dup. or Split
		00"	90558	
		06"	55262	
		12"	38844	
		18"	29176	
		24"	25924	
		30"	24912	
		36"	24386	
		42"	—	
		48"	23152	
		54"	—	
		60"	22262	
		66"	—	
		72"	24040	
		78"	—	
		84"	23660	

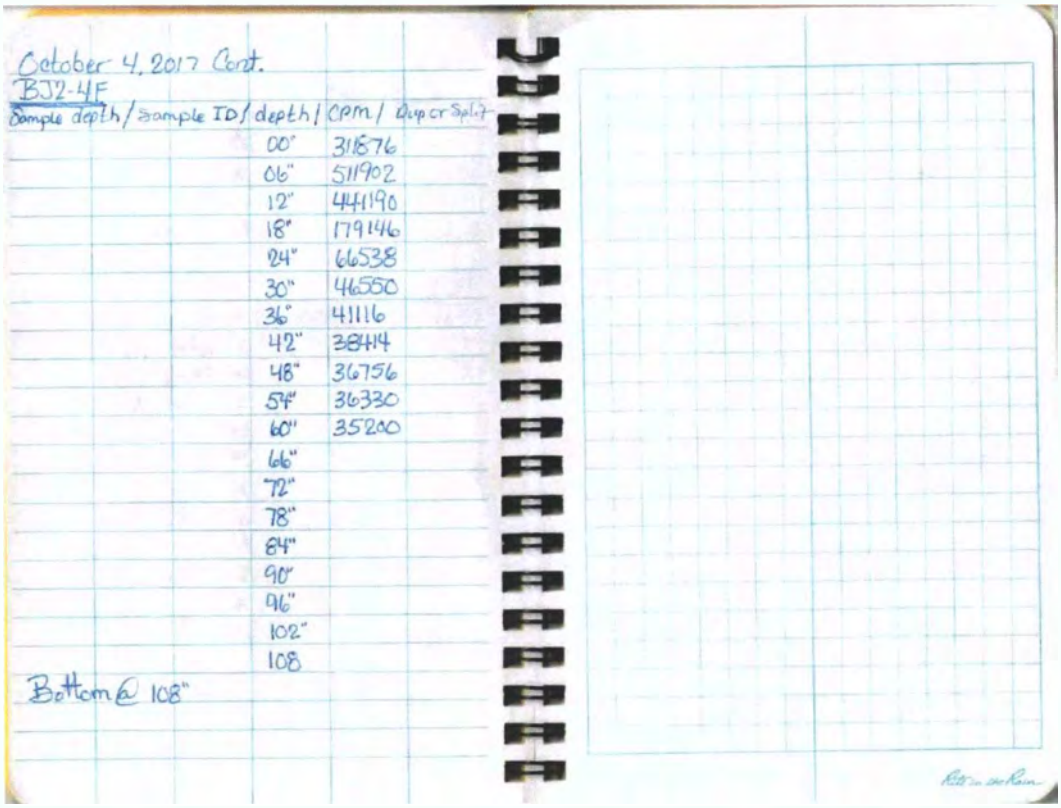
October 04, 2017 Cont.

BJ2-4D Cont.

Sample depth	Sample ID	depth	CPM	Dup or Split
		~~90~~	—	
		96"	25508	
		102"	—	
		108"	26642	

BJ2-4E

Sample depth	Sample ID	depth	CPM	Dup or Split
		00"	~~96182~~ 124698	
		06"	~~49208~~ 96132	
		12"	~~26230~~ 49208	
		18"	26230	
		24"	23084	
		30"	21916	
		36"	21392	
		42"	—	
		48"	25770	
		54"	—	
		60"	24220	



October 4, 2017 Cont.
BJ2-4F

Sample depth / Sample ID / depth	CPM / Dup or Split
00"	31876
06"	511902
12"	441190
18"	179146
24"	66538
30"	46550
36"	41116
42"	38414
48"	36756
54"	36330
60"	35200
66"	
72"	
78"	
84"	
90"	
96"	
102"	
108	

Bottom @ 108"

Attachment A6 (Soil Sampling Sheets)

ERG Soil Sample Collection Log

- Name(s) of personnel collecting soil samples: David Norwood & Randy Whicker
- Survey Instrument(s) with Serial Number(s): A) Ludlum 2221-176941/4410-PR150786 B) Ludlum 2221-262334/4410-PR321856
- Calibration Due Date(s): A) Sept. 18, 2018/09-26-2018 B) 09-26-2018/09-26-2018
- Project: Phase 3, Removal Site Evaluation
- Date: October 3,4 2017
- Weather/Field Conditions: Warm, Windy

Number	Sample ID	Depth (cm)	Gamma Reading (cpm) (µR/hr)	Time (24:00)	GPS Position Recorded	Comments	Initials
1	BJ2-1-0006-S-01	0-15	17588			All gamma readings are given	DN
2	BJ2-1-0612-S-01	15-30	20382			for the max depth of the	
3	BJ2-2-0006-S-01	0-15	18818			range given.	
4	BJ2-2-0612-S-01	15-30	20302				
5	BJ2-3-0006-S-01	0-15	458042				
6	BJ2-3-0612-S-01	15-30	106210				
7	BJ2-3-1218-S-01	~~45-60~~ 30-45	48760				
8	BJ2-3-1824-S-01	45-60	40188				
9	BJ2-3-2430-S-01	60-75	32936				
10	BJ2-4-0006-S-01	0-15	165718				
11	BJ2-4-0612-S-01	15-30	64980				
12	BJ2-4-1218-S-01	30-45	36130				
13	BJ2-4-2430-S-01	60-75	29270				
14	BJ2-4-3642-S-01	90-105	27814				
15	BJ2-4-6066-S-01	150-165	27812				

ERG Soil Sample Collection Log

- Name(s) of personnel collecting soil samples: David Norwood & Randy Whicker
- Survey Instrument(s) with Serial Number(s): A) Ludlum 2221-176941/4410-PR150786 B) Ludlum 2221-262334/4410-PR321856
- Calibration Due Date(s): A) Sept. 18, 2018/09-26-2018 B) 09-26-2018/09-26-2018
- Project: Phase 3, Removal Site Evaluation
- Date: October 3,4 2017
- Weather/Field Conditions: Warm, Windy

Number	Sample ID	Depth (cm)	Gamma Reading (cpm) (µR/hr)	Time (24:00)	GPS Position Recorded	Comments	Initials
1	BJ2-4-96102-S-01	240-265	23392			All gamma readings are given	DN
2	BJ2-4-114120-S-01	295-310	30302			for the max depth of the	
3	BJ2-4B-0006-S-01	0-15	499628			range given.	
4	BJ2-4B-0612-S-01	15-30	380898				
5	BJ2-4B-1218-S-01	30-45	120884				
6	BJ2-4B-2430-S-01	60-75	22000				
7	BJ2-4B-3642-S-01	90-105	no counts			See field book	
8	BJ2-4B-7278-S-01	180-195	no counts			See field book	
9	BJ2-4B-96102-S-01	240-265	no counts			See field book	
10	BJ2-4B-120126-S-01	310-325	28068				
11	BJ2-4B-144150-S-01	370-385	25914				
12	BJ2-4B-174180-S-01	445-460	no counts			See field book	
13	BJ2-4B-234240-S-01	585-600	no counts			See field book	
14	BJ2-5-0006-S-01	0-15	121414				
15	BJ2-5-0612-S-01	15-30	65894				

ERG Soil Sample Collection Log

- Name(s) of personnel collecting soil samples: David Norwood & Randy Whicker
- Survey Instrument(s) with Serial Number(s): A) Ludlum 2221-176941/4410-PR150786 B) Ludlum 2221-262334/4410-PR321856
- Calibration Due Date(s): A) Sept. 18, 2018/09-26-2018 B) 09-26-2018/09-26-2018
- Project: Phase 3, Removal Site Evaluation
- Date: October 3,4 2017
- Weather/Field Conditions: Warm, Windy

Number	Sample ID	Depth (cm)	Gamma Reading (cpm) (µR/hr)	Time (24:00)	GPS Position Recorded	Comments	Initials
1	BJ2-5-1218-S-01	30-45	34498			All gamma readings are given	DN
2	BJ2-5-2430-S-01	60-75	18776			for the max depth of the	
3	BJ2-6-0006-S-01	0-15	22634			range given.	
4	BJ2-6-0006-S-02D	0-15	22634				
5	BJ2-6-0612-S-01	15-30	22680				
6	BJ2-7-0006-S-01	0-15	19730				
7	BJ2-7-0612-S-01	15-30	19738				
8	BJ2-8-0006-S-01	0-15	17296				
9	BJ2-8-0612-S-01	15-30	17966				
10	BJ2-9-0006-S-01	0-15	9100				
11	BJ2-9-0612-S-01	15-30	10575				
12	BJ2-10-0006-S-01	0-15	16576				
13	BJ2-10-0612-S-01	15-30	15865				
14	BJ2-10-1218-01	30-45	16229				
15	BJ2-10-2430-01	60-75	22418	↓			↓

ERG Soil Sample Collection Log

- Name(s) of personnel collecting soil samples: David Norwood & Randy Whicker
- Survey Instrument(s) with Serial Number(s): A) Ludlum 2221-176941/4410-PR150786 B) Ludlum 2221-262334/4410-PR321856
- Calibration Due Date(s): A) Sept. 18, 2018/09-26-2018 B) 09-26-2018/09-26-2018
- Project: Phase 3, Removal Site Evaluation
- Date: October 3,4 2017
- Weather/Field Conditions: Warm, Windy

Number	Sample ID	Depth (cm)	Gamma Reading (cpm) (µR/hr)	Time (24:00)	GPS Position Recorded	Comments	Initials
1	BJ2-10-2430-S-01	60-75	22418			All gamma readings are given	DN
2	BJ2-10-4248-S-01	105-120	94822			for the max depth of the	
3	BJ2-10-7278-S-01	180-195	99454			range given.	
4	BJ2-10-102108-S-01	265-280	30430				
5	BJ2-10-138144-S-01	355-370	27088				
6	BJ2-11-0006-S-01	0-15	~~33494~~	847 234			
7	BJ2-11-0612-S-01	15-30	373356				
8	BJ2-11-1218-S-01	30-45	122970				
9	BJ2-11-2430-S-01	60-75	no count			See field book	
10	BJ2-11-3648-S-01	90-105	no count			See field book	
11	BJ2-11-96102-S-01	240-265	no count			See field book	
12	BJ2-11-120126-S-01	310-325	no count			See field book	
13	BJ2-11-150156-S-01	385-400	257340				
14	BJ2-11-234240-S-01	585-600	no count			See field book	
15	dn ~~BJ2-~~ BJ2-11A-0024-S-01	0-60	44078	↓			↓

ERG Soil Sample Collection Log

- Name(s) of personnel collecting soil samples: David Norwood & Randy Whicker
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Number	Sample ID	Depth (cm)	Gamma Reading (cpm) (µR/hr)	Time (24:00)	GPS Position Recorded	Comments	Initials
1	BJ2-11A-0024-S-025	0-60	44078			All gamma readings are given	DN
2	BJ2-11A-3036-S-01	75-90	29196			for the max depth of the	
3	BJ2-12-0012-S-01	0-30	20659			range given.	
4	BJ2-12-1218-S-01	30-45	20212				
5	BJ2-13-0006-S-01	0-15	14858				
6	BJ2-13-0612-S-01	15-30	17456				
7	BJ2-14-0018-S-01	0-45	26771				
8	BJ2-14-0018-S-02D	0-45	26771				
9	BJ2-14-1824-S-01	45-60	19206				
10	BJ2-14-3036-S-01	75-90	14338				
11	BJ2-15-0006-S-01	0-15	43594				
12	BJ2-15-0612-S-01	15-30	29064				
13	BJ2-16-3036-S-01	75-90	28912				
14	BJ2-1-CORR-	0-15	——				
15	BJ2-1-CORR-DIS	0-15	13220				

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Number	Sample ID	Depth (cm)	Gamma Reading (cpm) (µR/hr)	Time (24:00)	GPS Position Recorded	Comments	Initials
1	BJ2-2-CORR	0-15	——			All gamma readings are given	DN
2	BJ2-2-CORR-DIS	0-15	26840			for the max depth of the	
3	BJ2-3-CORR	0-15	——			range given.	
4	BJ2-3-CORR-DIS	0-15	36424				
5	BJ2-4-CORR	0-15	——				
6	BJ2-4-CORR-DIS	0-15	52157				
7	BJ2-5-CORR	0-15	——				
8	BJ2-5-CORR-DIS	0-15	52653				
9	BJ2-6-CORR	0-15	——				
10	BJ2-6-CORR-DIS	0-15	74979				
11	BJ2-7-CORR	0-15	——				
12	BJ2-7-CORR-DIS	0-15	135733				
13	BJ2-8-CORR	0-15	——				
14	BJ2-8-CORR-DIS	0-15	291917				
15	BA1-CORR1-COMP	0-15	14313				

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Number	Sample ID	Depth (cm)	Gamma Reading (cpm) (µR/hr)	Time (24:00)	GPS Position Recorded	Comments	Initials
1	BA1-CORR1-DIS	0-15	14313	↓		All gamma readings are given for the max depth of the range given.	DN
2	BA1-CORR2-	0-15	—				
3	BA1-CORR2-DIS	0-15	16133				
4	BA2-CORR1-	0-15	—				
5	BA2-CORR1-DIS	0-15	11439				
6	BA2-CORR2-	0-15	—				
7	BA2-CORR2-DIS	0-15	13028				
8							
9							
10							
11							
12							
13							
14							
15				↓			↓

ERG Soil Sample Collection Log

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Number	Sample ID	Depth (cm)	Gamma Reading (cpm) (µR/hr)	Time (24:00)	GPS Position Recorded	Comments	Initials
1	BJ1-1-0006-S-01	0-15	19798	—		All gamma readings are given for the max depth of the range given.	DN
2	BJ1-2-1-0006-S-02D	0-15	19798	—			DN
3	BJ1-1-0612-S-01	15-30	22888	—			DN
4	BJ1-2-0006-S-01	0-15	20618	—			DN
5	BJ1-2-0612-S-01	15-30	24474	—			DN
6	BJ1-3-0012-S-01	0-30	@30 26690	—			DN
7	BJ1-3-1218-S-01	30-45	25266	—			DN
8	BJ1-4-0018-S-01	0-45	30044	—			DN
9	BJ1-4-0018-S-02S	0-45	30044	—			DN
10	BJ1-4-1824-S-01	45-60	27750	—			DN
11	BJ1-5-0036-S-01	0-90	30916	—			DN
12	BJ1-5-3642-S-01	90-105	28936	—			DN
13	BJ1-6-0012-S-01	0-30	32554	—			DN
14	BJ1-6-1218-S-01	30-45	30638	—			DN
15	BJ1-7-0024-S-01	0-60	32680	—			DN

ERG Soil Sample Collection Log

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Number	Sample ID	Depth (cm)	Gamma Reading (cpm) (μR/hr)	Time (24:00)	GPS Position Recorded	Comments	Initials
1	BJ1-7-0024-S-01S	0-60	32680			All gamma readings are given	DN
2	BJ1-7-2430-S-01	60-75	31670			for the max depth of the	
3	BJ1-8-0006-S-01	0-15	34516			range given.	
4	BJ1-8-0612-S-01	15-30	32180				
5	BJ1-9-0006-S-01	0-15	25648				
6	BJ1-9-0612-S-01	15-30	27302				
7	BJ1-10-0006-S-01	0-15	23010				
8	BJ1-10-0612-S-01	15-30	28646				
9	BJ1-11-0006-S-01	0-15	22340				
10	BJ1-11-0612-S-01	15-30	27730				
11	BJ1-12-0006-S-01	0-15	16900				
12	BJ1-12-0006-S-02D	0-15	16900				
13	BJ1-12-0612-S-01	15-30	18292				
14	BJ1-13-0006-S-01	0-15	17750				
15	BJ1-13-0612-S-01	15-30	19408				

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Number	Sample ID	Depth (cm)	Gamma Reading (cpm) (μR/hr)	Time (24:00)	GPS Position Recorded	Comments	Initials
1	BJ1-14-0018-S-01	0-45	29254			All gamma readings are given	DN
2	BJ1-14-1824-S-01	45-60	26774			for the max depth of the	
3	BJ1-15-0036-S-01	0-90	32634			range given.	
4	BJ1-15-3642-S-01	90-105	31390				
5	BJ1-16-0024-S-01	0-60	28550				
6	BJ1-16-2430-S-01	60-75	26338				
7	BJ1-17-0024-S-01	0-60	23982				
8	BJ1-17-2430-S-01	60-75	22136				
9	BJ1-18-0006-S-01	0-15	24020				
10	BJ1-18-0612-S-01	15-30	25018				
11	BJ1-19-0006-S-01	0-15	22064				
12	BJ1-19-0612-S-01	15-30	24050				
13	BJ1-20-0006-S-01	0-15	22572				
14	BJ1-20-0612-S-01	15-30	25188				
15	BJ1-21-0006-S-01	0-15	512645				

ERG Soil Sample Collection Log

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- Weather/Field Conditions: Warm, Windy
- Calibration Due Date(s): A) Sept 12, 2018/09-26-2018 B) 09-26-2018/09-26-2018

Number	Sample ID	Depth (cm)	Gamma Reading (cpm) (µR/hr)	Time (24:00)	GPS Position Recorded	Comments	Initials
1	BJ1-21-0612-S-01	15-30	194774			All gamma readings are given	DN
2	BJ1-21-1218-S-01	30-45	114782			for the max depth of the	
3	BJ1-21-2430-S-01	60-75	49438			range given.	
4	BJ1-21-3642-S-01	90-105	38168				
5	BJ1-21-4854-S-01	120-135	37210				
6	BJ1-22-0006-S-01	0-15	161348				
7	BJ1-22-0006-S-020	0-15	161348				
8	BJ1-22-0612-S-01	15-30	78396				
9	BJ1-22-1218-S-01	30-45	27724				
10	BJ1-1-CORR-	0-15	—				
11	BJ1-1-CORR-DIS	0-15	~~14313~~ DN	11279			
12	BJ1-2-Corr-	0-15	—				
13	BJ1-2-CORR-DIS	0-15	~~16133~~ DN	21138			
14	BJ1-3-CORR-	0-15	—				
15	BJ1-3-CORR-DIS	0-15	27778				

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Number	Sample ID	Depth (cm)	Gamma Reading (cpm) (µR/hr)	Time (24:00)	GPS Position Recorded	Comments	Initials
1	BJ1-4-CORR-	0-15	—			All gamma readings are given	DN
2	BJ1-4-CORR-DIS	0-15	32784			for the max depth of the	
3	BJ1-5-CORR-	0-15	—			range given.	
4	BJ1-5-CORR-DIS	0-15	49658				
5	BJ1-6-CORR-	0-15	—				
6	BJ1-6-CORR-DIS	0-15	127225				
7	BJ1-7-CORR-	0-15	—				
8	BJ1-7-CORR-DIS	0-15	347021				
9	BJ1-8-CORR-	0-15	—				
10	BJ1-8-CORR-DIS	0-15	77571				
11							
12							
13							
14							
15							

ERG Soil Sample Collection Log

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Number	Sample ID	Depth (cm)	Gamma Reading (cps) (μR/hr)	Time (24:00)	GPS Position Recorded	Comments	Initials
1	M2-1-0006-S-01	0-15	22030			All gamma readings are given for the max depth of the range given.	DN
2	M2-1-0612-S-01	15-30	21898				
3	M2-2-0006-S-01	0-15	17724				
4	M2-2-0612-S-01	15-30	19840				
5	M2-3-0006-S-01	0-15	16474				
6	M2-3-0612-S-01	15-30	17512				
7	M2-4-0006-S-01	0-15	88640				
8	M2-4-0006-S-02D	0-15	88640				
9	M2-4-0612-S-01	15-30	43270				
10	M2-5-0006-S-01	0-15	27924				
11	M2-5-0612-S-01	15-30	24654				
12	M2-5-1218-S-01	30-45	22540				
13	M2-5-1824-S-01	45-60	21778				
14	M2-6-0018-S-01	0-45	38052				
15	M2-6-0018-S-02S	0-45	38052				

ERG Soil Sample Collection Log

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29586

Number	Sample ID	Depth (cm)	Gamma Reading (cps) (μR/hr)	Time (24:00)	GPS Position Recorded	Comments	Initials
1	M2-6-1824-S-01	45-60	~~23792~~			All gamma readings are given for the max depth of the range given.	DN
2	M2-7-0006-S-01	0-15	29612				
3	M2-7-0612-S-01	15-30	27540				
4	M2-7-1218-S-01	30-45	23114				
5	M2-8-0006-S-01	0-15	25586				
6	M2-8-0612-S-01	15-30	25962				
7	M2-9-0006-S-01	0-15	21030				
8	M2-9-0612-S-01	15-30	23428				
9	M2-10-0006-S-01	0-15	21448				
10	M2-10-0612-S-01	15-30	23618				
11	M2-11-0006-S-01	0-15	20556				
12	M2-11-0612-S-01	15-30	23900				
13	M2-12-0006-S-01	0-15	15792				
14	M2-12-0612-S-01	15-30	18158				
15	M2-13-0006-S-01	0-15	17550				

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Number	Sample ID	Depth (cm)	Gamma Reading (cpm) (µR/hr)	Time (24:00)	GPS Position Recorded	Comments	Initials
1	M2-13-0612-S-01	15-30	18634	⟷		All gamma readings are given	DN
2	M2-14-0006-S-01	0-15	90354			for the max depth of the	
3	M2-14-0612-S-01	15-30	59456			range given.	
4	M2-14-1218-S-01	30-45	45172				
5	M2-15-0006-S-01	0-15	17808				
6	M2-15-0612-S-01	15-30	19152				
7	M2-16-0006-S-01	0-15	18658				
8	M2-16-0612-S-01	15-30	20504				
9	M2-17-0006-S-01	0-15	20554				
10	M2-17-0006-S-02S	0-15	20554				
11	M2-17-0612-S-01	15-30	21320				
12	M2-18-0006-S-01	0-15	24290				
13	M2-18-0006-S-02D	0-15	24290				
14	M2-18-0612-S-01	15-30	26310				
15	M2-19-0036-S-01	0-90	773108	↓			↓

ERG Soil Sample Collection Log

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Number	Sample ID	Depth (cm)	Gamma Reading (cpm) (µR/hr)	Time (24:00)	GPS Position Recorded	Comments	Initials
1	M2-18-3036-S-01	75-90	38284	⟷		All gamma readings are given	DN
2	M2-19-4854-S-01	120-135	42396			for the max depth of the	
3	M2-19A-0030-S-01	0-75	45018			range given.	
4	M2-19A-0030-S-02S	0-75	45018				
5	M2-19A-3036-S-01	75-90	42178				
6	M2-21-0006-S-01	0-15	36026				
7	M2-21-0612-S-01	15-30	28218				
8	M2-21-1824-S-01	45-60	23268				
9	M-22-0006-S-01	0-15	18230				
10	M-22-0612-S-01	15-30	19906				
11	M-23-0006-S-01	0-15	22568				
12	M-23-0612-S-01	15-30	20266				
13	⟷	⟷	⟷				
14							
15				↓			↓

ERG Soil Sample Collection Log

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Number	Sample ID	Depth (cm)	Gamma Reading (cpm) (µR/hr)	Time (24:00)	GPS Position Recorded	Comments	Initials
1	MI-1-0006-S-01	0-15	45362			All gamma readings are given	DN
2	MI-1-0612-S-01	15-30	35128			for the max depth of the	
3	MI-2-0012-S-01	0-30	20816			range given.	
4	MI-2-1218-S-01	30-45	17814				
5	MI-3-0006-S-01	0-15	17128				
6	MI-3-0612-S-01	15-30	16260				
7	MI-4-0018-S-01	0-45	22290				
8	MI-4-0018-S-02S	0-45	22290				
9	MI-4-1824-S-01	45-60	23114				
10	MI-5-0012-S-01	0-30	44822				
11	MI-5-1218-S-01	30-45	24480				
12	MI-6-0006-S-01	0-15	14546				
13	MI-6-0612-S-01	15-30	15458				
14	MI-7-0024-S-01	0-60	1360786				
15	MI-7-0024-S-02S	0-60	1360786	↓			↓

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Number	Sample ID	Depth (cm)	Gamma Reading (cpm) (µR/hr)	Time (24:00)	GPS Position Recorded	Comments	Initials
1	MI-7-2430-S-01	60-75	310458			All gamma readings are given	DN
2	MI-8-0018-S-01	0-45	21518			for the max depth of the	
3	MI-8-1824-S-01	45-60	13036			range given.	
4	MI-9-0006-S-01	0-15	15944				
5	MI-9-0612-S-01	15-30	11372				
6	MI-10-0006-S-01	0-15	40426				
7	MI-10-0612-S-01	15-30	22496				
8	MI-11-0012-S-01	0-30	360160				
9	MI-11-0012-S-02S	0-30	360160				
10	MI-11-1218-S-01	30-45	23918				
11	MI-12-0018-S-01	0-45	46932				
12	MI-12-1824-S-01	45-60	23890				
13	MI-13-0006-S-01	0-15	562112				
14	MI-13-0612-S-01	15-30	181308				
15	MI-13-1824-S-01	45-60	41332	↓			↓

ERG Soil Sample Collection Log

- Name(s) of personnel collecting soil samples: David Norwood & Randy Whicker
- Survey Instrument(s) with Serial Number(s): A) Ludlum 2221-176941/4410-PR150786 B) Ludlum 2221-262334/4410-PR321856
- Calibration Due Date(s): A) Sept 12, 2018/09-26-2018 B) 09-26-2018/09-26-2018
- Project: Phase 3, Removal Site Evaluation
- Date: October 12, 2017
- Weather/Field Conditions: Warm, Windy

Number	Sample ID	Depth (cm)	Gamma Reading (cpm) (uR/hr)	Time (24:00)	GPS Position Recorded	Comments	Initials
1	M1-13-3642-S-01	90-105	23466			All gamma readings are given	DN
2	M1-9-0006-S-02D	0-15	15944			for the max depth of the	
3	M1-10-0006-S-02D	0-15	40426			range given.	
4	M1-13-2430-S-01	60-75	48832				
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

Attachment A7 (Instrument Function Check Forms)

#1

ERG

Single-Channel Function Check Log

Environmental Restoration Group, Inc.
1800 Washington St. NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224

METER	
Manufacturer:	LUDLUM
Model:	2221
Serial No.:	218564
Cal. Due Date:	4/16/16

DETECTOR	
Manufacturer:	LUDLUM
Model:	44-10
Serial No.:	PR288465
Cal. Due Date:	4/16/16

Comments:
ERG J16 @ THE NAAZBAAH
VETERANS CENTER PARKING
LOT.

Source: Cs-137 Activity: 4.81 uCi Source Date: 6/16/94 Distance to Source: 4.5"
Serial No.: 332-94 Emission Rate: N/A cpm/emissions

Date	Time	Battery	High Voltage	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
4/20/15	11:00	6.2	1000	52825	6928	45897	cf	THR: 105
4/20/15	17:10	6.1	1003	52114	6594	45520	cf	THR: 104
4/21/15	7:55	6.1	1003	53483	7154	46329	cf	THR: 105
4/21/15	17:45	6.0	1005	51901	6684	45217	cf	THR: 110
4/22/15	8:00	6.1	1005	52154	6905	45249	cf	THR: 106
4/22/15	—	NOT USED THIS DAY						
4/23/15	8:00	6.1	1008	53870	7194	46676	cf	THR: 108
4/23/15	—	NOT USED TODAY						
4/24/15	7:45	6.1	1006	54678	7143	47535	cf	THR: 107
4/24/15	—	NOT USED TODAY.						

#2

ERG

Single-Channel Function Check Log

Environmental Restoration Group, Inc.
1800 Washington St. NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224

METER	
Manufacturer:	LUDLUM
Model:	2221
Serial No.:	282973
Cal. Due Date:	10/22/15

DETECTOR	
Manufacturer:	LUDLUM
Model:	44-10
Serial No.:	PR118986
Cal. Due Date:	10/22/15

Comments:
ERG J16 @ THE NAAZBAAH
VETERANS CENTER PARKING
LOT.

Source: Cs-137 Activity: 4.81 uCi Source Date: 6/16/94 Distance to Source: 4-5"
Serial No.: 332-94 Emission Rate: N/A cpm/emissions

Date	Time	Battery	High Voltage	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
4/20/15	11:00	6.2	1100	53197	7336	45861	cf	THR: 98
4/20/15	17:10	6.1	1101	55192	7379	47813	cf	THR: 98
4/21/15	7:55	6.2	1104	55507	7548	47959	cf	THR: 99
4/21/15	17:45	6.0	1101	52945	7367	45578	cf	THR: 98
4/22/15	8:00	6.0	1106	53844	8039	45305	cf	THR: 99
4/22/15	18:10	5.8	1099	56276	9615	46661	cf	THR: 98 * AT ROAD BLOCKOUT.
4/23/15	08:00	5.9	1107	53702	7716	45986	cf	THR: 99
4/23/15	16:15	5.7	1101	54458	7415	47043		THR: 98
4/24/15	7:45	5.8	1106	55527 7493	7493 7493	48034	cf	THR: Y: 55527 REF 7493
4/24/15	10:00	5.6	1104	54270	7155	47115	cf	THR: 98

#3

Single-Channel Function Check Log

ERG

Environmental Restoration Group, Inc.
8809 Washington St. NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224

METER	
Manufacturer:	LUDLUM
Model:	2221
Serial No:	86306
Cal. Due Date:	10/22/15

DETECTOR	
Manufacturer:	LUDLUM
Model:	44-10
Serial No.:	PR090262
Cal. Due Date:	10/22/15

Comments:
ERG JIG @ NAAZ&AH VETERANS CENTER PARKING LOT.

Source: Cs-137 Activity: 4.81 uCi Source Date: 6/16/94 Distance to Source: 4.5"

Serial No.: 332-94 Emission Rate: N/A cpm/emissions

Date	Time	Battery	High Voltage	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
4/20/15	11:00	6.2	1150	52475	6824	45651	cf	THR: 102
4/20/15	17:10	6.1	1155	52717	7494	45223	cf	THR: 102
4/21/15	7:55	6.2	1157	53305	7265	46040	cf	THR: 102
4/21/15	17:45	6.0	1154	53359	7315	46044	cf	THR: 102
4/22/15	8:00	6.0	1160	52012	7606	44406	cf	THR: 103
4/22/15	16:10	5.8	1152	55996	9756	46240	cf	THR: 102
4/23/15	8:00	5.9	1159	53418	7558	45860	cf	THR: 103
4/23/15	16:15	5.7	1154	53030	7327	45703	cf	THR: 102
4/24/15	7:45	5.8	1160	53987	7335	46652	cf	THR: 102
4/24/15	16:00	5.6	1158	52980	7192	45788	cf	THR: 103

X

Single-Channel Function Check Log

ERG

Environmental Restoration Group, Inc.
8809 Washington St. NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224

METER	
Manufacturer:	LUDLUM
Model:	12
Serial No.:	274087
Cal. Due Date:	4/16/16

DETECTOR	
Manufacturer:	LUDLUM
Model:	43-5
Serial No:	PA2043 97
Cal. Due Date:	4/16/16

Comments:
ERG CAL JIG

Source: Th-230 Activity: N/A uCi Source Date: 6/15/11 Distance to Source: CONTACT

Serial No.: 7132-10 Emission Rate: 3830 cpm/emissions

Date	Time	Battery	High Voltage	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
4/21/15	7:55	✓	–	1000	0	1000	cf	LIGHT LEAK IN DIRECT LIGHT
4/21/15	17:45	✓	–	1000	0	1000	cf	✓
4/22/15	8:00	✓	–	1000	0	1000	cf	✓
4/23/15	8:00	✓	–	1000	0	1000	cf	✓
4/23/15	16:15	✓	–	1000	0	1000	cf	✓
4/24/15	7:45	✓	–	1000	0	1000	cf	✓
4/24/15	16:00	✓	–	1000	0	1000	cf	✓

(#4

ERG

Single-Channel Function Check Log

Environmental Restoration Group, Inc.
8809 Washington St. NE Suite 150
Albuquerque, NM 87113
(505) 298-4224

METER	
Manufacturer:	LUDLUM
Model:	~~44-10~~ 2221
Serial No.:	138368
Cal. Due Date:	7/19/16

DETECTOR	
Manufacturer:	LUDLUM
Model:	44-10
Serial No.:	PR154615
Cal. Due Date:	7/19/16

Comments:
@ BJ/MAC FUNCTION
CHECK LOCATION @
VETERANS CENTER
NAAZBAH.

Source: Cs-137 Activity: 4.81 uCi Source Date: 6/16/94 Distance to Source: ~ 4.5"

Serial No.: 332-94 Emission Rate: N/A ~~cpm/emissions~~

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
12/5/16	09:30	5.3	1150	100	53686	7289	46397	CF	
12/5/16	16:50	5.0	1148	99	52626	6984	45642	CF	
12/7/16	10:00	5.2	1148	100	53260	7314	45946	CF	
12/7/16	11:40	5.1	1148	102	52586	7383	45203	CF	

(#5

ERG

Single-Channel Function Check Log

Environmental Restoration Group, Inc.
8809 Washington St. NE Suite 150
Albuquerque, NM 87113
(505) 298-4224

METER	
Manufacturer:	LUDLUM
Model:	2221
Serial No.:	282961
Cal. Due Date:	~~7/19/17~~ 11/25/17

DETECTOR	
Manufacturer:	LUDLUM
Model:	44-10
Serial No.:	PR150786
Cal. Due Date:	~~7/19/17~~ 11/25/17

Comments:
@ BJ/MAC F/C AREA @
NAAZBAH VETERANS
CENTER @ SMITH LAKE
CHAPTER.

Source: Cs-137 Activity: 4.81 uCi Source Date: 6/16/94 Distance to Source: ~ 4.5"

Serial No.: 332-94 Emission Rate: N/A ~~cpm/emissions~~

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
12/5/16	09:30	5.7	1104	100	53866	7325	46541	CF	
12/5/16	16:50	5.4	1106	100	53488	7032	46458	CF	

ERG

Single-Channel Function Check Log

Environmental Restoration Group, Inc.
8809 Washington St. NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224

METER	
Manufacturer:	Ludlum
Model:	~~4410~~ 2221
Serial No.:	218563
Cal. Due Date:	5-1-18

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR150851
Cal. Due Date:	5-1-18

Comments:

Source: Cs137 Activity: 481 uCi Source Date: 6/16/94 Distance to Source: 4.5"

Serial No: 332-94 Emission Rate: N/A cpm/emissions

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
5/3/17	7:30am	5.6	1149	98	48937	6838	42099	MW	
5/3/17	2:55pm	5.4	1154	104	48502	7249	41253	MW	

ERG

Single-Channel Function Check Log

Environmental Restoration Group, Inc.
8809 Washington St. NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224

METER	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	262334
Cal. Due Date:	09-26-2018

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR321856
Cal. Due Date:	09-26-2018

Comments: A2-4410/2221

Source: Cs-137 Activity: uCi Source Date: Distance to Source:

Serial No.: Emission Rate: cpm/emissions

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
10-09-17	08:30	4.8	1055	101	72738	6512	66226	DN	Function check at Smith Lake
10-09-17	21:15	4.8	1055	100	55811	4461	51350	DN	Hotel Room
10-10-17	06:30	4.9	1052	102	59420	4621	54799	DN	" "
10-10-17	18:21	5.1	1051	103	61433	4614	56819	DN	" " Changed batt
10-11-17	06:21	6.3	1053	102	60076	4997	55079	DN	
10-12-17	05:10	6.2	1053	102	59636	5032	54604	DN	" "
10-13-17	0548	6.1	1053	103	60678	4817	55861	DN	" "

ERG

Single-Channel Function Check Log

Environmental Restoration Group, Inc.
1800 Washington St. NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224

METER	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	176941
Cal. Due Date:	Sept 12, 2018

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR150786
Cal. Due Date:	09-26-2018

Comments: A1-2221/44-10

Source: Cs-137 Activity: _____ uCi Source Date: _____ Distance to Source: _____

Serial No.: _____ Emission Rate: _____ cpm/emissions

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
10-03-17	09:22	6.2	1050	99	77178	7548	69,630	DN	
10-03-17	20:41	6.0	1045	99	58854	7729	51,125	DN	changed area of function check to hotel room
10-04-17	06:13	6.0	1046	99	58131	8032	50,099	DN	
10-04-17	19:30	5.9	1045	99	59188	7884	51,304	DN	
10-05-17	05:59	5.9	1045	99	56710	6956	49,754	DN	
10-05-17	22:59	5.9	1045	99	57625	7435	50190	DN	
10-09-17	08:13	5.9	1050	101	77268	7308	69960	DN	function check at Smith Lake
10-09-17	21:08	5.9	1050	100	54661	4461	50200	DN	Function check @ hotel
10-10-17	06:57	5.8	1046	100	61332	4851	56481	DN	"
10-10-17	18:16	5.7	1047	100	62256	5006	57250	DN	"
10-11-17	06:18	5.7	1047	100	62230	4908	57,322	DN	
10-12-17	05:00	5.6 on	1046	100	60413	5132	55,281	DN	

ERG

Single-Channel Function Check Log

Environmental Restoration Group, Inc.
1800 Washington St. NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224

METER	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	176941
Cal. Due Date:	Sept 12, 2018

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR150786
Cal. Due Date:	09-26-2018

Comments: A1-2221/44-10

Source: Cs 137 Activity: _____ uCi Source Date: _____ Distance to Source: _____

Serial No.: _____ Emission Rate: _____ cpm/emissions

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
10-13-17	05:50	5.7	1043	100	63622	4997	58625	DN	Hotel Room

Attachment A8 (Instrument Calibration Certificates)

Certificate of Calibration

Calibration and Voltage Plateau

Environmental Restoration Group, Inc.
8809 Washington St NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224
www.ERGoffice.com

Meter: Manufacturer:	Ludlum	Model Number:	2221r	Serial Number:	262334
Detector: Manufacturer:	Ludlum	Model Number:	44-10	Serial Number:	PR321856

☑ Mechanical Check ☑ THR/WIN Operation
☑ F/S Response Check ☑ Reset Check
☑ Geotropism ☑ Audio Check
☑ Meter Zeroed ☑ Battery Check (Min 4.4 VDC)

HV Check (+/- 2.5%): ☑ 500 V ☑ 1000 V ☑ 1500 V
Cable Length: ☐ 39-inch ☑ 72-inch ☐ Other:

Source Distance: ☐ Contact ☑ 6 inches ☐ Other:
Source Geometry: ☑ Side ☐ Below ☐ Other:

Threshold: 10 mV
Window:

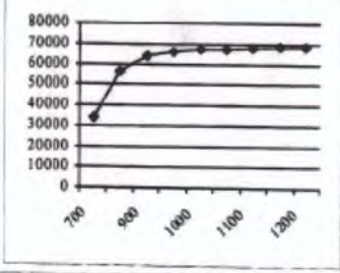
Barometric Pressure: 24.68 inches Hg
Temperature: 73 °F
Relative Humidity: 20 %

Instrument found within tolerance: ☑ Yes ☐ No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count	Log Scale Count
x 1000	400	400	400	399095	400
x 1000	100	100	100		100
x 100	400	400	400	39910	400
x 100	100	100	100		100
x 10	400	400	400	3991	400
x 10	100	100	100		100
x 1	400	400	400	399	400
x 1	100	100	100		100

High Voltage	Source Counts	Background
700	33960	
800	56433	
900	63914	
950	65921	
1000	66996	
1050	67216	10026
1100	67753	
1150	68487	
1200	68260	

Voltage Plateau



Comments: Comments: HV Plateau Scaler Count Time = 1-min. Recommended HV = 1050

Reference Instruments and/or Sources:

Ludlum pulser serial number: ☐ 97743 ☑ 201932
☐ Alpha Source: Th-230 sn: 4098-03@12,800dpm/6,520 cpm (1/4/12)
☐ Beta Source: Tc-99 sn: 4099-03@17,700dpm/11,100cpm(1/4/12)

Fluke multimeter serial number: ☐ 87490128
☑ Gamma Source Cs-137 @ 5.2 uCi (1/4/12) sn: 4097-03
☐ Other Source:

Calibrated By: _____ Calibration Date: 9-26-17 Calibration Due: 9-26-18

Reviewed By: _____ Date: 9-27-17

ERG Form ITC. 101.A

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997

LMI of Scientific and Industrial Instruments
www.ludlums.com

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
501 Oak Street
325-235-5494
Sweetwater, TX 79556, U.S.A.

ACCREDITED CERT # 4084.01

Customer: ERG — ORDER NO. 20318445/454100

Mfg. Ludlum Measurements, Inc. — Model 2221 — Serial No. 176941

Mfg. ____ Model ____ Serial No. ____

Cal. Date 12-Sep-17 — Cal Due Date 12-Sep-18 — Cal. Interval 1 Year — Meterface 202-159

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 72 °F RH 42 % Alt 710.0 mm Hg

☐ New Instrument Instrument Received ☐ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☑ Input Sens. Linearity
☑ F/S Resp. ck ☑ Reset ck. ☑ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck.
☑ Calibrated in accordance with LMI SOP 14.8 ☐ Calibrated in accordance with LMI SOP 14.9

Instrument Volt Set 1050 V Input Sens. 10 mV Det. Oper. ____ V at ____ mV Threshold Dial Ratio 100 = 10 mV

☐ HV Readout (2 points) Ref./Inst. 500 / 502 V Ref./Inst. 1500 / 1500 V

COMMENTS:

```
Calibrated with 39" cable
Calibrated with Win in "OUT" position
Firmware:   261027
```

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X 1000	400 Kcpm	N/A	400
X 1000	100 Kcpm		100
X 100	40 Kcpm		400
X 100	10 Kcpm		100
X 10	4 Kcpm		400
X 10	1 Kcpm		100
X 1	400 cpm		400
X 1	100 cpm		100

*Uncertainty within ± 10% C.F. within ± 20%

ALL Range(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout	400 Kcpm	N/A	40002-(0)	Log Scale	500 Kcpm	N/A	500 Kcpm
	40 Kcpm		4000		50 Kcpm		50
	4 Kcpm		400		5 Kcpm		5
	400 cpm		40		500 cpm		500 cpm
	40 cpm		4		50 cpm		50

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques.
The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 ISO/IE 17025:2005(E) State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources: Cs-137 S/N: ☐ 059 ☐ 2171CP ☐ 2261CP ☐ 720 ☐ 734 ☐ 781 ☐ 1131 ☐ 1616 ☐ 1696 ☐ 1909 ☐ 1916CP ☐ 2324/2521 ☐ 5717CO ☐ 5719CO ☐ 60646 ☐ 70897 ☐ 73410 ☐ E552 ☐ G112 ☐ 2169CP ☐ S-394 ☐ S-1054 ☐ T10081 ☐ T10082 Neutron Am-241 Be ☐ T-304 Ra-226 ☐ Y982

☐ Alpha S/N ____ ☐ Beta S/N ____ ☐ Other ____

☑ m 500 S/N 201934 ☐ Oscilloscope S/N ____ ☑ Multimeter S/N 92780460

Calibrator Josie Ruiz [signature] Title Technician Date 12 Sept 17

QC'd By [signature] Title Service Dept QC Date 13 Sep 17

This certificate shall not be reproduced except in full, without the written approval of Ludlum Measurements, Inc.
FORM SC22A 12/12/2016 Page 1 of 1

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed: ____

Certificate of Calibration

Calibration and Voltage Plateau

Environmental Restoration Group, Inc.
8809 Washington St NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224
www.ERGoffice.com

Meter: Manufacturer: Ludlum Model Number: 2221r Serial Number: 176941

Detector: Manufacturer: Ludlum Model Number: 44-10 Serial Number: PR150786

☐ Mechanical Check ☐ THR/WIN Operation
☐ F/S Response Check ☐ Reset Check
☐ Geotropism ☐ Audio Check
☐ Meter Zeroed ☐ Battery Check (Min 4.4 VDC)

HV Check (+/- 2.5%): ☐ 500 V ☐ 1000 V ☐ 1500 V
Cable Length: ☐ 39-inch ☐ 72-inch ☑ Other: 15'

Source Distance: ☐ Contact ☑ 6 inches ☐ Other:
Source Geometry: ☑ Side ☐ Below ☐ Other:

Threshold:
Window:

Barometric Pressure: 24.51 inches Hg
Temperature: 70 °F
Relative Humidity: 20 %

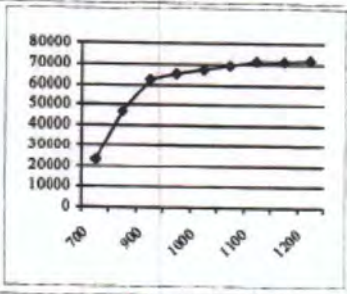
Instrument found within tolerance: ☑ Yes ☐ No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count	Log Scale Count
x 1000	400				
x 1000	100				
x 100	400				
x 100	100				
x 10	400				
x 10	100				
x 1	400				
x 1	100				

See Ludlum Cal Sheet

High Voltage	Source Counts	Background
700	23250	
800	46999	
900	62283	
950	65086	
1000	66980	
1050	68814	10050
1100	70904	
1150	71336	
1200	71851	

Voltage Plateau



Comments: Comments: HV Plateau Scaler Count Time = 1-min. Recommended HV = 1050

Reference Instruments and/or Sources:

Ludlum pulser serial number: ☐ 97743 ☑ 201932
Fluke multimeter serial number: ☐ 87490128
☐ Alpha Source: Th-230 sn: 4098-03@12,800dpm/6,520 cpm (1/4/12)
☑ Gamma Source Cs-137 @ 5.2 uCi (1/4/12) sn: 4097-03
☐ Beta Source: Tc-99 sn: 4099-03@17,700dpm/11,100cpm(1/4/12)
☐ Other Source:

Calibrated By: Calibration Date: 9-26-17 Calibration Due: 9-26-18

Reviewed By: Date: 9-27-17

ERG Form ITC. 101.A

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997

Certificate of Calibration

Calibration and Voltage Plateau

Environmental Restoration Group, Inc.
8809 Washington St NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224
www.ERGoffice.com

Meter: Manufacturer: Ludlum | Model Number: 2221r | Serial Number: 176941

Detector: Manufacturer: Ludlum | Model Number: 44-2 | Serial Number: PR188288

☐ Mechanical Check ☐ THR/WIN Operation
☐ F/S Response Check ☐ Reset Check
☐ Geotropism ☐ Audio Check
☐ Meter Zeroed ☐ Battery Check (Min 4.4 VDC)

HV Check (+/- 2.5%): ☐ 500 V ☐ 1000 V ☐ 1500 V
Cable Length: ☐ 39-inch ☐ 72-inch ☑ Other: 15'

Source Distance: ☐ Contact ☑ 6 inches ☐ Other:
Source Geometry: ☑ Side ☐ Below ☐ Other:

Threshold:
Window:

Barometric Pressure: 24.51 inches Hg
Temperature: 70 °F
Relative Humidity: 20 %

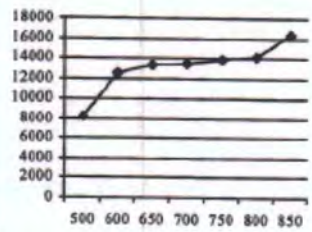
Instrument found within tolerance: ☑ Yes ☐ No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count	Log Scale Count
x 1000	400				
x 1000	100				
x 100	400				
x 100	100				
x 10	400				
x 10	100				
x 1	400				
x 1	100				

See Ludlum Cal Sheet

High Voltage	Source Counts	Background
500	8297	
600	12567	
650	13387	
700	13512	2086
750	13826	
800	14143	
850	16377	

Voltage Plateau



Comments: Comments: HV Plateau Scaler Count Time = 1-min. Recommended HV = 700

Reference Instruments and/or Sources:

Ludlum pulser serial number: ☐ 97743 ☑ 201932
Fluke multimeter serial number: ☐ 87490128
☐ Alpha Source: Th-230 sn: 4098-03@12,800dpm/6,520 cpm (1/4/12)
☑ Gamma Source Cs-137 @ 5.2 uCi (1/4/12) sn: 4097-03
☐ Beta Source: Tc-99 sn: 4099-03@17,700dpm/11,100cpm(1/4/12)
☐ Other Source:

Calibrated By: _____ Calibration Date: 9-26-17 Calibration Due: 9-26-18

Reviewed By: _____ Date: 9-27-17

ERG Form ITC. 101.A

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997

ERG

Certificate of Calibration

Calibration and Voltage Plateau

Environmental Restoration Group, Inc.
8809 Washington St NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224
www.ERGoffice.com

Meter: Manufacturer: Ludlum Model Number: 2221r Serial Number: 218564

Detector: Manufacturer: Ludlum Model Number: 44-10 Serial Number: PR288465

- ☑ Mechanical Check
- ☑ F/S Response Check
- ☑ Geotropism
- ☑ Meter Zeroed
- ☑ THR/WIN Operation
- ☑ Reset Check
- ☑ Audio Check
- ☑ Battery Check (Min 4.4 VDC)

HV Check (+/- 2.5%): ☑ 500 V ☑ 1000 V ☑ 1500 V

Cable Length: ☐ 39-inch ☑ 72-inch ☐ Other:

Source Distance: ☐ Contact ☑ 6 inches ☐ Other:

Source Geometry ☑ Side ☐ Below ☐ Other:

Threshold: 10 mV

Window:

Barometric Pressure: 24.33 inches Hg

Temperature: 74 °F

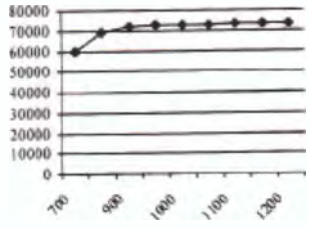
Relative Humidity: 20 %

Instrument found within tolerance: ☑ Yes ☐ No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count	Log Scale Count
x 1000	400	400	400	398892	400
x 1000	100	100	100		100
x 100	400	400	400	39888	400
x 100	100	100	100		100
x 10	400	400	400	3986	400
x 10	100	100	100		100
x 1	400	400	400	398	400
x 1	100	100	100		100

High Voltage	Source Counts	Background
700	59599	
800	69486	
900	71679	
950	72244	
1000	72475	9432
1050	72877	
1100	73119	
1150	73031	
1200	73241	

Voltage Plateau



Comments: HV Plateau Scaler Count Time = 1-min. Recommended HV =1000

Reference Instruments and/or Sources:

Ludlum pulser serial number: ☐ 97743 ☑ 201932

☐ Alpha Source: Th-230 @ 12,800 dpm (1/4/12) sn: 4098-03

☐ Beta Source: Tc-99 @ 17,700 dpm (1/4/12) sn: 4099-03

Fluke multimeter serial number: ☐ 8749012

☑ Gamma Source Cs-137 @ 5.2 uCi (1/4/12) sn: 4097-03

☐ Other Source:

Calibrated By:

Calibration Date: 4-16-15 Calibration Due 4-16-16

Reviewed By:

Date: 4/16/15

ERG Form ITC. 101.A

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997

Certificate of Calibration

Calibration and Voltage Plateau

Environmental Restoration Group, Inc.
8809 Washington St NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224
www.ERGoffice.com

Meter: Manufacturer: Ludlum Model Number: 2221r Serial Number: 282973

Detector: Manufacturer: Ludlum Model Number: 44-10 Serial Number: PR118986

☑ Mechanical Check ☑ THR/WIN Operation
☑ F/S Response Check ☑ Reset Check
☑ Geotropism ☑ Audio Check
☑ Meter Zeroed ☑ Battery Check (Min 4.4 VDC)
Source Distance: ☐ Contact ☑ 6 inches ☐ Other:
Source Geometry ☑ Side ☐ Below ☐ Other:

HV Check (+/- 2.5%): ☑ 500 V ☑ 1000 V ☑ 1500 V
Cable Length: ☐ 39-inch ☑ 72-inch ☐ Other:

Threshold: 10 mV
Window:

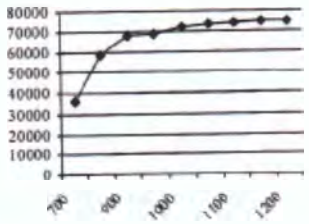
Barometric Pressure: 24.69 inches Hg
Temperature: 77 °F
Relative Humidity: 20 %

Instrument found within tolerance: ☑ Yes ☐ No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count	Log Scale Count
x 1000	400	400	400	399626	400
x 1000	100	100	100		100
x 100	400	400	400	39985	400
x 100	100	100	100		100
x 10	400	400	400	3998	400
x 10	100	100	100		100
x 1	400	400	400	399	400
x 1	100	100	100		100

High Voltage	Source Counts	Background
700	36064	
800	58303	
900	67676	
950	68787	
1000	71543	
1050	73189	
1100	73675	11545
1150	74374	
1200	74783	

Voltage Plateau



Comments: HV Plateau Scaler Count Time = 1-min. Recommended HV = 1100

Reference Instruments and/or Sources:

Ludlum pulser serial number: ☐ 97743 ☑ 201932
☐ Alpha Source: Th-230 @ 12,800 dpm (1/4/12) sn: 4098-03
☐ Beta Source: Tc-99 @ 17,700 dpm (1/4/12) sn: 4099-03

Fluke multimeter serial number: ☐ 8749012
☑ Gamma Source Cs-137 @ 5.2 uCi (1/4/12) sn: 4097-03
☐ Other Source:

Calibrated By: Calibration Date: 10-22-14 Calibration Due 10-22-15
Reviewed By: Date: 10/23/14 10/28/14

ERG Form ITC. 101.A

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997

ERG

Certificate of Calibration

Calibration and Voltage Plateau

Environmental Restoration Group, Inc.
8809 Washington St NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224
www.ERGoffice.com

Meter: Manufacturer: Ludlum Model Number: 2221r Serial Number: 86306

Detector: Manufacturer: Ludlum Model Number: 44-10 Serial Number: PR090262

☑ Mechanical Check ☑ THR/WIN Operation
☑ F/S Response Check ☑ Reset Check
☑ Geotropism ☑ Audio Check
☑ Meter Zeroed ☑ Battery Check (Min 4.4 VDC)
Source Distance: ☐ Contact ☑ 6 inches ☐ Other:
Source Geometry ☑ Side ☐ Below ☐ Other:

HV Check (+/- 2.5%): ☑ 500 V ☑ 1000 V ☑ 1500 V
Cable Length: ☐ 39-inch ☑ 72-inch ☐ Other:

Threshold: 10 mV
Window:

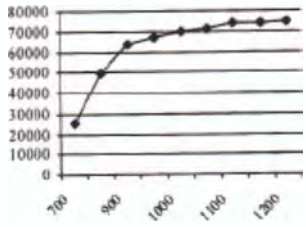
Barometric Pressure: 24.69 inches Hg
Temperature: 76 °F
Relative Humidity: 20 %

Instrument found within tolerance: ☑ Yes ☐ No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count	Log Scale Count
x 1000	400	400	400	399609	400
x 1000	100	100	100		100
x 100	400	400	400	39962	400
x 100	100	100	100		100
x 10	400	400	400	3995	400
x 10	100	100	100		100
x 1	400	400	400	400	400
x 1	100	100	100		100

High Voltage	Source Counts	Background
1050	70926	
1100	73928	
1150	73946	11361
1200	74343	
700	25330	
800	49292	
900	63873	
950	67039	
1000	69580	

Voltage Plateau



Comments: HV Plateau Scaler Count Time = 1-min. Recommended HV = 1150

Reference Instruments and/or Sources:

Ludlum pulser serial number: ☐ 97743 ☑ 201932
☐ Alpha Source: Th-230 @ 12,800 dpm (1/4/12) sn: 4098-03
☐ Beta Source: Tc-99 @ 17,700 dpm (1/4/12) sn: 4099-03

Fluke multimeter serial number: ☐ 8749012
☑ Gamma Source Cs-137 @ 5.2 uCi (1/4/12) sn: 4097-03
☐ Other Source:

Calibrated By:
Reviewed By:

Calibration Date: 10-22-14 Calibration Due 10-22-15

Date: 10/23/14
10/23/14

ERG Form ITC. 101.A

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997

ERG

Certificate of Calibration

Calibration and Voltage Plateau

Environmental Restoration Group, Inc.
8809 Washington St NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224
www.ERGoffice.com

Meter: Manufacturer: Ludlum Model Number: 12 Serial Number: 274087

Detector: Manufacturer: Ludlum Model Number: 43-5 Serial Number: PR204397

☑ Mechanical Check ☑ THR/WIN Operation
☑ F/S Response Check ☑ Reset Check
☑ Geotropism ☑ Audio Check
☑ Meter Zeroed ☑ Battery Check (Min 4.4 VDC)
Source Distance: ☑ Contact ☐ 6 inches ☐ Other:
Source Geometry ☐ Side ☑ Below ☐ Other:

HV Check (+/- 2.5%): ☑ 500 V ☑ 1000 V ☑ 1500 V
Cable Length: ☑ 39-inch ☐ 72-inch | Other:

Threshold: 10 mV
Window:

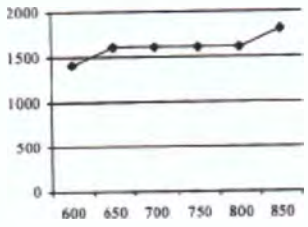
Barometric Pressure: 24.39 inches Hg
Temperature: 70 °F
Relative Humidity: 20 %

Instrument found within tolerance: ☑ Yes ☐ No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count	Log Scale Count
x 1000	400	400	400		
x 1000	100	100	100		
x 100	400	400	400		
x 100	100	100	100		
x 10	400	400	400		
x 10	100	100	100		
x 1	400	400	400		
x 1	100	100	100		

High Voltage	Source Counts	Background
600	1400	
650	1600	
700	1600	2
750	1600	
800	1600	
850	1800	

Voltage Plateau



Comments: HV Plateau Scaler Count Time = 1-min. Recommended HV = 700

Reference Instruments and/or Sources:

Ludlum pulser serial number: ☐ 97743 ☑ 201932
☑ Alpha Source: Th-230 @ 12,800 dpm (1/4/12) sn: 4098-03
☐ Beta Source: Tc-99 @ 17,700 dpm (1/4/12) sn: 4099-03

Fluke multimeter serial number: ☐ 8749012
☐ Gamma Source Cs-137 @ 5.2 uCi (1/4/12) sn: 4097-03
☐ Other Source:

Calibrated By:
Reviewed By:

Calibration Date: 4-16-15 Calibration Due 4-16-16
Date: 4/16/15

ERG Form ITC. 101.A

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997

ERG

Certificate of Calibration

Calibration and Voltage Plateau

Environmental Restoration Group, Inc.
8809 Washington St NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224
www.ERGoffice.com

Meter:	Manufacturer:	Ludlum	Model Number:	2221r	Serial Number:	282961
Detector:	Manufacturer:	Ludlum	Model Number:	44-10	Serial Number:	PR150786

☑ Mechanical Check ☑ THR/WIN Operation
☑ F/S Response Check ☑ Reset Check
☑ Geotropism ☑ Audio Check
☑ Meter Zeroed ☑ Battery Check (Min 4.4 VDC)
Source Distance: ☐ Contact ☑ 6 inches ☐ Other:
Source Geometry: ☑ Side ☐ Below ☐ Other:

HV Check (+/- 2.5%): ☑ 500 V ☑ 1000 V ☑ 1500 V
Cable Length: ☐ 39-inch ☐ 72-inch ☑ Other: Cuoly
Threshold: 10 mV
Window:

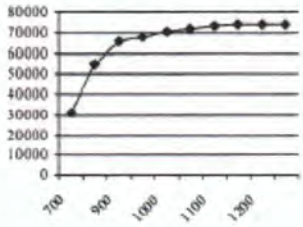
Barometric Pressure: 24.89 inches Hg
Temperature: 70 °F
Relative Humidity: 20 %

Instrument found within tolerance: ☑ Yes ☐ No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count	Log Scale Count
x 1000	400	400	400	398910	400
x 1000	100	100	100		100
x 100	400	400	400	39893	400
x 100	100	100	100		100
x 10	400	400	400	3988	400
x 10	100	100	100		100
x 1	400	400	400	397	400
x 1	100	100	100		100

High Voltage	Source Counts	Background
700	31039	
800	54820	
900	65946	
950	67927	
1000	70337	
1050	71980	
1100	73095	9770
1150	73716	
1200	73648	
1250	74225	

Voltage Plateau



Comments: HV Plateau Scaler Count Time = 1-min. Recommended HV =1100

Reference Instruments and/or Sources:

Ludlum pulser serial number: ☐ 97743 ☑ 201932
☐ Alpha Source: Th-230 @ 12,800 dpm (1/4/12) sn: 4098-03
☐ Beta Source: Tc-99 @ 17,700 dpm (1/4/12) sn: 4099-03

Fluke multimeter serial number: ☐ 87490128
☑ Gamma Source Cs-137 @ 5.2 uCi (1/4/12) sn: 4097-03
☐ Other Source:

Calibrated By:
Reviewed By:

Calibration Date: 25 Nov 16 Calibration Due: 25 Nov 17
Date: 11/28/16

ERG Form ITC. 101.A

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997

ERG

Certificate of Calibration

Calibration and Voltage Plateau

Environmental Restoration Group, Inc.
8809 Washington St NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224
www.ERGoffice.com

Meter: Manufacturer: Ludlum Model Number: 2221r Serial Number: 138368

Detector: Manufacturer: Ludlum Model Number: 44-10 Serial Number: PR154615

☑ Mechanical Check ☑ THR/WIN Operation
☑ F/S Response Check ☑ Reset Check
☑ Geotropism ☑ Audio Check
☑ Meter Zeroed ☑ Battery Check (Min 4.4 VDC)

HV Check (+/- 2.5%): ☑ 500 V ☑ 1000 V ☑ 1500 V
Cable Length: ☐ 39-inch ☑ 72-inch ☐ Other:

Source Distance: ☐ Contact ☑ 6 inches ☐ Other:
Source Geometry: ☑ Side ☐ Below ☐ Other:

Threshold: 10 mV
Window:

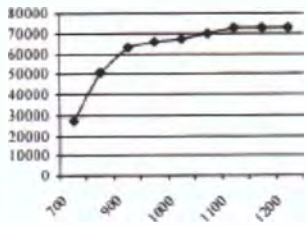
Barometric Pressure: 24.78 inches Hg
Temperature: 74 °F
Relative Humidity: 20 %

Instrument found within tolerance: ☑ Yes ☐ No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count	Log Scale Count
x 1000	400	400	400	398436	400
x 1000	100	100	100		100
x 100	400	400	400	39845	400
x 100	100	100	100		100
x 10	400	400	400	3984	400
x 10	100	100	100		100
x 1	400	400	400	399	400
x 1	100	100	100		100

High Voltage	Source Counts	Background
700	26998	
800	51037	
900	63340	
950	65550	
1000	67410	
1050	70113	
1100	72217	
1150	72561	9216
1200	72337	

Voltage Plateau



Comments: HV Plateau Scaler Count Time = 1-min. Recommended HV = 1150

Reference Instruments and/or Sources:

Ludlum pulser serial number: ☐ 97743 ☑ 201932
☐ Alpha Source: Th-230 @ 12,800 dpm (1/4/12) sn: 4098-03
☐ Beta Source: Tc-99 @ 17,700 dpm (1/4/12) sn: 4099-03

Fluke multimeter serial number: ☐ 87490128
☑ Gamma Source Cs-137 @ 5.2 uCi (1/4/12) sn: 4097-03
☐ Other Source:

Calibrated By: Calibration Date: 7-6-16 Calibration Due: 7-6-17

Reviewed By: Date: 7/20/16

ERG Form ITC. 101.A

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997

ERG

Certificate of Calibration

Calibration and Voltage Plateau

Environmental Restoration Group, Inc.
8809 Washington St NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224
www.ERGoffice.com

Meter: Manufacturer: Ludlum Model Number: 2221r Serial Number: 218563

Detector: Manufacturer: Ludlum Model Number: 44-10 Serial Number: PR150851

☑ Mechanical Check ☑ THR/WIN Operation
☑ F/S Response Check ☑ Reset Check
☑ Geotropism ☑ Audio Check
☑ Meter Zeroed ☑ Battery Check (Min 4.4 VDC)

HV Check (+/- 2.5%): ☑ 500 V ☑ 1000 V ☑ 1500 V
Cable Length: 39-inch ☑ 72-inch Other:

Source Distance: Contact ☑ 6 inches Other:
Source Geometry: ☑ Side Below Other:

Threshold: 10 mV
Window:

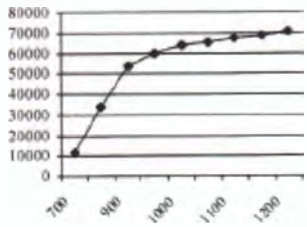
Barometric Pressure: 24.51 inches Hg
Temperature: 74 °F
Relative Humidity: 20 %

Instrument found within tolerance: ☑ Yes No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count	Log Scale Count
x 1000	400	400	400	399802	400
x 1000	100	100	100		100
x 100	400	400	400	39987	400
x 100	100	100	100		100
x 10	400	400	400	3998	400
x 10	100	100	100		100
x 1	400	400	400	400	400
x 1	100	100	100		100

High Voltage	Source Counts	Background
700	11246	
800	33904	
900	53843	
950	59637	
1000	63641	
1050	65147	
1100	66831	
1150	68228	9797
1200	70822	

Voltage Plateau



Comments: HV Plateau Scaler Count Time = 1-min. Recommended HV = 1150

Reference Instruments and/or Sources:

Ludlum pulser serial number: 97743 ☑ 201932 Fluke multimeter serial number: 87490128
Alpha Source: Th-230 sn: 4098-03@12,800dpm/6,520 cpm (1/4/12) ☑ Gamma Source Cs-137 @ 5.2 uCi (1/4/12) sn: 4097-03
Beta Source: Tc-99 sn: 4099-03@17,700dpm/11,100cpm(1/4/12) Other Source:

Calibrated By: Calibration Date: 5-1-17 Calibration Due: 5-1-18

Reviewed By: Date: 5/1/17

ERG Form ITC. 101.A

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
501 Oak Street, Sweetwater, TX 79556, U.S.A. 325-235-5494
10744 Dutchtown Road, Knoxville, TN 37932, U.S.A. 865-392-4601

CUSTOMER ERG ORDER NO. 20301042/443117

Mfg Ludlum Measurements, Inc. Model 19 Serial No. 221661

Mfg Model Serial No.

Cal. Date 29-Nov-16 Cal Due Date 29-Nov-17 Cal. Interval 1 Year Meterface 202-1070

Check mark applies to applicable instr. and/or detector IAW mfg. spec. T. 73 °F RH 29 % Alt 698.0 mm Hg

☐ New Instrument Instrument Received ☑ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☐ Input Sens. Linearity
☑ F/S Resp. ck. ☑ Reset ck. ☐ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 2.2 VDC
☐ Calibrated in accordance with LMI SOP 14.8 ☑ Calibrated in accordance with LMI SOP 14.9

Instrument Volt Set 525 V Input Sens. 27 mV Det. Oper. V at mV Threshold Dial Ratio = mV

☑ HV Readout (2 points) Ref./Inst. 500 / 500 V Ref./Inst. 1000 / 984 V

COMMENTS:

Gamma Calibration. GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
5000	4000 µR/hr	4000	4000
5000	1000 µR/hr	1000	1000
500	400 µR/hr = 72000 cpm	400	400
500	100 µR/hr	100	100
250	200 µR/hr = 36000 cpm	210	200
250	100 µR/hr	105	100
50	7200 cpm	40	40
50	1800 cpm	10	10
25	3600 cpm	20	20
25	900 cpm	5	5

*Uncertainty within ± 10% C.F. within ± 20%

50, 25 **Range(s) Calibrated Electronically**

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout				Log Scale			

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources: Cs-137 S/N: ☐ 059 ☐ 2171CP ☐ 2261CP ☐ 720 ☐ 734 ☑ 781 ☐ 1131 ☐ 1616 ☐ 1696 ☐ 1909 ☐ 1916CP ☐ 2324/2521
☐ 5717CO ☐ 5719CQ ☐ 60646 ☐ 70697 ☐ 73410 ☐ E552 ☐ G112 ☐ 2168CP ☐ S-394 ☐ S-1064 ☐ T10261 ☐ T10262 Neutron Am-241 Be ☐ T-304 Ra-226 ☐ Y962

☐ Alpha S/N ☐ Beta S/N ☐ Other

☑ m 500 S/N 251106 ☐ Oscilloscope S/N ☑ Multimeter S/N 15060230

Calibrator James McBeth Title Calibrator Date 29NOV16

QC'd By Title Date 29 NOV 16

This certificate shall not be reproduced except in full without written approval of Ludlum Measurements, Inc.
FORM C21A 07/25/2016 Page 1 of 1

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed

APPENDIX B

Attachment B1 (Analytical Laboratory Data Reports on CD)

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